

Addressing issues of epidemiological disaster: observations on the Delmas water-based crises 1993- 2007



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1 INTRODUCTION

In October 2008 South Africa's national Department of Water Affairs and Forestry (DWAF) 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 the Mpumalanga Province. 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 (SABC News, 30 October 2008; DWAFE, 2008). In many respects the announcement was of a groundbreaking nature. It was a firm indication that the Government was intent on giving serious attention to a simmering crisis situation that had been ever-present since 2005 when six people died as a result of contaminated drinking water in Delmas. However, as will be pointed out in this report, the plans to import maybe more costly potable water, supplied by Rand Water (the Gauteng-based bulk water supply utility), only represents 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 as well as storm water and sewage and environmental health in general in the municipal area of Delmas. Given the fact that DWAF announced in 2009, shortly before its water week celebrations, that it intended to take a more green stand by giving special attention to initiatives aimed at conserving the country's water resources (DWAFE, 2009). Delmas and its water crisis could well become a testing ground for the manner in which the country's local authorities intend supporting the praiseworthy policy accent of DWAF.

The latest research on the subject underlines the fact that Delmas' 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 at the end of 1993, 2005 and 2007 have consistently noted groundwater contamination of the A well field's groundwater abstraction boreholes. These are situated down-stream of the town's oldest waste water (sewage) treatment facility (WWTF). DWAF has on occasion described the groundwater aquifer as open and unconfined (Griesel et al., 2006). This means that the groundwater in the area is 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 also usually occurred immediately after the first heavy rainfall showers of the respective years. It should also be noted that both the 1993 and 2005 reports were inconclusive on the causes of diarrhoea outbreaks in the area. While water certainly had a role to play, other contributing environmental factors most certainly also was detrimental in this outcome. The physical environment,

for one, has been severely polluted. Also there had been significant interventions in environmental elements, such as local surface water streams. It then is evident that also surrounding natural resources such as the soil and grass needed to be studied (DWAF, 2007b). In this report attention will be given to the aforementioned matters. 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.

1.1 Motivation for study

As a result of a growing awareness about the HIV/AIDS pandemic, there has for a considerable period of time, been a distinct sensitivity in South Africa to issues of contagious disease. The cholera outbreaks in South Africa of 1998, 2000 and more recently the outbreak of 2008-9 that started in Zimbabwe in October 2008, spreading in a short while to South Africa and other SADC countries, are good examples. Public concern about potential epidemics and their implications are frequently articulated in readers' letters in the media and reportage that accentuate the need for more effective strategies to prevent these events from causing harm.

In the case of Delmas, the issue of what appeared in the media to have been unexplainable incidents of disease that could not be directly linked to customary diarrhoea and typhoid-related diseases, gave it an air of mystery. The fact that it was apparently not possible to bring an end to the outbreaks of the disease after the 2005 event, when it was reported for the first time since 1993, suggested that all was not well in Delmas.

In this study the objective is to try and understand:

- What were the major factors behind the outbreaks of water borne disease in Delmas?
- Would it be possible to introduce more effective disaster risk reduction strategies in the case of Delmas? and
- To what extent can the experience gained in Delmas be applied to prepare effective disaster risk reduction strategies in other parts of the country?

To determine the need for *inter alia*, more effective, efficient, economical, equal and sustainable environmental health management assistance to the Delmas Municipality Office, a wide range of foci were explored as a preliminary study and on which this report will broadly touch. The intention eventually will be to explore the application potential of the following objectives as outcomes if funds and time permits:

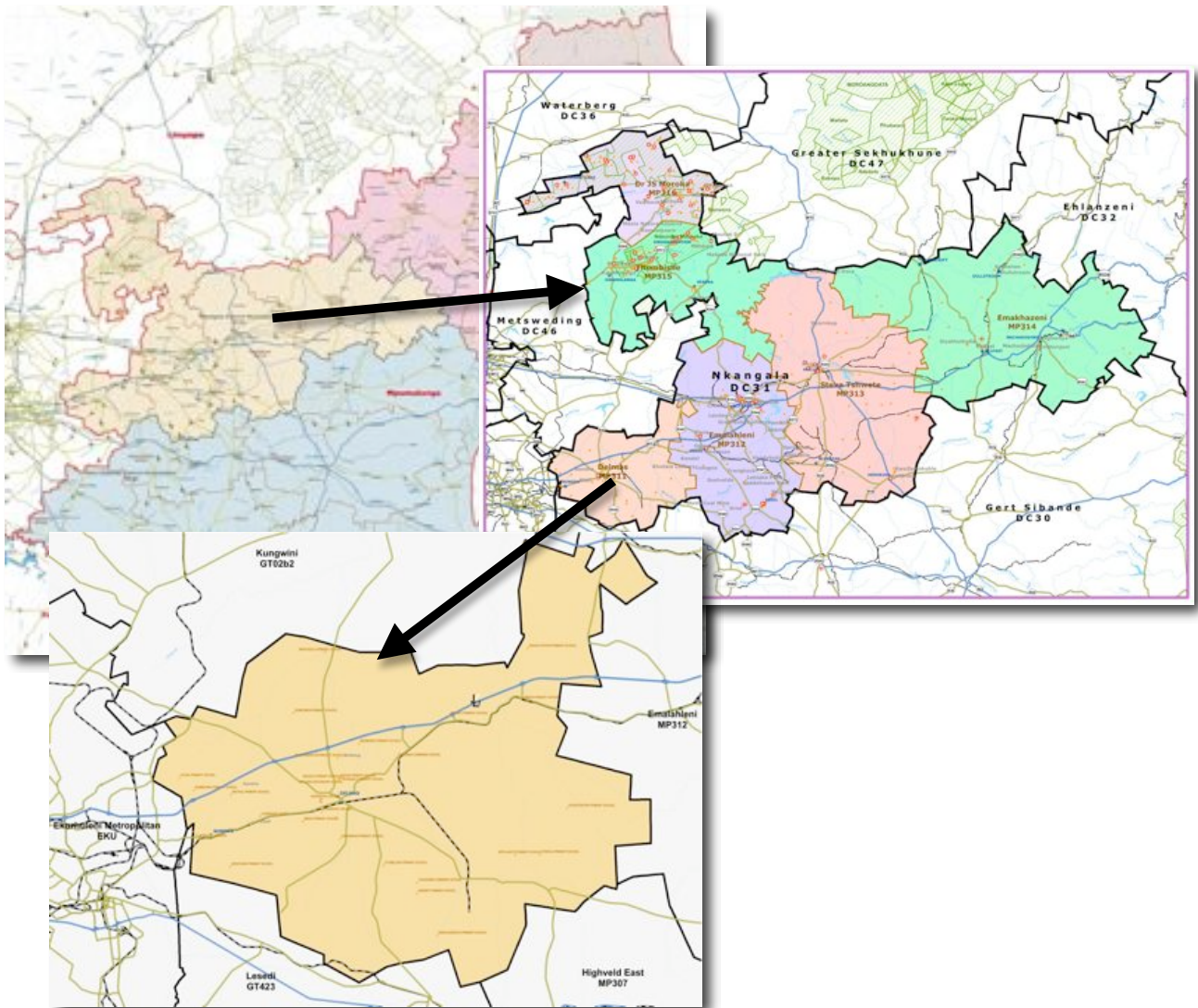
- To capacitate the Municipality with the essential knowledge and skills to be ready for any water related disasters and to be able to act pro-actively;

- To inform the citizens and train them on strategic aspects of the natural as well as the man-changed environment;
- To become familiarised with the typical geological, hydrological and geo-hydrological circumstances of the whole municipal jurisdiction of Delmas Municipality;
- To determine the nature and extent of some historical and demographical aspects over the past twenty years on the development of the Delmas Town;
- To do a desktop study of the nature and extent of the municipal governance in the Town;
- To be updated about the current potable water supply management system in place for especially the Town's citizens;
- To take notice of the standard of other basic municipal services like storm water facilities, sanitation systems, roads and electricity supply in the Town;
- To make some useful contributions towards the implementation of an effective Disaster and Risk Management Plan for the management of disasters, hazards, vulnerable areas, preparedness prevention and mitigation of natural and man made disasters; and
- To determine the influence of the aforementioned aspects on the establishment of a more effective, efficient, economic and sustainable public service delivery and water management system for the Delmas municipal area as a whole.

1.2 Area orientation

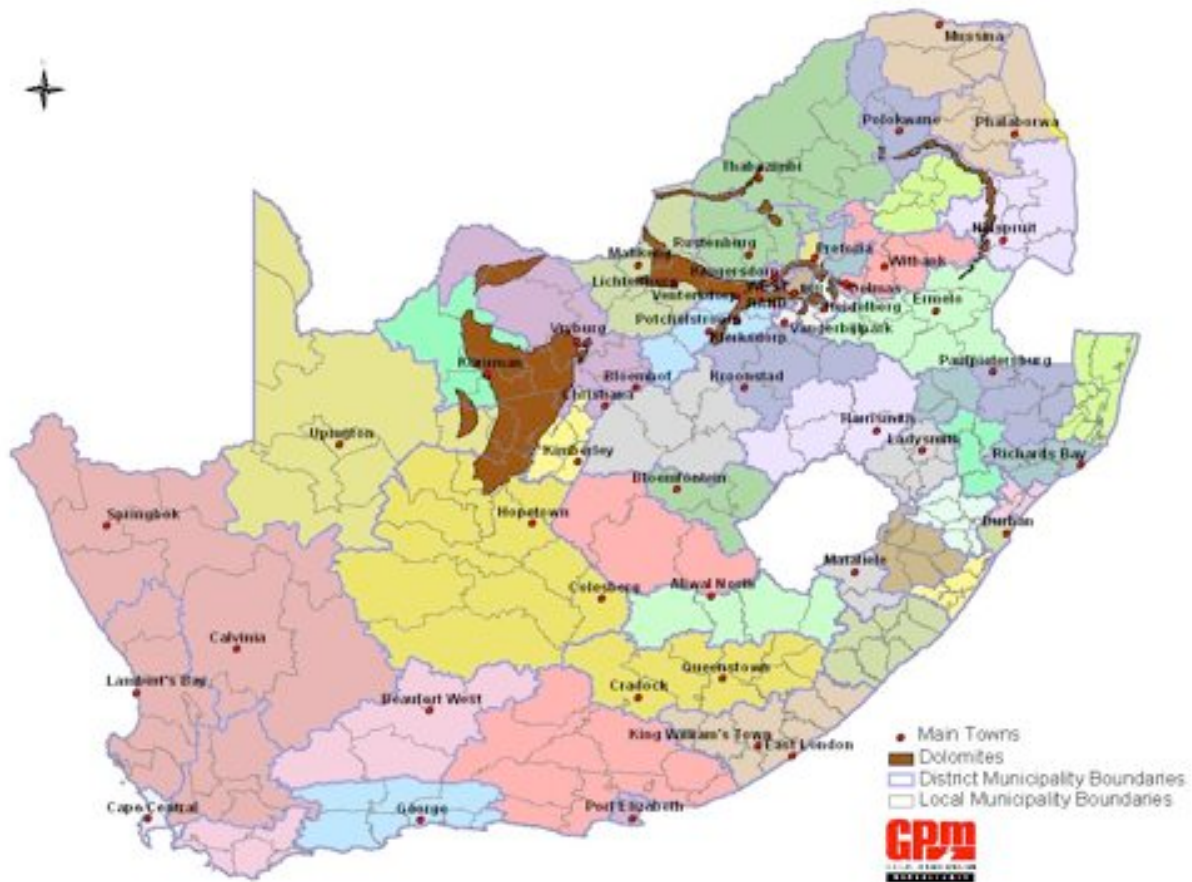
Currently Delmas Local Municipality, as most of all the municipalities in the developing South Africa, is exposed to an ever-increasing wave of urbanisation, with people from the country's rural areas, and neighbouring states, seeking jobs, safety, housing, improved basic public services and a more sustainable 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 of which the head office is situated in Middelburg, Mpumalanga Province. With an area of 2740km² it lies between 28° 25' to 29° 05' south latitude and 25° 45' to 26° 25' east longitude. The municipal area borders on the Gauteng Province in the north, west and south. To the north-west it borders with the Emalahleni Municipality and to the southwest with the Goven Mbeki Municipality of the Mphumalanga Province. 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 the town. The town also plays a vital regional role. It is an important urban hub, providing essential local services in concert with the larger towns and cities of Bronkhorspruit, Witbank, Pretoria and Johannesburg. See Map 1 for some more topo-cadastral information on the geographical locality of the Municipality and the town of Delmas.

Map 1: Topo-cadastral map of Delmas area



Fact of the matter is that the Delmas Local Municipality finds itself in a geologically underlain karst (dolomite) bedrock area from which the biggest portion of its potable water is abstracted via groundwater boreholes in four well-fields, namely A, B, C and D (see maps 2 and 3 hereunder).

Map 2: Topographical map of the wall-to-wall Municipalities and the karst (dolomite) areas in South Africa



In addition to Delmas' potable water supply from groundwater sources there is a small diameter pipeline of about 250 mm linked to the nearest Rand Water's Bloemendal storage facility. Currently the pipeline forms part of a network that supplies potable water supplies (albeit it at a considerable higher cost than would usually be considered as generally affordable for local authorities) to the residents of Sundra, Eloff and a small part of Delmas West. For many of these settlements the 'imported water' forms part of a crucial supply of safe and clean drinking water.

It is intended in this report to describe the baseline information of Delmas' development and especially the nature and extent of the Municipality's management of its potable water supply.

1.3 Scope and limitations

The information and suggestions in this report will help all the organisational units of for example, the Delmas Municipality, the governmental regulators such as the departments of Water Affairs and Forestry (DWAF), Mineral and Energy (DME) and Environmental Affairs and Tourism (DEAT), non-governmental organizations (NGOs), municipal forums, property owners, local communities etc. in

launching their quests for improved quality and professional municipal management and services delivery as well as an awareness for disaster reduction at the level of public decision-making, public information and transfer of modern technology.

2 A CONCISE HISTORY OF WATER BORNE DISEASE EVENTS IN DELMAS (1993-2007)

2.1 The diarrhea and typhoid outbreak of 1993

Early in 1993, media reports suggested all was not well with Delmas' potable water. In February 1993, at the time of the now famous Delmas trial hearings, it was reported that literally thousands of the town's school children 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 that came out of the town's tap water. The local health inspector, Mr Herman Timmerman, was reported as having said that it was the usual little worms that one would typically find in the suburban garden (Van Niekerk, 1993a).

From the outset the town's residents were pointing fingers at the local authority. The Municipality, in turn, tried to protect itself by suggesting that the government official who took the bottle of worm infested tap water to the office, lived in a block of apartments where the building's uncovered warm water system was notable for having worms in the water. It was thought that avian excretions were responsible for the presence of the worms in the water (Grobler, 1993). Then, towards the end of 1993, as the rain season set in, the crises once again surfaced. By November 1993 there were indications that an epidemic of typhoid fever and diarrhoea had broken out. Emergency medical teams were rushed to Delmas where four people had already died and thousands of residents reported to a field clinic of the South African Defence Force's medics, for treatment (Van Niekerk, 1993b). Ultimately more than 2000 cases of gastro-intestinal disease were treated by the emergency teams. Approximately 57 of these cases were confirmed to have contracted typhoid fever (Wits & CSIR, 1993). The onset of the epidemic in Delmas was rapid. Reported admissions suggested 100 - 160 cases had to be treated daily between 20 - 22 November 1993 (Wits & CSIR, 1993).

In the 1993 event it was estimated that 14 people died (Kahn, 2005). The authorities declined from specifically stipulating how the disease outbreak in the first place was caused. Several government departments and universities participated in the investigation at the time. General living conditions, the manner in which food was prepared, as well as the general condition of the local water, were said to be potential agents for the spread of the epidemic. Water, food and blood samples were analyzed. Community, educational and training programmes addressing hygiene and other aspects related to

the epidemic, were presented by community health workers. Daily feedback sessions concerning current developments were provided by the press and local government. Ultimately the general findings proved to be inconclusive. Researchers offered a variety of hypotheses, with no direct cause. Of one thing all the researchers were certain: *Salmonella typhi* could not be detected in any water, food or milk samples that had been subjected to tests (Wits & CSIR, 1993).

Some investigations seemed to suggest that the groundwater quality at the different well fields varied and that insufficient chlorination could have been a cause for the epidemic (Kahn, 2005). There were also references to an infrequent water quality and quantity monitoring programme. Researchers, at the time, recommended that a proper groundwater management scheme be designed for the greater Delmas municipal region. They also stated:

...Due to karstic geo-hydrological formations within the region, the whole area is very vulnerable to almost any pollution which can contaminate the groundwater. If pollution, be it industrial or sewage is not adequately managed or prevented, irreversible damage to the groundwater quality will result with catastrophic consequences...

The Medical Services Unit of the South African National Defence Force pointed to several problems. No treatment protocol was in place. This led to inconsistent treatment and monitoring of patients. There were no properly kept records of the patients and their progress. In many ways the Delmas epidemic underlined the need for treatment protocols.

Ironically, at the time of a later outbreak there were questions asked in the National Assembly, as to how the outbreak was dealt with by emergency teams in 1993 (DWAF, 2005) Although it appears, in retrospect, to have been good at the time, there were clearly some planning lacunae in the era of the 'old' South Africa that had not been addressed properly.

2.2 The diarrhea 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 2005 and August and that it unknowingly could have claimed more victims (Kahn, 2005; Anon., 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).

There was, at the time, considerable discontent in the community (Motoung, 2005). This tended to create difficult working conditions for the emergency teams in the area. The media reported that local residents resorted to vandalising tankers that daily carried clean drinking water into Botleng (Anon., 2005b). Mpumalanga provincial premier, Thabang Makwetla, urgently had to be removed from Botleng township as police opened fire with teargas on protesters (Anon, 2005c). Residents explained that they simply were not satisfied with having to live through the second outbreak of disease within the space of twelve years. They argued that the municipal authorities did nothing about the matter until it turned into a tragedy (Motloung, 2005).

As an emergency measure the Mpumalanga provincial department of Housing made available an amount of R2,5 million for the relocation of some 2000 families in an informal settlement of the Town, situated in the dolomitic area and also under the local flood-line. Money was also made available for drilling yet another borehole and linking it up with the existing local water supply of the town Van Wyk, 2000:4). At DWAF, officials gave the assurance that attention would be given to the matter. The national water regulating department along with the responsible provincial authorities in Mpumalanga, had also committed themselves to finding out what caused the outbreak of disease and take appropriate steps to combat it. (DWAFFEA, 2005) Government made numerous calls on local authorities to effectively maintain their available potable water resources (Anon., 2005d). Circumstantial evidence suggests that DWAF could not directly be held responsible for the deteriorating state of environmental affairs at Delmas. An electronic record-keeping inventory, dating back to 2004, contained a reported visit by officials of DWAF to Delmas. In discussions it was pointed out that the Town's water development programme had last been updated in 1999 and that work needed to be done on local infrastructure (DWAFFEA). Subsequent scheduled meetings, according to the program, were not updated.

The problematic issue of this outbreak event was that large numbers of secondary cases occurred after the epidemic, ascribed to as carriers of the disease. It was suggested that a special programme had to be introduced to monitor and manage an expected scenario. Several groups of experts offered advice to the local municipality for future action. For example, Watertek, SAIMR and Wits were mentioned in this respect. It was also recorded that the Department of Microbial, Biochemical and Food Biotechnology of the University of the Free State had tested the water at Delmas for a possible detection of the pathogen *Salmonella typhi* in 2005 but the overall finding was:

We have no conclusive evidence that the [detection of] these S.typhi bacteria [that they indeed found] are alive" when entering waters utilized for human consumption.

From a safety perspective the outbreak of violent protest, especially in Botleng, in 2005 was a disconcerting trend in civil society. Many of the activities were associated with a wave of activism that had been afoot in many parts of South Africa for a considerable period of time. In many of the country's communities there were active indications of large-scale activism aimed at protesting against service delivery and supply of local authorities. The government, in the era of President Thabo Mbeki (1999-2008) frequently called for order and specifically asked local authorities to improve on their service to the communities they served (Tempelhoff, 2009:30-53) 1. Ultimately, the Mbeki-administration suffered several hard political blows as a result of issues over local service delivery. On the state of affairs in Delmas, Mahlangu in 2006 reported to the Mpumalanga Provincial government (Mahlangu, 2006:8-17):

Delmas has been a unique case because of the dolomitic bedrock in the area where, for example, the Mandela informal settlement is located. The Municipality has purchased portions two and nine of the Farm Witklip. 360 building stands have been allowed on this farm as the rest of the land is unsuitable. Internal services for the 360 stands have been completed. Construction of the toilets has commenced and it is envisaged that it will be complete by the end of July 2006. After this process, 360 families will be moved to settle in this area. As this happens, 360 bucket toilets will be eliminated. Council intends to purchase portion six of the farm Middelburg 231 IR and Leeuwpoort, to develop a further 1500 stands. The application to purchase this land is currently with the Department of Land Affairs (DLA)...as you are aware there was a typhoid outbreak in Delmas last year. I am happy to report that the challenge and outbreak is controlled. Tap water is safe to drink in Delmas. As part of our turn-around strategy, we have connected the C wellfield borehole to the main reservoir. Previously the C wellfield borehole was supplying water directly to Delmas West residents from the chemical dosing plant. This did not give the water enough contact time with the chlorine which caused a risk for contamination and increased the risk of stomach ailments. Both the departments of Local Government and Housing and the Water Affairs and Forestry each contributed R1.25 million for the connection of the potable water supply pipe. We will officially hand over this project to the community of Delmas before the end of June this year. As part of the long term plan and heeding the 1993 report, we are looking at the possibility of connecting Delmas to the Rand Water Supply. The important and critical challenge, however, is to raise R100 million needed for this.

From this feedback on Delmas, the invaluable contributions of several government departments and specialist institutions were acknowledged. They included DWAF, the departments of health, provincial and local government (DPLG), agriculture and land administration as well as the provincial department of Health and Social Services, the department of health of Gauteng Province, Nkangala District Municipality, Council of Geoscience, Premier's Office of Mpumalanga Province, Ekurhuleni Municipality, South African Defence Force (SANDF) and Kumba Mine. As a result of the limited capacity of the Delmas potable water and sanitation infrastructure, the Mpumalanga provincial government in 2006 approved for the allocation of R30 million to revamp the Delmas potable water and sanitation infrastructure (Provincial Government, 2007; WISA, 2008:8).

Based on the 2006-2007 annual report of the Delmas Local Municipality, the health status of the community was still questionable and needed to be compared with past statistics to obtain a reliable impression. The report identifies the inhabitants of Botleng as still suffering under circumstances of bad health. During the report year no less than 20 044 patients had been treated with the Botleng Extension 3 clinic next in the row to treat 18 013 patients and the Dumat clinic as well as the mobile clinic respectively treating 14 530 and 3 240 patients. The total number of patients for the year amounted to 55 827. This represented an inordinately high number for a rural community like Delmas.

2.3 The diarrhea outbreak of 2007

When Delmas was once again in the news in November 2007, with one infant death 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 would not be affected. Shortly after the outbreak at Delmas, residents of Bronkhorstspuit, situated in the Kungwini Municipal area were concerned about water pollution in the Bronkhorstspuit 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 Bronkhorstspuit Dam (Keppler, 2007). Meanwhile Mumalanga'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, proved to be negative (Viljoen, 2007).

The provincial department of Water Affairs in Mpumalanga consistently maintained that Delmas' potable water was safe for drinking. Officials of the department and also the local authority took water samples daily for water quality tests. The provincial department had also made available R750 000 to appoint a private contractor to help the Municipality improve its management capacity of the municipal potable water works (Essop, 2007). Water quality tests conducted on the potable water supply of Delmas on 1 November 2007 proved that nothing was wrong with the potable water. This was consequently the provincial department's standpoint for maintaining the view that the potable water was uncontaminated. However, it was admitted that tests on borehole water in the vicinity suggested that the water could be contaminated. For that reason the abstracted borehole water was treated with chlorine. According to the municipal officials, low levels of chlorine contamination could have been responsible for the chlorine. On 22 November 2007 it was reported from Cape Town that the parliamentary portfolio committee on water affairs and forestry intended visiting Delmas to see

for themselves what was going on in the town that was experiencing its third November month of problems with local water in four years (Essop, 2007).

From the exposition given above it is possible to deduce that during the past three years the Delmas Municipality frequently came under severe public pressure as a result of local physical and man-changed environmental issues putting pressure on the health status of its inhabitants. Some sources scrutinized reflect the views contained in various governmental reports in which the statements accentuate overwhelming positive accounts regarding aspects such as the water quality of Delmas (compare Mahlangu, 2006), whereas others started questioning the water quality standards in South Africa in general because of the recent water problems Delmas have had, which is regarded as a micro example of a broader problem in especially rural areas that needs to be addressed (Compare Report Card, 2007). Whistle blowing reports by the press from time to time have also put some pressures on a maybe incapacitated Delmas Municipality.

In 2007 DWAF produced yet another report as a debate to determine other links of a possible outbreak of diarrhoea in the Delmas area. By 2009 difficulties in water quality and questions about insufficient water management locally were still controversial issues that required an extensive recap of past activities and several adaptations since to determine to what extent solutions and support in future is required (Compare DWAF, 2008).

Lastly it needs to be mentioned that it is clear from a scrutiny of recent scientific reports and news releases that, from a government perspective, they unfortunately failed to speak the language of the general public when warning them against the local environmental health risks of inter alia, living in a disadvantaged informal settlement. The danger of sinkhole formation in the dolomite underlain and abandoned areas and sights, and its possible effects on surface- and groundwater contamination if sewage spills and insufficient storm water and sanitation infrastructure exist, should more effectively be communicated on grassroots level and in ordinary every-day language.

It remains important to also consider the institutional capacity for disaster management in the Delamas area as compounding factors to an already volatile situation.

3 DISASTER MANAGEMENT INSTITUTIONAL CAPACITY

In order to determine the history of disaster management in the Delmas Local Municipality knowledgeable disaster management officials at both local and district level were consulted. These

officials were asked to answer various questions with regard to the current structure of disaster management in the local municipality, how disaster management was involved in previous hazard/disaster events in the area as well as the challenges facing disaster management officials in the municipality. Importantly are the context in which the questions were answered. Within the Delmas Local Municipality, disaster management resorts hierarchically within the fire service function unit of the Directorate: Operational Services.

With regards to disaster management structures, limited capacity exist at both local and district level. On local and district levels, disaster management officials have been appointed (usually with a dual function as is the case at Delmas Local Municipality) to carry out the task of disaster management but neither level currently has a functioning disaster management centre from where relief and response efforts can be coordinated in the case of a disaster. On District level there is a concerted attempt to establish a disaster management center and Delmas Local Municipality aims to establish a satellite disaster management centre as soon as facilities become available. No timeframe has been linked to these developments.

The current Disaster Management structure makes provision that during the emergency response phase of a disaster, before the event is declared as a disaster, the disaster manager forms part of the response team. Depending on the size of the incident the disaster manager should assume the function of Incident Commander/coordinator. When the incident is deemed to be a disaster, as was the case in 1993, 2005 and 2007, a Joint Operation Centre (JOC) is established, and the disaster manager becomes the coordinator of the response function. During the recovery and rehabilitation phase the Disaster Manager serves on the JOC as part of the coordination team, mostly in an advisory capacity and takes responsibility for the occupational health and safety aspects involved in these phases. The main activities of the disaster management officer with regard to a disaster event can therefore be condensed to the overall command of emergency operations, coordinating of duties and resource management. The disaster manager also plays a major role in times between disaster events through the coordination of for example, schools projects that relate to disaster management.

During the previous epidemiological disaster events (1993, 2003, and 2005), disaster management officials within the Delmas Local Municipality experienced various difficulties that have impeded their ability to respond to disaster events in an efficient and effective manner. The most notable of these difficulties has been the lack of overall command and control of specific situations. This usually results in either the duplication of work or neglecting some of the important facets of emergency response such as the safety of the responders. Another huge challenge encountered by disaster management officials during the handling of previous disasters was the interference of the politicians. Incidents

were often politicised at the expense of the community in need of assistance and relief. The availability of resources in the initial stages of disaster response is also a great challenge to disaster management officials. There is no budget available to acquire reserves in terms of tents and basic survival kits and this problem is further compounded by the challenge of safe storage of the resources that have been received.

Current procurement policies also increase the challenge of urgently acquiring the necessary resources needed to respond effectively to a disaster. Resources often have to be procured from district and provincial disaster management structures and then the acquired resources have to be obtained from either Middelburg (district) or Nelspruit (provincial), thereby slowing down the local municipalities capacity to respond even more. The final problem that the local municipality has faced in the past, was reluctance from other departments to assist in the management of the disaster as they perceive the disaster event not to have an immediate effect on their departments whilst they could actually play a crucial role in the effective response to a disaster (e.g. social services in the distribution of clothing, food parcels, etc to the affected people, or public works department when the need arise for creating diversion dykes in the event of heavy rains threatening communities of flooding). Many of the problems disaster managers at Delmas Local Municipality face are further augmented by the lack of funding, lacking material resources and insufficient human resources.

To counteract most of the difficulties described above, disaster management officials in Delmas Local Municipality aim to increase communication between departments in the local municipality as well as external agencies in order to streamline the availability of resources in the event of a disaster. Training will be provided to politicians to enable them understand their place and role in the established incident command system, with a view to improving their contribution to the operations and response function. Funding will also be acquired at local level to ensure the acquisition of resources as well as the safe storage thereof.

From the reseach it became evident that the current focus and attention within the local municipality still remain disaster response oriented. This can be ascribed to the fact that the traditional response agencies are also responsible for disaster management. It is thus logic that disaster management will only be viewed as a response to a given situation. The fact that the disaster management function is also not given high priority in the management and hierarchy of the municipality is a clear indication that disaster management is not implemented as it should be according to national legislation, policies and guideline.

The following section will shed some light on the organisational structure of the Delmas Local Municipality.

4 DELMAS LOCAL MUNICIPALITY

The Delmas Municipality is a Category B Local Municipality under the jurisdiction of the Category C Nkangala District Municipality situated in Middelburg, Mpumalanga Province. The District Municipality was awarded the prestigious VUNA Award, as the best district municipality in South Africa during 2004 and 2006, for municipal service excellence (NDM, 2009).

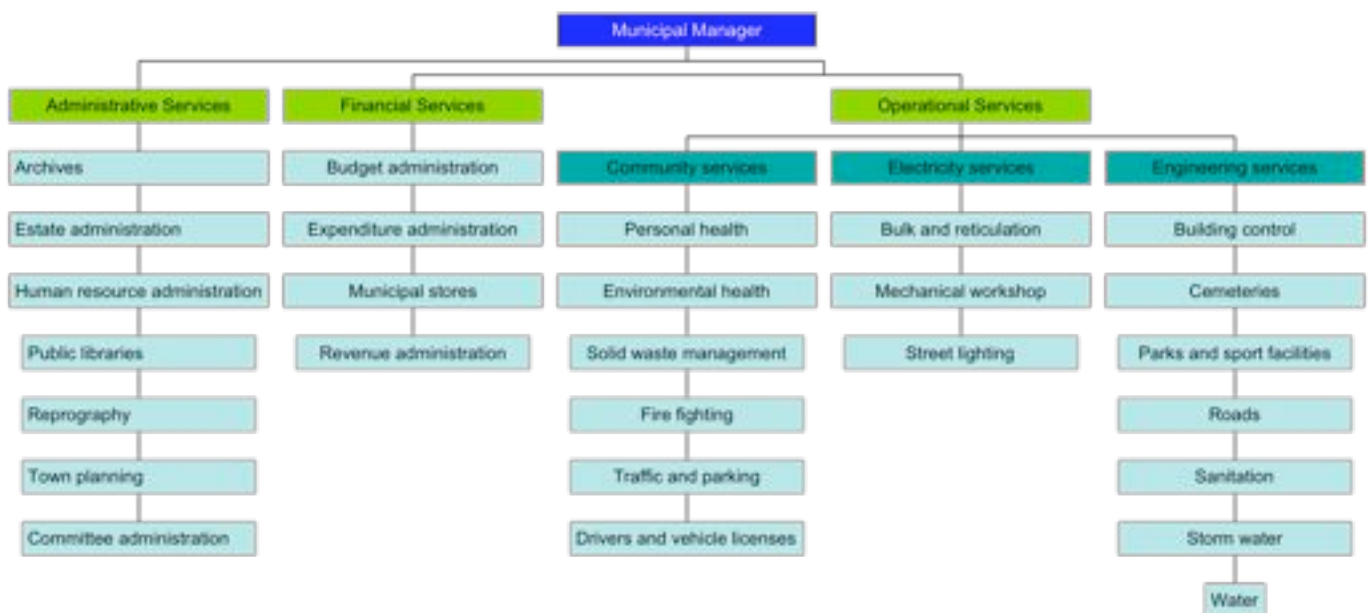
Delmas' population is estimated at 56 208 people of which women comprise 51.4%. The major language group is IsiZulu (37.1%), followed by IsiNdebele (25.6%), and in turn followed by Afrikaans (15.1%). The population is organised in 13 389 households. Of these households 8 304 live in formal houses; 9 462 households have running water on their sites; 8 523 have flush sanitation on site; 8 687 households have electricity. From approximately 23 000 employable people, an estimated 13 236 enjoy full-time employment. The employment rate is also reflected in that 9 495 families earn less than R19 200 per annum. The local economy is growing between 2.9% and 3.2% per annum (Delmas Municipality, 2006).

A collective executive system combined with a ward participatory system in terms of the Local Government: Municipal Structures Act, 117 of 1998 is in place. The local municipal council consists of 15 councillors: eight councillors are directly elected from the eight municipal wards and seven councillors are proportionally elected and therefore represent the major political parties (Delmas Municipality, 2006). The Municipal Council is chaired by a speaker. Ordinary meetings of the council are usually held on the first Monday of the month at 17:15 in the council chamber. The executive function of the council is seated in an executive mayor. The executive mayor has a mayoral committee of three members. To assist the executive mayor and the mayoral committee with its executive function, the following portfolio committees were established:

- Finance, administration and human resource;
- Economic and social development ; and
- Planning, infrastructure, transport and safety.

The municipal manager is the head of administration in the Municipality. The administration is divided into the following three directorates and subordinate units (Delmas Municipality, 2006):

Figure 1: Organisational chart of the Delmas Local Municipality



4.1 Organisational structuring regarding potable water and sanitation

In comparison to the ideal locality, visibility and ample parking (easy access) of the Delmas Municipality in the Town (next to the new Pick & Pay mall), the organisational unit responsible for the potable water supply, storm water and sanitation (Operational Services) unfortunately is situated in a very dilapidated and hidden FC Dumat Building in the centre of the CBD with no clear direction and information signs, boards, unsafe parking, disturbing dirty entrance etc. This organisational aspect might be indicative of a low priority section with very limited clientele service rendering, access, transparency and enticing citizen participation.

The potable water demand of the Delmas town area is about 16 Mℓ per day (Mℓ/d); about 10 Mℓ of this demand are abstracted from the groundwater well fields consisting of 17 boreholes of which only 10 are currently in operation. The remainder of the potable water demand is being 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 Municipality, Sundra & Eloff, the current volume is thus inadequate to supply the whole of Delmas with constant water supply. Due to shortage of supply in Delmas, especially in the dry season, the water is periodically diverted to augment the Delmas supply. In spite of this augmentation practice, the Municipality is unable to keep the potable water reservoirs at elevated levels. This is most probably due to water losses and leakages in the reticulation system but since a water-balance has not been done up till now, the unaccounted-for potable water figure is unknown.

The older established part of Delmas Town has two potable water reservoirs (5 Ml & 6 Ml) and two newer potable water reservoirs are in Botleng (3,2 Ml & 6 Ml). These reservoirs are fed from the boreholes extracting water from the 3 dolomite aquifers, 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/day). 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 wastewater before effluent of an acceptable quality is released back into the natural surface water streams draining northwards. The effluent of both facilities has been shown in the past to exceed the allowable limits prescribed in the license conditions. The receiving surface water resources are therefore being polluted after receiving the discharges. The older one of the two wastewater treatment facilities (WWTF) is situated closer to residential areas of the Town centre. It has a capacity of 5 Ml/day activated sludge type with maturation ponds. The facility is situated about 3.5 km upstream of the A well-field; the dolomite groundwater aquifer is thus directly downstream of the natural catchment of the stream receiving the effluent of the WWTF.

It now has been decided and approved by DWAF 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 in a year's time. From a holistic, integrated and water catchment orientated potable water management perspective the 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 turning into an underutilized 'white elephant'?

Another most 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 looming disasters due to the forming of cracks, ponors and sinkholes. This aspect warrants urgent and complete geophysical research and surveys and optimum transparency about the findings as well as optimum access to all role-players and stakeholders concerned. Especially a municipal area utilizing its groundwater resources and creating the lowering of the natural groundwater level - the same looming scenario manifests here as at the now almost devastated and down-run West Rand towns of Bank, Westonaria and Carletonville during the 1960s. The existence of and forming of new

sinkholes and maybe ineffective municipal management of a sensitive physical and man-changed environment can only lead to catastrophic consequences.

The Municipality's Vision is 'To provide a better life for all members of our community by striving to provide quality services and active participation'. In its strategic planning the following serious challenges have been identified that the local municipality has to contend with:

- Urbanisation with a rapid population growth;
- The urban area is not functioning optimally as a result of past planning policies (separate residential areas);
- Low economic and employment growth in the urban area as well as a decrease of work opportunities in the agricultural sector;
- Unemployment;
- Limited business and industrial sectors;
- Uncontrolled overspill of economic activities from Gauteng into the municipality;
- Geologically the area is underlain by dolomite bedrock influencing the urban form and town planning;
- High potential agricultural land competing with mining operations and urban extension;
- Limited municipal budget resulting in ineffective implementation of development policies;
- Closing of mines, with available housing infrastructure, at the wrong locality (not cost effective to provide services);
- Dispersed and fragmented towns (Botleng Proper in relation to Delmas, and Botleng Extensions 3 and 4 in relation to Delmas and Botleng Proper);
- Employment opportunities in Delmas Central Business District (CBD) and adjacent "Industrial" area, Commercial/Business development - Rietkol area, and at the mines throughout the area;
- Informal settlements (7) present in the area and influx of people due to farm evictions;
- Homelessness;
- Poverty;
- Dangerous pollution of all the spruite, wetlands, rivers, dams, canals and soil; and
- Pressure on use and 'mining' of groundwater reserves for municipal and irrigation purposes (Delmas Municipality, 2006).
-

Circumstantial evidence suggests that these challenges have everything to do with the manner in which the local water supply has been responding in recent years.

5 WATER AND SANITATION MANAGEMENT AT DELMAS

In addition to all the aforementioned challenges the lack of an effective, efficient, economic and sustainable water and sanitation management plan is of primary importance – especially in an area where potable water is being abstracted from groundwater boreholes in dolomitic water aquifers. The dangers of direct pollution of the underground water reserves as well as the forming of cracks, ponors (shallow ground surface subsidences) and sinkholes (due to the dolomite) in urban and developed town areas must be acknowledged, surveyed, demarcated and managed responsibly.

The demarcated municipal area (responsibility area) of the Delmas Municipality are roughly delimited according to the surface water drainage region boundaries - except for the North-east rise of the Blesbokspruit on the farms Droogefontein South-east of Sundra as well as the Southern rise of the Kromdraaispruit in the upper tributary of the Wilge River on the Eastern side of the Municipal area. These pleasing circumstances 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 Municipality and thereafter the rest of the magisterial area. There are municipal administrative offices in Botleng and Sundra with limited functionality. All municipal functions are managed and controlled from the Municipality's neat and fully accessible offices situated next to the new Pick & Pay Mall in the Delmas CBD. See Map 3 for some more information on for example the extent of the Town's suburbs, townships and location of groundwater production borehole fields.

5.1 Groundwater quality

There is consensus that the groundwater quality of Delmas has been compromised. The local groundwater aquifer has been subjected to:

- Salinisation – concern for the increase in salts mainly as a result of anthropogenic causes such as discharge of industrial effluents, irrigation returns flows and urban runoff;
- Eutrophication – concern for the increase in plant nutrients (phosphates and nitrates) resulting from treated sewage effluent discharges to rivers and streams, and causing excessive algal growth (including toxic blue-green algae) in dams and rivers with associated taste and odour problems and increased water treatment costs; and
- Bacteriological contamination – concern for rising faecal contamination levels associated with increasing population densities and inadequate sanitation levels especially in regard to informal settlements (Hobbs, 2004).

One report (GCS, 2006) points to a wide spread 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 the micro and macro constituents in most of the groundwater production boreholes except borehole C2 which shows elevated levels of Arsenic. However, this observation is based on a 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 due to the high levels of Mn and Fe in its abstracted water.

5.2 Potential sources of microbial groundwater pollution

According to Mthetwa (2008), the different land-uses by inhabitants of the area have been identified as potential sources of human and animal waste since microbial agents have illustrated to be the major problem on the surface as well as the groundwater qualities monitored in the municipal area. Therefore the first step 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 3 (Compare Mthetwa, 2008):

Table 2: Identified potential microbial sources at a local scale

Site name	X coordinate	Y coordinate	Surface elevation (mamsl)	Distribution category	Types of pollutants	Risk effect
Kraal 1	-2891223	-30117	1500	r & P	f & n	high
Kraal 2	-2890630	-30584	1552	r & P	f & n	high
Kraal 3	-2888886	-30633	1537	r & P	f & n	high
Kraal 4	-2888634	-31283	1546	r & P	f & n	high
Kraal 5	-2891600	-30078	1542	r & P	f & n	high
Kraal 6	-2891214	-30000	1544	r & P	f & n	high
Kraal 7	-2891200	-29997	1546	r & P	f & n	high
Kraal 8	-2891715	-30246	1478	r & P	f & n	high
Kraal 9	-2891762	-30354	1547	r & P	f & n	high
Kraal 10	-2891762	-30584	1546	r & P	f & n	high
Sinkhole 1	-2889061	-30656	1537	r & P	f & n	high
Sinkhole 2	-2888981	-30631	1537	r & P	f & n	high
Sinkhole 3 / dam	-2888900	-30623	1536	r & P	f & n	high
Sinkhole 4	-2890638	-29935	1537	r & P	f & n	high
Sinkhole 5	-2890611	-29859	1539	r & P	f & n	high
Sinkhole 6	-2890625	-29827	1537	r & P	f & n	high
Sinkhole 7	-2890620	-29186	1541	r & P	f & n	high
Sinkhole 8	-2890631	-29786	1538	r & P	f & n	high
Sinkhole 9	-2890610	-29718	1537	r & P	f & n	high
Sinkhole 10	-2890624	-29676	1538	r & P	f & n	high
Sinkhole 11	-2890754	-30017	1543	r & P	f & n	high
Sewage pipe leak 1	-2892065	-31336	1552	r & P & D	f & n & t	high
Sewage pipe leak 2	-2892081	-31328	1552	r & P & D	f & n & t	high
Sewage pipe leak 3	-2892129	-31276	1548	r & P & D	f & n & t	high
Sewage pipe leak 4	-2892088	-31321	1553	r & P & D	f & n & t	high
Sewage pipe leak 5	-2892156	-31256	1549	r & P & D	f & n & t	high
Sewage pipe leak 6	-2892097	-31312	1549	r & P & D	f & n & t	high
Sewage pipe leak 9	-2890671	-29952	1498	r & P & D	f & n & t	high
Sewage pipe leak 10	-2891494	-29898	1531	r & P & D	f & n & t	high
Sewage pipe leak 11	-2891515	-29910	1544	r & P & D	f & n & t	high
Domestic	-2888627	-31164	1548	r & P	s & o & n	high

furrow						
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mamsl = metres above mean sea level (elevation of ground surface)

u / r = urban / rural

P / L / D = point / line / diffuse pollution source

n = nutrient compounds

f = faecal pathogens

o = overall organic load

t = toxic organisms

s = salinity

During a field visit by one of the researchers to Delmas, a disturbing informal or unofficial dumping of refuse in big excavations right next the linking road of Botleng Proper and Botleng Ext 4 up-stream of the groundwater abstraction boreholes of the B well field was spotted. Surely this should have been prevented, regulated and clear warning signs be erected to inform the transgressors of the impact of their actions to the pollution of their own drinking water in the long run?

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

- The November 2007 diarrhoea outbreak was most 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 responsible research team with no other option but to declare the tap water as safe. Results from other, more specialized tests substantiate that the sustenance of the outbreak could not have been due to adverse tap water quality. The outbreak however still continued for at least 5 weeks after the "safeness" of tap water was scientifically confirmed.
- No evidence was found that led the research team to believe that deliberate action led to the low free chlorine levels that was recorded in the potable water supply. The low levels were rather due to at least 2 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 run-off 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 pipe-line. The latter water is disinfected by means of chloramination, which differently to chlorination, displays a "natural" 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 will result in a further reduction in the free chlorine residual levels.
- Both wastewater treatment facilities (WWTF) of the Town are suspected to mostly discharge 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 the constant pollution of the environment through Botleng Proper and Mandela Park. These discharges by the WWTFs as well as polluted run-off from the residential areas could therefore be regarded as the primary source for the unhealthy environment that prevails in- and the surrounding areas of Delmas.
- 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 polluted. Results generated on 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 Geo-hydrology, DWAF, stated that the quality of the groundwater could be declining due to default recharging of the groundwater resource by polluted surface water (stream & run-off). 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).

- Delmas Municipality is complying with the Drinking Water Quality Management Legislation; Regulation 5 under Section 9 of the Water Services Act (Act 108 of 1997). The Municipality has been monitoring abstracted borehole water from an operational perspective and has been depending 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 the municipal tap water was complying with the Microbiological Safety Requirements of SANS 241:2006, the National drinking water quality standard.
- The Municipality has failed to comply with Section 21 of the Water Services Act (Act 108 of 1997) to make and enforce Bylaws for the conditions of the provision of water services. Especially 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 under the Water Act of 1956.
- The quality of discharge at the Town's wastewater treatment works does not meet the License/General Authorizations conditions as set according to the National Water Act of 1998.

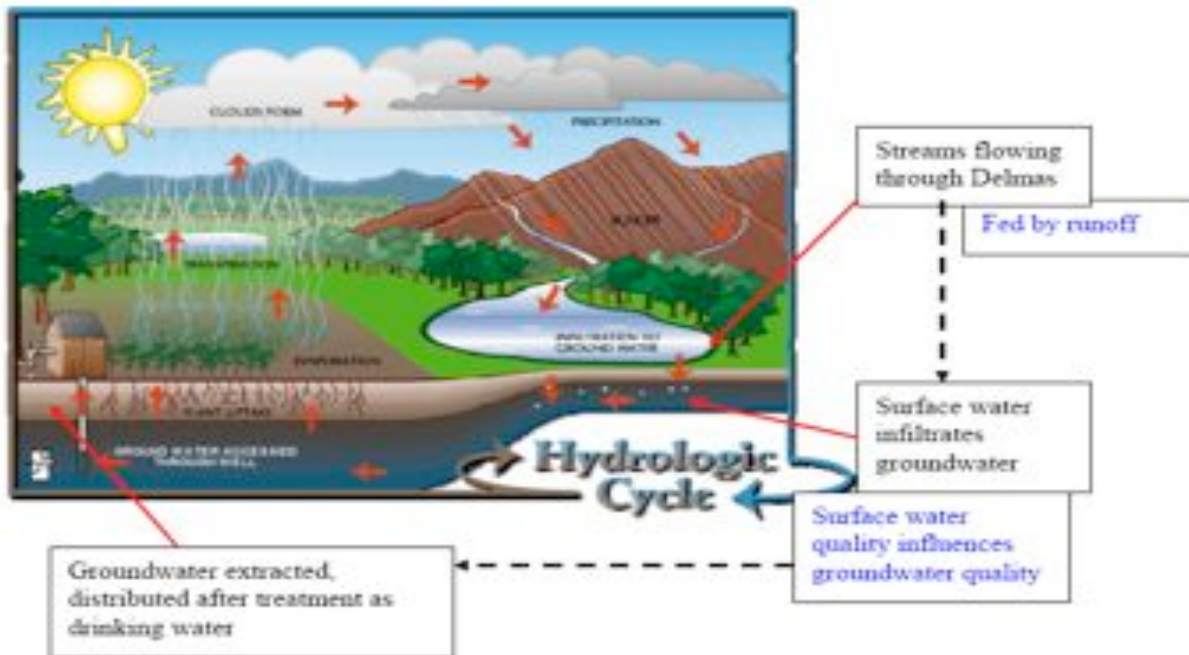
6 GEO-HYDROLOGICAL CHARACTERISTICS OF IMPORTANCE

6.1 Topography and surface drainage (hydrology)

The topography of the geographical area of Delmas Municipality is relative flat with gently undulating areas, plains, slopes and several scattered hill crests. The average surface elevation is ± 1580 (mamsl) and the area is mostly characterised by plains with some small rocky hills (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 mostly a few depressions / pans are found within the Delmas area. To proceed with an analysis of the hydrology and geo-hydrology of the area, a thorough understanding of the different phases of the Hydrological Cycle regarding water management is a must and is henceforth presented in Figure 2:

Figure 2: Nature of the geo-hydrological cycle in water management (DWAF ??? Johann???)



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, 2006b). Due 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 hence the water level of the Delmas dolomite aquifer is relatively flat mimicking the topography of the area. The Delmas groundwater management plan report shows an 86% correlation between groundwater level and surface elevation and therefore certifies that the groundwater level mimics topography.

Delmas is situated within the Upper Olifants River catchment area. The surface drainage of the Delmas region is towards the North through the Bronkhorstspuit which feeds the Bronkhorstspuit Dam. According to DWAF (2007b) most streams and rivers in the Delmas area tend to have a northerly flow direction and most rivers 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 this report, the following up-stream tributaries of the main Bronkhorstspuit, passing the Town on the eastern side, are identified and named (see Map 3 hereunder):

- 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;

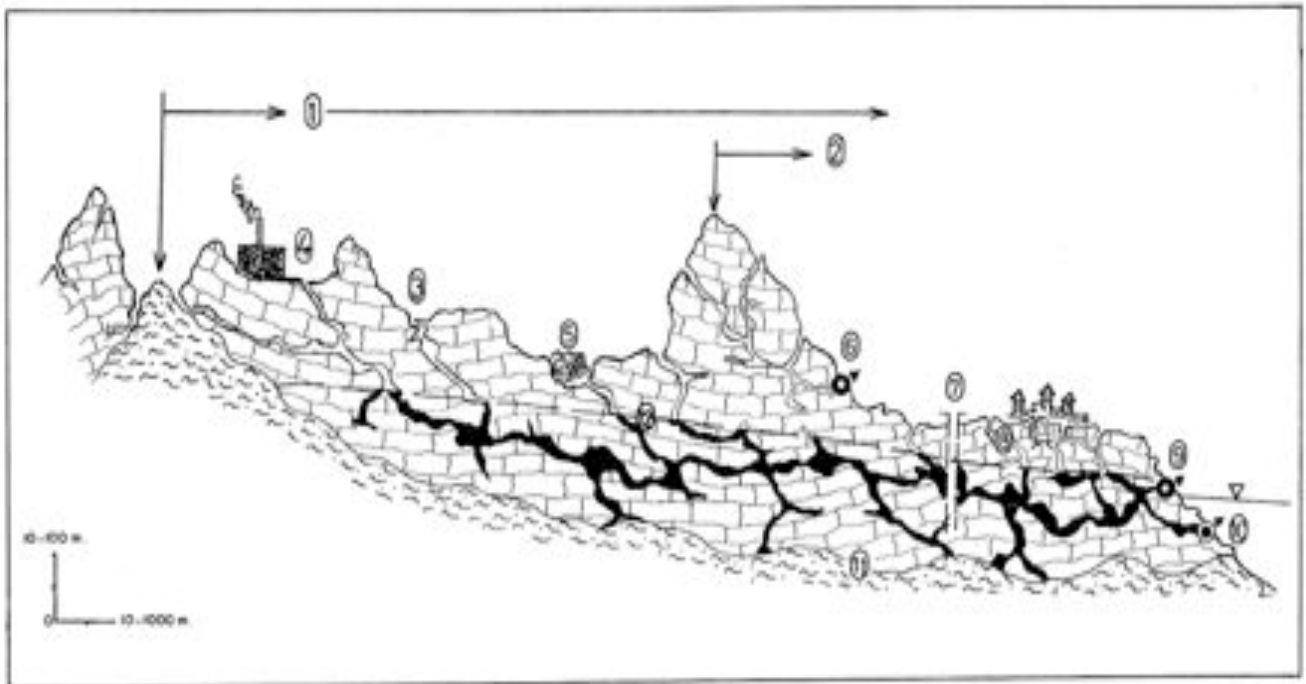
- The Delmasloop starts at the Witklip Dam and flows through the center of Delmas' CBD past the Sewage Disposal Works and joins the Welgevondenloop on the Eastern side of Botleng Proper Township;
- Botlengloop up to the confluence with the main Bronkhorstspruit at Mapandus and Sun Valley immediately 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 results that the Dwars-in-die-wegvlei drains southwest in the Aston Lake and can be left out of the Delmas Town equation regarding water management. The same argument counts for the Koffiespruit and Klipspruit passing the 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.

6.2 Nature and extent of the geo-hydrology

The geo-hydrological properties of the underground dolomite rock formations are determined by geologic 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 distinguishable based on 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 which will enhance the process of weathering. These chert rich formations are generally favourable for large-scale identification, development and abstraction of groundwater. See Figure 3 hereunder (Compare Mthethwa, 2008):

Figure 3: Karst features and utilization of the dolomite aquifer for water supply and waste disposal



(1) boundary of underground watershed, (2) boundary of surface drainage area, (3) ponor (swallow hole), (4) disposal of industrial waste water into a ponor, (5) solid waste disposal into a karstic depression, (6) karst spring (with limited watershed area), (7) water well, (8) disposal of municipal waste water into karst aquifer, (9) karst spring, (10) submarine karst spring, (11) base of karstification (impervious basement).

According to the Leskiewicz report (1986) and GCS (2006) the dolomite in this region extends over a large area, which by means of intrusive dolerite dykes is divided into four geo-hydrological underground compartments (maybe having different geo-hydrological characteristics), namely 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, 2006b). The dolomites to the north of the Delmas Town 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, 2006b). This group is classified as a major groundwater aquifer due to weathering and fracturing which result in karst formation particularly in the chert rich horizon. The water of Delmas is classified as freshwater. Freshwater in the area may be derived from surface sources and groundwater aquifers. Surface water is all the water 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 of the less treatment it requires, is consequently often the preferred sources 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 which over the years were drilled into the aforementioned dolomite formation and are utilised by the Delmas Municipality to supply the Town, urban and peri-urban neighbourhood with potable water. The recent drilled boreholes (2003) are yielding groundwater abstraction rates of between 6 and 30 litres/second (l/s) (GCS, 2006) while studies conducted by DWAF indicate possible groundwater abstraction rates of more than 50 l/s from this area (Leskiewicz, 1986). See Table 2 hereunder and Map 3 for information on and the localities of the current groundwater production boreholes in and around the Delmas Town (See GCS in VGC Consulting, 2006):

Table 2: Information on well field boreholes

Borehole Identification number	Static water level (mbgl = metres below ground level)	Depth of main groundwater strike	Borehole depth (mbgl)	Maximum allowable groundwater level drawdown	Borehole yield (l/s = litres per second)
A1	21.2	?	60	40	?
A3	23	?	47	31	?
A4	29	?	76	50	?
A7	29.15	64	112	59	?
B2	32.8	?	?	?	?
B4	55.16	98	181.18	93	?
B5	63.9	145	176.3	140	?
B6	64.7	95	110	90	?
B7	52.4	100	130.3	95	?
B8	47.1	92	102.3	87	?
C1	33	?	?	?	?
C2	57.5	?	?	?	?
C3	51	?	?	?	?
C4	17.4	?	?	?	?
D5	9	?	?	?	?
D10	8.8	?	?	?	?
					?

The lack of statistics for especially the production boreholes as shown in the aforementioned Table 2 is disconcerting – it indicates a lack of knowledge in the Municipality about, or unwillingness to accept the responsibility for effective data management which may probably stem from a lack of knowledge about managing any groundwater source.

According to DWAF (2007a) the low density of run-off 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.

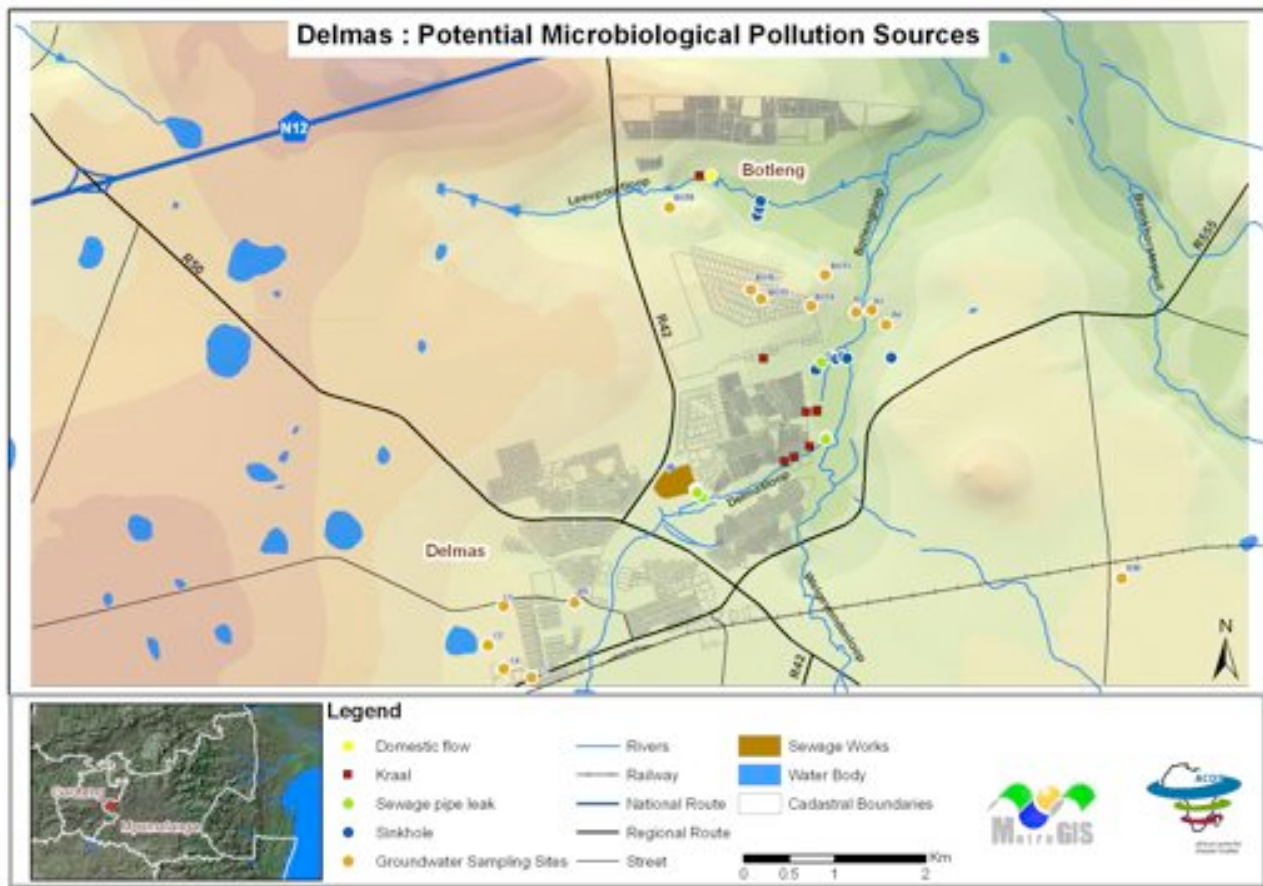
The nature and extent of the geography, hydrology, geology and geo-hydrology must be shared with all actors (role-players and stakeholders [citizens]) concerned. So for example, must the nature of the

underlying dolomite rock formations, the water flow in and through it, the existence of sinkholes in the bedrock as well as the dangers of new sinkholes forming be managed in a transparent manner with optimum access to all. The IDP of the Municipality is an impressive and well planned and presented document with one major flaw and oversight: it does not identify the existence of and potential disasters looming in the bedrock sinkholes, cracks and ponors (shallow holes).

6.3 Groundwater level

Griesel et al. (2006) in an investigation of an integrated water quality monitoring programme conducted in the town of Delmas, November 2005 to June 2006, have concluded that the groundwater in the Delmas area is sensitive to rainfall events – therefore, high groundwater recharge rates are expected. That could also mean that the underground water aquifer is vulnerable to direct surface contamination (GCS, 2006). GCS (2006) also identified that the groundwater level response to rainfall within boreholes in the A well field is immediate; hence the groundwater aquifer around this area is classified as unconfined (open). The groundwater level in the A well field is also the second shallowest compared to the other three B, C and D well fields which range between 21.2 and 29.2 mbgl. See Map 3 for the localities of the four respective well fields.

MAP 3: Delmas locality map with groundwater abstraction borehole positions and possible pollution sources



The nature and extent of the four different groundwater abstraction well fields (A, B, C and D), the treatment of the abstracted borehole water, the storage of it in water reservoirs and the reticulation of it in some instances differ throughout the Delmas town area and this must be explained and indicated to the tax payers and citizens in laypers’n’s language. So for example must the users and consumers of water in the Delmas-Wes area know and understand that their potable water comes from the C and D well fields, that the water is chemically treated at the boreholes itself before it is pumped directly into the water reticulation pipeline systems, and that their used water (sewage) eventually ends up at the oldest WWTF immediately north of the town’s golf course for aeration, flocculation, settling and chemical treatment before release of the effluent into the Delmasloop draining through the Botleng Proper township towards the down-stream groundwater abstraction well fields A and B.

7 CONCLUSION

In conclusion it is possible to agree with Genthe and Steyn (2006:3) who remarked that the typhoid epidemic in Delmas has illustrated how important inter-departmental collaboration is to deal with a public health problem. As it is not only an assignment of for example the departments of Health and Social Services, Water Affairs and Forestry, Local Government and Housing, and Agriculture and Land Administration as well as the Local Delmas Municipality.

Poor access to safe water and the provision of adequate sanitation is a group effort, though all group efforts are doomed to failure if there is one weak or weakest link. A question to be debated and addressed is to determine where that the weak link for the Delmas Municipality is and if it indeed is only one link that is problematic or perhaps more?

8 RECOMMENDATIONS

The following recommendations are made to improve the nature of municipal management and development in the Delmas municipal area:

- A well planned and managed skills and knowledge audit in the municipal area must be carried out. The audit of the area will find that there are enough experienced and skilled geo-hydrologists, 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 which can be utilized by the Municipality, DWAF and other governmental authorities as indicated earlier (No need to import an expensive consultant from Australia!).
- A well planned and managed land-use survey (with clear big-scale and effective identification, surveying, demarcation and mapping) in the whole surface water catchment of the Delmas Municipality must be carried out.
- The current state of the Municipality's potable water supply, sanitation and storm water infrastructure must be inspected, tested, maintained and perhaps upgraded with the view of improved sustainable basic service rendering.
- The under-performance of the Town's two WWTFs should be regarded as the direct cause for the unhygienic conditions that exist in and around the Delmasloop that 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 compelled to:
 - Compile a practical waste water management turn-around plan;

- The older WWTF should be given urgent attention since its effluent has a detrimental impact on the A well field aquifer. The effluent outflow must be consolidated and disinfected properly;
 - Process Controllers, who are adequately skilled and comply with the educational requirements as stipulated in Regulation 2834 under the Water Act of 1956, must be appointed and registered with DWAF;
 - DWAF must ensure that effluent quality is monitored and recorded. This information should be used to gauge tendencies of improvement, as well as to initiate intervention when so required; and
 - A new full conventional WWTF (flocculation; filtration & disinfection) needs to be put in place - all groundwater should also be subjected to treatment prior to distribution (DWAF, 2007b).
- A well planned and managed holistic and integrated orientation programme must be launched and maintained of informing, training and motivation of all actors (role-players and stakeholders) concerned to inculcate an institutional willingness to look, listen, learn, read and do research about the achieving of an improved municipal and environmental management in the Delmas municipal area – especially an understanding of the geo-hydrological cycle, the origin of its potable water, the handling of the waste and storm water and lastly the destiny of the used water, solids and refuse.
- The dolomite sinkhole areas of the Town call for urgent and new municipal management protocol and should be acknowledged and managed as such by the major role-players (Municipality, DME, Geo-Sciences and DWAF) 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 realised.
- An effectively planned and managed paper trail, record keeping, computer based information bases and water footprint in the area of effective, efficient, economic and sustainable water management according to the macro-surface water catchment area should be planned, initiated, incorporated and maintained by the Delmas Municipality. Special attention must be given to the volumes of groundwater abstracted through the different boreholes in the 4 well fields, fluctuations of groundwater levels, water quality monitoring system and any movements in the ground linked to the forming of sinkholes. It would be in the best interest of all Delmas residents if a Water Safety & Security Plan is drafted and implemented. This plan should be based upon the principles of the World Health Organization and follow the model as been developed by the Water

Research Commission. Such a plan will allow the Municipality to manage drinking water quality as stipulated in the Framework for Drinking Water Quality in 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 the slumbering developmental potential regarding development aspects such as agriculture, economy, accommodation and hospitality – especially in an area on the outskirts of the country's dynamo-hub in hosting major events like the Soccer World Cup in June 2010.
- Residents of Delmas must be informed about the nature and extent of their potable water's origin, treatment, management as well as the handling and destiny of their used water and the area's storm water (Danger / Ngozi / Gevaar signs), the treatment of it before it will be released in the draining streams and rivers for the benefit of down-stream water users and consumers. The bigger picture of the hydrological and geo-hydrological cycle plus the physical and man-changed environment should be explained to all role-players and stakeholders (consumers) concerned so that ownership and sustainable use of the environmental resources can be inculcated.
- DWAF has excellent policies and informative guidelines regarding more effective water and sanitation management in place which only need to be published, made available to and be communicated more effectively to the water users and consumers on the ground.
- New water management aspects to be researched, undertaken, developed and utilized 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 - cut out leaks, water losses and sewage spills;
 - More effective identification (geo-hydrology), surveying, development, transport, reticulation and pumping techniques of potable water;
 - Rainfall harvesting;
 - Artificial recharge of underground cavities and groundwater aquifers; and
 - 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, walk the surface water catchment area and be the respective regulators' 'environmental ears and eyes on the ground'.
- Regarding Disaster and Risk Management, the aspects of the railway line passing through the Town, the over-flying airplanes for landing at OR Tambo Airport, the Eloff storm-water and effluent, the agricultural small holdings, big scale farms surrounding the Town, the nearby N12

highway and lastly, maybe the most threatening is the dolomite bedrock with the formation of cracks, ponors and sinkholes should be monitored and managed more effectively.

- We must continuously try to construct and maintain more effective and sustainable 'bridges' between theory and practice with reference to strengthening a municipality like Delmas' hands about the benefits of cooperative research and collaboration and exploiting the basic knowledge matter of subject disciplines like Municipal Management and Administration, Hydrology, Geo-hydrology, History (traditions, beliefs, culture, water politics & communication) etc.
- Due to the increased demand for water in Delmas, and if the citizens of the municipal area can afford the more expensive 'imported' Rand Water, it is strongly recommended that a proper connection to Rand Water supply be considered. Augmentation of the Town's groundwater abstraction boreholes will become more important as Delmas is showing a positive population growth.

The research report aimed to provide the reader with "snap shot in time" as to the phenomenon under investigation. From the discussions it is evident that we are dealing with a complex situation which will require a multi-disciplinary solution. Although the recommendations are clear, it remains the responsibility of the Delmal Local Municipality to show political commitment toward solving its water and disaster related problems.

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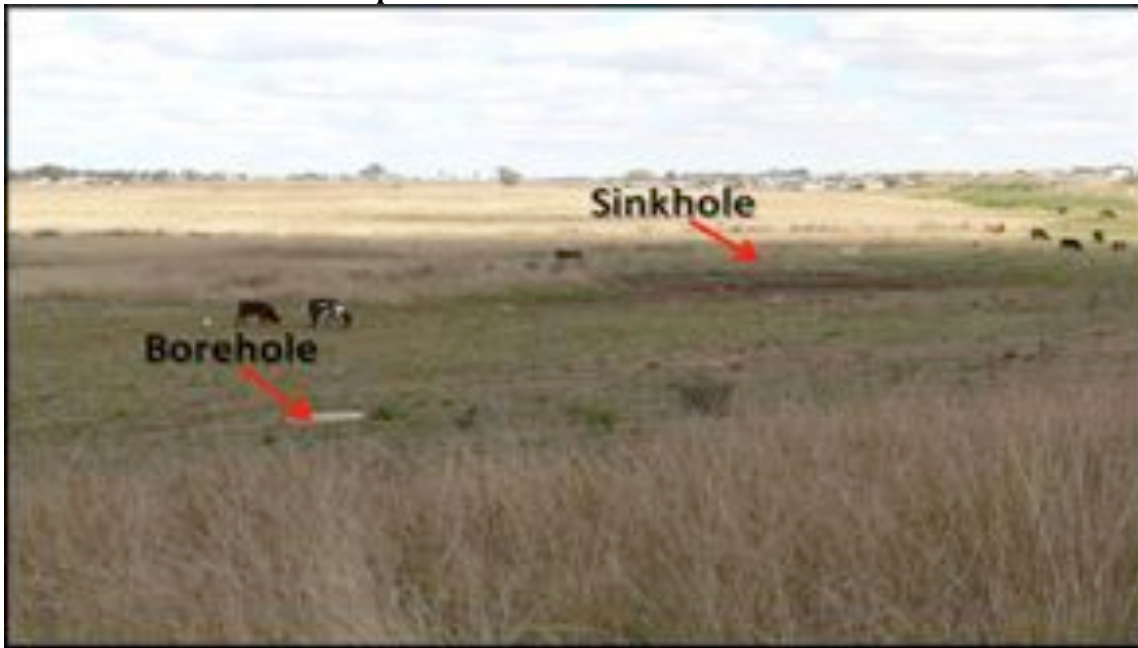
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10 ANNEXURE: PHOTOS

Photo 1: Sinkholes in the dolomite bedrock area immediately south (up-stream) of the A-field potable water abstraction boreholes



(Source: Mthethwa, 2008).

Photo 2: Sinkhole in the vicinity of the A-field boreholes



(Source: Mthethwa, 2008).

Photo 3: Refuse dump area immediately up-stream of the B-field potable water abstraction boreholes



(Source: Researchers' 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: Researchers' private collection).

Photo 5: Overflowing older waste water treatment facility on the northern side of Delmas



(Source: Researchers' private collection).

Photo 6: Depressing nature of a street in the Botleng suburb of Delmas



(Source: Researchers' private collection).