6

GROUNDWATER

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6.1 Background

South Africa is mainly reliant on surface water with over 33 billion m^3 total gross storage capacity, from 5 551 registered dams. While the total groundwater recharge for South Africa is estimated to be over 34 billion m^3/a. Groundwater refers to the water in saturated layers or zones below the land surface. The maximum national potential for accessible groundwater, is approximately 4.5 billion m^3/a; of which only 3.2 billion m^3/a is being utilised. Hence, groundwater is a strategic resource in many parts of South Africa, especially in rural areas. It plays an important role in the supply of water to small towns and villages in the drier parts of the country. Discharges or outflows of groundwater sustain springs and river flows in the dry season. Sustained river flows are important as they support people and communities who depend directly on rivers for their water, particularly during the dry season and droughts. There is considerable potential for additional development of groundwater resources to augment existing resources. The need for improved groundwater management to ensure sustainable and efficient use of the resource was first recognised in the National Water Resource Strategy-1 and led to the formulation of a National Groundwater Strategy through which strategic actions were undertaken.

South Africa is experiencing increasing water scarcity mainly due to its semi-arid climatic location coupled with its growing population, urbanisation, and climate change. Surface water, the traditional bulk supply source, is becoming unreliable and unavailable in some parts of the country. The costs of piping water from dams to supply the water needs of 59 million people are becoming increasingly challenging to meet. Groundwater is vital in sustaining water security and contributing to the water mix to augment conventional resources.

6.1.1 Groundwater Strategic Water Source Area

South Africa’s water supply is dependent on Strategic Water Source Areas (SWSAs). SWSAs are defined as areas of land of national importance that either: (a) supply relatively large quantities of mean annual surface water runoff compared to their size or (b) have high groundwater recharge and high dependence or (c) areas that meet both criteria (a) and (b). All surface water SWSAs are located in high rainfall areas where baseflow is at least 1 125 mm/a, which is evidence of a strong link between groundwater and surface water in the SWSAs. The water produced by these areas supports at least 50% of the population, 64% of the economy, and supplies about 70% of the water used by irrigated agriculture. Gauteng gets about 65% of its water from these areas, and Cape Town and eThekwini about 98%. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa. These SWSAs supply about 46% of the groundwater used by agriculture and 47% of the groundwater used for industrial purposes in South Africa.

There are 37 national groundwater Strategic Water Source Areas (Gw-SWSA), which cover around 9% of the land surface of South Africa. They account for up to 42% of the river baseflow generated by these water source areas and have a key role in sustaining surface water flows during the dry season. The total groundwater recharge for South Africa is estimated to be 34 912 million m^3/a. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa. These SWSAs supply about 46% of the groundwater used by agriculture and 47% of the groundwater used for industrial purposes in South Africa.

6.2 Groundwater Level Status

The DWS has over 1800 active groundwater level monitoring sites across the country. The frequency of the data collection varies, some are monthly, while others are bi-monthly, quarterly, or bi-annual. Groundwater level fluctuations are influenced by recharge, discharge and water abstractions. Recharge naturally comes from rain and can also be artificial. Depth to water table is a dynamic, not static value, shallow water tables, usually fluctuate annually in response to wet season recharge and dry season depletion. The rate of depletion is a combination of natural and manmade factors. Groundwater resources are significantly stressed when abstractions exceed recharge, which usually takes place during drought. Water-level measurements provide insight into the physical properties that control aquifer recharge, storage, and discharge.

The groundwater level is presented as a percentage of the groundwater level status (GwLS). The historical groundwater level monitoring record is per borehole to ensure a constant point of reference. The GwLS of the geosites is averaged within the topo-cadastral 1:50 000 map sheet grid. The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of the relative water level over time.

The GwLS approach allows the comparison of groundwater level data of any geosite/borehole on the same scale.

Figure 6.1 shows GwLS for the month of September 2023 and the available data at the time of reporting. GwLS average greater than 60% dominates over level below 25%, indicating another year of adequate recharge from above-normal rainfall received for almost all parts of South Africa, apart from some isolated parts in Northern Cape as reported in Chapter 3. 2023 marks a third consecutive year of above-normal annual rainfall, which significantly improved groundwater levels (Figure 6.2).

There is a need for groundwater data collaborations whereby DWS can include all locally collected data from key water sector institutions like local municipalities and the South African Environmental Observation Network (SAEON).

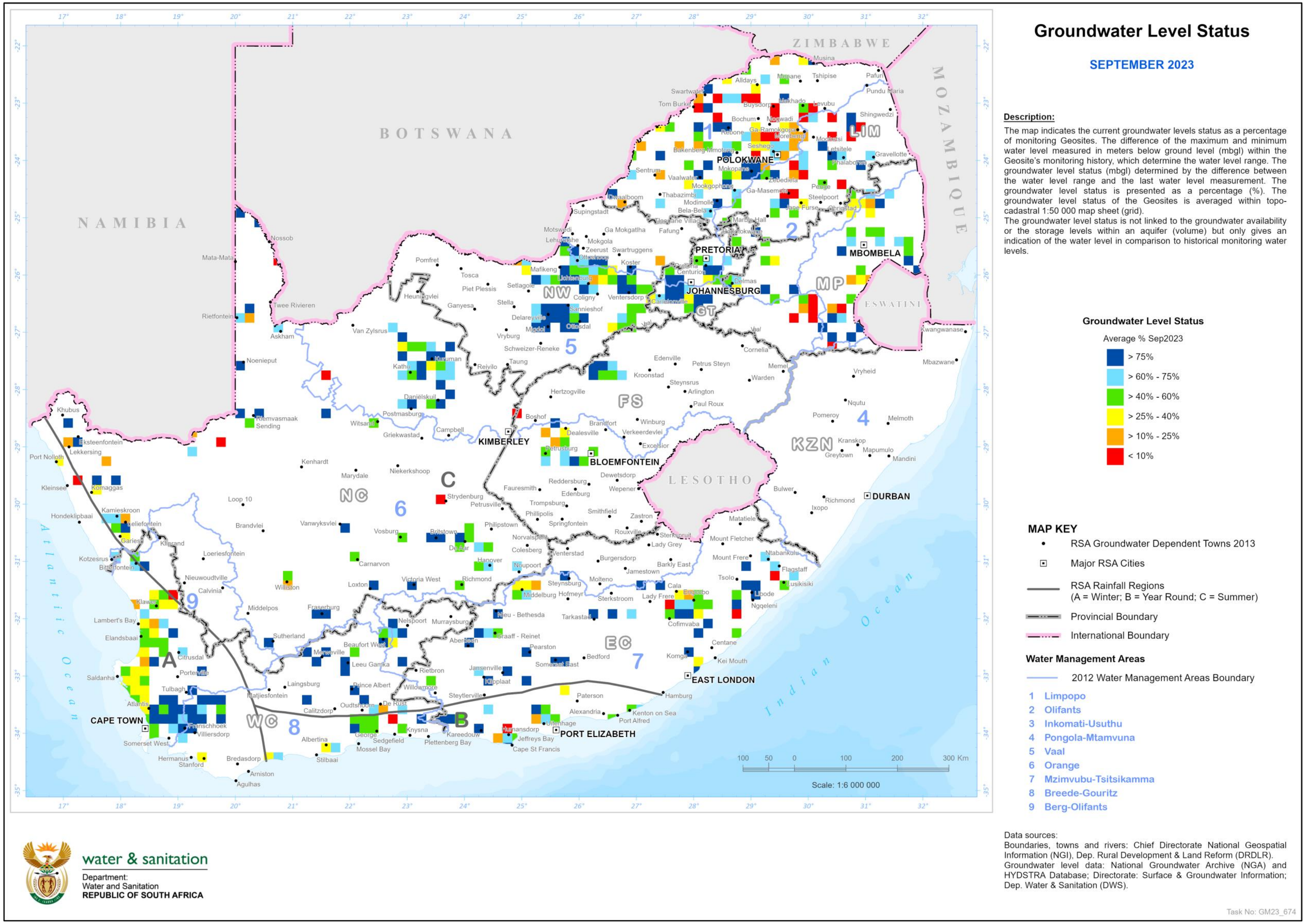

Figure 6.1 Groundwater Level Status Map – September 2023

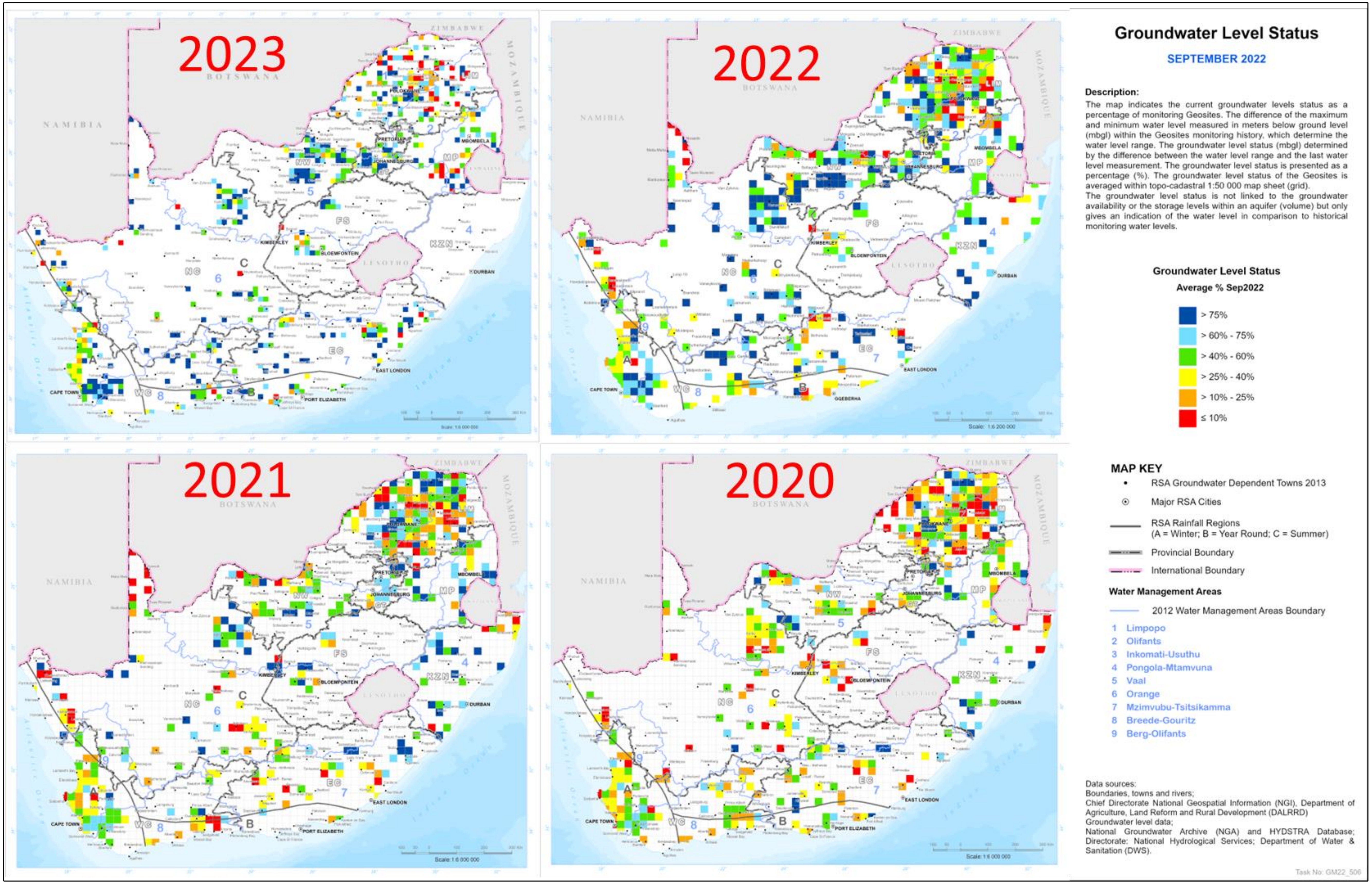

Figure 6.2: Groundwater Level Status comparison – past four hydrological years.

The impact of groundwater over-abstraction during drought can be presented by its severity on the groundwater resource (average groundwater level status). There are seven percentile ranges used to classify GwLS. The average GwLS is presented against the percentiles of the historical groundwater levels Figure 6.3.

The graph provides a visual presentation to alert of drought conditions. Restrictions on groundwater abstraction can be implemented timeously before any negative impacts occur. Each grouping of boreholes will have a different severity range.

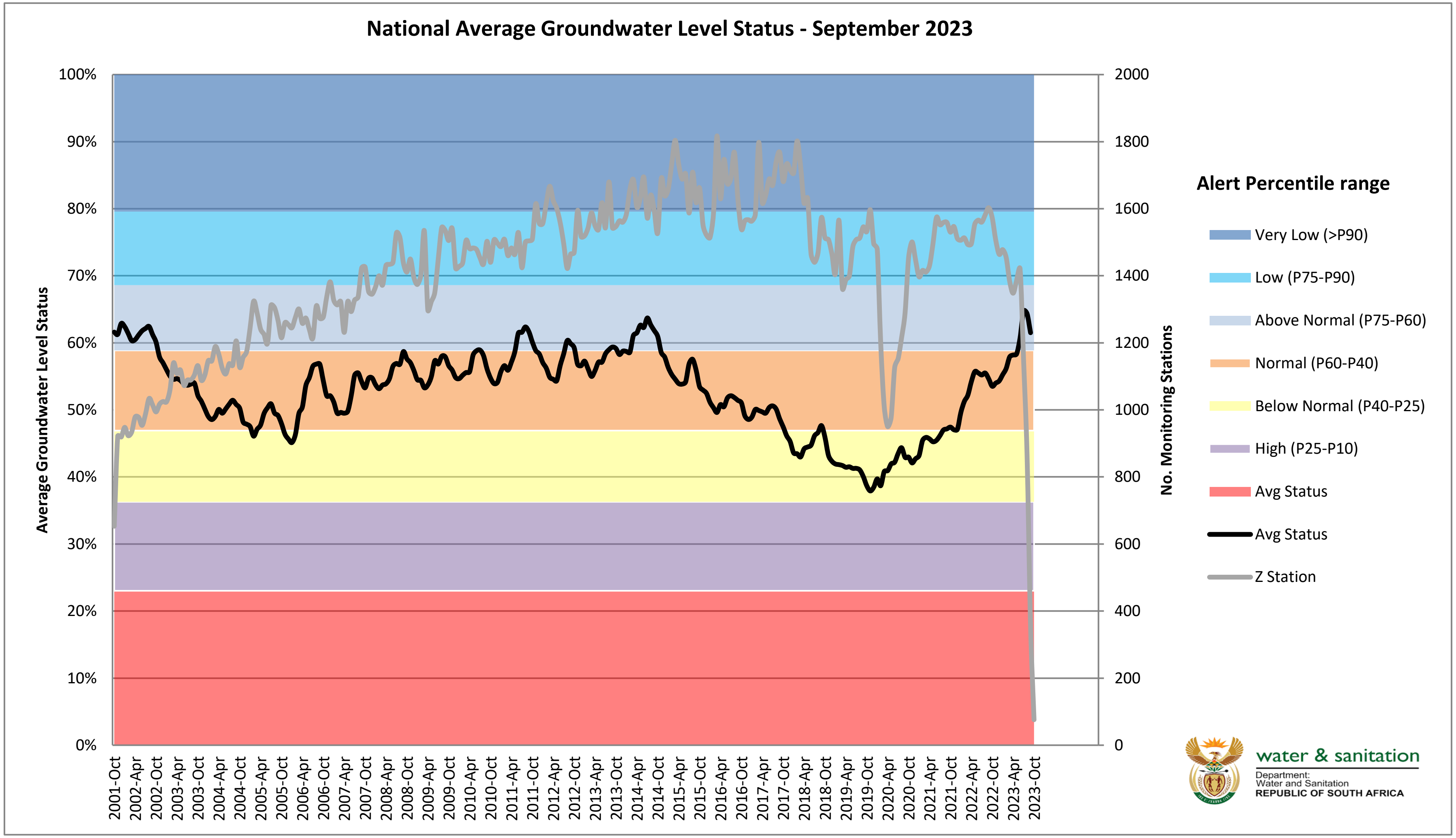

Figure 6.3: National Average Long Term Groundwater Level Status

The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of water level based on individual geosite's entire historical groundwater level monitoring record.

The national average groundwater level status indicates a recovery trend from below normal in 2019 to above normal at the end of September 2023 (Figure 6.3). This can be attributed to the above-normal rainfall received in the current and previous years, which has significantly recharged aquifers, now showing above-normal percentile levels. At levels below normal, restrictions on groundwater abstraction can be implemented to stabilise groundwater levels and mitigate risks of groundwater depletion.

6.3 Groundwater Quality Status

The frequency of the data collection is bi-annual, before rainfall (September/October) and after rainfall (April/May). In addition to these national stations, we have the Acid Mine Drainage (ADM) special monitoring programme, located at the CoH-WHS, where monitoring frequency is four times a year. The collected data is archived on WMS and the National Groundwater Archive (NGA).

The most noticeable element of concern for groundwater quality in South Africa is nitrate measured as nitrogen (N), with some exceedances observed for fluoride. Nitrate is a known persisting problem and has been flagged by Marais (1999) as the single most common reason for groundwater sources to be declared unsuitable for drinking in South Africa. High nitrate concentration in drinking water is a major health risk for bottle-fed infants, it causes methaemoglobinaemia also known as "blue-baby syndrome".

Relatively high groundwater nitrate concentrations are found in some parts of South Africa, particularly the Limpopo and Vaal WMAs (Figure 6.4). Fluoride concentrations higher than 1.5 mg/L are found in the Limpopo WMA mainly associated with geothermal springs (Figure 6.5). The spatial Electrical Conductivity (EC) data shows higher salinity dominating the following WMAs: Limpopo, Vaal, Mzimvubu-Tsitsikamma; and Berg-Olifants (Figure 6.6). Evidently, the Limpopo WMA has nitrate, Fluoride and EC water quality concerns. Groundwater in Limpopo and North West plays a significant role in the water supply regime, together the two provinces have the most Groundwater Strategic Water Sources Areas (Gw-SWSAs). Gw-SWSAs provide water to 126 towns and rural supply schemes. Key regional centres that are highly dependent on groundwater are: Mafikeng with >75%, Lichtenburg >50%, Giyani >26% and Polokwane >11% (Le Maitre et al.2018).

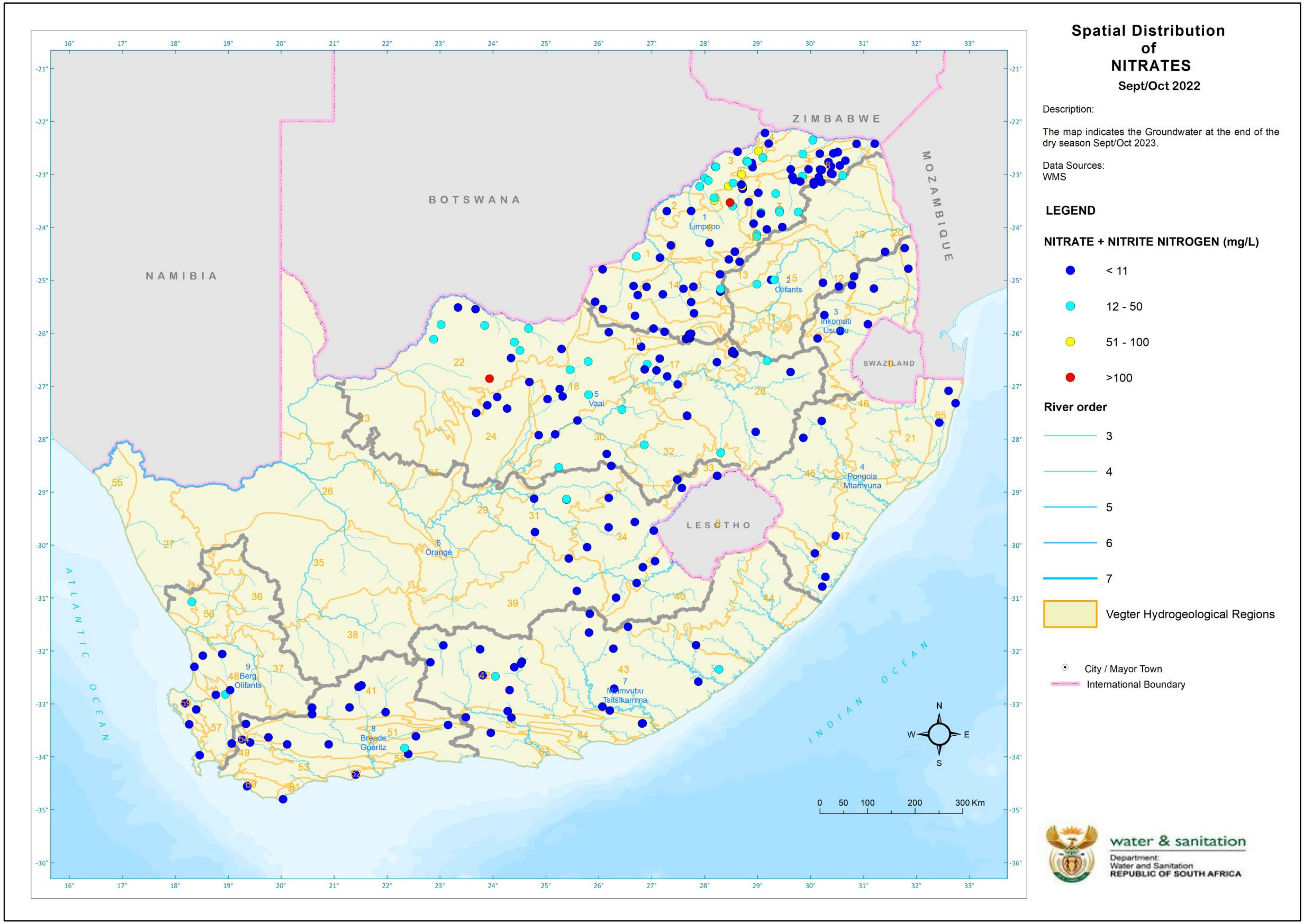

Figure 6.4: Spatial distribution of nitrate in groundwater Sept/Oct 2022.

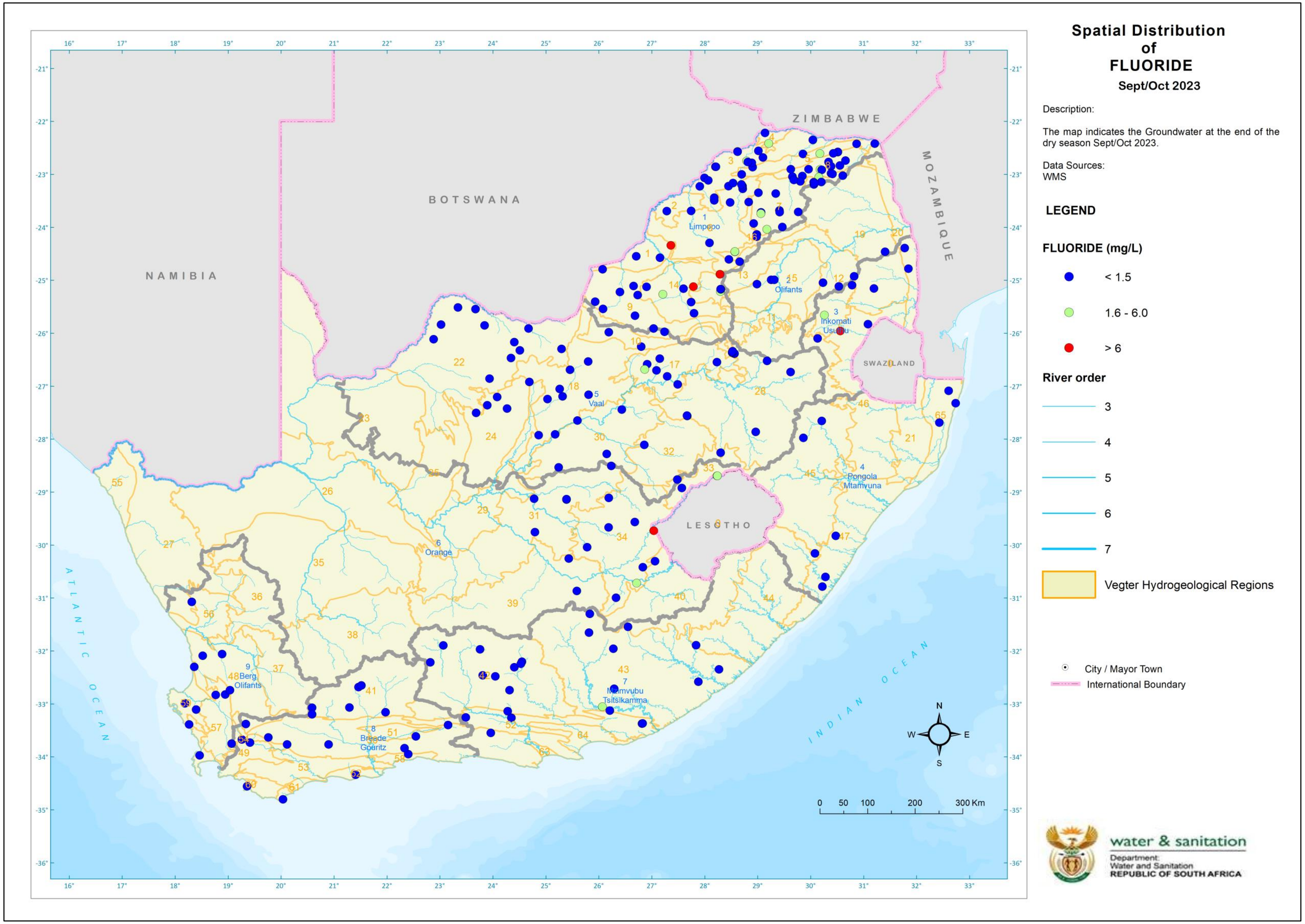

Figure 6.5: Spatial distribution of Fluoride in groundwater Sept/Oct 2022.

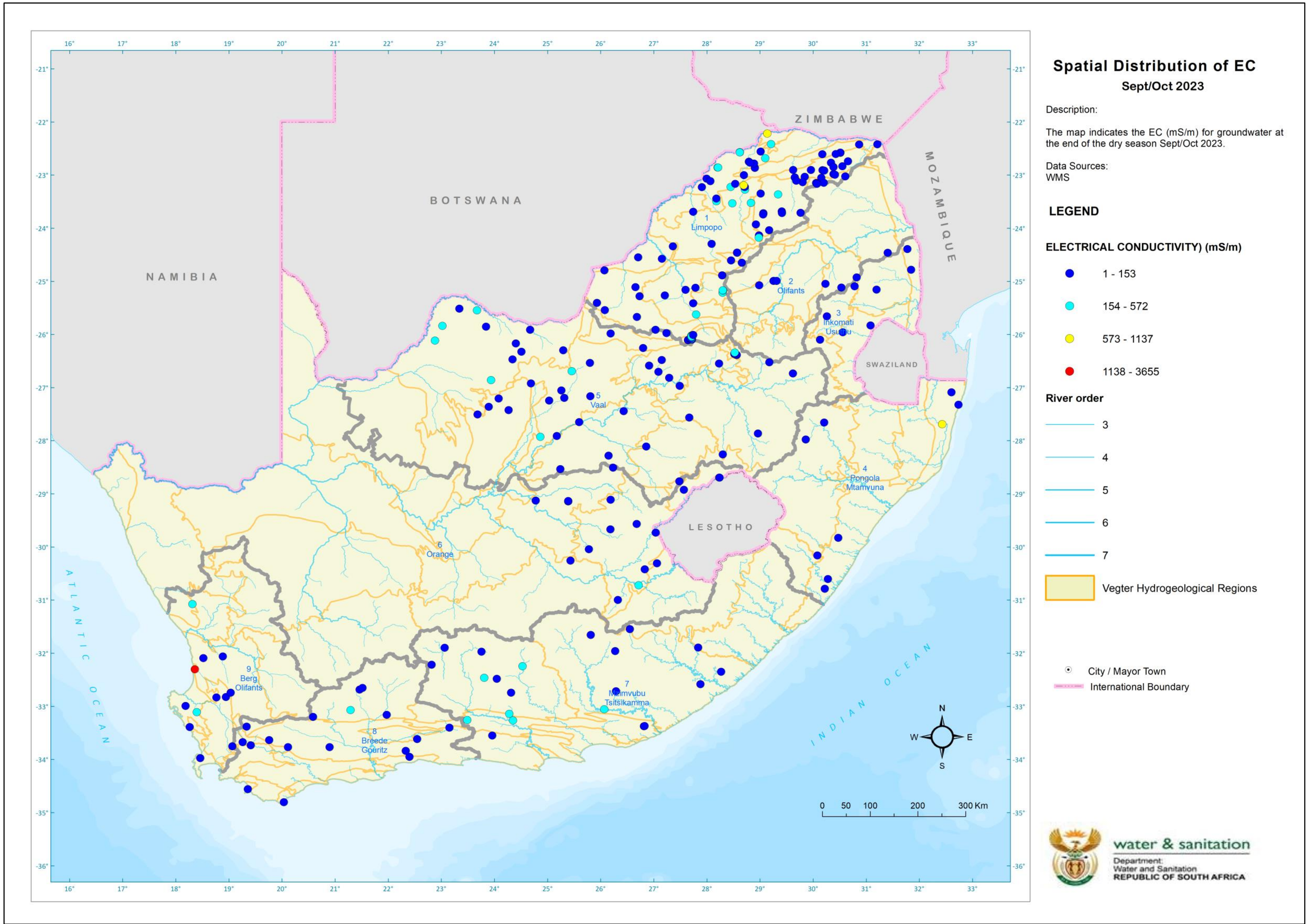

Figure 6.6: Spatial distribution of EC in groundwater Sept/Oct 2022.

6.3.1 Nitrate hotspots.

The results from the two monitoring runs continue to raise a flag on the persisting nitrate pollution status of the groundwater in Limpopo and North West Provinces. The groundwater monitoring sites with the highest nitrate concentrations in 2022/23 are listed on (Table 6-1) and the trend over time is presented in Figure 6.7. Two borehole sites ZQMGYA2 from North West and ZQMGMI1 from Limpopo anomalously crossed the 110 mg/L levels for the first time since monitoring started. Other monitoring sites that had anomalous record high include, ZQMMGE1, ZQMKHK2, ZQMBGG1, and ZQMSWW1, ZQMPPI1. These new record high levels of nitrate maybe indicative of impacts of land use activities polluting groundwater at a fast rate.

The Department is compelled to react to these new record-high figures, more research is required to study these anomalies plus, more innovative groundwater protection and remediation options need to be explored. Currently available, easy efficient methods for the reduction of nitrate ions in groundwater to the acceptable levels, is blending polluted water with pollution-free surface water. The other reduction methods such as electrodialysis, ion exchange or biological processes are costly and not always efficient (Bohdziewicz et al., 1999).

Authorities need to raise awareness and help mothers protect their bottle-fed infants from nitrate-polluted water. Education about the dangers of excessively boiling nitrate-polluted water for bottle-fed babies should be a priority during prenatal, and postnatal classes at the local clinics.

Table 6-1: Monitoring sites with the highest nitrate concentrations 2022/23

Monitoring Site	2022 mg/L	2023 mg/L	Province, Village	Comment
ZQMGYA2	109	**130**	NW, Ganyesa	Record high
ZQMGMI1	103	**125**	LP, Ga- Musi	Record high
ZQMMGE1	**93**	86	LP, Darling	Record high
ZQMKHK2	65	**92**	LP, Kramhoek	Highest Sept-2000
ZQMBGG1	**90**	n/a	LP, Bangalong	Record high
ZQMSWW1	23	**86**	LP, Dassenberg	Record high
ZQMPPI1	**78**	n/a	LP, Papegaai	Highest Sept-2017
ZQMBLT3	18	**76**	LP, Baltimore	Record high
ZQMBLT2	**73**	16	LP, Baltimore	Record high
ZQMSMA1	12	**69**	LP, Semenya	Record high
ZQMKLH1	13	**67**	NW, Radnor	Record high

Bold: highest value.

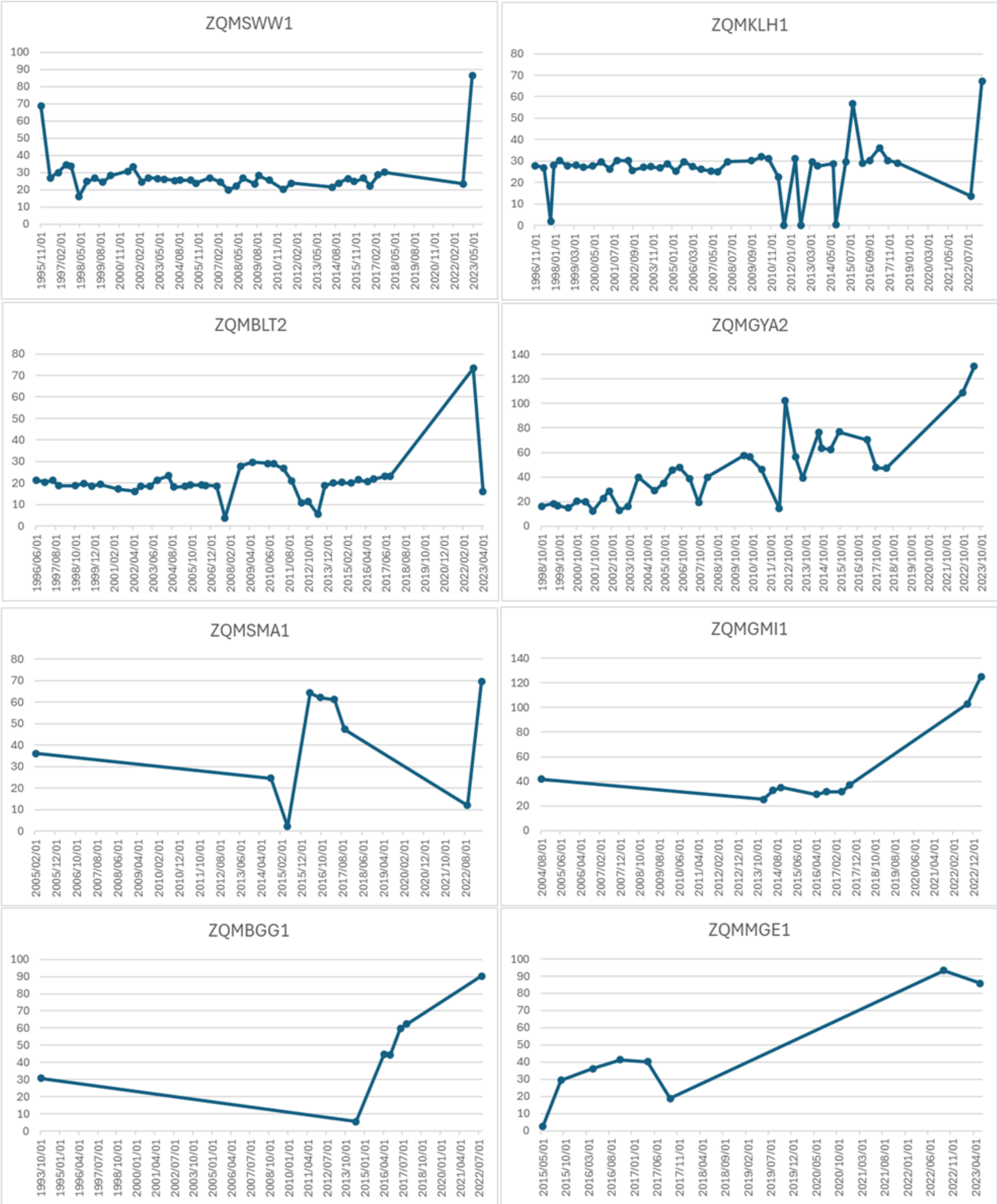

Figure 6.7: Nitrate concentrations of flagged monitoring sites.

6.4 Groundwater Use Per Economic Sector

Water Use Authorisation and Registration Management System (WARMS) data shows over 3 232 million m^3 groundwater is abstracted per annum. Figure 6.8 is a percentage pie chart illustrating national groundwater use per economic sector for 2023. Three sectors dominate groundwater use volumes, with over 55% (1 788 Mm^3/a) of the abstracted groundwater goes to irrigation, while 21% (677 Mm^3/a) goes to mining and 11% (340 Mm^3/a) goes to water supply. The balance 13% (424 Mm^3/a) goes to other minor users such as aquiculture, livestock, schedule 1, industry, urban, power generation and recreation.

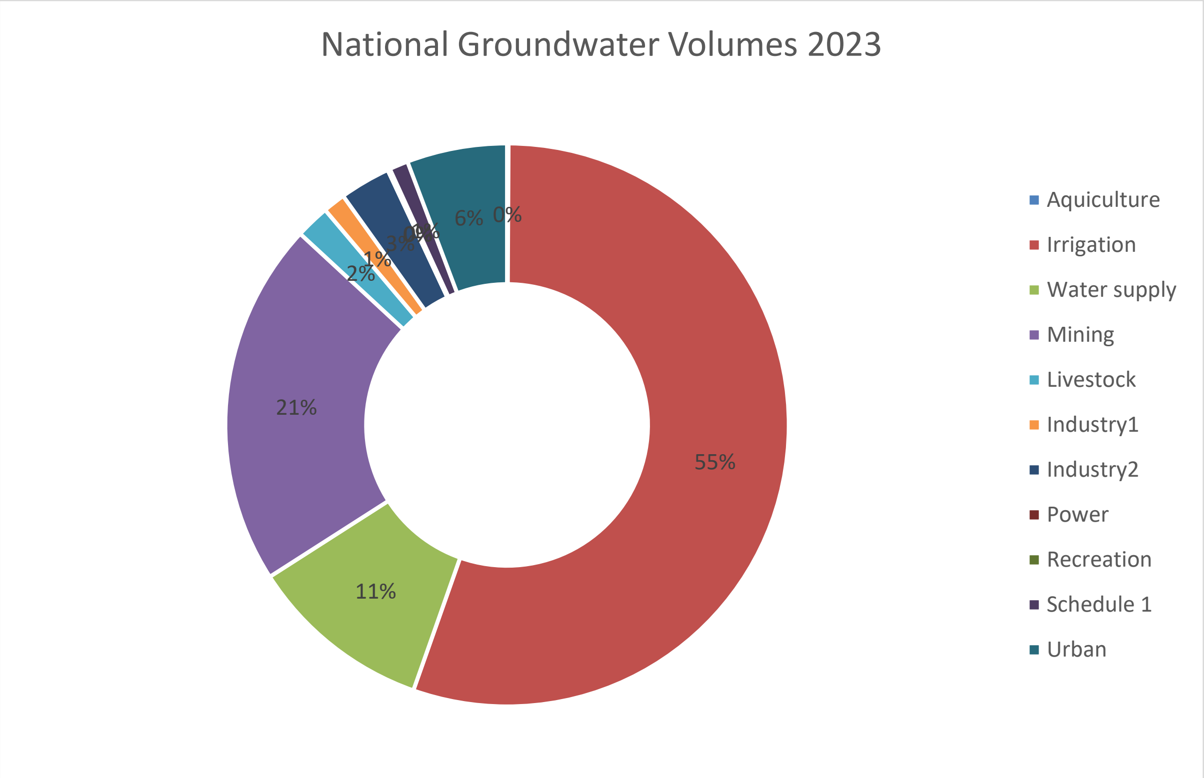

Figure 6.8: Groundwater use per economic sector 2023.

There are two WMAs dominating the irrigation groundwater use volumes, with over 51%, are Limpopo (30%) and Vaal (21%) (Figure 6.9). Groundwater plays a significant role in food security and water supply in rural communities of Limpopo and Eastern Cape. For the mining sector, groundwater mainly goes to three WMAs, Olifants (41%), Vaal (36%) and Limpopo (19%) (Figure 6.10). The Olifants WMA covers a significant part of Mpumalanga where there are mainly coal and platinum mines in operation. The Vaal WMA covers mining operations located in Free State, Gauteng, North West and Northern Cape. The Limpopo WMA covers platinum mining operations mainly located in the North West.

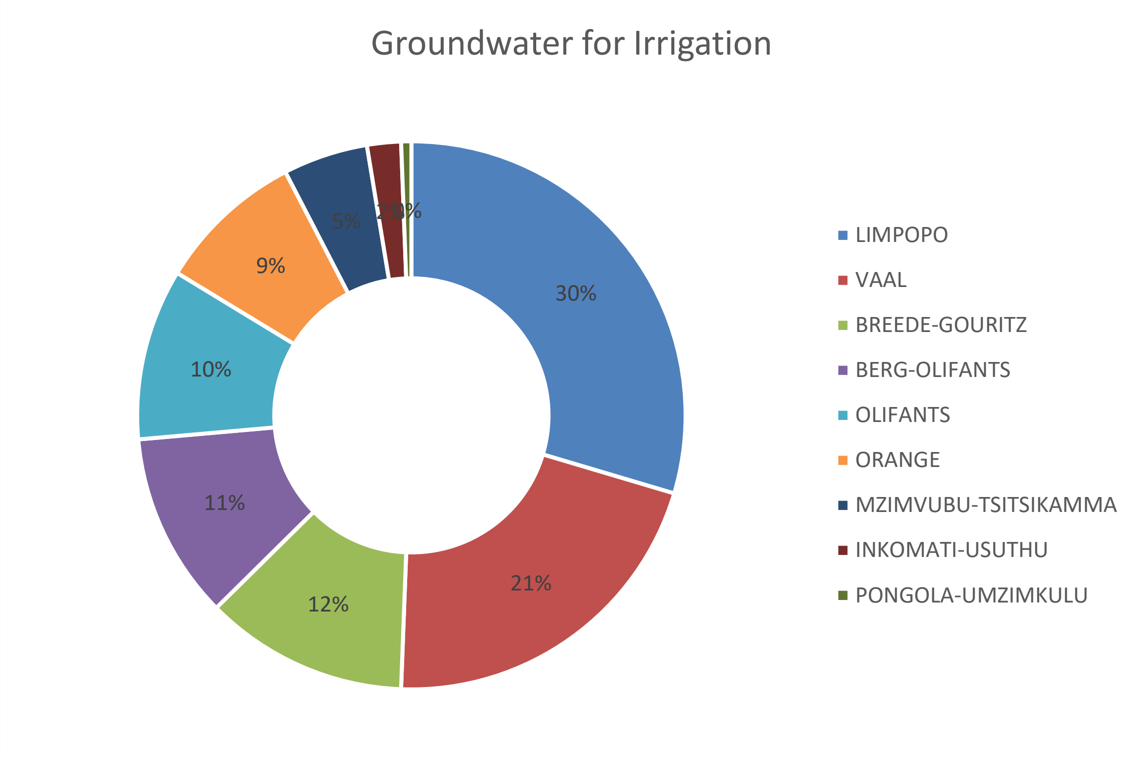

Figure 6.9: Groundwater for irrigation, per Water Management Area.

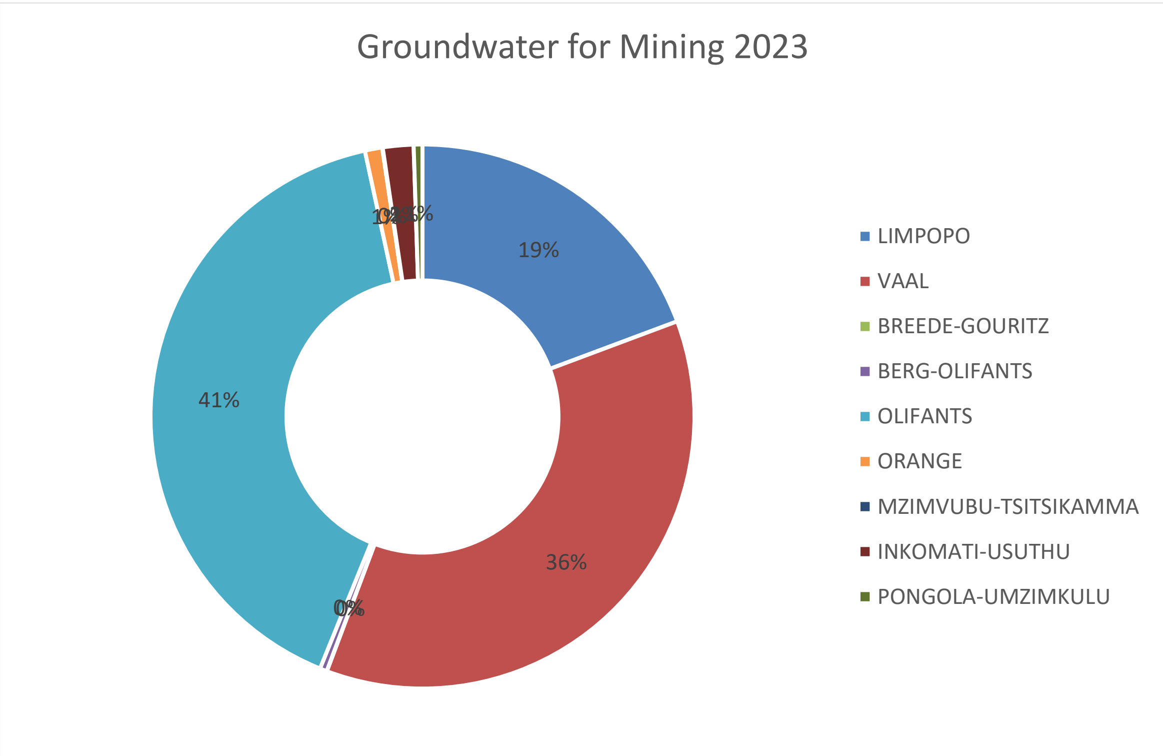

Figure 6.10: Groundwater for Mining, per Water Management Area.