

The essence of water services management according to surface water catchment regions

A case study of Delmas Municipality

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ABSTRACT

The nature and extent of local governance regarding water services management in South Africa (SA) have been transformed since the proclamation of the *Constitution of the Republic of South Africa, 1996*, the *National Water Act 36 of 1998* and the *Local Government: Municipal Structures Act 117 of 1998*. For the first time, the place and role of a developmentally orientated local government sphere have been clearly identified. Unfortunately, there are some serious challenges that the newly-merged municipalities must try to manage more effectively, efficiently, economically, equally and environmentally sensitively than their predecessors did. Aspects that come to mind include the need to incorporate a more holistic and integrated management approach to water services management according to the surface water catchment areas the Department of Water Affairs demarcated, to consider account the dangers of developing urban areas that are geologically underlain by dolomite rock, as well as the need to obtain, develop and retain the necessary experience, knowledge and skills capacity to manage the diverse and highly-complex basic services, such as the potable (drinking) water supply in a sustainable manner. This article will firstly highlight the changed environmental context of public service delivery in the local government sphere of the country. Hereafter, the focus will shift to the

nature and extent of current realities of local governance. This includes the dynamics and challenges regarding a basic public service, such as potable water supply. Lastly, the nature and extent of water services management in, for example a municipality situated in a dolomite area (Delmas) will be explored. The article aims to contribute to the cultivation of an environment conducive to consolidating local governance and gaining knowledge of water management in the local government sphere.

INTRODUCTION

The South Africa's local government has come a long way from the period when there were over 800 racially segregated local government sphere institutions. These institutions included municipalities, town councils, town boards, divisional councils, village management boards, health committees and similar entities and were scattered all over the country. Notably, large peri-urban and rural areas fell in regions where there were no or very limited municipal services rendered. This was a local government outcome brought about by the previous National Party government's separate development policies. The nature and extent of local governance underwent a serious transformation after the African National Congress (ANC) won the country's first democratic election in April 1994.

The *Constitution of the Republic of South Africa, 1996* (hereafter referred as the Constitution), led the way for a flood of new and transformed legislation in the developing South Africa. For the first time, local government's specific place and role was clearly identified and taken up in legislation. The Constitution establishes three categories of municipality, namely:

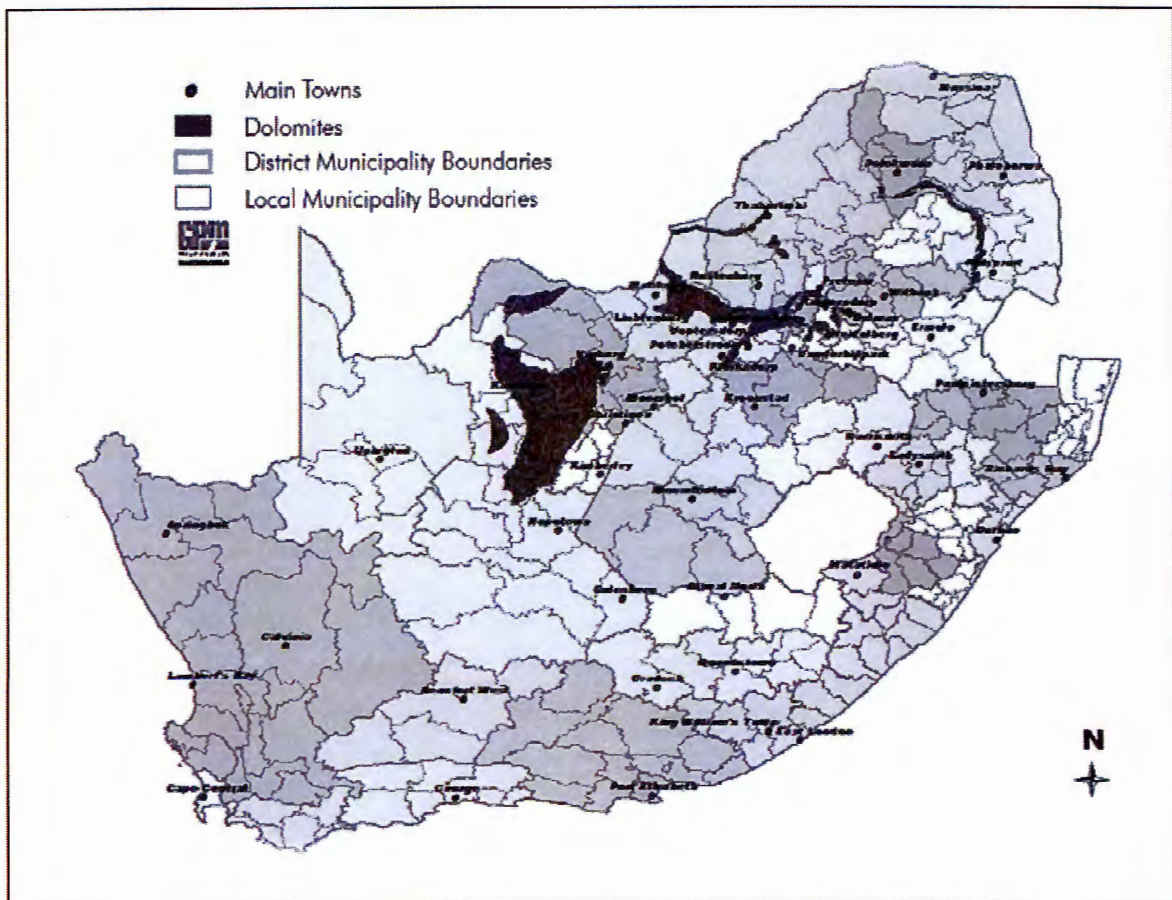
- Six (6) Category A (metropolitan) municipalities that have exclusive municipal executive and legislative authority in their geographically demarcated areas;
- 231 Category B (local) municipalities that share executive and legislative authority in their geographically demarcated areas with the Category C (district) municipalities within whose municipal areas they fall; and
- 46 Category C (district) municipalities that have executive and legislative authority in areas that include more than one (Category B) municipality.

The subsequent *Local Government: Municipal Demarcation Act 27 of 1998* established the 283 municipalities that now completely cover the country in a 'wall-to-wall' manner. Their current areas of responsibility are focused on growing local economies. Furthermore, these municipalities aim to maintain

and provide more diverse and complex basic municipal services to new geographical areas, as well as the millions of citizens who might have been neglected in the past.

The newly-established and merged municipalities are demarcated according to geographical aspects, such as interdependence, capacity, existing boundaries, land use, administrative consequences and the topographical, environmental and physical characteristics of an area. Unfortunately, the last mentioned factor did not specifically take into consideration geographical demarcation aspects, such as the extent of the surface water catchment (river basin) areas and the overall geology (such as sensitive dolomite areas with hydro-geologically unconfined groundwater aquifers). With reference to the last-mentioned aspect, a large number of the municipalities of South Africa are situated in such dolomite-underlain areas. Map 1 indicates the extent of the 231 Category B municipalities and provides an indication of the dolomite areas (darkest shading). Some examples of towns and cities underlain by dolomite are Delmas, Centurion (Pretoria), Alberton (East Rand), Randfontein,

Map 1: Topographical map of the wall-to-wall local municipalities and the dolomite areas in South Africa



Source: GPM Consultants 2009

Krugersdorp, Carletonville, Potchefstroom, Ventersdorp, Lichtenburg, Vryburg and Kuruman.

This transformed local government environment has brought about many changes in the nature and extent of basic public services delivered at the grass-roots level of a developing country with limited resources and unlimited needs – especially in the area of potable water (drinking water) supply services.

Firstly, this article will highlight the changed environmental context of public service delivery in the country's local government sphere. Hereafter, the focus will shift (and provide greater detail) to the nature and extent of current realities with regard to local governance, dynamics and the challenges municipalities face in their respective municipal areas with regard to basic public services, such as potable water supply management. Lastly, the nature and extent of water services management in and by a municipality situated in a dolomite area (Delmas) will be explored. The article aims to contribute towards cultivating an environment that is conducive to consolidating local governance and creating water management knowledge in the local government sphere of a developing city.

HISTORICAL OVERVIEW OF LEGISLATIVE TRANSFORMATION

The Constitution arranges the so-called "social contract" between the South African Government and the citizens of the country by the structuring of three spheres of governmental legislature, judiciary and execution of public policies. As new ANC-led government accepted the Constitution, it has a moral obligation to be sensitive, to identify, and seriously take notice of the unlimited needs of all the country's citizens. These societal needs and possible government-initiated solutions need to be prioritised effectively. This helps determine which of them should be addressed through effective and efficient public administration and management in an attempt to add developmental value to the respective communities and society as a whole.

The new Government immediately emphasised that its Reconstruction and Development Programme (RDP), as part of its political manifesto and foundation of all its new public policies, would be implemented. Furthermore, it stipulated that every effort would be made to improve public service delivery in all three spheres of Government.

In line with the transformation of legislation, the local government sphere elections on 5 December 2000 ushered in a new system of local governance in South Africa. The newly-structured and empowered local government sphere

has been granted some degree of autonomy and expanded responsibilities, which indicates a shift towards a developmental local government (Fast and Engelbrecht 1999:2).

The legal and administrative structures that the current Government inherited did not serve the broad population of all the municipalities. Public participation – now a constitutional requirement – was non-existent (Motshekga 2008:1). Consequently, all decision-making related to public service delivery was undertaken on behalf of the majority. Municipal boundaries have been re-demarcated and newly merged municipalities with new organisational structures and policies have been created to ensure that integrated economic development and improved basic public services are delivered in a more effective, efficient, and economical manner to all citizens – especially the under-serviced communities. This also led to the incorporation of transformed organisational arrangements for more accessible and transparent citizen participation (Craythorne 2006:51–54).

One of the four pillars of the RDP is “meeting basic needs”. Subsequently, access to basic drinking water and sanitation services for all citizens of South Africa was made a priority (DWAF 2004:4). In May 1994, the former Minister of the then Department of Water Affairs and Forestry (DWAF), Prof. Kader Asmal, initiated a process to review all water-related legislation (Gildenhuys 1999:10). The overall objective of this process was to change the South African water dispensation, so that socio-economic demands and environmental management requirements would be met in an effective, efficient and economical manner to ensure that all South Africans have equal access to these services (Pienaar and Van der Schyff, cited in Tempelhoff 2005:263). Table 1 provides examples of transformed governmental policies and legislation (in date sequence) within South Africa’s water affairs and municipal environment.

Table 1 highlights that, since South Africa’s change in government in 1994, existing executive public policies have been revisited and revised to help further the country’s developmental environment. For example, the Constitution brought about a restructuring of public sector institutions with transformed strategies and goals. As a result, executive policies such as the RDP and *Batho Pele* (people first) were revisited. With reference to the new Government’s quest to improve the public management of water affairs, the *National Water Act* was promulgated in 1998. For this first time in the country’s history, Government made a sincere attempt to bring about integrated water resources management, according to the surface water drainage regions and to the benefit of all the country’s citizens.

The need then arose to identify and regulate the place and role of a more effective, representative and development-orientated local government sphere

Table 1: Important examples of water- and municipal governance-related legislation in South Africa since April 1994

Year:	Act:	Summarised purpose and/or goal:
1994 (Nov.)	<i>White Paper on Water Supply and Sanitation Policy.</i>	This document is dedicated to the millions of South African citizens who struggle daily with the burden of not having access to the most basic of services (RSA 1994).
1995 (Nov.)	<i>White Paper on the Transformation of Public Service.</i>	To establish a policy framework to guide the introduction and implementation of new policies and legislation aimed at transforming the South African Public Service (RSA 1995).
1996 (Oct.)	<i>Constitution of the Republic of South Africa, Act 108 of 1996.</i>	This is the supreme law of the Republic, which embraces the human rights principles and sets forth the right of access to water, as part of a lengthy list of social and economic rights (RSA 1996).
1997 (Oct.)	<i>White Paper on Transforming Public Service Delivery (Batho Pele [people first] White Paper).</i>	This seeks to introduce a fresh approach to service delivery: an approach which puts pressure on systems, procedures, attitudes and behaviour within the public service and helps redirect their attention to the customer, an approach which puts the people first (RSA 1997a).
1997 (Dec.)	<i>Water Services Act 108 of 1997.</i>	To ensure the right of access to basic water supply and basic sanitation, setting national standards and norms and standards for tariffs, water services development plans, establishing water boards, monitoring water services and financial assistance to water services institutions (RSA 1997b).
1998 (Jul.)	<i>Local Government: Municipal Demarcation Act 27 of 1998.</i>	To provide criteria and procedures for determining municipal boundaries by an independent authority (RSA 1998a).
1998 (Aug.)	<i>National Water Act 36 of 1998.</i>	To recognise that water in South Africa is a scarce and unevenly distributed national resource that belongs to all its inhabitants and that the National Government is responsible for the nation's water resources and its use. This should be attained in a sustainable manner by means of integrated water catchment management of all aspects of water resources and, where appropriate, delegating management functions to a regional or catchment level to enable participation (RSA 1998b).
1998 (Nov.)	<i>National Environmental Management Act 107 of 1998.</i>	To provide for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state (RSA 1998c).
1998 (Dec.)	<i>Local Government: Municipal Structures Act 117 of 1998.</i>	To provide for the definition and establishment of municipalities, in accordance with the requirements relating to categories and types of municipalities, as well as to provide for an appropriate division of functions and powers between the categories of municipalities (RSA 1998d).
2000 (Nov.)	<i>Local Government: Municipal Systems Act 32 of 2000.</i>	To enable municipalities to move progressively towards the social and economic upliftment of local communities, and to ensure universal access to essential services that are affordable to all (RSA 2000).
2004 (Feb.)	<i>Local Government: Municipal Finance Management Act 56 of 2003.</i>	To secure sound and sustainable management of the financial affairs of municipalities and other institutions in the local sphere of government (RSA 2003).

through, for example, the *Local Government: Municipal Structures Act* 117 of 1998. Chapter 5 of the *Structures Act* covers the functions and powers of municipalities in detail.

With reference to the aforementioned legislation on especially the water services management in and by executive institutions within the country's local government sphere, Thompson (2006:235-236) identified that, according to the Constitution and the *Structures Act*, a Category C (district) municipality has the power and functions to administer potable water supply systems, domestic waste water, sewage disposal systems and solid waste disposal sites for the municipal district as a whole. On the other hand, a Category B (local) municipality falling in a specific Category C municipality's geographical area of responsibility only has to take care of and administer stormwater management systems within its own built-up areas. However, the Minister for Cooperative Governance and Traditional Affairs could authorise a Category B municipality to perform a delegated function or exercise a power relating to potable water supply systems. Authorisation is given after consultation with the Minister of Water and Environmental Affairs and the Member of the Executive Council responsible for local government in the province concerned (RSA 1998d: sections 83-85).

The aforementioned seem to reflect a paradox in the legislation and implementation, particularly of water services management in the very dynamic, vibrant and developing local government sphere of South Africa (Craythorne 2006:157). One finds that, in most instances, the existing Category B municipalities have been responsible for the potable water supply, as well as the management of their waste-water and sewage systems in their individual responsibility areas all-along. As a result, these municipalities have built up and acquired the necessary skills and experience and are "connected" to the grass-roots water users. The *Structures Act* delegates authority regarding water services management away from these municipalities and entrusts it to the overseeing Category C municipality in whose geographical area of municipal management they fall. Usually these supervising and managing Category C municipalities are located far from the municipalities (too far to walk or easily drive). Moreover, the Category C municipality does not have the experience and skills to manage a similar type of potable water supply service in line with the individual Integrated Development Plans (IDP). Furthermore, they are not effectively connected to the geographically dispersed citizens of their respective Category B municipal areas. This legislatively-created paradox might create possible grey areas, where the respective municipal responsibilities cannot be pin-pointed. Often, this leads to sloppy municipal management with regard to something as important as the life-giving drinking water supply.

THE CONTEXT IN WHICH LOCAL GOVERNMENT MUST ACHIEVE IMPROVED WATER SERVICES MANAGEMENT

It is important to gain insight into the nature and extent of South Africa's post-1994 municipal governance of basic public services within a semi-arid and developing environment. The place and role of potable water supply and the Government's attempts to provide this service a more effective, efficient, economic, equal, empathetic and environmentally friendly manner may be regarded as of pivotal importance. Government will have to take note of the most urgent challenges of specific basic services. These challenges must be addressed in a more coordinated, pro-active and macro goal-orientated manner to ensure that its public management is improved. Government, together with its citizens, should know and understand that, as inhabitants of a semi-arid country, serious consideration must be given to James Clarke's statement as far back as 1991:

"Seventy one per cent of the Earth's surface is covered in water. While ninety eight per cent thereof is undrinkable sea water, only 1,2 per cent constitutes fresh water, which is locked in the polar caps and in glaciers. Consequently, inhabitants have a mere 0,8 per cent to inter alia, drink, irrigate their crops, manufacture steel, cool power stations, bath and transport sewage" (Clarke 1991:79).

To understand this situation better, the municipal officials, political office-bearers and committed citizens of municipal areas require more knowledge on the nature and extent of the so-called hydrological water cycle, from rainfall to water runoff. This hydrological system is highly complex and entails several interconnected and interdependent processes (infiltration of water, surface water runoff, the recharging of underground-formed groundwater aquifers, seepage, re-infiltration of water, and moisture recycling) and has only one direction-of-flow: downstream (IUCN 2005:22). Knowledge about the place and role of the hydrological system becomes more essential where municipalities are geologically underlain by dolomite bedrock. In this type of natural environment, water resources must be effectively managed by considering the nature and extent of the surface water catchment regions, as set out by the Department of Water Affairs (DWA). Furthermore, municipalities must take note of and implement specific scientifically established hydro-geological protocols to prevent ground-surface cracks and sinkholes.

The aforementioned section served to clarify some essential environmental and hydro-geological concepts in the water services management arena. Bearing this in mind, one can now focus on ensuring proper water services management in practice.

NATURE AND EXTENT OF WATER SERVICES MANAGEMENT – THE CASE OF DELMAS LOCAL MUNICIPALITY

Within a developing country such as South Africa, transformed municipal management of potable water supply requires that highly-complex hydrological, hydro-geological and public management functions be executed in a dynamic and highly-regulated environment. In addition, the nature and impact of the physical environment may also be difficult to manage. Therefore, municipal managers, leading officials and committed political office-bearers of a municipality should be equipped with knowledge and information regarding the physical environment. Furthermore, they should be able to utilise geographical mapping tools in order to improve their “big-picture thinking” and long-term planning skills. Other aspects include:

- Unclear demarcation of responsibilities between the categories B and C municipalities by the *Structures Act* as well as the subsequent *Local Government: Municipal Structures Amendment Act 33 of 2000*, with reference to potable water supply to citizens in the respective municipal areas.
- South Africa is a semi-arid country with scarce drinking-water resources. The country’s average annual rainfall is approximately 500 mm, compared to an international average of 860 mm. The rainfall is unevenly distributed and 65% of the country receives less than 500 mm of rain annually, which is usually regarded as the minimum for successful dry-land farming. Moreover, 21% of the country receives less than 200 mm of rain a year (DWA 1986:1.3). Of the “fallen rain”, only 10% reaches the rivers, which are regarded as a crucial potable water resource in the country.
- The *National Water Act 36 of 1998* now makes provision for all the citizens of the country. The Act supports a more holistic and integrated approach to water management according to surface water drainage regions. Unfortunately, the demarcated geographical jurisdictions of municipalities usually do not concur with the identified surface water (rivers) drainage regions. This situation prevents logical, holistic and effective integrated water resources management.
- A lack of effective municipal planning and budget compilations include aspects such as conducting municipal surveys and profiles of privately-owned land, as well as setting budgets for restructuring, expanding and the maintenance of local government infrastructure (CSIR 2007). One of the reasons for this might be that the nature and extent of the newly-merged municipal areas have not always been made clear to all the public service delivery-rendering municipalities. Some of their leading managers and

political office-bearers are still “in the dark” and have with no insight into the utilisation of for example the geographical, hydro-geological and planning maps needed for “big-picture thinking” (Bertram, Interview 2009; Kleinhans, Interview 2009).

- The typical nature and extent of municipal public services have now become much more diverse and complex. Due to a high urbanisation level of 56% in the country, millions more citizens need these services (SACN 2006) at many more locations and further away from sources than what the municipalities during the previous government dispensation had to take care of.
- The current municipal environment is highly politicised. Notably, it must be recognised that citizens play a pivotal role in more effective public policy-making and implementation.
- Hydro-geological aspects are playing a more important role where municipalities are responsible for water-related basic public services, such as potable water supply, wastewater, sewage and waste management – especially where they fall in areas underlain with dolomite rock.
- A lack of attention to maintenance and the sustainability of water management infrastructure have resulted in high levels of per capita water loss due to internal leakages in houses and deteriorating infrastructure, such as potable water reticulation pipelines.
- Community members are mostly uninterested in the origin and management of their potable water, as well as the management and disposal of their wastewater and sewage.

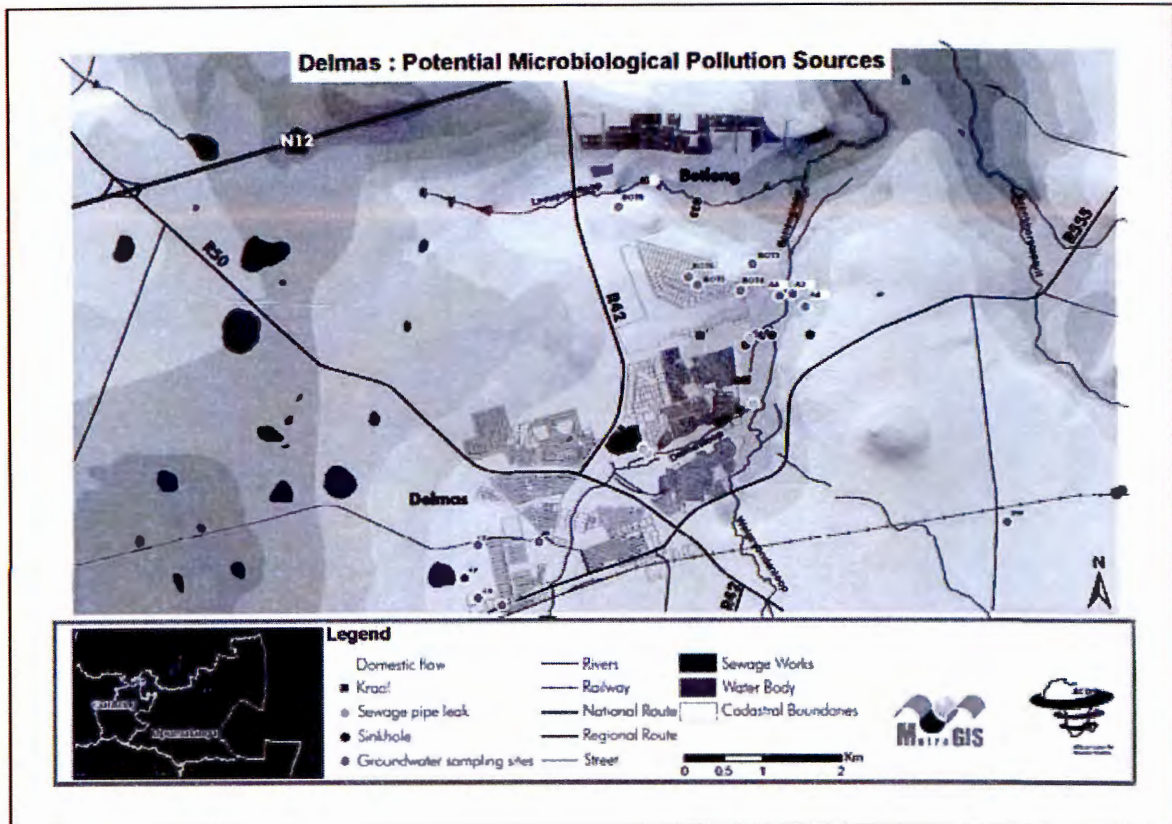
The following section provides an exposition of the nature of potable and wastewater management in and by the Delmas Local Municipality. It will highlight some of the above provision- and management-based realities that the country's current municipal public service delivery institutions face.

Case study – Delmas Local Municipality

Like most of the municipalities in the developing South Africa Delmas Local Municipality faces an ever-increasing wave of urbanisation. People from the country's rural areas and neighbouring states, seek 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. It has approximately 59 000 residents and forms part of the Nkangala District Municipality, of which the head office is located in Middelburg, Mpumalanga Province. With a responsibility area of 2 740 km², Delmas is situated between 28° 25' and 29° 05' south latitude and 25° 45' and 26° 25' east longitude. The municipal area borders on the Gauteng Province

Map 2: Delmas locality map with groundwater abstraction borehole positions and possible pollution sources



Source: MetroGIS 2009

to the north, west and south. To the north-west it borders on the Emalahleni Municipality and to the south-west with Mpumalanga Province's Govan Mbeki Municipality. Strategically, Delmas Local Municipality also forms part of the Maputo corridor. The vital N12 highway that passes the northern side of the town is a busy east-west communications route. The town also plays a vital regional role, as it is an important urban hub that provides essential local services in association with the larger towns and cities of Bronkhorstspuit, eMalahleni (Witbank), Pretoria and Johannesburg. Map 2 below provides topocadastral information on the geographical locality of, amongst others, the town of Delmas. It indicates the municipal area, major roads, streams, rivers, sewage works, kraals, sewage pipe leaks and sinkholes, as well as the municipality's potable water abstraction boreholes.

The largest portion of the Delmas Municipality's potable water is abstracted from a geological area that is underlain with dolomite bedrock. The water in question is abstracted via groundwater boreholes in four well-fields, namely A, B, C and D. The surface – and possibly also its underground – water drainage area stretches from the south to the north into the Bronkhorstspuit River, which flows into the Bronkhorstspuit Dam. Located 21 km north of Delmas,

the Bronkhorstspruit Dam serves as the town of Bronkhorstspruit's potable water reservoir.

In October 2008, the then DWAF (renamed as the Department of Water Affairs [DWA]) signed a R100 million contract for a comprehensive, 38 km water pipeline that stretches between Bloemendal and Delmas in the Mpumalanga Province. The aim was to link the town's water supply with that of the Rand Water Board. In a "historic Memorandum of Agreement", DWAF explained that this development was one of numerous "measures to prevent the outbreak of waterborne diseases" in the Highveld town, which is situated in one of the country's productive maize-growing areas (DWAFFEA 2008).

In many respects, the aforementioned announcement was groundbreaking. It was a firm indication that Government was intent on paying serious attention to a simmering crisis situation that had been ever-present since 2005 when six people died after drinking contaminated water in Delmas. However, the plan to import 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 importing potable water from elsewhere, special attention needs to be paid to promoting more effective municipal management of potable water, as well as stormwater, sewage and environmental health in general in the Delmas municipal area. Shortly before its 2009 National Water Week celebrations, the DWAF announced its intent to take a "greener" stand by paying special attention to initiatives aimed at conserving the country's water resources (DWAFFEA, 2009). Delmas and its water crisis could well become a testing ground for the manner in which the country's local authorities intend on supporting this praiseworthy national policy.

The latest research on the subject underlines the fact that Delmas' problematic location in a dolomite area is largely responsible for the problems that have been experienced in recent years with the town's water supply (Bertram, Interview 2009). 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 from the town's oldest waste-water (sewage) treatment facility.

DWAF has on occasion described Delmas' groundwater aquifer as open and unconfined (Griesel, Kuhn, Kempster, Mamabolo, and Silberbauer 2006:37-38). 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 groundwater aquifer is vulnerable to direct surface contamination. The disease outbreaks also usually occurred immediately after the first heavy rainfall showers in the respective years (Bertram, Interview 2009). It should also be noted that both the 1993 and 2005 reports were inconclusive regarding the causes of the diarrhoea outbreaks in the Delmas area.

While water certainly had a role to play, other contributing environmental factors also played a role. The physical environment, for one, has been severely polluted. At that time, there had been significant interventions in environmental elements, such as local surface water streams. Therefore, it is evident that surrounding natural resources, such as the soil and grass, also needed to be studied (DWAF 2007). 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 for what could be expected in the near future.

Recommendations for improving municipal water services management

The following aspects were identified to help the country's municipalities in improving their management of potable water services in particular:

- Correctly identify, survey, map, demarcate and inform all involved role-players and stakeholders about the nature and extent of a water drainage region with its rivers, marshes, fountains, groundwater, the number of water users and consumers, the quantity and quality of water. Hereafter implement a well-defined, planned and orchestrated holistic management plan for the region.
- Assist in obtaining and supplying hydrological and logistical knowledge, skills and infrastructure to correctly manage the various aspects of water management. This includes identification, surveying, development, transport, storage, treatment, distribution, and administering of tariffs of potable water, the collection, storage and treatment of used and storm water; and the return of the treated used water (effluent) into the surface water catchment for use by downstream water users.
- Municipalities should investigate and implement the conjunctive use of surface (river) and underground (borehole) water. Groundwater is less exposed to evaporation and is often of better quality (naturally pre-filtered). Moreover, it provides a slow release of water to a cyclical surface water supply (DWAF 2006).
- Encourage administrative and political willingness to put party-politics and overemphasised “red tape” aside (even for only a few years) and to look, listen and learn to bring about effective transformation and improvement in local governance and basic public service delivery. This will help ensure economic growth, development and prosperity.
- A municipality's public service delivery infrastructure should be maintained, developed, expanded, constructed and managed in a more proactive, effective, efficient and economical way.

CONCLUSION

The place and role of the local government sphere in South Africa have now been demarcated and the necessary legislation and structures are in place. The governmental public service providers must “just get their act together” and start to implement and execute the numerous governmental policies to provide the country’s citizens with public services in an efficient and effective fashion. With reference to water services management in and by municipalities, using an integrated and holistic approach according to DWA’s identified surface water catchment regions is an important key to successful development and basic service delivery within the country’s the municipal sphere.

Hard work has been done in creating democratic and accountable Government by overhauling the local governance model that existed before 2000. Unfortunately, the committed municipalities are continually experiencing new pressures to deliver a wider variety of usually more complex basic urban public services to citizens who are developing new and more sophisticated needs. This quest to deliver public services in a more effective manner now requires an optimum level of cooperation and integration between all the role-players and stakeholders involved. Together, these actors will be able to bring about a positive difference.

NOTES

- 1 This article is based on a paper delivered at the Water Resources Management 2009 Conference, 9–11 September 2009 in Malta.

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