6

GROUNDWATER

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6.1 Background

Groundwater is water in saturated layers or zones below the land surface. While South Africa mainly relies on surface water with over 33 billion m^3 total gross dam storage capacity, the total groundwater recharge for South Africa is estimated to be over 34 billion m^3/a. 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. Although groundwater is underutilised, it 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. Groundwater services between 52% and 82% of community water-supply schemes in the Eastern Cape, Limpopo, Northern Cape, North West and KwaZulu-Natal.

Discharges or outflows of groundwater sustain springs and river flows during dry seasons. Sustained river flows are important as they support people and communities who depend directly on rivers for their water, particularly during the dry seasons 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 conditions, 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. Hence, groundwater is vital in sustaining water security and contributing to the water mix to augment conventional resources.

6.2 Groundwater Strategic Water Source Areas

South Africa's water supply is dependent on Strategic Water Source Areas (SWSAs). SWSAs are natural water source areas that supply disproportionately large volumes of water per unit area. These areas are strategically significant for water security from a national planning perspective, either for surface water,groundwater, or both. Groundwater SWSAs are areas of land of national importance that have high groundwater recharge and high dependence.

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. These groundwater SWSAs supply about 46% of the groundwater used by agriculture and 47% for industrial purposes in South Africa.

There are 37 national groundwater SWSA, which cover around 9% of the land surface of South Africa. National groundwater SWSAs contribute around 42% to baseflow 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, with 15% (5,397 million m^3/a) contributed by groundwater SWSAs. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa.

The inputs to the groundwater sections below came from the Directorate: National Hydrological Services.

6.3 Groundwater Level Status

Groundwater level fluctuations are influenced by recharge, discharge, and water abstractions. Recharge naturally comes from rain and can also be artificial. Depth to the water table is dynamic and usually fluctuates short and long-term in response to seasonal precipitation patterns. The rate of depletion is a combination of natural and manmade factors. Groundwater resources are significantly stressed when abstractions exceed recharge, usually during drought. Water-level measurements provide insight into the physical properties that control aquifer recharge, storage, and discharge. The Department has over 1,800 active groundwater level monitoring sites nationwide. The frequency of the data collection varies; some are monthly, while others are bi-monthly, quarterly, or bi-annual.

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 (Figure 6.1). The average GwLS is presented against the percentiles of the historical groundwater levels. The graph was created by D: Water Resource Management Planning. It paints a visual picture used to raise a drought condition warning. Restrictions on groundwater abstraction can be implemented promptly before any negative impacts occur. Each grouping of boreholes has a different severity range. The average groundwater level status as of September 2024 shows normal percentile groundwater levels (green), which is lower compared to the same time in 2023, when the levels were above normal (light blue). However, it must be noted that the number of stations used for September 2024 levels is 1099 (61%).

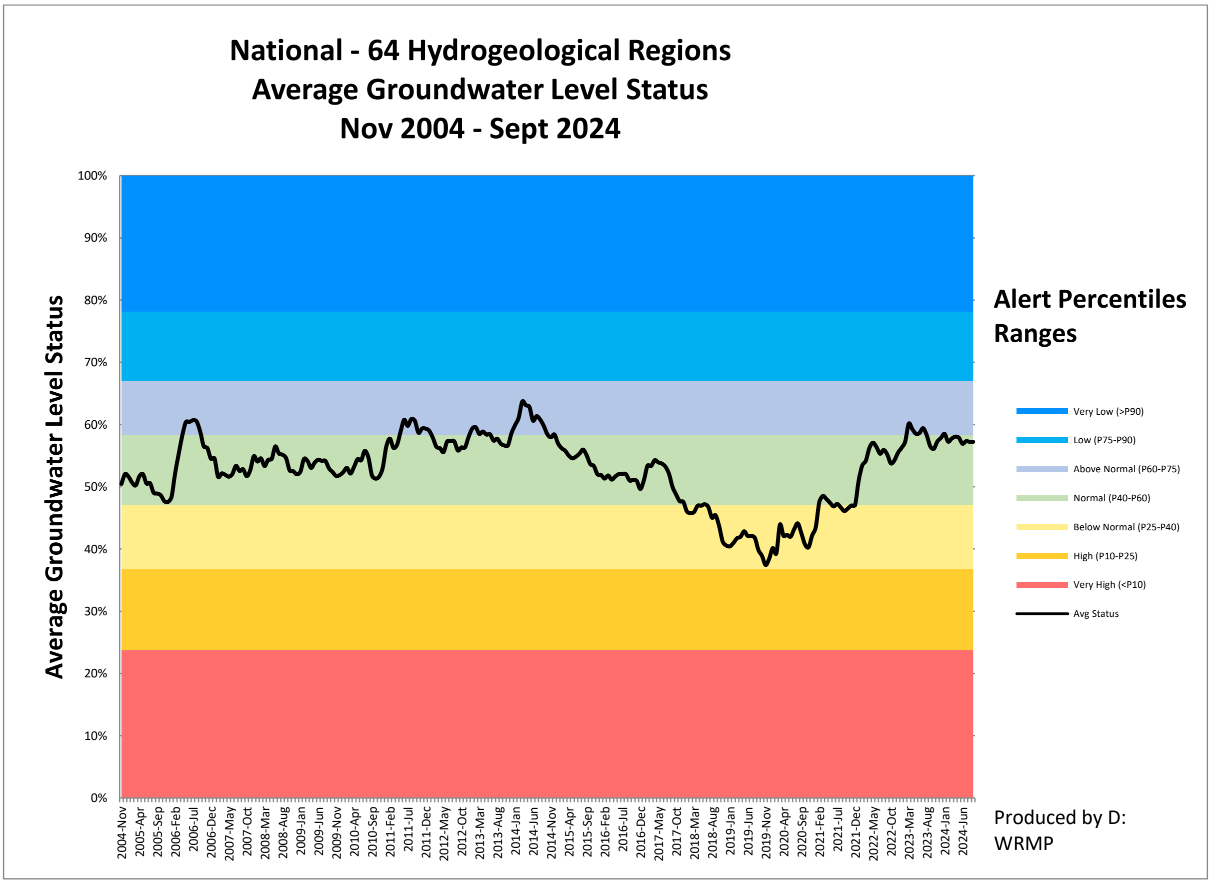

Figure 6.1: National Average Long-Term Groundwater Level Status (data extracted January 2025).

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 for the comparison of groundwater level data of any geosite on the same scale. Figure 6.2 shows GwLS for September 2023. GwLS average greater than 60% dominates over levels below 25%. Spatially, the southwest parts of the country, which received winter rainfall, have better levels dominated by the blues and green. Meanwhile, the rest of the country is dominated by the orange-yellows-red levels. Overall, the colours indicate another year of adequate recharge from above-normal rainfall received for almost all parts of South Africa, apart from some isolated parts in the Northern Cape as reported in Chapter 3. Compared to the previous three hydrological years, the end of the 2023/24HY water level spatial data shows groundwater levels are replenished by the annual rainfall received in 2024 (Figure 6.3).

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).

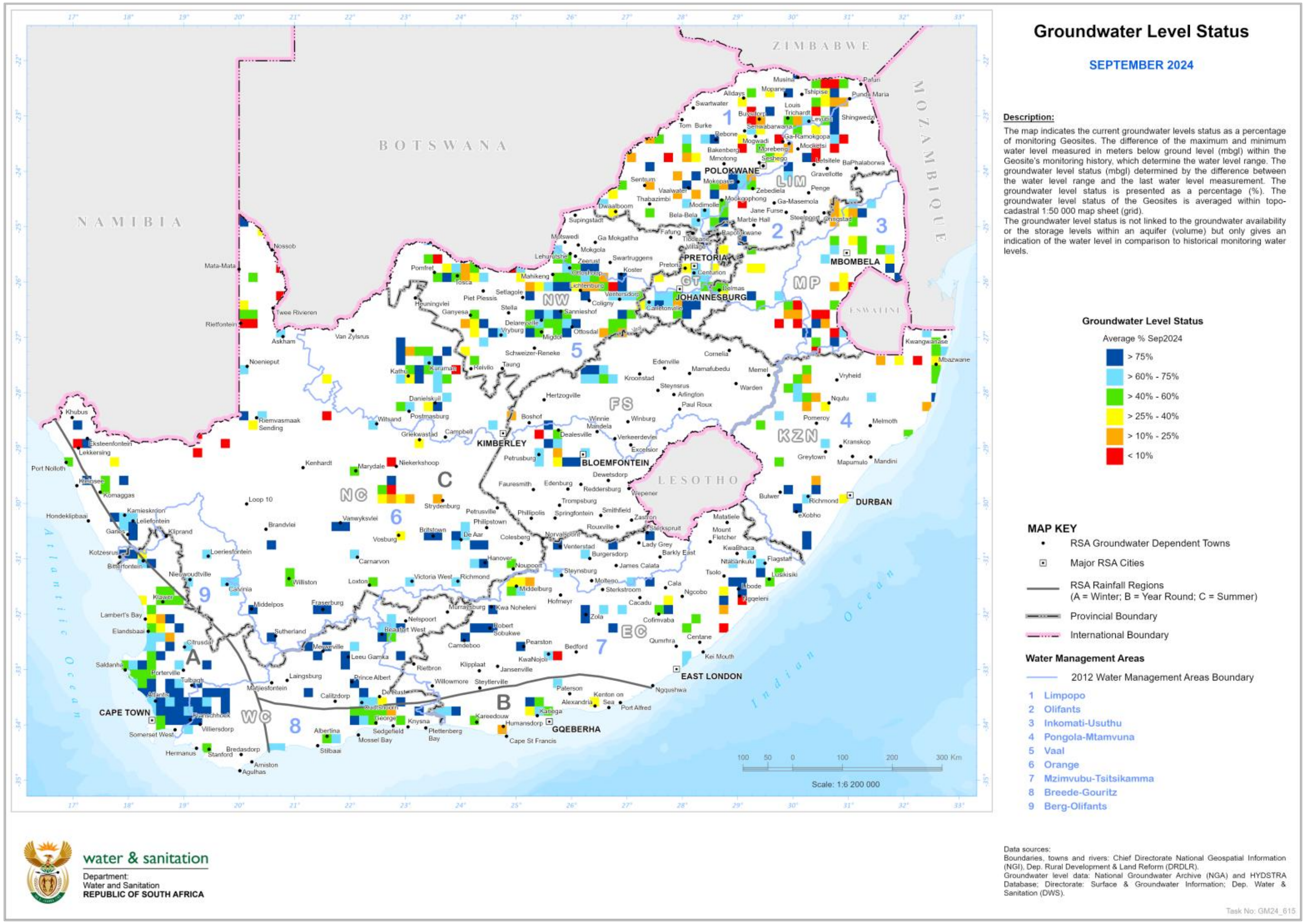

Figure 6.2: Groundwater Level Status Map – September 2024.

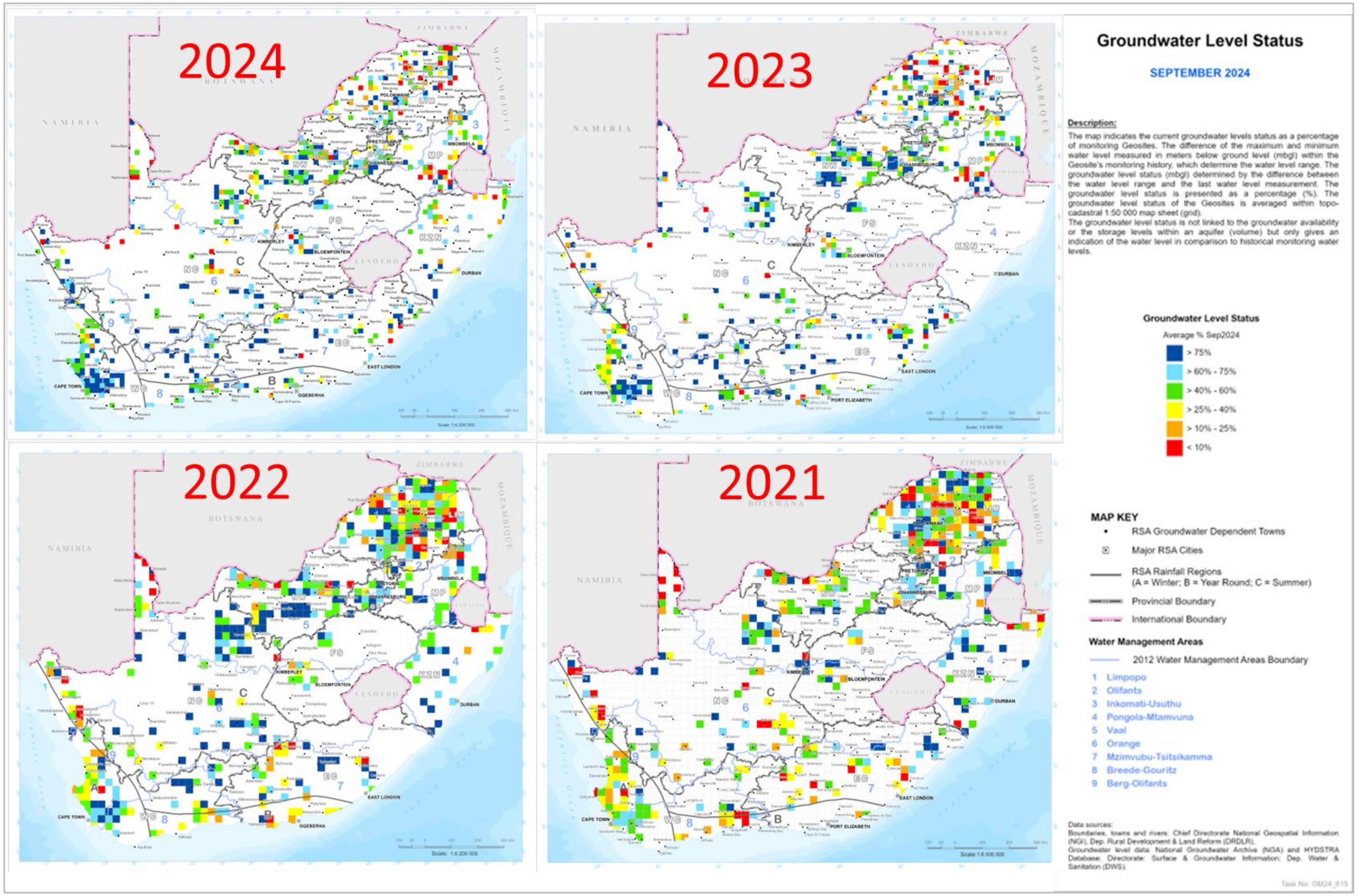

Figure 6.3: Groundwater Level status comparison - past four hydrological years

6.4 Groundwater Quality Status

For the groundwater quality monitoring programme, the frequency of the data collection is bi-annual, before rainfall (September/October) and after rainfall (April/May). In addition to these national stations, there are Acid Mine Drainage (ADM) special monitoring programmes, managed by the National Office. The AMD sites are located at the CoH-WHS and Dundee, and the 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, with some exceedances observed for fluoride. Nitrate is a known persisting problem and has been flagged 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, and it causes methaemoglobinaemia, also known as “blue-baby syndrome”.

During the last hydrological year, ten-year-mean analyses were performed on a variety of chemical water quality parameters, and maps were generated to show high-resolution spatial distribution. The samples came from the DWS groundwater quality monitoring programme and from non-monitoring once-off samples. The analyses were averaged to determine a representative concentration level of the chemical per geosite. Each hexagon on the map represents 25 km^2. The maps only illustrate the groundwater quality, not its fitness for any use.

The ten-year-mean nitrate spatial distribution shows high (>20 mg/L) geosites are found mainly in the northern parts of South Africa, particularly the Limpopo-Olifants and Vaal-Orange WMAs (Figure 6.4).

The Limpopo-Oliphant high nitrate situation is the most severe of the two WMA (Figure 6.5). The map also shows us two areas with >50 mg/L nitrate, one far and another at the provincial border of Limpopo and North West. Limpopo has the highest combined ratio of pit latrines at 69% (StatsSA, 2024). The high nitrate levels in groundwater in Limpopo are well understood to be associated with pit latrines. Lalumbe and Kanyerere (2022) found that high nitrate concentration levels in the Soutpansberg groundwater region area were associated with pit latrines and the agricultural use of nitrate compound fertilisers.

In a recent study by Ndhlovu (2024), 319 groundwater samples, from 17 monitoring sites located within Limpopo granulite-gneiss region collected between 2000 and 2017, were analysed to evaluate groundwater suitability for drinking and irrigation purposes. Over 71% of the water samples have concentrations of nitrate higher than the WHO and SANS241 recommended guideline value of ≤11 mg/L, making 15 out of 17 monitoring sites unsuitable for drinking. However, the remaining two sites failed drinking water suitability in other chemical categories. To mitigate methemoglobinemia, it was recommended that authorities should adequately flag nitrate-polluted groundwater and educate the community particularly mothers about this deadly non-microbial contaminant. The author also suggested that at the clinics, during prenatal and postnatal consultations, mothers should be made aware that while boiling water works to kill microbial contaminants, extended boiling with excessive nitrate, can further increase the levels of nitrate during evaporation. Alternative safe water should be made available to mothers regularly, and the blending of surface water and groundwater should be promoted. The author also recommended that sustainable and affordable groundwater remediation options be considered and implemented urgently to prevent bottle-fed babies from drinking formula made from nitrate-contaminated water. Magnesium nitrate should be flagged as unsuitable for use as a fertiliser in the affected areas, to prevent further groundwater contamination.

Vaal-Orange WMA's high nitrate situation is less intense than that of Limpopo-Olifants WMA (Figure 6.6**Error! Reference source not found.**). Stampriet Transboundary Aquifer System (STAS) is shared between Botswana, Namibia, and South Africa and is utilised massively, especially in Namibia. The STAS' nitrate problem is also well understood. The aquifer supplies water to Ramotswa, a community on the Botswana side of the border. Groundwater supply in Ramotswa was abandoned in the 1990s when the nitrate concentrations were found to be higher than the 50 mg/L global drinking standards and because Ramotswa lacked the capacity and resources to treat the water. The source of nitrate pollution is understood to be pit latrines. Surface water was, therefore, piped in from Gaborone to Ramotswa. A severe drought from 2013 to 2016 severely lowered the Gaborone reservoir level to <5% capacity from late 2014 to early 2016. If the reservoir has a capacity below 5%, it fails to release water. In 2014, the Ramotswa groundwater supply was reopened as an emergency source of water until Tropical Cyclone Dineo struck Botswana in Feb 2017 and filled the Gaborone reservoir. The drinking water supplied in Ramotswa is a blend of high nitrate (>50 mg/L) groundwater from the Ramotswa wellfield and surface water supplied by pipes from the Gaborone Dam. However, the volumes of dilution water from Gaborone were not always unavailable. This led to water restrictions for hours and sometimes days. The community then turned to groundwater-contaminating pit latrines for waterless sanitation.

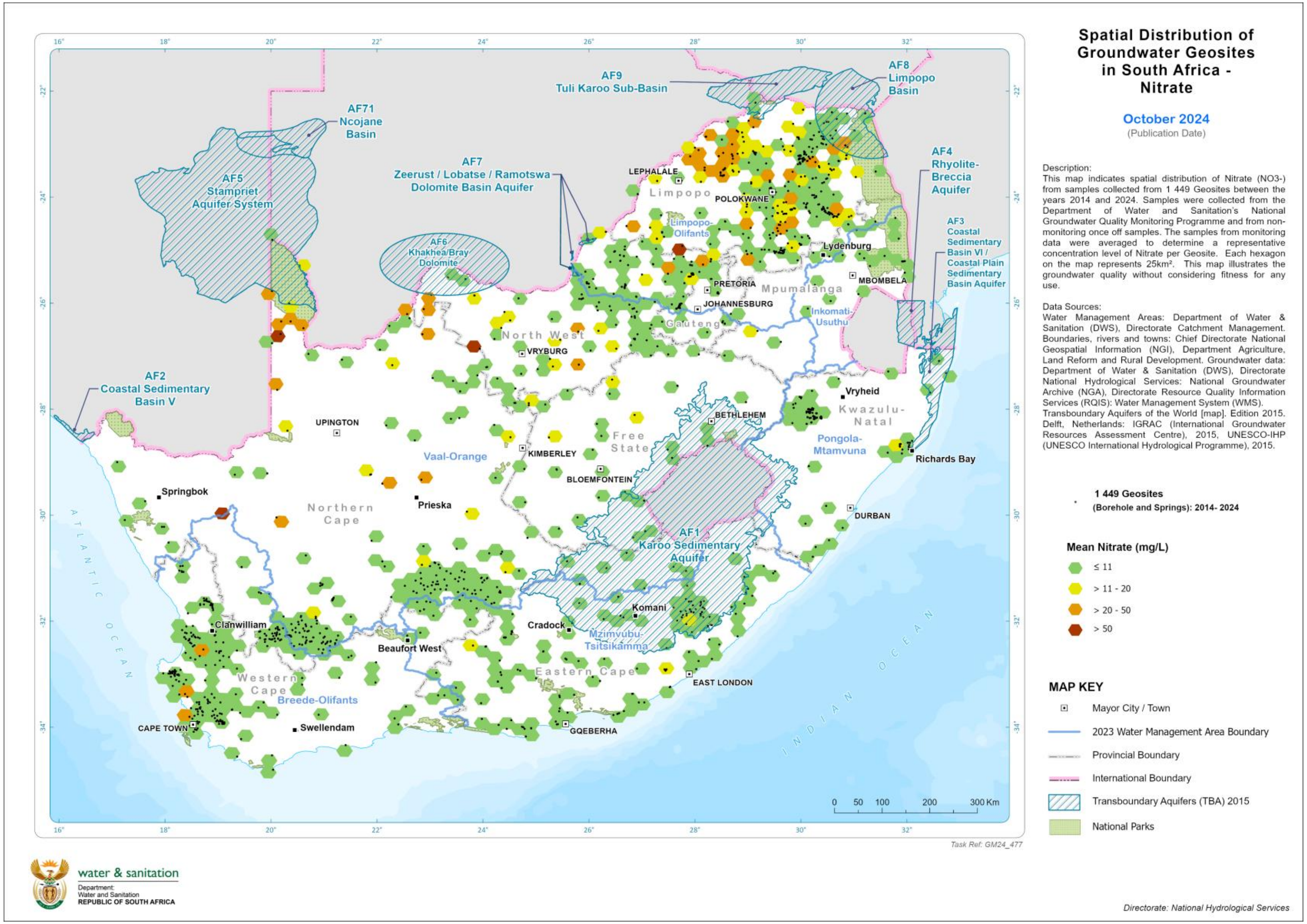

Figure 6.4: Spatial distribution of mean nitrate in groundwater 2014-2024

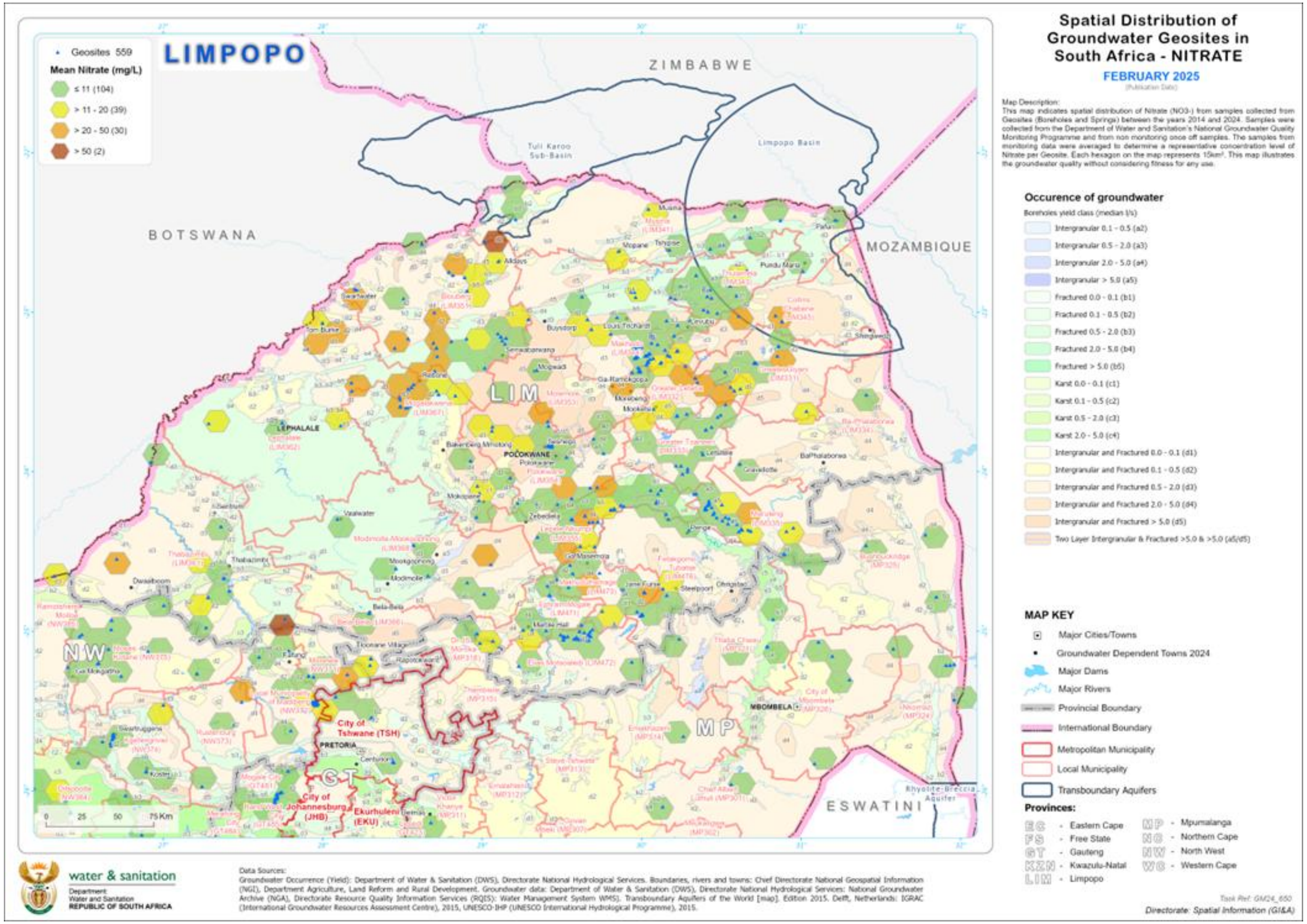

Figure 6.5 Limpopo spatial distribution of mean nitrate, each hexagon on this map represents a 15 km2 radius.

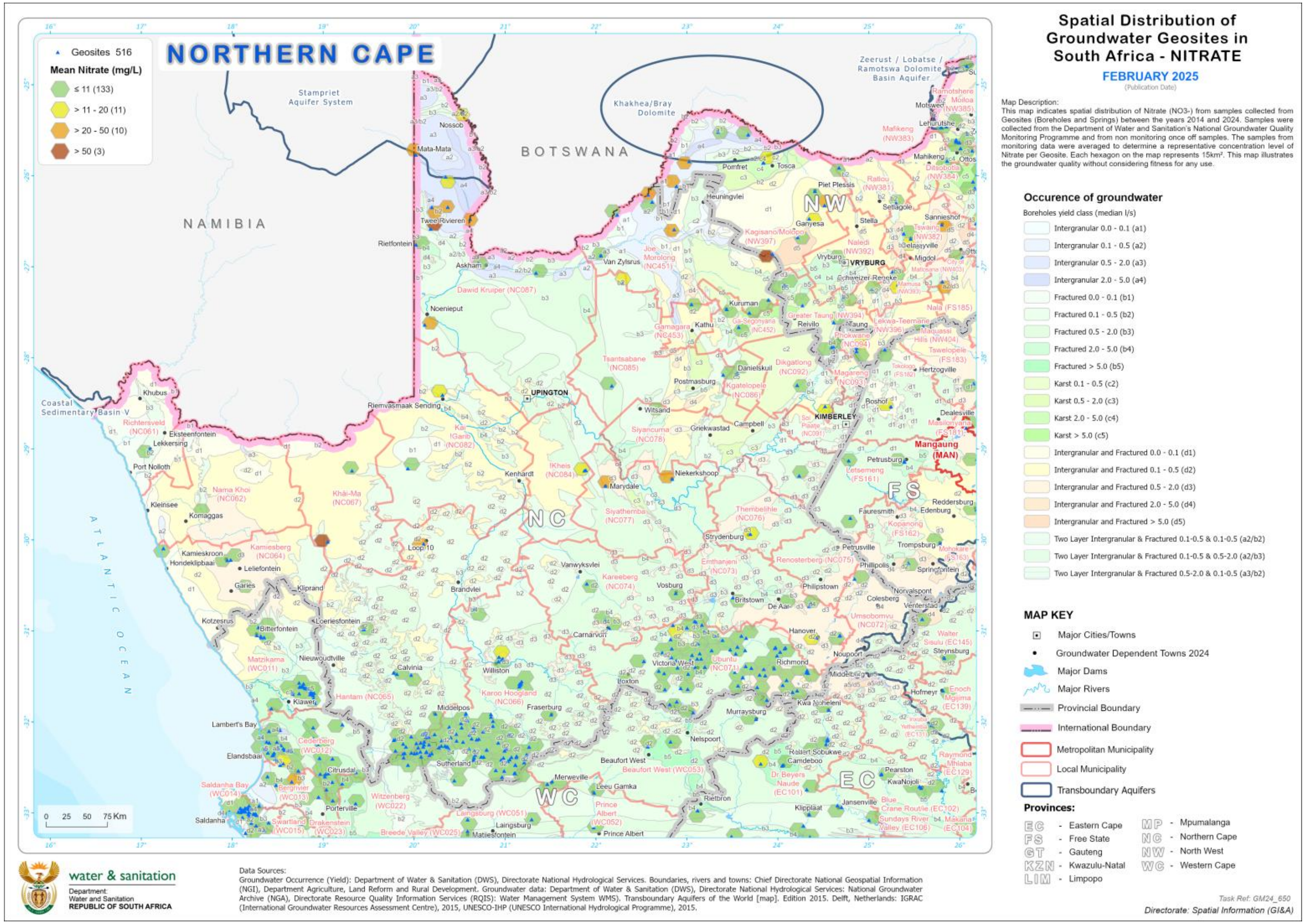

Figure 6.6 Northern Cape spatial distribution of mean nitrate, each hexagon on this map represents a 15 km2 radius

The ten-year-mean fluoride spatial distribution shows high fluoride concentrations (>1.5 mg/L) found in groundwater, mainly in the Limpopo-Olifants WMA (Figure 6.7). There are isolated areas with >5 mg/L fluoride in Mpumalanga, Free State, Eastern Cape, and around the Limpopo North West provincial border. These concentrations are natural and are known to be associated with geothermal springs. South Africa is relatively well endowed with thermal springs, with Limpopo hosting relatively more than any other province. Some of these thermal springs have been developed for recreational and tourism purposes, with facilities including swimming pools, jacuzzis, and spas fed by water from the springs. Limpopo reportedly also has the most developed thermal spring resorts. In South Africa, a handful of the thermal spring water is bottled and sold for therapeutic purposes; in some cases, the thermal spring is the only water source for the entire resort.

The ten-year-mean Electrical Conductivity spatial distribution shows higher salinity (>370 mS/m) in the Northern Cape and some isolated coastal areas around Clanwilliams, Western Cape and Gqeberha, Eastern Cape (Figure 6.8). The proximity of coastal aquifers to the sea and geological, geomorphological, and hydrological factors promote salinity intrusion into the aquifers.

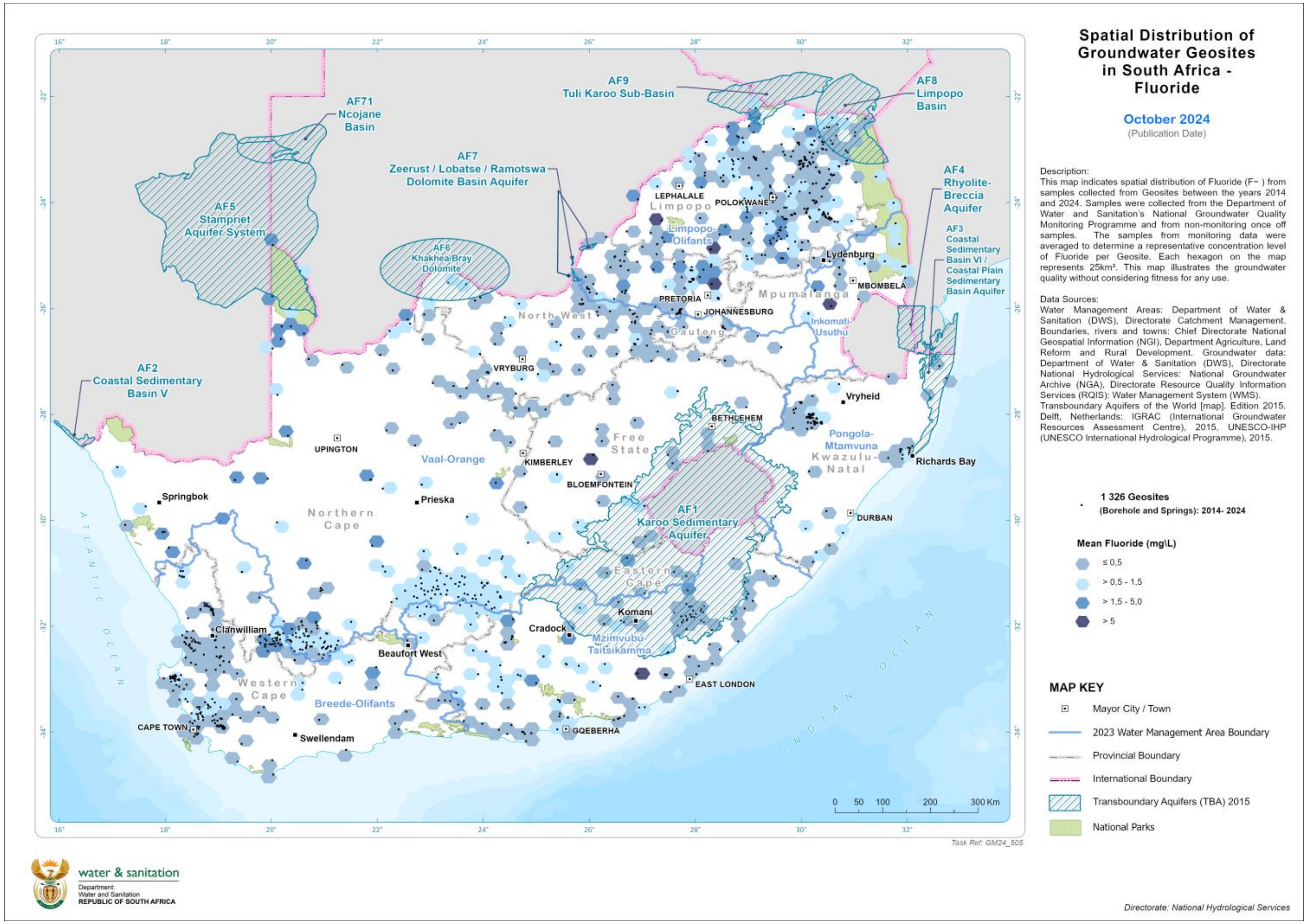

Figure 6.7 Spatial distribution of mean fluoride in groundwater 2014-2024

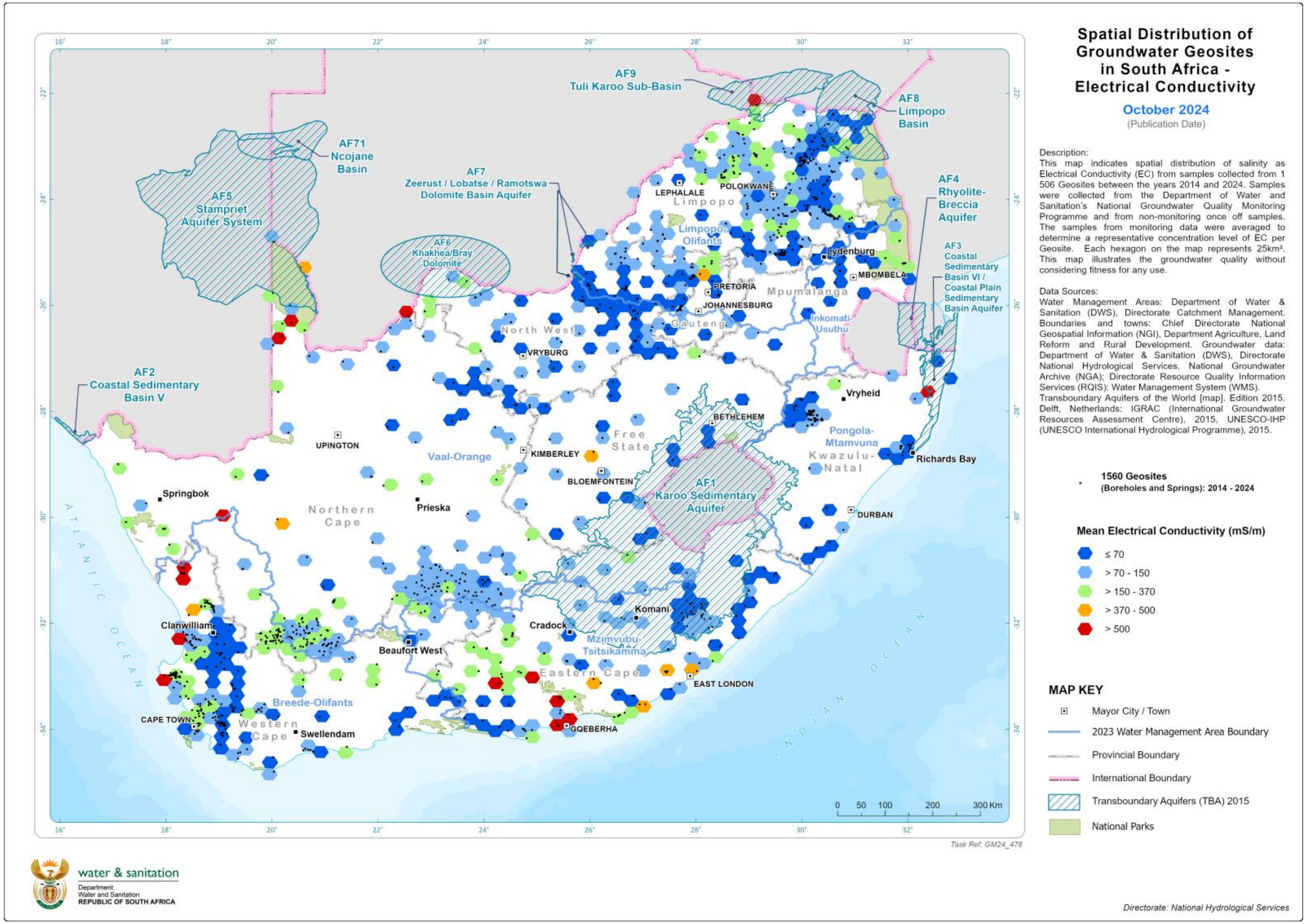

Figure 6.8: Spatial distribution of mean EC in groundwater 2014-2024