Geohydrological issues of importance in the area
governed by the Delmas Local Municipality

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Abstract

The constraints that have been experienced in recent years with the Delmas water supply have largely been as a result of it being situated in a dolomite area, the environmental reality which, from a human and economic standpoint, seems to be a definite drawback. Previous reports on diarrhoea outbreaks in the Delmas area (1993, 2005 and 2007) have consistently noted a groundwater contamination of the A well field’s groundwater abstraction boreholes.

While water contamination certainly had a role to play in the diarrhoea outbreaks, there were other contributing environmental factors. Amongst these
were the physical environment has been severely polluted and significant interventions in environmental elements, such as local surface water streams, that were recorded during the research process.

The nature and extent of water (raw, potable and waste) management in and by the Delmas Local Municipality will be the focus of this article, and certain significant geohydrological issues to consider in the achievement of effective municipal governance will be debated. Recommendations on the possible improvement of the municipal water services management in and by the Municipality will form part of the debate and may serve as pointers for improving the governance, by local governments, of the geohydrological realities that cause constraints in their various areas of responsibility. These outcomes may also find an application in other similarly problematic municipal areas.

**Keywords:** Diarrhoea outbreak, dolomite, environmental management, geohydrological, municipal governance, potable water supply, surface water catchment area

1 **INTRODUCTION**

In October 2008, South Africa’s national Department of Water Affairs and Forestry (DWAF), now named the Department of Water Affairs (DWA), signed a contract to the tune of R100 million for a comprehensive water pipeline over a distance of 38 km between Bloemendal and the town of Delmas in Mpumalanga. In what was a ‘historic Memorandum of Agreement’, the Department explained that this development was one of a variety of ‘measures to prevent the outbreak of water borne disease’ in the Highveld town, situated in one of the productive maize-growing areas of the country (DWAFEA 2008; SABC News 30 October 2008). In many respects the announcement was of a groundbreaking nature. It was a firm indication that the government was giving serious attention to a crisis that had been, in effect, simmering since 2005, when six people died as a result of imbibing contaminated drinking water in Delmas. However, as will be pointed out in this article, the plans to import maybe more costly potable (drinking) water supplied by Rand Water (the Gauteng-based bulk water supply utility) only represent a partial solution to the problem. In addition to the importation of potable water from elsewhere, special attention needs to be given to promoting more effective municipal management of potable and stormwater and more effective management of sewage and environmental health in general in the municipal area of Delmas. Delmas and its water crisis could well become a testing ground for the manner in which the country’s local authorities implement the DWA’s executive policies.
The latest research on the subject emphasises the fact that Delmas’s problematic location, in a dolomitic area, is largely responsible for the problems that have been experienced in recent years with the town’s water supply (Mthethwa 2008). Previous reports on the diarrhoea outbreaks during 1993, 2005 and 2007 have consistently noted groundwater contamination of the A well field’s groundwater abstraction boreholes. (See Map 1 for the location of these boreholes.) These boreholes are situated downstream of the town’s oldest waste water (sewage) treatment facility (WWTF). The DWA has, on occasion, described the underground water aquifer as open and unconfined (Griesel et al. 2006). This means that the ground surface and sub-surface flowing groundwater in the area are sensitive to rainfall events and that high groundwater recharge rates are expected. This could also mean that the underground water aquifer is vulnerable to direct surface contamination (GCS 2006). The disease outbreaks usually occurred immediately after the first heavy rainfall showers in the years concerned.

Both the 1993 and 2005 reports on the diarrhoea outbreaks were inconclusive about the exact causes of the disease in the area. While water certainly had a role to play, other contributing environmental factors definitely exacerbated the situation. The physical environment, for one, is seriously polluted. Also, there had been significant interventions in certain environmental elements, such as local surface-water streams. It is evident, therefore, that the surrounding natural resources such as the soil and grass also need to be studied (DWAF 2007b).

In this article, attention will be given to the above by examining the geography of the area. The nature and extent of water and sanitation management in and by the Delmas Local Municipality will then be highlighted, after which a superficial exposition of certain significant geohydrological issues will be made. Lastly, the article will put forward some recommendations on possible ways in which the Municipality can improve its management of municipal water services.

2 AREA ORIENTATION

Delmas Local Municipality, like most municipalities in South Africa, is exposed to an ever-increasing wave of urbanisation, with people from the country’s rural areas and neighbouring states seeking jobs, safety, housing, improved basic public services and a more sustainable livelihood. The Municipality’s area of jurisdiction is located in the north-eastern part of the Highveld region, has approximately 59 000 residents and forms part of the Nkangala District Municipality, whose head office is situated in Middelburg, Mpumalanga (Delmas Local Municipality 2006). With an area of 2740 km², it lies between 28° 25’ to 29° 05’ south latitude and 25° 45’ to
26° 25’ east longitude. The municipal area borders Gauteng in the north, west and south. To the northwest it borders with the Emalahleni (Witbank) Municipality and to the southwest with the Govan Mbeki Municipality of Mpumalanga. Strategically, the Municipality also forms part of the Maputo corridor. The vital N12 highway is a busy east-west communications route, passing on the northern side of Delmas. The town also plays a vital regional role in that it is an important urban hub, providing essential local services in concert with the larger towns and cities of Bronkhorstspruit, eMalahleni (Witbank), Pretoria and Johannesburg. See Map 1 for more topo-cadastral information on the locality of the Municipality and the town of Delmas itself.

Map 1: Delmas locality map with groundwater abstraction borehole positions and possible pollution sources
Source: MetroGIS 2009
Delmas Local Municipality is geographically located on Karst (dolomite) bedrock, from which the biggest portion of its potable water is abstracted via groundwater boreholes in four well fields, namely A, B, C and D. In Map 2, the dolomite areas are indicated in the dark shading.

Map 2: Topographical map of the wall-to-wall Municipalities and the Karst (dolomite) areas in South Africa
Source: GPM Consultants 2009

In the DWAF’s Delmas Regulatory Report (2007b: 20), the following findings were noted:

• The November 2007 diarrhoea outbreak was probably triggered by an unrecorded pulse of contaminated water that could have entered the reticulation system during the period when free chlorine levels were found to
be lower than the norm (0.2mg/l). DWAF acknowledges that this finding is based upon scientific speculation in the absence of any record of deteriorated drinking water quality during this period. Following this statement, it should be noted that since 30 November 2007, no drinking water sample was detected to be of adverse quality in terms of microbiological and chemical quality. This left the research team responsible with no other option but to declare the tap water as safe. Results from other, more specialised tests substantiate that the sustenance of the outbreak could not have been due to adverse tap water quality. The outbreak, however, continued for at least five weeks after the tap water was scientifically confirmed as being safe.

- No evidence was found that led the research team to believe that deliberate action led to the low free chlorine levels that were recorded in the potable water supply. The low levels of chlorine were, instead, due to at least two contributing factors:
  - Chlorine dosing rates were constant, but free chlorine levels dropped which means that the raw water’s chlorine demand increased. There is reason to believe that increased surface water runoff and subsequent infiltration of the dolomite groundwater aquifer might have led to a periodic deterioration of the groundwater abstracted from the boreholes.
  - Groundwater levels dropped over the latter part of the winter months of 2007, which compelled the Municipality to increase augmentation of their supply with water via the Rand Water pipeline. This water is disinfected by means of chloramination which, unlike chlorination, displays a “naturally” low free chlorine level. When the Delmas chlorinated water and Rand water (chloraminated water) is mixed in the reticulation system, a new chlorine demand is generated and this, in turn, results in a further reduction in the free chlorine residual levels.

- Both wastewater treatment facilities (WWTF) of the town are suspected of discharging mainly substandard-quality effluent into the downstream receiving streams. The discharge from the older works in town, which also maintains water flow in the passing Delmasloop, is causing constant pollution of the environment in Botleng Proper and Mandela Park. These discharges by the WWTFs, as well as polluted runoff from the residential areas, can therefore be regarded as the primary reason for the unhealthy environment that prevails in and around the Delmas area.

- The groundwater resource (boreholes) in the A well field was found to be heavily contaminated and the quality of the water is deteriorating. In 1993 and 2005, the quality of the A well field groundwater was already reported as being polluted. Results generated about the quality of surface water resources...
in the Delmas area confirm pollution of the surface water resources in the vicinity of the underground dolomitic aquifer – the hydrological connectivity already indicated by the Directorate Geohydrology, DWAF, which stated that the quality of the groundwater could be declining owing to default recharging of the groundwater resource by polluted surface water (stream and runoff). Sinkhole formation in this well field area has been detected and this would accelerate infiltration of surface water and possible pollution of the groundwater (see photos in Annexure A).

- The Delmas Municipality is complying with Drinking Water Quality Management legislation – that is, Regulation 5 under section 9 of the Water Services Act, 108 of 1997. The municipality has been monitoring abstracted borehole water from an operational perspective and depends on the provincial Department of Health to monitor the microbiological quality on a monthly basis. Except for the period when residual chlorine was recorded to be lower than the appropriate level of 0,2mg/ℓ, compliance sample-monitoring has shown that Delmas municipal tap water complied with the Microbiological Safety Requirements of SANS 241:2006, the national drinking water quality standard.

- The municipality failed to comply with section 21 of the Water Services Act, 108 of 1997, in that it failed to establish and enforce bylaws for the conditions governing the provision of water services – especially with regard to making provision for the quality and volumes of industrial effluent discharged into the municipal sewer system. A huge contributing factor to the inability of both the wastewater treatment plants to produce effluent of an acceptable standard is the quantity and quality of industrial effluent that is being discharged into the sewer systems.

- The capacity and expertise levels of process controllers at the town’s wastewater treatment works do not comply with Regulation 2834 of the Water Act of 1956.

- The quality of discharge at the town’s wastewater treatment works does not meet the licence/general authorisation conditions as prescribed by the National Water Act of 1998.

The intention in this article is to describe the baseline information of Delmas’s development and, especially, the nature and extent of the municipality’s management of its potable water supply. The information and suggestions contained in this article should help all the organisational units of, for example, the Delmas Local Municipality, governmental regulators such as the Department of Water Affairs (DWA) and the Department of Mineral and Energy (DME), non-governmental
organisations (NGOs), municipal forums, property owners, local communities etc. in launching their quests for improved quality and professional municipal management and services delivery. Such suggestions will also raise awareness in respect of disaster reduction at the level of public decision making, public information and transfer of modern technology.

3 A CONCISE HISTORY OF WATER-BORNE DISEASE EVENTS IN DELMAS SINCE 1993

3.1 The diarrhoea and typhoid outbreak of 1993

Early in 1993, media reports suggested all was not well with Delmas’s potable water. In February 1993, at the time of the now famous Delmas trial hearings, it was reported that thousands of the town’s schoolchildren had been to local doctors to get treatment for diarrhoea. There was also a rumour to the effect that an official at the town’s magistrate court took a bottle of town water to the office to show colleagues green worms in the town’s tap water. The local health inspector, Mr Herman Timmerman, was reported as having said that these were the common little worms that one would typically find in a suburban garden (Van Niekerk 1993).

3.2 The diarrhoea outbreak of 2005

When the first news report on the outbreak surfaced in September 2005, four people had already died. According to officials in the area at the time, 528 cases had been reported and 69 people had to be hospitalised (SAPA 2005). It was believed that the outbreak had already surfaced in June and August 2005 and that, unbeknown to anybody, it could have claimed more victims (Anon 2005; Khan 2005). Again, health officials and scientists were unable to determine if typhoid was responsible for the outbreak. More than 90 health workers had been distributed throughout the community to inform the public on essential strategies towards combating the potential spread of the disease (Kahn 2005).

3.3 The diarrhoea outbreak of 2007

When Delmas was once again in the news in November 2007, with the death of an infant and 648 people being treated for diarrhoea (Viljoen 2007), there were indications that discontent with local water and health-related conditions were likely to spread well beyond the borders of the town. Neighbouring communities tended to take note of developments and made sure that they were not be affected. Shortly
after the outbreak, residents of Bronkhorstspruit, which is situated in the Kungwini municipal area, were concerned about water pollution in the Bronkhorstspruit Dam. They said that water (surface and groundwater) from the Delmas and Standerton areas, where diarrhoea was wreaking havoc with peoples’ stomachs, flowed into the Bronkhorstspruit Dam (Keppler 2007). Meanwhile Mpumalanga’s spokesperson for health, Mpho Gabashane, stated that it was uncertain where the sudden outbreak of diarrhoea had its origin. All tests conducted on the water in Delmas for bacteria and viruses on patients and the treated water again proved to be negative (Viljoen 2007).

4 NATURE OF WATER AND SANITATION MANAGEMENT IN AND BY DELMAS LOCAL MUNICIPALITY

The potable water demand of the Delmas town area is about 16 Mℓ per day (Mℓ/\(\text{d}\)); about 10 Mℓ of this demand is abstracted from the groundwater well fields A, B, C and D, which consist of 17 boreholes (of which only ten are currently in operation). The remainder of the potable water demand is augmented via a 250 mm diameter pipeline of Rand Water from Bloemendal. This additional potable water supply has been constructed to primarily supply two other towns under the jurisdiction of the Delmas Local Municipality: Sundra and Eloff. The current volume is thus inadequate for supplying the whole of Delmas with a constant water supply. Due to Delmas’s shortage of drinking water, especially in the dry season, water is periodically diverted from elsewhere to augment Delmas’s supply. In spite of this, the municipality is unable to keep the potable water reservoirs at elevated levels. This is probably due to water losses and leakages in the reticulation system but, since a water-balance has not yet been carried out, the unaccounted-for potable water figure is unknown.

The older established part of Delmas has two potable water reservoirs (5 Mℓ and 6 Mℓ) and two newer potable water reservoirs are in Botleng (3.2 Mℓ and 6 Mℓ). These reservoirs are fed from the boreholes that extract water from the three dolomite aquifers, that is, the A, B and C well fields. Before being pumped to the water reservoirs, rapid-gravity sand filters and flocculation channels are deployed to treat the potable water from the A7 and B2 boreholes (2.6 Mℓ/\(\text{d}\)). (See Map 1 for the location of the well fields.) The rest of the potable water supply is only subjected to disinfection by means of chlorination (DWAF 2007b).

Delmas is only served by two wastewater treatment facilities. Both of these facilities are constantly overloaded and fail to adequately treat the storm- and waste water before effluent of an acceptable quality is released back into the natural surface water streams draining northwards to the Bronkhorstspruit Dam (Personal interview 2009). The effluent of both facilities has been shown in the past to exceed the allowable limits prescribed in the licence conditions. The receiving surface water
streams and resources are therefore being polluted after receiving the discharges. The older of the two waste water treatment facilities is situated closer to the town centre’s residential areas. It has a capacity of 5 Mℓ/day, and is an activated sludge type with maturation ponds. The facility is situated about 3.5 km upstream from the A well field; the dolomite groundwater aquifer is thus directly downstream from the natural catchment of the stream receiving the effluent from the WWTF.

It now has been decided and approved by the DWA that the Bloemendal (Rand Water) potable water supply pipeline over a distance of 38 km and at a total cost of R100 million will be built. From the perspective of holistic, integrated and water catchment-orientated potable water management, questions could be asked concerning the future of the cheaper groundwater reserves and what will be done to prevent the much more expensive Rand Water potable water supply infrastructure from turning into an underutilised ‘white elephant’.

Another extremely disturbing factor regarding the current development and municipal management of the town is the fact that the IDP for 2006/2007 (Delmas Municipality 2006) does not acknowledge the nature and extent of the dolomite bedrock foundations (Karst) underlying the whole area and the risks and potential disasters associated with this fact (as a result of the formation of ground surface subsidence, cracks, ponors and sinkholes). This issue warrants urgent and detailed geophysical research and surveys, along with complete transparency about the findings and optimum access to these findings by all role-players and stakeholders. Given that this is a case of a municipal area utilising its groundwater resources and possibly lowering the natural groundwater level, Delmas might face the same scenario experienced by the now dilapidated and run-down West Rand towns of Bank, Westonaria and Carletonville during the 1960s. In short, the existence of and formation of new sinkholes and (possibly) ineffective municipal management of a sensitive physical and man-changed environment can only have catastrophic consequences.

The demarcated municipal area (responsibility area) of the Delmas Local Municipality is roughly delimited according to the surface water drainage region boundaries – except for the northeast rise of the Blesbokspruit on the farms Droogefontein southeast of Sundra and the southern rise of the Kromdraaispruit in the upper tributary of the Wilge River on the eastern side of the municipal area. This advantageous location will ease the nature and extent of municipal and environmental management by the municipality, district and even the province in bringing about a more holistic and integrated management that will add more effective, efficient, economic and sustainable value in the long run.

Eloff, Sundra and Botleng towns were merged with the Delmas Local Municipality and the rest of the magisterial area, although there are still municipal
Administrative offices in Botleng and Sundra exercising limited functionality. All municipal functions are managed and controlled from the municipality’s properly furnished and fully accessible offices situated next to the new Pick & Pay Mall in the Delmas CBD.

5 GEOHYDROLOGICAL ISSUES OF IMPORTANCE

5.1 Topography and surface drainage (hydrology)

The topography of the geographical area of the Delmas Local Municipality is relatively flat with gently undulating areas, plains, slopes and several scattered hill crests. The average surface elevation is ±1 580 metres above mean sea level (mamsl) and the area is characterised by plains with some small rocky outcrops (DWAF 2007b).

Meandering spruit- and river estuaries typify the overall topography of the area. The area generally declines in height from south to north. The flat landscape illustrates that there are few definite identifiable rivers/streams, and a few depressions or pans are found within the Delmas area. To proceed with an analysis of the hydrology and geohydrology of the area, a thorough understanding of the different phases of the hydrological cycle regarding water management is a must, and is shown in Figure 1:

![Figure 1: Nature of the geohydrological cycle in water management (DWAF 2007a)](image)
Groundwater levels in dolomite aquifers are controlled by the topography, permeability and transmissivity of the water aquifer, compartmentalisation, positions of springs and drainage lines, abstraction/impacts and volume of recharge (DWAF 2006). Owing to the high permeability of the Karst (dolomite) features, groundwater level gradients tend to be flatter in dolomite aquifers than in aquifers of other rock types, which is why the water level of the Delmas dolomite aquifer is relatively flat, thus mimicking the topography of the area.

Delmas is situated within the Upper Olifants River catchment area. The surface drainage of the Delmas region is towards the north through the Bronkhorstspruit, which feeds the Bronkhorstspruit Dam. According to the DWAF (2007b), most streams and rivers in the Delmas area tend to have a northerly flow direction and they originate from fountains or where the underground water seeps out next to, for example, dolerite dykes. These streams merge to form seasonal rivers.

For the purpose of research in the area, the following upstream tributaries of the main Bronkhorstspruit, passing the town on the eastern side, have been identified and named (see Map 1):

- Middelbultloop rising in the south and draining the area up to the Witklip Dam, which is situated immediately south of the town;
- Welgevondenloop up to the confluence with the Delmasloop immediately east of Botleng Proper Township;
- The Delmasloop starts at the Witklip Dam and flows through the centre of Delmas CBD, past the sewage disposal works, and joins the Welgevondenloop on the eastern side of Botleng Proper Township;
- Botlengloop up to the confluence with the main Bronkhorstspruit at Mapandus and Sun Valley immediately south of the N12 highway; and
- Leeuwpoortloop rising from the farm Leeuwpoort and joining the Botlengloop on the eastern side of Botleng Ext 4.

The surface water drainage region boundary (water divide) in the area south of Eloff and extending towards Nigel means that the Dwars-in-die-wegvlei drains southwest in the Aston Lake and can be left out of the Delmas town equation as far as water management is concerned. The same argument applies to the Koffiespruit and Klipspruit passing Delmas Town on the far western side, as well as the main Bronkhorstspruit draining the geographical area on the far eastern side of the town.
5.2 Nature and extent of the geohydrology

The geohydrological properties of the underground dolomite rock formations are determined by geological and geo-morphological controls such as structure, stratigraphy and morphology. The water-bearing properties of the dolomite stem from carbonate dissolution along structural and litho-logical discontinuities such as faults, fractures, joints and bedding planes. The formations of the dolomites are identifiable on the basis of their chert content. The chert-poor formations weather evenly to produce a low storage potential residue of silty clay. The chert-rich rock formations weather quite differently. The dolomite weathers faster than the chert, leaving the rock supported by chert structures. Eventually the chert will weather and collapse under its own weight, leaving a permeable coarse chert breccia and, unfortunately, sinkholes. Chert-rich formations develop a greater concentration of fissures and fractures that will hasten the weathering process. These chert-rich formations are generally favourable for the large-scale identification, development and abstraction of groundwater (see Figure 2).
According to GCS (2006), the dolomite in the Delmas region extends over a large area which, by means of intrusive dolerite dykes, is divided into four geohydrological underground compartments (which possibly possess different geohydrological characteristics): Witkoppies, Elandsfontein, Varkfontein-Knoppiesfontein and Bapsfontein-Delmas. The municipal area under research for this report is located in the Bapsfontein-Delmas dolomite compartment. The intrusive dolerite dyke’s strike direction is southwest-northeast, with subordinate northwest-southeast and north-south trends. A major northwest-southeast trending dyke transects the central part of the outcrop, sub-parallel to the Delmas-Bapsfontein road (DWAF 2006). The dolomites to the north of the town of Delmas are overlain by a series of sedimentary rock sequences of the Pretoria group. The dolomite emerges from the Chuniespoort group, which mainly consists of chert-rich dolomite and chert breccia, and is distributed as a northwest-to-southeast strip around Delmas (GCS 2006), dipping 15° northeast (DWAF 2006). This group is classified as a major groundwater aquifer owing to weathering and fracturing which, in turn, result in Karst formation particularly in the chert-rich horizon.

The water of the Delmas area is classified as freshwater and is derived from surface sources and groundwater aquifers. Surface water refers to all water that is open to the earth’s atmosphere, and includes rivers and streams. Groundwater is, as the name implies, water under the ground. Such water is usually less contaminated than surface water, because it does not receive all the runoff which enters surface water. Groundwater, because it requires less treatment, is often the preferred source of water for drinking by small communities (DWAF 2007b: 4).

Groundwater is fairly abundant in the Delmas municipal area in that it is basically situated on top of a dolomite water aquifer. Currently there are 17 groundwater abstraction boreholes in the respective A, B, C and D well fields which, over the years, were drilled into the aforementioned dolomite formation and which are utilised by the Delmas Local Municipality to supply the town, and the urban and peri-urban neighbourhoods with potable water. The recently drilled boreholes (2003) are yielding groundwater abstraction rates of between 6 and 30 litres/second (ℓ/s) (GCS 2006), while studies conducted by the DWAF indicate possible groundwater abstraction rates of more than 50 ℓ/s from this area. See Table 1 below and Map 1 for information on the localities of the current groundwater production boreholes in and around Delmas (GCS 2006).
Geohydrological issues of importance in the area governed by the Delmas Local Municipality

Table 1: Information on well field boreholes

<table>
<thead>
<tr>
<th>Borehole identification number</th>
<th>Static water level (mbgl = metres below ground level)</th>
<th>Depth of main groundwater strike</th>
<th>Borehole depth (mbgl)</th>
<th>Maximum allowable groundwater level drawdown</th>
<th>Borehole yield (l/s = litres per second)</th>
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<td>A1</td>
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<td>?</td>
<td>60</td>
<td>40</td>
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<tr>
<td>A3</td>
<td>23</td>
<td>?</td>
<td>47</td>
<td>31</td>
<td>?</td>
</tr>
<tr>
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<td>29</td>
<td>?</td>
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<td>?</td>
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<td>64</td>
<td>112</td>
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<tr>
<td>C2</td>
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<tr>
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</table>

Unfortunately, there seems to be a lack of a complete and comprehensive set of borehole data (i.e. yield, groundwater levels and water quality) and statistics at the municipality and at the DWAF for, in particular, the production boreholes as shown in Table 1, which is disconcerting – this indicates a lack of knowledge on the part of the municipality about, or unwillingness to accept responsibility for, effective geohydrological data management. This, in turn, probably stems from a lack of knowledge on how to manage any groundwater source effectively.

According to the DWAF (2007a), the low density of runoff drainage suggests a high percentage of groundwater recharge and a predominance of water flow underground, which eventually drains into surface streams at topographic lows or emanates as springs next to, for example, dolerite dykes. The nature and extent
of the geography, hydrology, geology and geohydrology must be shared with all role-players and stakeholders (i.e. citizens) concerned. So, for example, must the nature of the underlying dolomite rock formations, the water flow in and through it, and the existence of sinkholes in the bedrock. Also, of course, the dangers of new sinkholes forming must be managed in a transparent manner, with information being accessible to everyone. The municipality’s Integrated Development Plan (IDP) is an impressive, well-planned and presented document with one major flaw and oversight: it does not identify the existence, and the potential disasters looming as a result of, the dolomite bedrock (i.e. cracks, ponors [shallow holes] and sinkholes).

5.3 Groundwater level

Griesel et al. (2006), in an investigation of an integrated water quality monitoring programme conducted in the town of Delmas from November 2005 to June 2006, concluded that the groundwater in the Delmas area is sensitive to rainfall events—high groundwater recharge rates are therefore to be expected. This could also mean that the underground water aquifer is vulnerable to direct surface contamination and that the groundwater level response to rainfall within boreholes in, for example, the A well field, is immediate; hence the groundwater aquifer around this area is classified as unconfined (open) (GCS 2006). The groundwater level in the A well field is also the second shallowest (closest to the ground surface) compared to the other three B, C and D well fields, which range between 21.2 and 29.2 metres below ground level (mbgl). See Map 1 for the locations of these four well fields.

In the Delmas area generally, there are differences in the nature and extent of the four groundwater abstraction well fields A, B, C and D, and there are differences in the treatment of the abstracted borehole water and the ways in which this water is stored in water reservoirs and reticulated. These differences must be explained and clearly indicated to the taxpayers and citizens in layperson’s language. For example, the users and consumers of water in the Delmas-Wes area should be informed and should understand that most of their potable water probably comes from the C and D well fields, that this water is chemically treated at the boreholes themselves before it is pumped directly into the water reticulation pipeline systems, and that their used water (sewage) eventually ends up at the oldest WWTF. This WWTF is located immediately north of the town’s golf course, and their used water goes there for the purposes of aeration, flocculation, settling and chemical treatment before being released as effluent into the Delmasloop, which drains through the Botleng Proper township towards the downstream groundwater abstraction well fields A and B.
There is consensus that groundwater quality in the Delmas area has been compromised. The local groundwater aquifer has been subjected to the following (Hobbs 2004):

- **Salinisation** – there is concern that there has been an increase in salts mainly as a result of anthropogenic causes, such as discharge of industrial effluents, irrigation return flows and urban runoff;
- **Eutrophication** – there is concern that there has been an increase in plant nutrients (phosphates and nitrates) resulting from treated sewage effluent discharges to rivers and streams, and which has caused excessive algal growth (including toxic blue-green algae) in dams and rivers, with associated taste and odour problems and increased water treatment costs;
- **Bacteriological contamination** – there is concern that there has been a rise in faecal contamination levels associated with increasing population densities and inadequate sanitation levels, especially in the informal settlements.

The report by GCS (2006) points to a widespread occurrence of faecal pollution, especially within the A well field, and suggests that the pollution emanated from the poor quality of the surface water flowing in the Delmasloop towards the A well field. The report also shows acceptable levels of micro and macro constituents in most of the groundwater production boreholes except borehole C2, which shows elevated levels of arsenic. However, this observation was based on short-period water-quality-monitoring data and therefore should be treated with circumspection. Levels of manganese (Mn) and iron (Fe) have also been noted to be high in some boreholes. In conversation with the municipality, it was noted that production borehole B2 is not in use anymore owing to the high levels of Mn and Fe in its abstracted water.

### 6 POTENTIAL SOURCES OF MICROBIAL GROUNDWATER POLLUTION

According to Mthetwa (2008), the different land uses by inhabitants of the Delmas area have been identified as potential sources of human and animal waste, since microbial agents have been shown to be the major problem in the surface as well as the groundwater quality monitored in the municipal area. The first step, therefore, in more effective groundwater quality protection is to identify the nature, extent and locality of water pollution sources. The potential microbial pollution sources have been identified during a field survey and are displayed in Table 2 and on Map 1:
Table 2: Identified potential microbial sources on a local scale

<table>
<thead>
<tr>
<th>Site name</th>
<th>X coordinate</th>
<th>Y coordinate</th>
<th>Surface elevation (mamsl)</th>
<th>Distribution category</th>
<th>Types of pollutants</th>
<th>Risk effect</th>
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### CONCLUSION

In conclusion it can be remarked that the typhoid epidemic in Delmas in 2005 has illustrated how important inter-departmental collaboration is in dealing with a public health problem. The national and provincial departments of, among others, Health and Social Services, Water and Environmental Affairs, Mines, Local Government, Housing, Agriculture and Land Administration, as well as the Delmas Local Municipality itself, have to take the lead here by actively engaging in effective cooperative governance.

Poor access to safe drinking water and the provision of adequate sanitation is a group effort, although all group efforts are doomed to failure if there is one weak link. A question to be debated and addressed is to determine where the weak link for the Delmas Local Municipality is and if it indeed is the only link that is problematic. Given the fact that local authorities, especially in the more rural regions of South Africa, have built up a negative reputation for service delivery in the water sector, Delmas could well serve as a benchmark of what can be expected in the near future.
8 RECOMMENDATIONS

The following recommendations are made with a view to improving the nature of municipal water services management and development in the Delmas municipal area:

- A properly planned and managed skills and knowledge audit of the municipal area must be carried out. The audit of the area will show that there are enough experienced and skilled geohydrologists, pollution experts, municipal managers, academia, tertiary research institutions and NGOs in the municipal area available to, for example, form a small but effective focus group/research unit that can be utilised by the municipality, the DWA and other governmental authorities (as indicated earlier);
- A properly planned and managed land-use survey (with clear, large-scale and effective identification, surveying, demarcation and mapping) must be carried out of the whole surface water catchment area in the Delmas Local Municipality;
- The current state of the municipality’s potable water supply, sanitation and stormwater infrastructure must be investigated, tested, more effectively maintained and perhaps upgraded with a view to improving the basic service rendered (which must, of course, be sustainable).
- The under-performance of the town’s two WWTFs should be regarded as the direct cause of the unhygienic conditions that exist in and around the Delmasloop, which flows through the centre part of Delmas and past Botleng Proper. This is also a major contributor to the deterioration of the groundwater quality in the A well field dolomite aquifer. The municipality is obliged to do the following:
  - Compile a practical waste water management turn-around plan.
  - Give its urgent attention to the older WWTF, since the effluent from this WWTF has a detrimental impact on the A well field aquifer. The effluent outflow must be consolidated and properly disinfected.
  - Process controllers, who are adequately skilled and who comply with the educational requirements as stipulated in legislation must be appointed and registered with DWA.
  - The DWA must ensure that effluent quality is monitored and recorded. This information should be used to gauge any trends in improvement, and to initiate intervention when required.
Geohydrological issues of importance in the area governed by the Delmas Local Municipality

- A new, fully conventional WWTF (flocculation, filtration and disinfection) needs to be put in place – all groundwater should also be subjected to treatment prior to distribution. (DWAF 2007b)

- A properly planned and managed holistic and integrated orientation programme must be launched and maintained, which must include informing, training and motivating all actors (role-players and stakeholders) in order to inculcate an institutional willingness to look, listen, learn, read and do research into achieving an improved municipal and environmental management in the Delmas municipal area – especially an understanding of the geohydrological cycle, the origin of the area’s potable water, the handling of its waste and stormwater and, lastly, the destiny of the used water, solids and refuse;

- The dolomite sinkhole areas of the town call for urgent attention and a new municipal management protocol; these sinkholes should be acknowledged and managed as such by the major role-players (the municipality, Department of Mining, Geo-Sciences and DWA) in their servicing and regulating of development in the municipal area;

- Updated and accurate statistical and census data on the nature and extent of all water users and consumers within the municipality’s jurisdiction area must be sought, recorded and maintained so that effective, efficient, economic, equal and sustainable water management (according to the surface water drainage region delimitation) can be achieved;

- An effectively planned and managed paper trail, record-keeping, computer-based information bases and water footprint in the area of effective water services management according to the macro surface water catchment region should be planned, initiated, incorporated and maintained by the Delmas Local Municipality. Special attention must be given to the volumes of groundwater abstracted through the different boreholes in the four well fields, fluctuations of groundwater levels, water quality monitoring systems and any movements in the ground surface linked to the forming of subsidence, cracks and sinkholes. It would be in the best interests of all Delmas residents if a Water Safety and Security Plan is drafted and implemented. This plan should be based on the principles prescribed by the World Health Organisation and should follow the model developed by the Water Research Commission. Such a plan will allow the municipality to manage drinking water quality as stipulated in the Drinking Water Quality Framework for South Africa;

- A programme of effective, efficient and economic image-building, publicity and marketing of the town should be drawn up and implemented to inform ‘the real world out there’ and, especially, the nearby passing highway commuters,
tourists and investors about Delmas’s slumbering developmental potential in terms of agriculture, economy, accommodation and hospitality – note that this area is on the outskirts of the country’s ‘hub’, a ‘hub’ that has hosted major events such as the Soccer World Cup (June 2010);

- The DWA has excellent policies and informative guidelines on effective water and sanitation management, and these only need to be made available and communicated more effectively to water users and consumers themselves;

- New water management issues to be researched, undertaken, developed and utilised are the following:
  - Better use of identifying, development and management of groundwater resources.
  - Seek/adopt new technologies for water and sewage treatment.
  - More innovative reallocation of potable water and maintenance and upgrading of infrastructure – minimise or eliminate water leaks, water losses and sewage spills.
  - More effective identification (geohydrology), surveying, development, transport, reticulation and pumping techniques of potable water.
  - Rainfall harvesting.
  - Artificial recharge of underground cavities and groundwater aquifers.
  - Re-use and recycling of water.

- Recruitment, training and use of environmental blue and green ‘scorpions’ (potential job creation) to assist with environmental and water management activities. There is also a need to walk the surface water catchment area and be the regulators’ ‘environmental ears and eyes on the ground’;

- As far as disaster and risk management is concerned, the aspects of the railway line passing through the town, the over-flying airplanes landing at OR Tambo International Airport, the Eloff stormwater and effluent, agricultural smallholdings, big-scale agricultural farms surrounding the town, coal mining, the nearby N12 highway and, lastly (perhaps the most threatening), the dolomite bedrock (with the formation of subsidence, cracks, ponors and sinkholes) should be monitored and managed more effectively.

The research aimed to provide the reader with a ‘snapshot in time’ of the phenomenon under investigation. From the discussions it is evident that we are dealing with a complex situation which will require a multidisciplinary solution. Although the recommendations are clear, it remains the responsibility of the Delmas Local Municipality to show political commitment in solving its water and disaster-related problems.
Geohydrological issues of importance in the area governed by the Delmas Local Municipality

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GPM Consultants. 2009. Topographical map of the wall-to-wall municipalities and the Karst areas in South Africa. Polokwane: GPM.

**ANNEXURES: PHOTOS**

![Sinkholes in the dolomite bedrock area immediately south (upstream) of the A-field potable water abstraction boreholes](image1)

**Photo 1:** Sinkholes in the dolomite bedrock area immediately south (upstream) of the A-field potable water abstraction boreholes
Source: Mthethwa 2008

![Sinkhole in the vicinity of the A-field boreholes](image2)

**Photo 2:** Sinkhole in the vicinity of the A-field boreholes
Source: Mthethwa 2008
Geohydrological issues of importance in the area governed by the Delmas Local Municipality

Photo 3: Refuse dump area immediately upstream of the B-field potable water abstraction boreholes
Source: Researcher’s private collection.

Photo 4: Small dam of raw sewage on the ground surface near the D-field potable water abstraction boreholes and 300m from the Municipal Offices in Delmas
Source: Researcher’s private collection.
Photo 5: Overflowing older waste water treatment facility on the northern side of Delmas
Source: Researcher’s private collection.

Photo 6: Depressing state of a street in the Botleng suburb of Delmas
Source: Researcher’s private collection.