THE JOHANNESBURG BROCHURE

The Johannesburg hydrogeological map (JHM), compiled at a scale of 1: 500 000, covers an area of about 76 000 square kilometers. This area, bordered by latitudes 25 to 27 degrees south and longitudes 26 to 30 degrees east, embodies the largest industrial development in South Africa and sustains a large population. All of this places a heavy burden on the capacity of water resources, and groundwater utilization plays an important role as an additional source of potable water.

The JHM, printed in 1999, forms part of a countrywide map series and the legend is founded on the 1983 UNESCO legend. The primary aim of the map series is to produce a synoptic overview of the hydrogeological character of the map area. The main features shown on the JHM are lithology, borehole yields, aquifer types, groundwater use and groundwater quality. A conceptual profile was drawn to illustrate the regional hydrogeology in terms of simplified geology, and to evince target areas for groundwater development.

The basis of the map is the lithology, which dictates the occurrence of groundwater. Different hydrogeological areas were defined on which borehole records were overlain in order to draw yield boundaries. The same methodology was used for the compilation of the groundwater quality map.

- An **intergranular** (alluvial) aquifer occurs along the Crocodile River, downstream of the Roodekopjes and Vaalkop dams. Alluvium of up to 30 m thick has been reported and boreholes seldom yield less than 5 l/s. A distinguishing feature of this aquifer is its hydraulic connection with the Crocodile River. The quality of the alluvial groundwater is good and is suitable for all purposes, since none of the parameters exceed maximum allowable limits for drinking water. The water from this aquifer has a magnesium-carbonate character.
- The **fractured** mode of groundwater occurrence describes aquifers associated with fractures, fissures and joints. The rocks of the Witwaterrand Supergroup, the Kameeldoorns and Bothaville Formations of the Ventersdorp Supergroup, and the sandstone and quartzite of the Wilge River Formation (Waterberg Group) all display the characteristics of the fractured regime. The dominant yield category of all these units, except the Bothaville and Wilge River Formations, falls in the 0.5 - 2.0 l/s interval. The yield class for the Bothaville Formation is 2.0 - 5.0 l/s and that for the Wilge River Formation is 0.1 - 0.5 l/s. Groundwater types vary between magnesium - carbonate for the Witwatersrand Supergroup aquifers and calcium - magnesium - bicarbonate for most of the other aquifers of this regime. Groundwater quality for all the aquifers of the fractured regime is good as the EC values of between 26 and 60 mS/m indicate.
- The **karstic** aquifer, denoting cavities associated with fracturing and jointing, is represented by the carbonate rocks of the Chuniespoort Group. These sediments alternate between the chert-rich dolomite of the Monte Christo and Eccles Formations, and the chert-poor dolomite of the Oaktree, Lyttleton and Frisco Formations. A few dolomite "outliers" represent remnants of the Transvaal Supergroup enclosed by the younger Bushveld Complex. The dolomites of the Chuniespoort Group arguably constitute the most important aquifer in South Africa. Recharge values of between 9 and 13.9% of mean annual precipitation have been calculated for various portions of the aquifer. Groundwater yield is excellent and 50% of boreholes yield more than 5 l/s. The total discharge (spring flow and abstraction) amounts to 435.2 million cubic metres/a. Although the average EC value of 63 mS/m indicates groundwater acceptable for any use, a number of elements, particularly chloride, sulphate and nitrate often show coefficients of variation greater than 200%. This suggest the presence of contamination which calls for caution when the groundwater is considered for human consumption. Groundwater from the Chuniespoort Group has a calcium - magnesium - bicarbonate nature.
- The **intergranular and fractured mode** of groundwater occurrence depicts groundwater contained in intergranular interstices and in fractures, notably in crystalline rocks, but also in a number of sedimentary rock groups. The following rock units display characteristics of the intergranular and fractured regime: the granite and gneiss of the Basement Complex, andesite of the Klipriviersberg Group and the Rietgat and Allanridge Formations of the Ventersdorp Supergroup, andesite, rhyolite and shale of the Pretoria and Rooiberg Groups (Transvaal Supergroup), granodiorite, gabbro, norite and granite of the Bushveld Complex, syenite, foyaite and carbonatite of the Alkaline Complexes, and mudstone, shale and sandstone of a number of formations of the Karoo Supergroup. Dominant yield classes vary from the 0.1 - 0.5 l/s to the 2.0 - 5.0 l/s ranges.

The majority of cold springs, especially those that support strong yields, are associated with the dolomite of the Chuniespoort Group. Three thermal springs and a number of thermal artesian boreholes occur southwest of Groblersdal. A few deep artesian boreholes occur north of Zeerust and Delmas, and are

associated with the dolomite of the Chuniespoort Group. Two artesian boreholes southwest of Groblersdal are seemingly controlled by the so-called Dennilton anticline.

Groundwater drainage patterns generally mimic that of surface water, although intensive groundwater abstraction in some localities, can lead to the disturbance of the natural groundwater flow patterns.

Four relatively small subterranean government water control areas (SGWCAs) occur in or partly in the map area. They are:

- The Bo-Molopo SGWCA north of Lichtenburg, which was established with the objective of controlling abstraction from dolomitic aquifers in order to ensure water supplies to urban areas such as Mmabato and Mafikeng.
- The Kroonstad/Marikana SGWCA east of Rustenburg was proclaimed due to landowner's concerns at the loss of groundwater following dewatering by platinum and chrome mines in the Rustenburg Layered Suite.
- The Crocodile River Valley SGWCA from north of Brits to downstream of Thabazimbi was proclaimed to protect groundwater stored in alluvial deposits along the river.
- The proclamation of the Schoonspruit SGWCA north of Ventersdorp was necessitated by the need to protect the spring, which supplies Ventersdorp with water.

The over-exploitation of groundwater resources is a common problem in areas where groundwater represents a substantial source of water for irrigation, urban and industrial use. Groundwater management by means of groundwater level and groundwater quality monitoring is thus practised at various localities and provide a means to maintain the sustainable exploitation of many of the groundwater resources in the map area, notably in the various dolomitic groundwater compartments. Groundwater management has, however, not reached the level of sophistication already achieved in the management of surface water resources. This is due mainly to the classification of groundwater as private in the Water Act (No. 54 of 1956). This limitation has been removed by the new Water Act (No. 36 of 1998), which draws no legal distinction between surface water and groundwater. As such, it provides the DWAF with a legal basis to extend the management of water resources to include groundwater.

Groundwater, like surface water, is often vulnerable to pollution. In the map area the vulnerability of the dolomitic aquifers is especially high. High concentrations of nitrate have been introduced into groundwater systems via pit latrines in informal settlements, cattle kraals, sewage plant effluent and excessive agricultural fertilisation. The location of various mining activities and their contribution to the degradation of water quality is substantial.

Groundwater is the only source of water supply in many places, notably in the rural areas, but the agricultural sector remains the largest consumer of groundwater in the map area. The approximate abstraction of groundwater for municipal, agricultural and mining amounts to 400 million cubic metres per annum.

The high yield potential of dolomitic aquifers underneath younger formations, geological structures associated with brittle failure, pollution of dolomitic aquifers and pollution of surface water and groundwater resources due to mining activities, are topics which could be considered for future studies. These studies should be integrated into the much broader objective of catchment management as envisioned in the National Water Act (No. 36 of 1998).