8 WATER RESOURCES

8.1 PRESSURES ON WATER RESOURCES

8.1.1 Introduction

Water is a fundamental natural resource and is indispensable to life. Located largely in a semi-arid part of the world, SA's water resources are scarce. Although renewable, water is to all intents and purposes a finite resource, which requires careful management and protection.

It is estimated that the total requirement for water use in SA will double over the next 30 years. Given that SA is classified as a semi-arid country, with an average annual rainfall of 497 mm (compared to the international average of 860 mm per annum), it is clear that integrated water resource management will increasingly play a pivotal role in securing a sustainable future. This view is underscored by the fact that SA's water resources are unevenly distributed, with 60% of the country's river flow arising from only 20% of its land area. In addition, major industrial developments and associated urban settlement in SA have generally taken place away from the readily available water resources, resulting in a substantial potential impact on the water quality of an already limited supply of water (DWAF, 1997, from van Wyk et al 2003).

Water is highly susceptible to land, air and ground water pollution, not only in the form of point-source pollution, but also diffuse waste disposal to air or soil in a variety of forms, such as effluent irrigation, dumping, mining wastes or gaseous emissions. Continued deterioration of water quality in some parts of SA has lead the DWAF and the DEAT to adopt a more comprehensive approach of integrated pollution control and waste management.

8.1.2 Pressures on Water Quality

Water resources are inherently affected by discharges into the systems, as well as abstractions from the systems and natural losses through seepage and evaporation. In EMM, principal drivers of water quality include, but are not limited to:

- excess minewater;
- mine waste deposits (tailings), residue dumps, including quarries;
- industry;
- general waste disposal sites;
- sewage treatment works;
- sewer reticulation;
- urban development;
- stormwater;
- informal housing developments;
- agriculture.

8.1.2.1 Excess minewater

A significant risk to the surface water resources in EMM is the discharge of excess underground water from operating and defunct mining operations of the region. Many mines in the region and upper catchment areas generate excess groundwater, which is discharged to surface water systems.

A significant component of this excess water presently flows into the Blesbokspruit catchment from the Grootvlei mine systems and into the Elsburgspruit from ERPM (East Rand Proprietary Mines Ltd). Both these mines have pre-treatment facilities for pH neutralisation and some metal precipitation, but not salt removal.

There are also actual and potential contributions from a number of other mine systems in the area, including ERGO (East Rand Gold Operations), Knights and DRD (Durban Roodepoort Deep). Such discharges are expected to continue indefinitely after the mines close, representing significant volume and salt loads to the Vaal system.

8.1.2.2 Mine waste deposits (tailings), residue dumps, including quarries

Mine waste deposits, residue dumps and quarries that have given the Reef its unique appearance also represent long-term potential environmental liabilities and impact on surface and groundwater quality. Many of the mine deposits located in the catchments feeding into EMM, ie contributors to the Klip River system, as well as located within EMM itself, ie Blesbokspruit, Natalspruit and Elsburgspruit catachments, were created up to a century ago, prior to the implementation of present environmental management and protection requirements. The locations of mine operations, quarries and residue deposits are shown in Figure 8.1, while waste sites are shown in Figure 4.5 and sewage works in Figure 7.2.

Figure 8.1 The locations of scheduled industries, tailings dams, rock dumps and quarries

In many cases the ore from which the gold was extracted and consequently the wastes created, contained pyritic fractions, iron sulphides etc. When these are exposed to water (rain) and oxygen (air), they undergo oxidation which generates sulphuric acid ($H2SO_4$), iron oxides and hydroxyoxides, resulting in a phenomenon colloquially known as acid mine drainage (AMD). The acidity generated by the sulphuric acid formation can subsequently mobilize and release heavy metals previously bound in the wastes, including arsenic, nickel, copper, zinc and aluminium, as well as solubilisation of salts of sodium, chloride, potassium and fluoride.

The oxidation and mobilization of pollutants from mine residue and waste deposits occurs slowly. Given the massive volumes of polluting material that have accumulated within the water domain of EMM, there is an existing risk to surface and groundwater resources of the region.

8.1.2.3 Industry

The majority of industries in EMM is serviced by connections to the municipal sewerage systems, so that direct discharges of trade effluents to surface water resources and land are limited. However, there is the potential for surface spills and accidental discharges to occur to surface water courses, specifically during storm periods, and as a result of illegal connections to stormwater systems and deliberate illegal discharges.

In some cases, industrial effluents have been irrigated to site areas as a means of wastewater disposal, (historical practice of Sappi Enstra in Springs and AECI Modderfontein, or discharged to evaporation ponds (historical practice of NCP Chloorkop). Although these have been accepted practices in the past, protection of surface and groundwater resources has necessitated review of such effluent disposal practices for future environmental protection.

8.1.2.4 General Waste Disposal Sites

A number of formal, and many more informal, waste disposal sites are located within EMM, and within its upper catchment impact areas. As with the mine residue deposits, the waste sites created to receive domestic, commercial and industrial waste, were created prior to the implementation of more stringent environmental management requirements, and so represent a long-term potential risk to surface and groundwater resources of the region. In several cases, ie Simmer & Jack, Weltervreden and Rietfontein, waste sites have been created on the footprints, or within historical mine residue deposits, using the floor of tailings material as a base for waste disposal.

The formal municipal and private general waste sites in the Ekurhuleni metropolitan area are formally permitted in terms of DWAF's Minimum Requirement Guidelines and this includes control of excessive leachate and run-off (Ekurhuleni 2003).

Informal waste disposal sites (dumps), have often arisen in the dense informal settlement areas, where service provision was previously limited. Particular issues have been identified in Tembisa, Katlehong, Tokhoza, Kwathema, but the problem is ubiquitous to most dense settlements. (SRK 1998; DWAF 2000, WRC 2000). These too represent a long-term potential risk to surface and groundwater resources of the region, particularly as a result of rain induced leachate production and seepage. No information is available on the dimensions of this potential problem.

8.1.2.5 Sewage Treatment Works

Ekurhuleni has a number of sewage treatment plants of its own, though operated under contract by a section 21 company, the East Rand Water Care Company (ERWAT). There are also a number of sewage works, particularly those of the southern region of Johannesburg, that also discharge into the river systems flowing through EMM, principally the Johannesburg discharges to the Klip River system.

Treated sewage generally achieves acceptable discharge quality, including disinfection of bacterial hazards, with limited resultant pollutant load on the receiving water courses. However, occasional upsets in the performance of the sewage works, particularly as a result of excessive stormwater hydraulic loads and aging infrastructure, can result in the release of less acceptable final effluent qualities. The sewage purification works in EMM are generally able to achieve acceptable discharge quality to minimize risk to downstream users. [However, recent newspaper reports indicate that aging infrastructure in the Vaal Triangle is creating a problem of some 1 million litres of raw sewage per day entering the Vaal Barrage (The Citizen, 24 October 2003).]

8.1.2.6 Sewerage Reticulation

Although EMM has an extensive and comprehensive sewerage reticulation system, much of the network is old and its integrity is in doubt. In some areas long-term population expansion has increased above the historic sewerage capacity, which is further exacerbated due to stormwater infiltration.

In some areas blockages occur as a result of limitations on maintenance capacity to remove tree root growth, litter and stormwater silt loads, and/or deliberate vandalism; blockages cause spillage. In some cases, in the absence of adequate alternative solid waste disposal facilities, the sewers are used to dispose of solid waste, again resulting in blockages and sewage spills to the environment.
Sewage reticulation discharges can represent a more serious local pollution hazard as the spillage is of raw sewage and occurs to internal urban drainage channels and streams that are not adapted to receiving raw sewage, and to which human and animal exposure may be more significant.

8.1.2.7 Urban Development

Urbanization not only increases the return flows of rainfall to the natural water courses by changing the catchment surface dynamics, it also has the potential to increase the pollutant loads on surface waters. The major pressures of urbanisation on surface water systems are shown in Table 8.1.

Table 8.1 Major pressures of urbanisation on surface water systems

Hydrology	Morphology	Water Quality	Habitat & Ecology
Increased frequency of erosive bankfull floods	Stream channel widening and downcutting	Pulses of sediment during construction activities	Shift from external to internal stream production
Increased volume of surface run-off	Increased streambank erosion	Increased pollutant washoff	Reduction in diversity of aquatic flora & fauna
More rapid stream velocities	Shifting bars of coarse-grained sediments	Nutrient enrichment leads to benthic algal growth	Reduction in diversity and abundance of fish
Decrease in dry-weather baseflow	Elimination of pool/riffle structure	Bacterial contamination during dry and wet weather	Destruction of wetlands, riparian buffers, and springs
	Imbedding of stream sediment	Increased organic loads	
	Stream relocation/enclosure or channelisation	Higher levels of toxins and trace metals	
	Stream crossing form fish barriers	Increased water temperature	
		Trash/debris jams	

8.1.2.8 Stormwater

Stormwater from formal and informal areas often becomes contaminated and flushes to the main receiving watercourse. Stormwater may also carry solid waste, which is often disposed of or accumulates in the stormwater channels. Contamination also arises as a result of inadequate stormwater management, where stormwater drains cross open developed areas, capturing silt and debris. Inadequate maintenance of stormwater channels and the absence of formal drainage systems, specifically in dense informal settlement areas, can increase the risk of flooding during storm events. Stormwater from industrial areas may also be polluted by poor housekeeping and materials handling practices and by on-site storage of solid wastes.

8.1.2.9 Informal housing development

Ekurhuleni, like all urban areas in Gauteng, has been subject to burgeoning growth in dense, informal settlements. Although the EMM and other municipalities in the region are attempting to provide basic services, the inability to provide formal, effective waste, water and sanitation services contributes to the significant problems of greywater (polluted waters) emanating from informal settlements and their detrimental impacts on surface and groundwater resources. As much of the contamination is human waste based, particularly where sanitation services are absent or rudimentary in the form of pit latrines and chemical toilets, as well as a prevalence of domestic animals and ad-hoc solid waste disposal, greywaters are similar to raw sewage in representing significant potential health and environmental risks. Table 8.2 illustrates some sources and causes of greywater pollution in dense informal settlements.

Table 8.2 Greywater pollution in dense informal settlements (WRC 2000)

Problem type	Possible sources
Water Supply	Broken taps and leaking pipes, due to vandalism or poor maintenance, or deliberately left open
	Illegal connections to water mains and yard taps
	Overflowing of containers when filling at standpipes
	Washing of clothes, pans etc and children at standpipes, washing of vehicles near standpipes
	Washdown of houses, garden watering and dust suppression
	Washout of household sanitation buckets
	Lack of facilities to drain away greywater and prevent ponding and contamination
	Vandalised and misused communal ablution blocks with ponds of murky greywater
	Inadequate facilities at some public places like: taxi ranks, public halls and other places
	Direct exposure to greywater by children and domestic animals
Sanitation	Some preference by individuals to relieve themselves outside, either because of the absence of adequate facilities, or comfort and ease, specifically males
	Inadequate technology in DIY pit latrines causing overflowing, leakages, rain floods and collapse
	Inadequate capacity and/or servicing of chemical bucket toilets and aqua-privies etc causing overflowing
	Children may not use toilets due to cultural practices, and/or safety and access problems associated with aqua-privies, chemical toilets etc.
	Inaccessibility of sanitation systems to the elderly and infirm
	Toilets may be locked to prevent overuse and extend toilet life span
	Pierced aquaprives – to prolong usage
	Frequently broken sewerage lines – accidental, caused by overloaded pipelines heavy with solids and foreign matters /stones, plastic bags, newspapers, rags etc
	Household overnight buckets are used even where aquaprivies etc are provided because of security fears at night and privacy. The waste is often disposed in an ad-hoc manner outside the house/shack, and often into natural drainage channels
	Backyard shack dwellers not having access to sewerage systems
	Many people are obliged to utilise hard anal cleaning materials ie newspapers and plastics, which can block sanitation facilities, causing spillage or abandonment of the facility.
	Some of the sanitation systems are not appropriate technology for the community, and in the absence of adequate maintenance and servicing often fail. Specific concerns have been identified with low-flush systems, which do not provide adequate flushing for waste resulting in blockages and misuse, and the frequent failure of the flushing mechanisms
	Deliberate vandalism of sewer lines, specifically theft of manhole covers and use of sewers for disposal of solid waste, ash, refuse etc causing blockage.
Solid Waste	Waste, refuse cumulated on the streets and nearby shacks – residents irresponsible behaviour
	Inadequate number and capacity of waste sites resulting in waste and litter being dumped in an ad-hoc manner, and specifically accumulating in natural and constructed stormwater drainage systems
	Inadequate waste collection facilities, skips, bins etc for domestic, commercial and small scale industrial wastes, resulting in ad-hoc waste disposal, specifically around shops, shabeens, spaza's etc
	Waste collection skips etc are not accessible to children and the elderly who often have the responsibility to dispose of waste, hence necessitating dumping
	Theft of bins and use for cooking, heating, water storage and brewing etc.
	Few people put litter in waste refuse bags despite the fact that they are provided for free
	Leachate, seepage and burning of waste creating run-off quality problems
	Inadequate waste removal service, resulting in overflowing skips and waste piles, and waste not within formal skips not being collected and allowed to accumulate
	Ash from household fires deposited next to the walk path, access road or shack
	Domestic animals and humans scavenging in, and spreading waste piles and materials

Problem type	Possible sources
Stormwater	General absence of adequate stormwater run off control infrastructure
	Surface dirt washed off to the natural water courses
	Absence of tarred road, mostly sandy or gravel, creating dust, debris and dirt accumulation in drainage channels, exacerbating blockage potential
	Location of shacks and some houses in flood lines and across natural stormwater channels creating wash away and blockage problems
	Blocked drainage systems due to littering, erosion and poor maintenance etc
General	Uncontrolled, overpopulated number of domestic animals
	Overpopulated and under serviced settlements
	Settlements dwellers very small input into upgrading, making their own life easier
	Authorities are expected to provide, clean, service and maintain

8.1.2.10 Agriculture

Direct irrigation demand in EMM for agricultural purposes is considered significant enough to represent a major water user. Not only does direct abstraction affect the hydrological regime of the water courses, in-stream dams created by the farmers also affect the hydrological regime. Furthermore return water flows and storm water flows off cultivated lands contribute to pollution loads via the leaching of fertilizers (increased nutrient loads) and pesticide/ herbicide residues. There is a general paucity of information on the significance of these pollution loads in SA.

8.1.2.11 Ecological reserve

One of the bigger water users, as specified by DWAF, is the Marievale Bird Sanctuary (DWAF 2002). This is in terms of the NWA, which establishes the ecological requirements of aquatic ecosystems and basic human needs as the primary claimants to and users of water resources. The reason for setting aside water for ecological purposes is precisely to ensure that ecosystem functions which assist with the assimilation of wastes are maintained in a healthy state.

8.2 STATE AND IMPACTS

8.2.1 State of Water Service Provision

Table 8.3 and Table 8.4, and Figure 5.9 and Figure 8.2, drawn from the national census report for EMM for 2001, illustrates the historic racial and socio-economic disparity in water supply and sanitation service provision. Poor, black communities remain inadequately serviced, with full services being focused in wealther, historically white areas. Similarly, the establishment of extensive informal settlements and mass influx into the urban areas has predominantly been of the poor, black population.

Table 8.3 Source of water available to households in Ekurhuleni (Census 2001)

Source of water	Black African	%	Coloured	%	Indian/ Asian	%	White	%
Piped water inside dwelling	171429	54.30%	9841	3.12%	8701	2.76%	125733	39.83%
Piped water inside yard	271504	92.23%	5193	1.76%	814	0.28%	16872	5.73%
Piped water on community stand: distance less than 200m from dwelling	56129	96.04%	364	0.62%	103	0.18%	1850	3.17%
Piped water on community stand: distance greater than 200m from dwelling	58344	90.93%	510	0.79%	270	0.42%	5040	7.85%
Borehole	787	88.43%	18	2.02%	0	0.00%	85	9.55%
Spring	43	93.48%	0	0.00%	0	0.00%	3	6.52%
Rain-water tank	513	96.98%	0	0.00%	0	0.00%	16	3.02%
Dam/pool/stagnant water	481	95.63%	4	0.80%	0	0.00%	18	3.58%
River/stream	119	94.44%	0	0.00%	0	0.00%	7	5.56%
Water vendor	1191	95.51%	9	0.72%	3	0.24%	44	3.53%
Other	8677	97.54%	77	0.87%	12	0.13%	130	1.46%

Table 8.4 Sanitation facilities of households in Ekurhuleni (Census 2001)

Toilet facilities	Black African	%	Coloured	%	Indian/ Asian	%	White	%
Flush toilet (connected to sewerage system)	435476	71.95%	15059	2.49%	9715	1.61%	145001	23.96%
Flush toilet (with septic tank)	6346	67.01%	134	1.41%	64	0.68%	2926	30.90%
Chemical toilet	3864	97.26%	17	0.43%	3	0.08%	89	2.24%
Pit latrine with ventilation (VIP)	6805	95.48%	50	0.70%	9	0.13%	263	3.69%
Pit latrine without ventilation	73909	99.45%	241	0.32%	19	0.03%	151	0.20%
Bucket latrine	6338	94.64%	214	3.2%	12	0.18%	133	1.99%
None	36479	95.75%	303	0.80%	83	0.22%	1234	3.24%

Figure 8.2 Percentage households with flush toilet facilities

8.2.2 Surface Water

8.2.2.1 Water Quantity

In EMM natural stream flows are overshadowed by significant contributions from treated sewage effluent, particularly that generated by the 3 Johannesburg municipal sewage plants of Goudkoppies, Bushkoppies and Olifantsvlei). These three works contribute a combined average daily flow of the order of 475 000 m^3/d to a base flow of the Harringtonspruit above the sewage works of the order of 104 000 m^3/d.

Average daily flow of the Klip River after the confluence between the Klip River and the Rietspruit (ie including contributions from the Natalspruit and Elsburgspruit) is of the order of 1 000 000 m^3/d, i.e. approximately 50% of the flow is treated sewage from Greater Johannesburg, with significant additional flows of the order of 240 000 m^3/d added from sewage treatment plants for EMM.

Little flow data is available for the Klip River system or the Blesbokspruit system. Data for the monitoring weir below the confluence of the Klip River and Rietspruit illustrates the significant contribution from treated sewage in that there is relatively little variation on a month-by-month basis, irrespective of the actual seasonality of rainfall in the catchment.

Besides the treated sewage volumes contributed to the Blesbokspruit of the order of 160 000 m^3/d, there is also approximately 60 000 m^3/d contributed from minewater discharges, again providing an unnatural base flow in the system, irrespective of natural rainfall. Average daily flow of the Suikerbosrant River below the confluence with the Blesbokspruit is only 230 000 m^3/d, indicating the significance of the extraneous inputs, and also indicating the loss of water within the system by re-infiltration into the groundwater systems, evaporation and abstraction for irrigation use etc.

8.2.2.1.1 Stormwater

As mentioned in Section 1.2 the EMM consists of seven quaternary catchments. Due to significant increases in urbanisation, runoff peaks have increased by as much as 300%. This in turn is causing much higher flood peaks and hence higher flood levels in all the major rivers. Due to the higher flood levels many developments (especially low cost housing settlements) are prone to significant flooding, causing damage and even loss of life. Some of the main problem areas are listed in Table 8.5 below.

Table 8.5 Areas of concern with regards to stormwater

Catchment	Towns
Kaalfontein	Tembisa, parts of Kempton Park
Elsburgspruit/Natalspruit	Katlehong, Tokoza, Vosloorus
Rietspruit	Tsakane
Blesbokspruit	Nigel

As is seen from above a significant number of townships, hence people are at high risk of being flooded. This is mainly due to the lack of integrated planning and the lack of floodline data. To date only about 20% of watercourses have floodlines determined. The impacts and further problems encountered due to flooding are:

- Significant damage to property and municipal services has occurred due to flooding in urban and rural areas.
- Several roads have been damaged beyond repair due to uncontrolled stormwater.
- Significant economic losses have occurred decreasing the economic growth of the area.
- Health hazards have occurred due to uncontrolled stormwater, mainly in rural areas, affecting poor, previously disadvantaged individuals and communities.
- *Ad hoc* implementation of stormwater systems has occurred which are costly and cannot be maintained.

Catchment management and natural watercourses are essential components of stormwater management in an urban environment. Together with the creation of suitable open spaces, "servitudes" (linking open spaces with natural water courses) as part of precinct plans and even regional SDFs, can contribute to the creation of more sustainable and affordable stormwater management systems for the whole catchment area which will more likely be environmentally friendly.

8.2.2.2 State of Water Quality

The majority of EMM has access to municipal water or borehole water supplies. No formal abstraction from surface streams for domestic purposes should be occurring. However, given the extent of informal settlements throughout EMM, it is apparent that most of the tributaries are being used, for direct domestic supply, for ablutions and washing of clothes. Surface water quality can therefore have a direct impact upon sectors of the EMM human population, as well as agricultural and irrigation demands. Water from most, if not all the catchments, is known to be used for cattle watering and irrigation (DWAF 2001). The catchments may also be considered for recreational use and maintenance of the aquatic habitat.

Figure 8.3 illustrates the Rand Water and DWAF water quality monitoring positions. Table 8.6 summarises the ecological status of the Klip River and Blesbokspruit, as derived from the River Health Programme assessments. Definitions for indicators and categories are provided below the table.

Table 8.6 The ecological status of the Klip River, Natalspruit and Blesbokspruit

River Health Indicator	Upper Klip River	Natalspruit	Lower Klip River	Upper Blesbokspruit	Mid Blesbokspruit	Lower Blesbokspruit
Habitat	Good	Fair	Fair	Poor	Fair	Fair
Aquatic Invertebrates	Poor	Poor	Poor	Poor	Poor	Fair
Fish Populations	Poor	Poor	Poor	Poor	Poor	Poor
Riparian Vegetation	Fair	Fair	Poor	Poor	Good	Poor
Water Quality	Poor	Poor	Fair	Poor	Poor	Poor

Source: River Health Programme 2003

Definitions:

River Health Indicators

Habitat: *Instream availability and habitat diversity*

Aquatic Invertebrates: *A variety of organisms (snails, insect larvae, crabs & worms) requires specific habitat types and water quality for part of their life cycle*

Fish populations: *Fish are good indicators of the longer term influences on a river reach and general habitat conditions*

Riparian vegetation: *Healthy riverbanks maintain the form of the river channel, provide habitat for species (aquatic and terrestrial) and filter sediment minerals and light*

Water quality: *The chemical, physical and bacteriological properties of water determine its suitability for use*

River Health Category

Natural: *No negligible modification of habitat and biota*

Good: *Some human-related impact; biodiversity largely intact*

Fair: *Significant pressure from development and land use; sensitive species may be lost*

Poor: *Natural functioning disrupted; extensive use of river ecosystem*

No rivers remain in their natural state, although the habitat and riparian vegetation remain largely intact in the Upper Klip River (near Soweto) and Middle Blesbokspruit respectively. Aquatic biota and water quality are generally in poor to fair condition.

8.2.2.2.1 Water quality trends for the Klip River and Blesbokspruit

The trends of selected water quality indicators for the Klip River system and Blesbokspruit are presented in Table 8.7and Table 8.8 respectively. The overall trend in water quality is best described using electrical conductivity (EC), and these are presented in Figure 8.4 and Figure 8.5. The water quality objectives for EC are depicted in the graphs (these are water quality management objectives set for all rivers, in terms of the NWA).

Indicator chemical parameter concentrations are highly variable but this does not appear to be linked to either season or time. There is a perceived improvement in quality as the trends generally appear to decrease at the sampling points for the salts and nutrients. However, viewed as a series of points from the upper catchment to the lower catchment, the poor quality water in the upper Klip

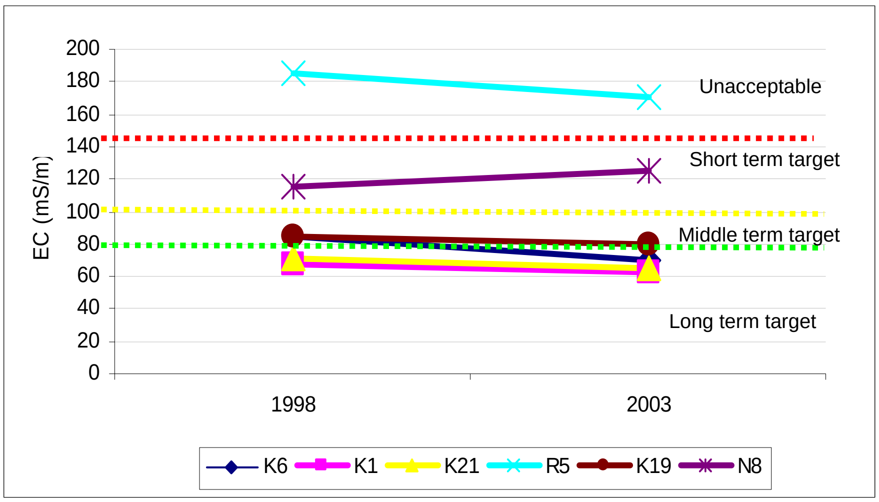
River appears to be diluted by the cleaner water of the Johannesburg sewage works discharges (Olifantsvlei, Bushkoppies and Goutkoppies),. It appears that the quality continues to improve as the river flows through the wetland systems along its course and as it passes through EMM. There is only one of the selected Rand Water monitoring points which displays unacceptable EC levels in relation to the objective. The majority of the sample points have met the middle and long-term objectives for the river.

Figure 8.3 Surface water and water quality monitoring points

Table 8.7 Water quality trends for the Klip River (1998-2003)

	K6		K1		K21		R5		N8		K19	
	1998	2003	1998	2003	1998	2003	1998	2003	1998	2003	1998	2003
Cond mS/m	85	70	68	62	71	65	185	170	115	125	85	80
NO_3 mg/l	2.1	1.7	5.3	5.6	4.5	4.9	6.8	0.05	4.9	4.1	4.8	4.5
PO_4 mg/l	0.6	0.17	0.71	0.3	0.77	0.27	0.21	0.05	1.2	0.39	0.78	0.45
SO_4 mg/l	200	185	115	110	110	105	450	580	340	360	165	160

Source: Klip River Monitoring Forum 2003



Source: Klip River Monitoring Forum 2003

Figure 8.4 Electrical conductivity trends and targets in the Klip River

The data for the Blesbokspruit monitoring in the Ekurhuleni area for the period 2000-2003 similarly illustrates a wide variability in quality at individual sampling stations, but a general decrease in overall quality, particularly with respect to salt load. This could occur as a result of the discharges of significant volumes of excess minewater from Grootvlei mine and associated mining operations. There is also a general decrease in quality with respect to nutrient loading, as represented by nitrate and phosphate. These parameters are not usually mine activity related, but more an indication of releases of sewage (treated and spillages, including greywater) and agricultural run-off.

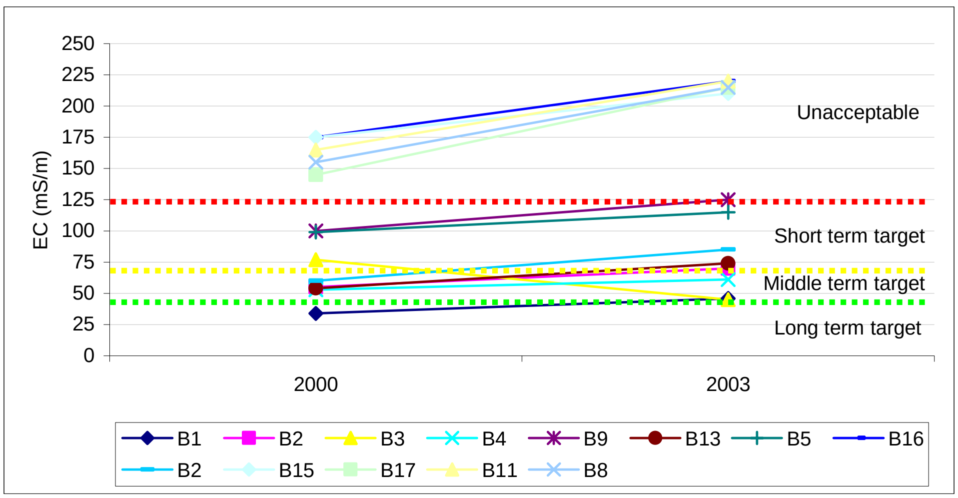
Table 8.8 Water quality trend for the Blesbokspruit (2000-2003)

	B1		B2		B3		B4		B9		B13		B5	
	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003
Cond mS/m	34	46	55	70	77	45	53	61	100	125	54	74	99	115
NO_3 mg/l	0.18	7.6	0.47	3.1	1.6	1.5	0.77	1.1	0.15	2.1	0.72	0.93	0.28	1.6

PO_4 mg/l	0.03	0.22	2.4	1.8	0.2	1.3	0.4	0.23	0.27	0.34	0.79	1.5	0.37	1.9
SO_4 mg/l	36	62	32	39	160	32	60	80	115	115	59	90	105	110

	B16		B2		B15		B17		B11		B7		B8	
	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003	2000	2003
Cond mS/m	175	220	60	85	175	210	145	215	165	220	100	-	155	215
NO_3 mg/l	0.08	2.1	0.13	0.23	0.09	0.24	0.07	0.33	0.08	1.2	0.09	-	0.09	1.6
PO_4 mg/l	0.33	0.43	0.03	0.03	0.25	0.47	0.33	0.29	0.18	0.27	0.03	-	0.09	0.37
SO_4 mg/l	500	680	185	370	445	690	405	530	445	690	325	-	405	540

Source: Blesbokspruit Monitoring Forum 2003



Source: Blesbokspruit Monitoring Forum 2003

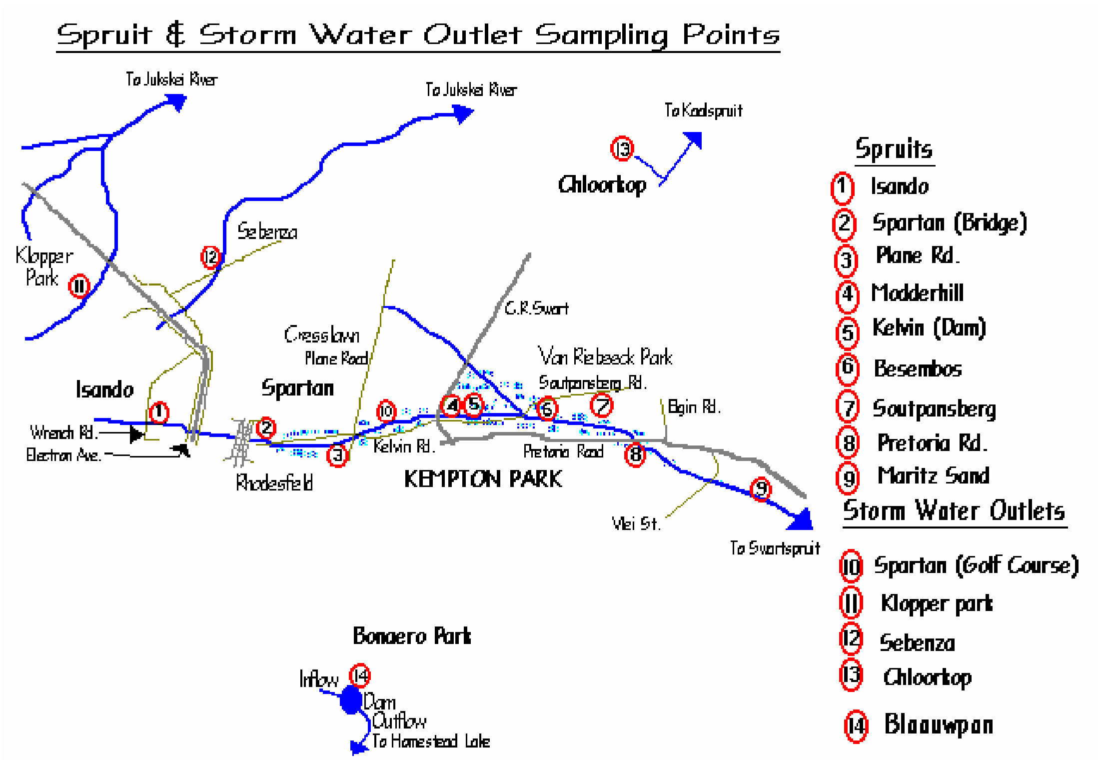
Figure 8.5 Electrical conductivity trends and target for the Blesbokspruit

Several of the monitoring points display unacceptable levels of EC, while most fall within the short and medium term objectives.

Without adequate water quality and flow data for the Kaalspruit, Rietrivierspriut and Grootrivierspruit, trend assessment cannot be undertaken at this time. However, visual observations suggest quality deterioration is occurring, and may be expected to continue as pressure and demand increase on the water resources, and particularly while management of sanitation and stormwater facilities remains inadequate.

8.2.2.2.2 Trends in the state of water quality for other water systems

Within the environmental monitoring programs of EMM, there are also regular monitoring of surface water courses, dams and stormwaters. Figure 8.6 illustrates the monitoring positions of the Kempton Park area program, with Table 8.9 illustrating an example of water quality for an individual sampling period. Table 8.10 illustrates an example of water quality results for sampling undertaken by EMM for the Springs service area. Table 8.11 illustrates an example of water quality results for sampling undertaken by EMM for the Nigel service area. Again, it is apparent that water quality varies significantly within the river systems, but elevated bacterial contamination is evidence of sanitation problems.



Source: EMM

Figure 8.6 Water Monitoring Points Kempton Park Area

Table 8.9 Water Quality Monitoring Data for Kempton Park Area (Ekurhuleni Muncipality)

SWARTSPRUIT MONITORING PROGRAMME - MEAN VALUES

SAMPLING POINT N°	LOCATION	Elec. Cond. mS/m	pH Units	Nitrate mg/l N	Ammonia mg/l N	o-Phosphate mg/l	C.O.D. mg/l	Susp.Sol. mg/l
1	Isando	43.5	7.5	5.5	0.92	0.31	185.5	25
2	Spartan Bridge	39.1	7.7	1.8	1.28	0.41	73.1	18.5
3	Plane Road	50	7.7	2.1	1.62	0.51	37.3	14.2
4	Modderhill	44.1	7.9	1.2	0.9	0.22	56	46
5	Kelvin Road (Dam)	41.3	8.1	0.72	0.98	0.29	28.4	11.1
6	Besembos Road	33.7	7.8	0.3	1.04	0.24	26.6	33.4
7	Soutpansberg Road	34.4	8.0	0.4	1.34	0.22	24.3	9.4
8	Pretoria Road	38.5	8.0	0.57	0.94	0.16	25.1	7.7
9	Maritz Sand	35	7.9	1.9	2.14	0.37	25.7	3.82

KAALSPRUIT MONITORING PROGRAMME - MEAN VALUES

SAMPLING POINT N°	LOCATION	Elec. Cond. mS/m	pH Units	Nitrate mg/l	Ammonia mg/l	o-Phosphate mg/l	C.O.D. mg/l	Susp.Sol. mg/l	E. Coli CFU/100 m
1	Isiphetweni	34.8	7.6	0.82	3.5	0.56	28.9	15.2	81879
2	Welomlambo	38.9	7.6	1.9	4.9	0.71	38.8	24.7	46536
3	Khatamping School	220	7.6	1.7	2.1	0.44	43.1	27.7	40630
4	Lethabong MSS	93	7.7	1.5	4.4	0.65	32.1	21.8	47256
5	Gahlanso	69.9	8.0	1.9	1.9	0.29	28.5	15.7	33269
6	Khatamping Bridge	129.5	7.6	1.1	3.3	0.37	36	20	108193
7	Khatamping Section	140.4	7.5	1.2	9.7	1	82.9	43.6	687216
8	Midrand MSS	61.2	7.6	1.4	8.6	1.4	82.5	49.9	301773
9	Central	40.7	7.7	3.8	5.1	1.12	47.7	15.1	746227

BLAAUWPAN MONITORING PROGRAMME - MEAN VALUES

SAMPLING POINT N°	LOCATION	Elec. Cond. mS/m	pH Units	Nitrate mg/l N	Ammonia mg/l N	o-Phosphate mg/l	C.O.D. mg/l	Susp.Sol. mg/l
14	Blaauwpan Inflow	23.2	7.9	0.34	1	0.2	31.2	21.2
14	Blaauwpan Dam	23.6	8.1	0.21	0.54	0.23	63.3	22.3
14	Blaauwpan Outflow	19.1	8.0	0.34	0.68	0.29	33.3	27.3

LEGEND

	Elec. Cond. mS/m	pH Units	Nitrate mg/l	Ammonia mg/l	o-Phosphate mg/l	C.O.D. mg/l	Susp.Sol. mg/l	E. Coli cfu/100 ml
Fit for use	< 70	6.5 - 8.5	< 6	< 0.18	< 0.1	< 50	< 25	< 125
Acceptable	70-150	6.5 - 8.5	6-10	0.18-0.4	0.1-0.5	50-75	25-50	125-200
Action Level	150-295	5-6.5/8.5-9	10-20	0.4-2.6	0.5-1	75-100	50-75	200-400
Intervention	>295	< 5 / > 9	>20	>2.6	>1	>100	>75	>400

Table 8.10 Ekurhuleni Municipality Springs Service Area Water Quality Monitoring (January 2002)

RIVERS MONITORING	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R13	R14	R15	R16	R17	R18
Feacal Coliforms- 24h @ 44.5ºC	2	24	9000	22	12000	102	80	173	86	8000	850	270000	164	0	64	150	50
PH	7.5	8.4	7.9	8.0	7.9	7.7	7.8	7.5	7.7	7.6	7.7	7.8	7.7	7.4	7.7	7.7	8.7
Electrical Conductivity @ 25ºC (mS/m)	57	57	224	130	114	215	64	75	224	82	203	119	55	347	190	212	56
Chloride	62	78	396	198	16	178	96	108	176	114	170	92	86	210	146	172	68
Sodium	53	56	346	161	127	148	30	54	154	63	116	107	48	208	136	138	53
Sulphate	98	116	149	163	137	704	144	98	774	95	694	134	43	1386	597	720	111
Ammonia Nitrogen	<0.1	<0.1	ND	0.4	2.9	1.2	<0.1	0.7	0.1	1.9	2.4	8.7	0.4	3.9	0.6	0.7	0.3
Nitrate Nitrogen	1.3	1.1	ND	0.1	0.1	1	0.1	5.4	0.1	10.9	0.4	0.1	1.3	<0.1	0.1	<0.1	1.2
Iron	0.3	0.3	0.6	0.4	1.0	0.6	0.9	0.6	0.3	1.5	3.7	1.6	0.5	3.3	0.2	0.3	0.1
Manganese	0.7	0.7	0.4	0.4	0.5	1.7	0.3	0.3	2.1	0.2	1.0	0.5	0.2	3.6	1.2	2.2	0.1
Chemical Oxygen Demand	36	19	253	81	65	29	15	47	39	74	27	213	19	2	23	15	30
Ortho-phosphate	0.1	0.1	0.2	0.2	1.1	0.7	0.1	0.2	0.5	0.2	0.2	3.5	1.7	0.1	0.4	0.4	0.1
All results except pH and conductivity are expressed in mg/l																	

Source: EMM 2003

BRAKPAN MONITORING	RB1	RB2	RB3	RB4	RB5	RB6	RB7
Feacal Coliforms- 24h @ 44.5ºC	50 000	150	86 667	395	1035000	18 028	3 228
PH	7.9	8.4	7.7	8.3	7.3	7.8	7.6
Electrical Conductivity @ 25ºC (mS/m)	56	90	47	90	77	89	89
Chloride	68	104	58	102	82	90	98
Sodium	44	111	37	140	84	139	133
Sulphate	109	195	88	197	142	191	200
Ammonia Nitrogen	0.6	3.9	0.3	4.4	7.9	5.1	3.5
Nitrate Nitrogen	3.4	1.2	1.1	1.7	7.2	1.8	2.9
Iron	0.6	0.8	3.2	1.0	3.8	1.8	1.1
Manganese	0.4	0.2	0.4	0.1	0.4	0.2	0.3
Chemical Oxygen Demand	8	17	32	24	119	5	33
Ortho-phosphate	0.5	0.3	0.2	0.3	4.4	0.7	0.8
All results except pH and conductivity are expressed in mg/l							

Table 8.11 Ekurhuleni Municipality Nigel Service Area Water Quality Monitoring (January 2003)

SAMPLE POINT	PH	E.C. mS/m	SO4	NH4	NO3	C.O.D.	PO4	Cl-	Na	Fe	Mn	Feacal Coliform/100ml
D1 - NIGELDAM	9.2	102	268	0.3	0	30	0	104	116.5	0.05	0.14	2
D2 - SPAARWATER	7.6	53	74	0.5	0	119	0	51	54.1	0.2	0.11	42
D3 - PIET VAN WYK	9	390	640	0.8	0.1	98	0	780	591	0.26	0.12	20
D4 - MARIEVALE	7.9	164	540	0.2	0	56	0	118	146.1	0.05	0.54	19
D5 - R42	8.2	215	720	3.5	4.1	63	2.7	165	206.1	0.05	0.71	220
D6 - BALFOURPAD	7.9	219	700	0	0	56	0.7	169	216.9	0.08	1.53	170
D7 - NOYCEDALE	8.1	214	690	0	0	51	0.3	166	238.5	0.14	0.89	290
D8 - POORTJE	8.1	208	670	6.5	0.3	72	0.3	160	215.5	0.23	1.03	580

mg/l unless stated

Source: EMM 2003

8.2.2.3 Water Quality Impacts

Comparison of the summary results with the guidelines indicates that water quality is generally demonstrating signs of contamination in terms of salts, as well as nutrients and microbiological contamination.

The rivers are generally classed presently as Tolerable rather than Acceptable or Ideal. The rivers are therefore generally impacted for the following purposes:

- Direct domestic supply and direct body contact with waters with high bacteriological levels potentially may lead to a risk of water borne disease. In addition, the high salt levels of the Blesbokspruit system in particular, but also sections of the Klip River, may affect the taste of the water and may contribute to digestive disorders, as well as increasing the potential for enhanced erosion and corrosion of water process systems, including kettles and geysers. Elevated iron and manganese levels can also give rise to staining on clothes and taste and odour problems in potable water;
- Direct livestock watering may also be affected in areas of high salinity and microbial contamination;
- Surface water quality has a direct potential impact upon the crops that can be cultivated under irrigation, as well as the practical productivity of the crops. Declining water quality in the surface waters, particularly increasing sodium and chloride concentrations, are of particular concern to farming activities.
- Irrigation use of water with high bacteriological levels for crops eaten raw, for example vegetables, may put consumers at risk of being infected by pathogenic bacteria adhering to the surface of the crop; Irrigation with water high in salt, particularly sodium and chloride, can affect the productivity of some sensitive crops;
- Whilst farming activities demand large quantities of water, they also have the potential to detrimentally impact downstream users. Problems arise as a result of fertilizer (natural ie manure and chemical), herbicide and pesticide run-off into surface waters, as well as increased erosion, silt loading and drainage of natural wetlands areas.
- Industrial use can be put at risk by high salinity in the waters, particularly sulfate enhancing erosion and corrosion of water process systems, including reticulation systems and power/steam generation boilers.
- The aquatic ecology of the river systems may be impacted by the volume and salinity, pH and metal concentrations of minewater discharges, particularly in the Blesbokspruit and Elsburgspruit systems which are impacted by the Grootvlei mine and ERPM mine respectively. The aquatic ecology is also impacted by the presence of elevated nutrients, which stimulates excessive algal and plant growth, which leads to a process of water quality deterioration called eutrophication.

8.2.3 Groundwater

Groundwater occurs as a result of the infiltration of rainwater and surface water into the underlying soil and rock layers. Where the infiltrating water meets a layer of resistance it tends to accumulate and form layers or aquifers. As a consequence of the heterogeneity of geological formations there may be a number of aquifer layers formed in the vertical profile, which may or may not be interconnected.

Generally, groundwater flow mimics surface drainage, being driven by gravitational forces and topography. Consequently, although the primary observation of groundwater is its use and potential use as a water supply via borehole abstraction, groundwater can also form base flow into streams and rivers. This occurs where the rest level of the aquifer layer intercepts a stream bed, and water drains from the groundwater system into the stream. Similarly, the occurrence of natural springs is a result of groundwater breaching through the ground surface.

Although the underlying rocks of the Ekurhuleni area are mainly sedimentary, they have gone through several episodes of tectonic events leading to fracturing and faulting, due to brittle failure, and karst formation, due to dissolution. As such, the main groundwater occurrence in these rocks is in fractures (secondary porosity) rather than between sediment grains (primary porosity), although the latter may be important in certain instances. Due to the varied nature of the aquifers, individual zones are discussed according to the predominant aquifer(s) underlying the zone(s). Data is taken from Barnard (2000).

8.2.3.1 Kempton Park area

Granite-gneisses of the Basement Complex dominate in the Kempton Park area and to the north-west of Tembisa, with some scattered outliers north of Benoni (Figure 2.11). Groundwater in the granites generally occurs in the upper weathered zone, with the water table ranging from about 5 to 30 metres below ground. The combination of the relatively high storage of the weathered zone and the presence of a sandy soil cover makes the granites susceptible to contamination when exposed to risk (such as the high pollution risk industries in the Kempton Park area).

Borehole yields in the Basement Complex can vary from dry to more than 7.2 m^3/h. This is controlled by the borehole location in relation to fractures and the weathered zone.

Water quality for the Basement Complex (samples extending beyond EMM's boundary) is shown in Table 8.12. The water quality is generally good but the chloride and sulphate contents vary widely.

Table 8.12 Groundwater quality of the Basement Complex Granite-Gneisses

Element /Parameter	Minimum	Maximum	Mean
PH	6.7	8.4	7.5
EC (mS/m)	8.6	180.0	38.0
TDS (mg/l)	67.0	1170.0	263.0
Ca (mg/l)	5.0	155.0	29.0
Mg (mg/l)	2.0	48.0	16.0
Na (mg/l)	2.0	172.0	23.0
K (mg/l)	0.4	18.1	2.4
Cl (mg/l)	1.0	274.0	18.5
SO4 (mg/l)	1.0	202.0	18.4
Total Alkalinity (mg/l CaCO3)	24.0	284.0	122.0
NO3 (mg/l)	0.1	47.0	6.5
F (mg/l)	0.1	1.7	0.3

8.2.3.2 Germiston-Boksburg-Benoni and Nigel-Dunnottar-Duduza areas

The dominant rock types in this area are fractured quartzites, conglomerates and shales of the West Rand and Central Rand Groups (Witwatersrand Supergroup). In general, the water table is at a depth of between 10 and 25 metres below ground, being shallowest along valleys and other depressions.

The West Rand and Central Rand Group aquifers are classified as moderate yielding, with approximately 65% and 80% of boreholes yielding less than 7.2 m^3/h, respectively.

The quality of the groundwater is generally good, but can be contaminated to unsuitable quality locally due to human induced pollution. Table 8.13 compares the general water quality of the West Rand and the Central Rand Group aquifers.

Table 8.13 Groundwater quality of the West Rand and Central Rand Groups of the Witwatersrand Supergroup Geological formations

Element/ Parameter	**West Rand Group Aquifers**			**Central Rand Group Aquifers**		
	Minimum	**Maximum**	**Mean**	**Minimum**	**Maximum**	**Mean**
pH	5.3	8.4	7.2	6.1	10.0	7.3
EC (mS/m)	2.6	256.0	37.3	3.9	115.6	29.3
TDS (mg/l)	21.3	1492.0	254.0	14.0	611.0	207.0
Ca (mg/l)	1.0	243.0	27.0	1.0	100.0	17.6
Mg (mg/l)	1.0	12.0	18.9	1.0	65.0	13.7
Na (mg/l)	1.0	16.0	18.7	2.0	84.0	20.0
K (mg/l)	0.1	8.4	1.8	0.1	33.8	2.6
Cl (mg/l)	1.0	570.0	24.7	1.0	113.0	17.9
SO_4 (mg/l)	1.0	22.0	16.1	1.0	23.0	3.5
Total Alkalinity (mg/l) ($CaCO_3$)	8.0	346.0	117.0	3.0	278.0	85.0
NO3 (mg/l)	0.1	30.2	4.5	0.1	14.7	2.0
F (mg/l)	0.1	1.7	0.3	0.1	0.8	0.3

8.2.3.3 Alberton, Rietfontein-Tambokiesfontein, Kempton Park and Duduza areas

The dominant rock types in these areas are lavas and sediments of the Klipriviersberg and Platberg Groups restricted to the area south to Kempton Park. Groundwater generally occurs in basins of weathering as well as in the transitional zone between the weathered and fresh lava. The water table is generally between 10 and 25 metres below ground and usually mimics the surface topography.

Water quality is generally acceptable but variation in sulphate can be high (Table 8.14).

Table 8.14 Water quality of the Klipriviersberg Group

Element/Parameter	Minimum	Maximum	Mean
pH	6.9	9.7	7.6
EC (mS/m)	13.2	264.0	60.0
TDS (mg/l)	108.0	1860.0	405.0
Ca (mg/l)	4.0	246.0	49.0
Mg (mg/l)	3.0	162.0	30.0
Na (mg/l)	4.0	104.0	27.0
K (mg/l)	0.1	11.7	1.8
Cl (mg/l)	2.0	316.0	36.0
SO_4 (mg/l)	1.0	1038.0	70.0
Total Alkalinity (mg/l) $CaCO_3$)	7.0	574.0	151.0
NO3 (mg/l)	0.1	31.0	6.3
F (mg/l)	0.1	1.1	0.2

8.2.3.4 Katlehong-Voslorus, Tembisa, Springs areas

Dolomites of the Chuniespoort Group and, to a lesser extent, quartzites of the Timeball Hill Formation (Transvaal Sequence) are the main rocks and aquifers in these areas. The dolomites, although probably the most important source of groundwater in the country, can be hazardous due to their susceptibility to form sinkholes under certain conditions, They are also highly vulnerable to contamination.

They usually form ‘compartments’ separated from each other by dykes. The borehole yield in the dolomites can vary from average (18 m^3/h) to very high (450 m^3/h). The quality is generally good but variations in chloride, sulphate and nitrate, can be high (Table 8.15).

Table 8.15 Groundwater quality in the Chuniespoort Dolomites

Element/Parameter	Minimum	Maximum	Mean
pH	5.8	9.5	7.6
EC (mS/m)	4.4	397.0	62.9
TDS (mg/l)	43.1	3402.0	443.6
Ca (mg/l)	1.0	436.0	52.7
Mg (mg/l)	1.0	223.0	35.4
Na (mg/l)	1.0	299.0	24.1
K (mg/l)	0.1	39.0	2.3
Cl (mg/l)	1.0	900.0	37.7
SO_4 (mg/l)	1.0	2172.0	70.5
Total Alkalinity (mg/l) $CaCO_3$)	8.0	664.0	177.3
NO3 (mg/l)	0.1	122.0	5.6
F (mg/l)	0.1	2.8	0.3

8.2.3.5 KwaThema, Nigel, Brakpan, Springs, Daveyton and Benoni areas

The Karroo Supergroup (represented in the area by the Dwyka tillite and various sediments of the Vryheid Formation, all intruded to various degrees by dolerite) covers most of the surface area of the municipality. The water table in these rocks ranges between 5 and 25 metres below ground and springs usually occur at lithological contacts. The groundwater quality is usually suitable for any use. However, possibly due to association with coal bearing horizons, there is a high variation in sodium, chloride and sulphate.

Although it generally has a lower borehole yield, the groundwater quality in the Dwyka tillite has less variation. Hydrogeologically, the Vryheid Formation and the associated intrusive dykes are taken as one aquifer unit, even though there are significant geological differences. Table 8.16 indicates the groundwater quality of the Vryheid Formation.

Table 8.16 Groundwater quality of the Vryheid Formation

Element/Parameter	**Minimum**	**Maximum**	**Mean**
PH	4.8	8.5	7.5
EC (mS/m)	3.7	344.0	57.0
TDS (mg/l)	33.0	1835.0	400.0
Ca (mg/l)	1.0	184.0	38.0
Mg (mg/l)	1.0	174.0	24.0
Na (mg/l)	1.0	492.0	43.0
K (mg/l)	0.3	38.0	3.6
Cl (mg/l)	1.0	919.0	44.0
SO_4 (mg/l)	1.0	919.0	47.0
Total Alkalinity (mg/l) $CaCO_3$)	12.0	539.0	162.0
NO3 (mg/l)	0.1	80.0	3.9
F (mg/l)	0.1	2.6	0.4

8.2.3.6 Groundwater Use

There is presently little data available on the actual usage of groundwater in the Ekurhuleni Municipal area. Approximately 890 households are estimated to use borehole water, principally amongst previously disadvantaged households, although this is considered to be an underestimate. Many of the agricultural holdings and plots are reliant on borehole water supply for domestic purposes. Groundwater abstraction for irrigation and animal watering also occurs.

Table 8.17 Groundwater use by households in Ekurhuleni (Census 2001)

Source of water	**Black**		**Coloured**		**Indian/ Asian**		**White**	
	Households	**%**	**Households**	**%**	**Households**	**%**	**Households**	**%**
Borehole	787	88.43%	18	2.02%	0	0.00%	85	9.55%
Spring	43	93.48%	0	0.00%	0	0.00%	3	6.52%

8.3 RESPONSES

8.3.1 Policy

8.3.1.1 Surface water

Water services in EMM are a ‘regional’ function (EMM being divided into 3 regions, i.e. Northern, Eastern and Southern). Each region is responsible for monitoring:

- Industrial effluent. The Municipality requires industries to acquire a permit to discharge to sewer which includes quality standards to which the industry’s’ effluent must comply. Since industrial effluents often cause problems at purification works, the regions are in constant contact with ERWAT – which is contracted to handle sewerage purification - and problems arising are addressed and action taken at co-ordination meetings between ERWAT and the Metro.
- Potable water. Potable water is monitored by the regions to monitor the quality of drinking water supplied to the public.
- Environmental water. Surface water courses are monitored by the EMM regions to identify points of pollution and to act promptly, where possible. This includes storm water monitoring.
- EMM participates in the Catchment Management Forums of the region, the Klip River and Blesbokspruit Forums in particular, for which Water Quality Objectives have been developed (for the RAMSAR site, a Class C objective has been set), for which monitoring is principally by Rand Water and DWAF. Individual users also monitor local water qualities as required by licence conditions, particularly the mines of the area. The ecological reserve for the Blesbokspruit has been estimated (linked to the Grootvlei water use licence application). The Upper Vaal Catchment Management Agency’s formation is in an advanced stage.
- ERWAT and Johannesburg Water (on behalf of Johannesburg Municipality) monitor the quality of the treated sewage discharged into the river systems as required by DWAF Water Use Licence conditions for the sewage works. The quality of those effluents is very important to the overall status of the rivers, as it represents a significant contribution to the base flow of the rivers.
- Working for Water has allocated funds for the rehabiliation of the Coalspruit, Swartspruit and Jukskei River.
- Data from the national wetlands survey will be made available during the last quarter of 2003, to assist in the identification and management of wetlands.
- Local, District and Metropolitan Councils have been developing IDPs in which strategies and plans are discussed, which include proposals for the provision of services to all consumers of the area.
- Other than the DWAF programme to develop strategies to manage the water quality effects of urban and informal settlements, water quality management receives little specific attention in the LDOs. Broad expressions are commonly made, such as: “bulk infrastructure should be provided on an environmentally and socially sound basis” or “supplying water to erven necessitates the introduction of waste water disposal arrangements for sullage which could become a problem”. Such expressions may be considered to imply some requirement to cover water quality management.

8.3.1.2 Groundwater

In line with DWAF's intention to devolve management of water resources to the local level, Catchment Management Forums have been established for the Blesbokspruit and Klip River systems. Quarterly meetings are held where issues of ongoing water quality are presented, as well as review of management and development plans as affects the individual catchments, including licence applications for sewage works upgrades, such as the Waterval works of EMM. Representation of EMM participates in the Catchment Management Forums.

The existing and increasing discharge of excess minewaters into the Vaal catchments encouraged the creation of the Amanzi project. The project aims to jointly investigate and implement a program to collect and treat, for potable re-use, minewaters from mines of the East and West Rand, by mines on the East and West Rand, in consultation with DME, DWAF, Rand Water, the effected River Forums and associated stakeholders.

The capital cost for such a scheme is estimated in the billions of Rand, with operational costs of hundreds of million Rand per annum. DWAF has shown, however, that there would be substantial economic benefit to the community using water from the middle and lower Vaal River system should the project be implemented; and that it would be cheaper to implement water treatment (incl. desalination) now that would convert the excess minewater to potable water than to bring forward mega-billion Rand water supply augmentation schemes.

The future development of this very important initiative by stakeholders affected by the minewater discharges will impact upon the water quality of the Blesbokspruit and associated waters, to its detriment if action is delayed, and to its benefit if implementation proceeds. If the water treatment and recovery initiatives are implemented, it is expected that the flows in the Blesbokspruit and associated waters will decrease significantly as the present minewater flows are stopped. Consideration will need to be given to the management of such flow reductions to minimize negative impacts on the Blesbokspruit's ecosystems.

8.3.2 Legislation

It is noted that with the dynamic nature of South African legislation, it is difficult to keep up with which sections of which acts are in force at any one time. To ensure accurate information it is recommended that the relevant government departments be consulted.

8.3.2.1 Constitution of the Republic of South Africa Act 108 of 1996

Section 24 states that everyone has the right

- to an environment that is not harmful to their health or well being; and
- to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that
  - prevent pollution and ecological degradation
  - promote conservation
  - secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

There are other rights which indirectly relate to environmental issues such as the right to access of information (Section 32), the right to enforcement of the rights (Section 38) and the right to public administration governed by the democratic values and principles enshrined in the Constitution (Section 195).

8.3.2.2 National Environmental Management Act 107 of 1998

The Act provides for co-operative environmental governance by establishing decision-making principles on matters affecting the environment including the following:

- sustainable development
- integrated environmental management using the best practicable environmental option (BPEO)
- the Polluter Pays Principle
- cradle to grave responsibility
- the Precautionary Principle
- the involvement of Interested and Affected Parties (IAPs) in decision making.

Of specific note is Section 28, which imposes a duty of care and remediation of environmental damage on an owner of land or premises; a person in control of land or premises; or a person who has a right to use the land or premises.

8.3.2.3 National Water Act 36 of 1998

Table 8.18 Summary of the National Water Act, Act No. 36 of 1998

Chapter	Description
1	**Fundamental principles of the Act** Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources
2	Development of strategies to facilitate the proper management of water resources Part 1 : Requires the progressive development, by the Minister, of a National Water Resource strategy. Part 2 : Requires every catchment management agency to progressively develop a catchment management strategy for the water resources within its water management area
3	Protection of water resources Parts 1, 2 and 3 : Measures which are intended to ensure the comprehensive protection of all water resources. Part 4 and 5 : Measures to prevent the pollution of water resources and measures to remedy the effects of pollution
4	Use of water and basis for regulating water use Part 1 : General principles for regulating water use. Part 2 : Guidelines for responsible authorities to issue and to attach conditions to general authorisations and licences. Part 3 : Existing lawful water uses. Part 4 and 5:Ministers power to regulate activities which reduce stream flow or have a detrimental impact on resources Parts 6-10 : Procedures and requirements for licence application and renewal and the consequences of contravention
5	Measures to finance the provision of water services and implementation of water management strategies Part 1 : Water use charges and pricing strategies, incentives and penalties Part 2 : Provision for financial assistance from the Minister

6	General power and duties of the Minister and the Director-General Part 1 : General power and duties of the Minister, such as delegation and expropriation. Part 2 : General procedures for making regulations. Part 3 : Power of the Minister to fulfil the function of a catchment management agency. Part 4 : Power of Director-General
7	Establishment and operation of Catchment Management Agencies to delegate water resources management of a regional or catchment scale
8	Establishment and operation of Water User Associations (eg. Irrigation Boards)
9	Establishment and operation of Advisory Committees
10	Establishment and operation of bodies to implement certain international agreements
11	Establishment and operation of Government Works (eg. water storage dams, water transfer schemes)
12	Measures to improve the safety of new and existing dams. Registration of dams
13	Access to land and private property for authorised persons Part 1 : Access for inspections Part 2 : Access for authorised use of water
14	Establishment and operation of a national monitoring system Part 1 : National monitoring system Part 2 : National information system Part 3 : Flood and drought information database available to public
15	Establishment of the Water Tribunal to hear appeals
16	List of offences and remedies
17	General and transitional provisions

8.3.2.4 Water Services Act 107 of 1997

The Water Services Act deals with water supply, sanitation, sewerage and waste water removal services. The first and main objective of this act is to ensure that everybody has access to basic water supply and sanitation services necessary for human health and well-being. Furthermore, the Water Services Act sets national standards and norms for water services and tariffs, ensures that water services are properly planned, establishes the institutional arrangements for water services provision and sets out who is responsible for different activities, and promotes effective water resources management and the conservation of the Nation’s water resources. Again, due to its volume, it was not practical to include this Act as part of this report.

8.3.2.5 Lawful Water Use

The NWA promulgated in October 1998 now controls water use, but the sections on water use have just come into effect (as of 1 October 1999). Prior to this date, the water use provisions in the repealed Water Act 54 of 1956, remained in effect. The enforcing authority is DWAF.
Water uses that need to be licensed (Section 21) include:

- water abstraction from a water resource;
- water storage;
- disposal, in any manner, of waste water from industrial processes (see below);
- alteration of flow in a watercourse;

- controlled activities (irrigation with waste water, modification of atmospheric precipitation; hydro power generation, intentional recharging of aquifers with waste water - Sections 27 and 28);
- use of water for recreational purposes.
- removing and/ or discharging of underground water;

Licenses are not required (Section 22) where:
- the water use is an existing lawful use (a use which was authorised before the commencement of the Act);
- the use is permissible under a general authorisation (a draft general authorisation has been published for comment – the aim of this is to avoid a flood of licence applications and it will be revoked after a certain time);
- the water use is listed in Schedule 1 (domestic use, non-commercial gardening, emergency water use such as fire-fighting, and run-off/ storm-water from sites into any conduit where approval has been obtained from the party authorised to receive treat and dispose of this water*);
- a responsible authority has waived the need for a licence (because it is satisfied that the purpose of the Act will be served by an authorisation under any other law).

*However as this section has not yet been brought into force, Section 21 of the 1956 Water Act is considered to still apply. Contravention of an authorisation will be dealt with by the responsible authority (Sections 53 and 54) as follows:
- a notice will be served;
- the authority will carry out actions necessary to rectify the contravention at the cost of the party on which the notice was served if the party does not take the specified corrective action timeously;
- suspend the entitlement to use of water.

8.3.2.6 1956 Water Act requirements for water use licences

Prior to 1 October 1999 permits for water use were obtained in terms of the old Water Act:
- use of water (more than 150 m3/ day) for industrial purposes (Section 12)*;
- purification and disposal of water used for industrial purposes and effluent (Section 21). There are exceptions to this requirement and one of them is when the water is discharged into a sewer, for the purposes of treatment, which is controlled by the Minister or relevant local authority (see below).
- use of flow from a public stream (Section 9);
- abstraction of water in excess of a certain quantity (Section 9 B);
- authorisation of water-care works (Section 12A);
- use of water removed from an underground mine (Section 12 B);
- alteration of a course of a public stream (Section 20);

* The establishment of the Water Services Act 1997 infers that DWAF will no longer issue usage permits, but that these will be issued by the water service provider. The formalisation of water service providers has not occurred.

8.3.2.7 Industrial discharges to sewer

Discharges to sewer must comply with any relevant local authority by-laws. Written permission is usually needed from the Town Engineer. The permission may include specific detailed conditions relating to the discharge in addition to those specified in the by-laws. In some cases the local authorities do not have specific by-laws in which the Standard By-laws, issued by DWAF, are usually considered to apply.

The by-laws may also include a tariffing structure, which is usually based on the volume of effluent being discharged and the composition of that effluent, as determined by the local authorities sampling programme.

8.3.2.8 Storm water run-off

Discharges of storm water to open drains or watercourses need to comply with DWAF's 'General Standard' (guideline values issued in Regulation 991 under the terms of the Water Act 1956).

8.3.2.9 Pollution incidents

Under the NWA, Part 4 (Section 19), any person who owns, controls, occupies or uses land is deemed responsible for taking measures to prevent pollution. This is taken to apply retrospectively so could also relate to historic pollution incidents. This means that the owner of a site is responsible for anything happening, or that has happened, on its land even if a tenant or contractor carries, or carried out, the offending action. However Paragraph 5 of Section 19 states that the cost of remedial work carried out by the Catchment Management Agencies (once these are set up – currently DWAF) can be recovered jointly and severally from:

- Any person who is or was responsible for, or who directly or indirectly contributed to, the pollution or potential pollution;
- The owner of the land at the time when the pollution or the potential for pollution occurred, or that owner's successor-in-title;
- The person in control of the land or any person who has a right to use the land at the time when: the activity of the process is or was performed or undertaken; or the situation came about; or
- Any person who negligently failed to prevent: the activity or the process being performed or undertaken; or the situation from coming about.

This means that should the Catchment Management Agency (to be formed in terms of the new NWA when established, decide to take action retrospectively for damage caused by any contractors or tenants who contributed to the problem, the site owner could also be considered liable.

8.3.3 Programmes and Initiatives

There is no formal EMM "Water Management Program", nor any specific long-term plan, however, in the various Catchment Management Forums, to which EMM contributes, there are certain water quality objectives that the catchments have identified as long-term objectives to be achieved with the support of the relevant stakeholders and the Metro. Table 8.19 illustrates activities carried out by the municipality, their nature and response

As drainage from EMM contributes to the inflows to the Vaal River system, consequently to the primary fresh water source for the greater Gauteng area, the management of the water entering the Vaal River is important. As a consequence, the river systems in EMM are monitored by DWAF, as the custodian of the nation’s water resources, as well as Rand Water as primary water service provider, operator of the water treatment plants and main distribution systems for the region, in additional to local monitoring by EMM itself.

The River Health Programme, established by DWAF, monitors the ecological condition of river systems in the area, particularly the Klip River and Blesbokspruit systems, and reports via the respective Forums.

Ekurhuleni’s involvement in the Catchment Management Forums for the Blesbokspruit and Klip River systems has been discusssed.

Table 8.19 Activities Carried Out by the EMM, Nature and Response

ACTIVITY	RELEVANT DEPARTMENT	NATURE OF RESPONSE	CONTROLLING LEGISLATION	COMMENT
Water quality sampling	Community Services	Routine	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Selected monitoring points are sampled regularly for the Blesbokspruit and Klip River Forum systems by Rand Water and DWAF. Ekuhukeni monitors additional internal streams and stormwater systems on an ad-hoc basis
	Environmental Health	in response to complaints		Some bacteriological sampling is undertaken where areas of concern are identified, including historical cholera sampling when a problem was identified
Visual inspection of rivers and sewer lines	Environmental Health	Routine	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Blocked sewer lines, illegal waste deposition etc. will be reported to the relevant department for remedial action, when observed.
Repair of sewer lines, manholes and storm water drains	Town Engineers	in response to complaints	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Repairs are carried out as soon as resources permit.
Dealing with complaints	Various	in response to complaints	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Most complaints are received centrally at the main Municipal office, Rand Water or DWAF, however occasionally they come direct to the relevant department. Investigations will then be carried out. It is not known if a formal log of the complaints received and the response made is kept.
Pollution incident reports	Environmental Health or Town Engineers	in response to complaints	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Under the current local By-laws point source pollution discharges can be stopped or prevented by issuing of Notices. Non-compliance with notices can lead to prosecution. This process has been used on occasion for some industrial discharges.
Control of industrial pollution	Town Engineers	in response to complaints	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Industrial discharges to sewer are controlled by the Town Engineers under the terms of the local By-laws. Charges are levied for such discharges.
	DWAF	not known		DWAF is responsible for the control of mining and industrial discharges direct to watercourse.
Education/ awareness	Community Services	some proactive work	National Water Act 1998, National Health Act 1977, Environmental Conservation Act 1989 & local by-laws	Ekuhuleni is carrying out some education and awareness campaigns. Application is also being made for further resources to extend the work. Work includes involving entrepreneurs in the clean up of illegal waste in informal settlements and river courses.

8.4 MONITORING

It is necessary to have as complete a monitoring programme in place from which appropriate information can be drawn on an annual basis to assess any changes to the status of water resources in EMM, and to contribute to the development of action plans to improve water resources management.

8.4.1 Information and data gaps

8.4.1.1 Water supply and sanitation

Water supply and sanitation service provision, as provided by the EMM, is recorded in the national census data and as presented by the Demarcation Board data base (www.demarcation.org.za). The Municipal treasury department has its data base for credit control of water services, detailing the level of service provided. As EMM expands and develops, water service provision demand will increase over and above commitments to meet national programmes for adequate water and sanitation service provision to presently disadvantaged community sectors and areas. Information management will need to be adequate in order to monitor sustainability indicators for water service provision.

8.4.1.2 Stormwater

Flood envelopes and quantitative data regarding water quantity are major gaps.

8.4.1.3 Surface water quality

The Blesbokspruit has been monitored at various points by the Blesbokspruit Forum since 1994. The management structure includes numerous industries, local councils, government, as well as the private sector. The quarterly reports of the Blesbokspruit Forum provide an important information source for the monitoring data of Rand Water and DWAF in the catchment and reports from Forum members on incidents, developments and catchment management initiatives.

The Klip River has been monitored at various points by the Klip River Forum. The Natalspruit had been monitored by the Natalspruit Forum which subsequently merged to form part of the Klip River Forum, where reporting of the Elsburg spruit continues. The Rietspruit has also been monitored by the Natalspruit Forum and currently by the Klip River Forum. As above, the quarterly reports of the Klip River Forum provide an important information source for the monitoring data of Rand Water, DWAF and Johannesburg Municipality, and reports from Forum members on incidents, developments and catchment management initiatives.

Several internal monitoring points are sampled by the service regions of EMM. The Kaalspruit has been monitored by Kempton Park/Tembisa Municipality at the municipal boundary and data is available from 1997. *Ad hoc* data is also available for spruits feeding the Jukskei and Swartspruit and stormwater outlets. A comprehensive monitoring programme of rivers, dams and water supply systems is provided on a monthly basis by the Springs and Brakpan service area of EMM, and monitoring is undertaken of the Blesbokspruit in Nigel and Nigel dump site dam by EMM.

Johannesburg Water monitors the upper Klip River and Midrand area, contributing to the Kaalspruit and Julskei River systems. The Rietrivier spruit and Grootrivierspruit are monitored by DWAF as part of the Crocodile River Forum.

There does not appear to be a coordinated monitoring programme for EMM. Different areas monitor at different frequencies, they monitor different parameters or water quality indicators, and data presentation varies. There also appear to be limitations on the ability to interpret monitoring data into action plans. It is recommended that a centralised data base be established for water quality monitoring in EMM which will draw on monitoring by the Municipality itself and other agencies, Rand Water, DWAF, Johannesburg Water, etc.

Water quality monitoring data for the Blesbokspruit and Klip River systems illustrate the concentration for indicator substances at points in the catchments, and guideline in-stream water quality objectives. EC indicates the level of salts in the water and inorganic pollution. Sulfate as a major component of the salt load is principally related to minewater discharges and seepage from mine residues. Nitrate and phosphate are indicators of organic pollution, principally associated with sewage spillages, contaminated run-off and treated sewage discharges. As flow data for the rivers is limited, the pollution load cannot be calculated efficiently.

Bacterial monitoring is also undertaken by Rand Water, DWAF and EMM at selected monitoring points. Poor bacteriological levels are indicative of run-off and greywater discharges from urban areas (including sewage overflows as a result of blockages) and informal settlements.

8.4.1.4 Groundwater quality

Groundwater quality data is limited with no routine monitoring system in place. A few boreholes have been monitored for quality on an *ad hoc* basis, but the data is not readily available.

8.4.1.5 Effluent discharges

Treated sewage effluent discharges from the sewage works are undertaken under a permit from DWAF. Quality data for the sewage works discharges was not available at the time of compiling this report. It is reported that the various sewage works have generally performed well, although incidents of poor performance have and do occur (Klip River and Blesbokspruit Forums 2003). Mine discharges are also undertaken under a permit from DWAF. Quality data for mine discharges was not available at the time of compiling this report. It is again reported that the primary treatment applied to ERPM and Grootvlei discharges have generally performed well, for the purposes presently designed for, i.e. pH correction and some metal precipitation but not salt load reduction. Again, incidents of poor performance have occurred. (Klip River and Blesbokspriut Forum 2003)

8.4.2 Recommended future indicators

8.4.2.1 Water Service Provision

The Constitution of the Republic of South Africa has guaranteed access to clean water to all and the provision of a safe and healthy environment. It is therefore essential that such commitments can be measured.

8.4.2.2 Water Supply

Requires: annual update of numbers of households provided with each level of service

- Piped water inside dwelling supplied by Municipality;
- Piped water inside yard supplied by Municipality;
- Piped water; distance less than 200m from dwelling, supplied by Municipality;
- Piped water on community stand; distance greater than 200m from dwelling, supplied by Municipality;
- Borehole supply;
- Spring supply;
- Rain-tank supply;
- Dam/Pool/Stagnant water;
- Water vendor;
- River abstraction;

Requires: a comprehensive hydrocensus be carried out in the area to quantify the volumes and quality of abstracted surface and groundwater. The hydrocensus will not only confirm the current status of water conditions in EMM, but also form a basis for designing a detailed monitoring strategy.

8.4.2.3 Sanitation Service Provision

Requires: annual update of numbers of households provided with each level of service

- Flush toilet (connected to Municipal sewerage system);
- Flush toilet (connected to septic tank and soak-away);
- Chemical toilet;
- Pit Latrine with Ventilation;
- Pit Latrine without ventilation;
- Bucket latrine collected by Municipality;
- None.

8.4.2.4 Greywater Service Provision

Requires: annual update of numbers of households provided with each level of service

- Standpipes drain connected to Municipal sewerage system;

- Standpipe drain connected to soak-away;
- Standpipe drain connected to on-site treatment (evaporation/wetland/grass plot);
- Wastewater drain connected to Municipal sewerage system;
- Wastewater drain connected to soak-away;
- Wastewater drain connected to on-site treatment (evaporation/wetland/grass plot);
- Waste dump seepage/leachate to above options
- Stormwater channels to above options etc

8.4.2.5 Water Management Service Provision

Requires: annual update of licenses issued and permit conditions compliance reporting

- Licensing and monitoring of industries discharging to sewer;
- Licensing and monitoring of sewage treatment plants;
- Licensing and monitoring of solid waste disposal sites;
- Licensing and monitoring of industries and mines discharging to surface water resources;
- Licensing and monitoring of all recognised water uses by mines and industry;
- Licencing and monitoring of borehole water users;
- Licencing and monitoring of surface water users and abstractors.

8.4.2.6 Water Quality

Requires: an effective sampling and flow monitoring programme to be initiated to understand the current situation and to identify any future trends and system needs.

A coordinated and consolidated monitoring programme should be established for EMM which not only includes monitoring undertaken by EMM itself, but also monitoring undertaken by Rand Water, DWAF, Johannesburg Municipality etc.

A G.I.S based data management system should be established to coordinate monitoring, reporting and action planning. A programme of surface water quality monitoring for all watercourses (additional points may be required) on a monthly basis, should be undertaken until trends can be identified, which would allow rationalisation of monitoring points and parameters. Monitoring should include chemical, as well as visual and bacteriological assessment.

Specific water quality indicators would include:

- electrical conductivity to assess changes in salt loads (mS/m);
- sulphate to assess minewater contributions and potential for biological induced corrosion;
- chemical oxygen demand (COD) or biological oxygen demand (BOD), to monitor organic contamination and risk of oxygen deprivation of the water course;
- pH as a general indicator of the buffering capacity of the stream (pH unit);
- dissolved oxygen *in situ* in the streams to assess suffocation potential;
- suspended solids to determine sediment transport in the river;
- microbial quality to indicate levels of bacteriological contamination (E. Coli & Total Plate Count/100 ml).

* *measured as mg/l unless specified*

A full analysis (including the major cations, anions and metals) should be carried out with a six-month frequency.

Physical indicators, which provide an indication of the aesthetic quality the water resource and a visual indicator of potential adverse impacts, include:

- Litter, whether from domestic or industrial sources (type and mass of litter);
- Solid waste from domestic and industrial sources (type and mass of solid waste);
- Erosion of river banks, stormwater drains etc (visual assessment of extent of erosion);
- Odour, indicating possible septic conditions (aesthetic qualification);
- Turbidity/colour, indicating possible pollution and declining water quality (aesthetic qualification);
- Observation of point and non-point source discharges and catchment management (visual assessment).

Where a discharge is licenced, i.e. sewage and minewater treatment plants, or where specific problems are identified, i.e. leachate from waste sites, it may be necessary to extend the monitored parameters to comply with specific DWAF permit conditions.

8.4.2.7 River Health

Requires: the implementation of a monitoring programme in accordance with the river health monitoring programme established by DWAF, which provides a basis to monitor the ecological status of the river systems, and the associated impacts of water use and water pollution. Aspects to be monitored once a year or every two years), include

- Habitat: Describing the in-stream availability and diversity of habitat;
- Aquatic invertebrates: SASS 5 invertebrate index and fish habitat indices;
- Fish populations: Fish (number of species, sensitivity, size and condition) are good indicators of the longer term influences on river reach and general habitat conditions;
- Riparian vegetation: Healthy river banks maintain the form of the river channel, provide habitat for species (aquatic and terrestrial) and filter sediment, minerals and light.

8.4.2.8 Groundwater

Requires: identification of groundwater sensitive areas and areas where groundwater abstraction is practiced. These areas are presently undefined and should be determined. Groundwater monitoring can then be initiated.

A detailed (quarterly) sampling program may be undertaken for a period of 2 years, after which a reduction in frequency may be implemented if data suggests this is suitable at the time.

Specific water quality indicators would include:

- electrical conductivity to assess changes in salt loads (mS/m);
- sulphate to assess possible contamination from leaching of mine and waste residues and minewater contributions;
- nitrate to assess possible contamination from on-site sanitation or industry/agriculture

- pH as a general indicator of the buffering capacity of the groundwater (pH unit);
- microbial quality to indicate levels of bacteriological contamination (count/100 ml).

  * mg/l unless specified

A full analysis (including the major cations, anions and metals) should be carried out at least on a six monthly frequency.

Where a soil and groundwater contamination source is evident, i.e. waste sites, it may be necessary to extend the groundwater quality monitoring to comply with specific DWAF permit conditions.

Of particular importance is monitoring of fluctuations in the water table and changing quality, since in areas underlain by dolomites such fluctuations and quality changes may lead to the development of sinkholes.

8.5 CONCLUSIONS

Natural water resources in EMM are largely dominated by the effects of upstream activities as well as internal activities. Upstream activities affecting the hydrology and quality of the surface water resources include the discharges of treated sewage from the Greater Johannesburg area, which provides a significant base flow of water to the Klip River system, irrespective of seasonal natural rainfall, and associated impact on quality. Similar significant treated sewage loads affect the Blesbokspruit and Natal spruit systems from within EMM.

Although a large proportion of EMM is served by the Municipality with formal full-bore sewerage infrastructure, a significant percentage, particularly in the informal and low cost settlements and rural areas, have rudimentary on-site sanitation systems, which inherently pose a water quality management risk.

Storm water run-off, particularly from the urbanised areas and informal settlements, can significantly affect the water quality, whilst run-off from the mine areas and discharge of underground water, particularly to the Elsburgspruit and Blesbokspruit, represents a significant extraneous water load and quality impact to the catchments within EMM.

Although there is little direct formal water abstraction for potable use from rivers within EMM, there is informal abstraction for domestic purposes, as well as recreational and agricultural use. Most of EMM is serviced by the Municipality with Rand Water potable water, with limited use of groundwater.

As water from EMM ultimately feeds into the river systems of the Vaal Dam supply scheme to the south and the Crocodile River - Hartbeespoort dam supply scheme to the north, water quality management in EMM has widespread implications for the supply of water to the region.

As the water systems are of such strategic importance, Catchment Management Forums have been established for the Blesbokspruit and Klip River systems. Quarterly meetings are held where issues of on-going water quality are presented, as well as review of management and development plans as affects the individual catchments. Representatives of EMM participate in the Catchment Management Forums.

Water quality in the river systems can be considered generally non-ideal as a result of activities within the catchments. Consequently Water Quality Objectives have been drafted for the Klip River and Blesbokspruit systems and the Catchment Management Forums will endeavour to achieve an on-going improvement in water quality, necessitating the involvement and participation of EMM.

Although limited groundwater is abstracted for domestic or irrigation use in EMM, the groundwater resource can be considered of strategic importance. Significant potential impacts on the groundwater systems are associated with mine dewatering activities, mine residue disposal practices, as well as domestic and industrial waste disposal practices, on-site sanitation, and agricultural practices.

Management of the surface water resources will inherently require participation in the strategic management of groundwater resources.

Indicators of water quality management for surface and groundwater resources have been identified which will assist in the development of on-going improvement and performance monitoring.

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