CHAPTER 2 : BROAD PERSPECTIVE REGARDING THE WATER SITUATION IN THE MIDDLE VAAL WMA

2.1 Introduction

In this chapter summarised information from the NWRS and the "Overview of Water Resources Availability and Utilisation" reports for the Middle Vaal WMA (DWAF, 2003a) is included to provide the reader with the required background of the water situation in the Middle Vaal WMA. When more detailed background information is required the reader is referred to the NWRS document and secondly to the "Overview of Water Resources Availability and Utilisation" reports for each WMA. These reports should, in general, provide sufficient detail for most readers. Even more detail can be obtained from the "Water Resources Situation Assessment Study" as prepared for each Water Management Area (DWAF, 2002).

The Middle Vaal WMA is part of a larger water supply system which includes adjacent WMAs. This system is referred to in this document as the Vaal River System. A schematic of the system is shown in **Appendix B**. The Vaal Overarching ISP has been developed to deal with the strategies for this system. The Middle Vaal WMA is one of three WMAs in the Vaal River System, which is the drainage area of the Vaal River from its headwaters to the confluence of the Vaal and Orange Rivers. The Middle Vaal ISP should be read in conjunction with the Vaal Overarching ISP (DWAF, 2004b) to gain a complete understanding of the strategies for the WMA.

This chapter is structured to capture the background and related strategies for the Middle Vaal WMA in a logical and descriptive manner. A broad overview of the salient details that were identified in the Middle Vaal WMA workshops is also included. This will at the same time serve as an introduction to the detailed descriptions of the strategies that are presented in **Appendix A.**

The tables in **Appendix A** present the strategies in a structured format which includes management objectives, background information in support of the motivation for the strategies, management actions that are required for the implementation as well as lists of related issues that were raised at the workshops or captured from study reports. The tables also contain cells to indicate the priority or relative importance of each strategy as well as which of the DWAF Directorates would be responsible for implementation. A distinction is also drawn between over-arching Vaal River System issues, which will be dealt with at a national level, and regional issues, which will be dealt with by the CMA.

In addition to the water resource system specific issues, listed in **Appendix A**, issues or strategies that were identified for consideration at national level are excluded from this document and will be dealt with through a separate document that will focus on all the National Issues. These items typically cover aspects that should be under the Minister's

control, relate to national policy, or were identified in several other WMAs and therefore require a high level of co-ordination.

2.2 General Catchment Description

2.2.1 Overview

The Middle Vaal WMA is located downstream of the confluence of the Vaal and the Rietspruit Rivers and upstream of Bloemhof Dam; It extends to the headwaters of the Schoonspruit River in the north and the Vet River in the south, covering a total catchment area of 52 563 km^2. The Middle Vaal WMA includes parts of Free State and North-West provinces.

Major rivers in the Middle Vaal Water Management Area include the Schoonspruit, Rhenoster, Vals, Vet and Vaal rivers. The tertiary drainage areas in the Middle Vaal WMA comprises C24, C25, C41, C43, C60 and C70.

The NWRS describes and discusses the Middle Vaal WMA in three sub-areas, viz. the Rhenoster/Vals, Sand/Vet and Middle Vaal. The geographical extent of the sub-areas are shown in **Figure 2.1**. The broad overview of the water resource in the Middle Vaal WMA is discussed in terms of the NWRS sub-areas. A more detailed map showing the sub-catchments and the main tributaries is given in **Appendix B**.

The Middle Vaal is part of the Vaal River System. The Vaal River forms the main tributary to the Orange River and originates on the plateau west of the Drakensberg escarpment and drains much of the central highveld of South Africa. Within South Africa, the Orange/Vaal River Basin includes 5 of the 19 Water Management Areas (WMA). These are the Upper Vaal, Middle Vaal, Lower Vaal, Upper Orange and Lower Orange WMAs. The Middle Vaal WMA lies between the Upper and Lower Vaal WMA's, with the Crocodile West and Marico WMA to the north and the Upper Orange WMA to the south of the Middle Vaal WMA.

The Vaal River is probably the most developed and regulated river in Southern Africa, while some of the largest dams in Africa have been built in Lesotho and on the main stem of the Orange River. Although linked together by the natural watercourses, a particular characteristic of the Orange/Vaal WMAs is the extensive inter-catchment transfer of water within WMAs as well as interbasin transfers between these and other adjoining WMAs.

The Middle Vaal WMA is largely dependent on water releases from the Upper Vaal WMA for meeting the bulk of the water requirements by the urban, mining and industrial sectors

within its area of jurisdiction, with local resources mainly used for irrigation and smaller towns. However, local resources are also used for urban use, such as the dependency of Sedibeng Water on Allemanskraal Dam for water supply to Virginia. Water is also transferred via the Vaal River through this WMA, from the Upper Vaal WMA to the Lower Vaal WMA. Water quality in the Vaal River is strongly influenced by usage and management practices in the Upper Vaal WMA.

2.2.2 Topography

The water in the Middle Vaal WMA flows from the Upper Vaal, across the Middle Vaal, Lower Vaal and Lower Orange WMAs before reaching the Atlantic Ocean near the town of Alexander Bay in the western corner of the country. This cascading characteristic illustrates the interdependence of the 5 WMAs in the Vaal River system and emphasises the need for water resource management to take place across the WMA boundaries.

The Middle Vaal WMA is relatively flat with a maximum elevation of about 2 200 m in the hilly upper reaches of the Vals River and a minimum elevation of about 1 250 m in the vicinity of Bloemhof Dam. Pans and other enclosed drainage basins are features of the western parts. In this WMA the predominant veld type is “pure grassveld”. In the northern areas there is a bit of “false grassveld” while upstream of Bloemhof Dam there is some “tropical bush and savanna”.

2.2.3 Geology and Soils

The geology is varied with a large dolomitic intrusion occurring in the Orkney area of the WMA. Diamonds are found in the north east of the WMA, with rich gold ore in the vicinity of Klerksdorp and Welkom. The area south of the Vaal River is underlain by fine sedimentary rocks of the Karoo system, which represents about 80% of the Vaal River Basin. To the north of the Vaal River igneous and metamorphic rocks predominate but there are extensive dolomitic exposures in the most northerly part of this WMA and also east of Klerksdorp.

Soil depths are generally moderate to deep with flat to undulating relief over the entire Middle Vaal WMA. There are three main soil types that predominate and these are distributed across the catchment as follows:

Sandy Loam : Most of the WMA consists of this soil type from the central portion of the WMA upstream of Bloemhof Dam.

Clay Loam: This soil type extends from the sandy loam area further eastwards into the headwaters of the Sand, Vet, Elandspruit and Renoster Rivers.

Clay Soil: A relatively small area at the confluence of the Sand and Vet Rivers.

A detailed report on the groundwater in the WMA is given in **Appendix D**.

Figure 2.1 : Layout and location of the Middle Vaal WMA

2.2.4 Climate

Climatic conditions can vary considerably from west to east across the Middle Vaal WMA The mean annual temperature ranges between 18 °C in the west to 14 °C in the east, with an average of about 16 °C for the catchment as a whole. Maximum temperatures are experienced in January and minimum temperatures usually occur in July. Rainfall is strongly seasonal with most rain occurring in the summer period (October to April). The peak rainfall months are December and January. Rainfall occurs generally as convective thunderstorms and is sometimes accompanied by hail. The overall feature of mean annual rainfall over the Middle Vaal WMA is that it decreases fairly uniformly westwards from the eastern escarpment regions across the central plateau area. The MAP for the watershed ranges from a high of 700 mm in the east to a low of 500 mm in the west with an average of about 550 mm.

Frost occurs throughout the Middle Vaal WMA in winter, typically over the period mid-May to late August. The average number of frost days per year for the Middle Vaal as a whole ranges from 30 in the northern and eastern parts up to 40 in the central plateau areas of the Free State.

Humidity is generally highest in February (the daily mean over the Middle Vaal WMA ranges from 62 % in the west to 66 % in the east) and lowest in August (the daily mean ranges from of 52 % in the west to 58 % in the east).

Average gross potential mean annual evaporation (as measured by Class A-pan) ranges from 1 800 mm in the east to a high of 2 600 mm in the dry western parts. The highest A-pan evaporation is in January (range 200 mm to 300 mm) and the lowest evaporation is in June (100 mm to 120 mm).

2.2.5 Environmentally Sensitive Areas

The Allemanskraal game reserve is the best known reserve in the water management area. Some smaller conservation areas are also to be found in the Middle Vaal water management area.

2.2.6 Demography, Land Use and Development

The Middle Vaal water management area is relatively sparsely populated and represents just over 3% of the national population. The total urban population in this WMA is approximately 1,1 million while the rural population is approximately 0,4 million (1995 figures). Most of the urban and rural population is concentrated in the Middle Vaal sub-area (quaternaries C24 and C25) in the main urban and mining centres of Klerksdorp, Orkney and Stilfontein, as well as the Vet sub-catchment (quaternaries C41, C42 and

C43), in the main urban and mining centres of Welkom and Virginia. A relatively large population is also evident in the Rhenoster-Vals sub-area in the town of Kroonstad (which is not a mining town).

The future demography and population distribution of the water management area will largely be influenced by economic opportunities and potential. Urban populations are expected to decline over much of the water management area mainly as a result of the decline in mining activity as well as due to a lack of other economic stimulants in the region. However, moderate population growth is foreseen in the Middle Vaal sub-area, which is probably attributable to the migration of people towards the more diversified economy in the Klerksdorp area in search of economic opportunities. This trend is expected to stabilise after 2005. A decline in rural population is also expected throughout the water management area as the pace of urbanisation in the country gains momentum.

Table 2.1: Middle Vaal WMA : Population in 1995

Source : Middle Vaal Water Management Area: Water Resources Situation Assessment, August 2002

CATCHMENT						POPULATION IN 1995		
PRIMARY		SECONDARY		TERTIARY		URBAN	RURAL	TOTAL
No.	Description	No.	Description	No.	Sub-catchment Description			
C	Vaal	C7	Rhenoster	C70	Rhenoster (70A-K)	62 350	37 856	100 206
		C6	Vals	C60	Vals (C60A-J)	148 050	41 152	189 202
		C2	Schoonspruit	C24	Schoonspruit (C24C-G)	21 150	31 915	53 065
			Vaal	C24-C25	Vaal (C24A-B, C24H-J, C25A-C)	404 700	89 497	494 197
			Bloemhof	C25	U/S Bloemhof (C25D-F)	51 200	21 961	73 161
		C4	Allemanskraal	C42	Allemanskraal (C42A-E)	4 150	16 717	40 867
			Erfenis	C41	Erfenis (C41A-E)	26 500	18 408	44 908
			Vet	C41-C43	Vet (C41F-J, C42F-L,C43A-D)	376 800	136 695	513 495
Total in Free State						**708 950**	**310 263**	**1 019 213**
Total in North-West						**405 950**	**83 939**	**489 889**
TOTAL IN WMA						**1114 900**	**394 202**	**1 509 102**

The predominant land use, in the Middle Vaal WMA is rain fed cultivation covering about 40% of the 53 000 km^2 of the WMA with the main crops being wheat and fodder pastures (kikuyu and rye). This percentage was obtained through visual inspection of **Figure 3** of reference, DWAF (2003a). Irrigation covers an area of about 210 km^2 and alien vegetation 70 km^2.

Agriculture is one of the main activities in this WMA. The irrigation of crops such as maize, groundnuts, sorghum and sunflowers occurs mainly downstream of the dams and along the Vaal River. The Sand-Vet GWS is the most important irrigation area in the WMA. Livestock farming consisting mainly of beef, dairy and sheep farming enterprises as well as some game farming. There is no sugarcane or significant afforestation in this WMA.

Urban development is significant in the area of the North West Goldfields (Klerksdorp, Orkney and Stilfontein) and the Free State Goldfields (Welkom, Virginia, etc). The MidVaal Water Company is the main supplier of bulk water to urban areas in the North West Goldfields and Sedibeng Water is the main supplier of bulk water in the Free State Goldfields.

There are no significant power stations or large industries in the WMA. The WMA is characterised by a large number of gold mines (Free State Goldfields area and North West Goldfields area). The economy of the Middle Vaal WMA is dominated by the mining sector, particularly gold mining. The following table shows land use per sub-catchment as well as population.

Table 2.2: Middle Vaal WMA : Land Use & Population

Source: Middle Vaal Water Management Area: Water Resources Situation Assessment, August 2002

CATCHMENT		Irrigation (field area) (km²)	Alien vegetation (km²)	Urban (km²)	Other (km²)	Total (km²)	Population
No.	Description						
C7	Rhenoster	21,9	0	0	6 634,1	6 656	100 206
C6	Vals	2,4	1,6	43	7 824,0	7 871	189 202
C2	Schoonspruit	41,8	3,9	0	5 598,3	5 644	53 065
	Vaal	9,4	17,8	78	8 175,8	8 281	494 197
	Bloemhof	0	45,8	0	4 913,2	4 959	73 161
C4	Allemanskraal	0	0	0	3 628,00	3 628	40 867
	Erfenis	0	0	0	4 724,00	4 724	44 908
	Vet	132,4	1,5	131	10 535,1	10 800	513 495
Total in Free State		**161,5**	**31,6**	**174**	**38 573,7**	**38 940,8**	**1 019 213**
Total in North-West		**46,4**	**39,0**	**78**	**13 458,8**	**13 622,2**	**489 889**
TOTAL IN WMA		**207,9**	**70,6**	**252**	**52 032,5**	**52 563,0**	**1 509 102**

(1) Dryland sugar cane and afforestation all zero.
(2) For Dryland crops, Nature Reserves and Rural Settlements, data was not readily available.
(3) Field area (or green cover area) taken from the Vaal River Irrigation Study (Loxton Venn & Assoc., 1999b)

2.2.7 Economic Characterisation of the WMA

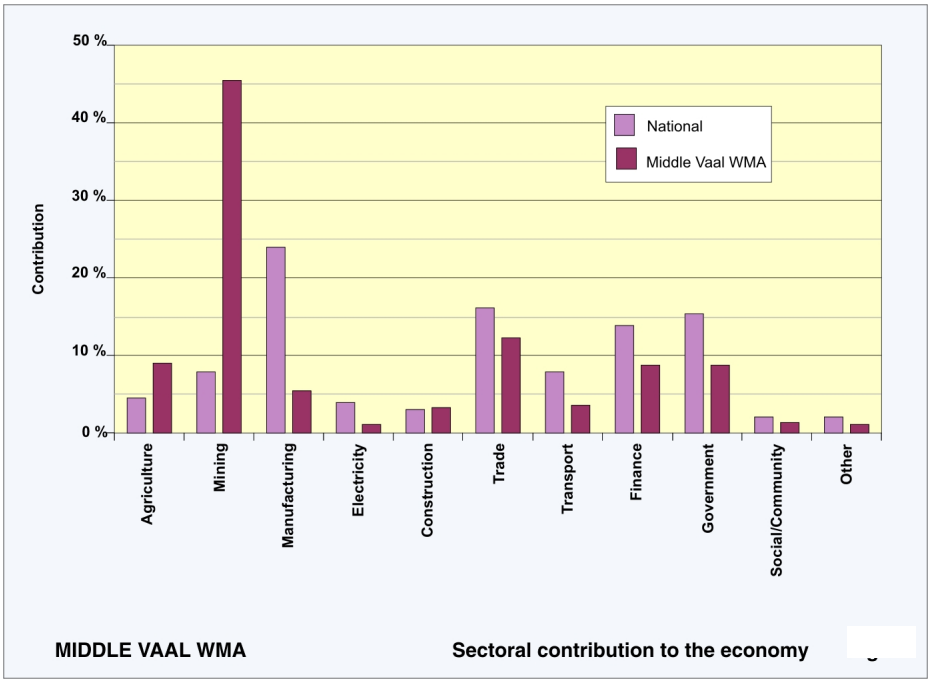
The economy of the Middle Vaal WMA contributes about 4% of the GDP of South Africa. The GGP of the Middle Vaal WMA was R20,7bn in 1997. The most important magisterial districts in terms of contribution to GGP in this WMA are shown below:

- Klerksdorp 33,5%
- Welkom 26,6%
- Virginia 10,0%
- Kroonstad 7,2%
- Other 22,7%

2.2.8 Economic Profile

The composition of the Middle Vaal WMA economy is shown in **Figure 2.2**. The most important sectors in terms of contribution to GGP are shown below:

- Mining 45,6%
- Trade 12,3%
- Agriculture 8,9%
- Other 33,2%



Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Figure 2.2 : Contribution by Sector to Economy of Middle Vaal WMA, 1988 and 1997 (%)

Some of the main irrigation crops are maize, groundnuts and sorghum. There has recently been an increase in sunflower production, because of an unstable maize market and higher profit margins on sunflower production. Livestock farming consists mainly of dairy, beef and sheep farming enterprises.

The main economic sector in the Middle Vaal WMA is mining, with a contribution of 45,6% to GGP. The main mining activity in this area is gold mining. Although very few gold mines have a life span beyond the year 2010, the reserve base in the Goldfields District could support gold mining up to the year 2030.

The trade sector is the second largest contributor to GGP, with a contribution of 12,3%. The trade sector is dependent on levels of demand in the economy, which are largely

driven by personal consumption expenditure, capital investment and international trade. Manufacturing activities in the water management area mainly relate to the mining and agriculture sectors as well as items for local consumption.

According to the report "Overview of Water Resources Availability and Utilisation for the Middle Vaal WMA, September 2003, the Middle Vaal WMA has a work force of 659 000 people (1994 figures). The breakdown of employment of the workforce is as follows:

- Formal Sector - 67% (24% mining, 16% government, 12% agriculture, 15% other)
- Informal Sector - 10%
- Unemployed - 23% (national average 29%)

The economy of the water management area is expected to remain largely static over the medium term as there are no major economic drivers in the region. Gold mining is probably the most important sector where this water management area has a comparative advantage over other mining districts in South Africa. However the contribution of gold mining to the economy of this region is not expected to grow as production by this sector is set to decline.

Bearing in mind that about 46% of the GGP in the water management area comes from the mining sector, such decline will have a significant impact on the socio-economic status of the region as well as on water requirements in the water management area. The decline in the mining sector will have a ripple effect on other sectors such as the construction sector in the region, which has a strong reliance on the mining industry.

The agricultural sector is however expected to remain relatively stable as a result of the diversity of products both in terms of crop and livestock production. Levels of production by the agricultural sector in the region will remain unchanged in the medium term and agriculture will continue to make an important contribution to the regional economy.

2.3 Water Resource availability

2.3.1 Surface Water

The bulk of the surface water in the Middle Vaal water management area is derived from the Vaal River, most of which originates in the Upper Vaal water management area. The Surface water flows that originate within the water management area are highly seasonal and variable, with intermittent flow in many of the tributaries. There are no natural lakes or swamps in the water management area. Vlei areas occur along the lower Vet River and in the upper Schoonspruit catchment. Base flow in the Schoonspruit is fed from dolomitic springs in the upper reaches (much of which is abstracted for irrigation and urban use in the Ventersdorp area).

There are no commercial forests in the water management area, although significant quantities of water are estimated to be lost through infestations by alien vegetation, much of which occur on the banks of the Vaal River. No significant land use impacts have been quantified in the water management area, although some influence on the water resources will result from the large areas under cultivation. A summary of the natural mean annual runoff (MAR), together with the estimated requirements of the ecological component of the Reserve, is given in **Table 2.3**.

Table 2.3: Natural Mean Annual Runoff and Ecological Reserve (million m³/a)

Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Natural MAR (1)	Ecological Reserve (2)
Rhenoster-Vals	295	35
Middle Vaal	170	29
Sand-Vet	423	45
Total	**888**	**109**

1. Quantities given are incremental, and refer to the sub-area under consideration only.

2. Total volume given, based on preliminary estimates. Impact on yield is a portion of this.

According to the Middle Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "It is important to note that the data with respect to the mean annual runoff as well as the ecological component of the Reserve have been taken from national data sources, for the purpose of compatibility of the water management area information in the National Water Resource Strategy. In many instances more detailed studies have been conducted or are under way, from which improved information may be obtained (also on items other than the MAR and Reserve, eg. Water quality), and which should also be referred to with respect to detail planning and design work."

"Naturally the quality of surface water in the water management area is good, but can be of high turbidity. Wash-off and return flows from urban areas in the proximity of the Vaal River and its main tributaries, such as at Klerksdorp, also impact on water quality. Water that enters the Middle Vaal water management area along the Vaal River, contains a large proportion of urban and industrial return flows from the Johannesburg area with part of the water having been through more than one cycle of use. As a consequence, salinity levels can be very high and need to be managed through blending with fresh water in the Upper Vaal water management area, so as not to exceed certain target concentrations. High nutrient concentrations also occur as a result of the large domestic component of return flows which, together with the low turbidity of the return flows, stimulates excessive algal growth. Pollution of the Schoonspruit has also been experienced as a result of the impacts of diamond digging operations on the banks of the river."

"Development of surface water naturally occurring in the water management area has reached its potential and all the water is being fully utilised. The main storage dams are:

Rietspruit and Johan Neser Dams on the Schoonspruit tributary in the Middle Vaal sub area; Koppies Dam on the Rhenoster River, Serfontein Dam and a diversion weir on the Vals River together with the off-channel Bloemhoef Dam at Kroonstad, in the Rhenoster Vals sub-area; and Allemanskraal Dam on the Sand River and Erfenis Dam on the Vet River, in the Sand-Vet sub-area."

"Bloemhof Dam is located on the Vaal River immediately below the confluence of the Vet River. The dam structure is in the Lower Vaal water management area, although most of the reservoir falls within the Middle Vaal water management area. The yield from the dam is available in the Lower Vaal water management area. The incremental yield of Bloemhof Dam is not sufficient to meet the water requirements imposed on the dam, with the result that releases are required from the Vaal Dam (in the Upper Vaal WMA), particularly during low runoff periods."

"The dams on the tributaries are operated independently from the Vaal River, although flood spillage from the dams and flow from unregulated tributaries, are captured at Bloemhof Dam at the downstream end of the water management area. The full yield from the local surface runoff is used within the water management area, mostly for irrigation, but with a large proportion also for urban supplies to towns in the water management area."

"In addition, large quantities of water are released into the water management area along the Vaal River, to augment the local resources. Most of this water is used for urban, industrial and mining purposes in the Klerksdorp-Orkney and Welkom-Virginia areas. Water is also abstracted from the Vaal River for supply to Bothaville and Wolmaranstad as well as for irrigation. A small quantity of water is transferred from Vaal Dam in the Upper Vaal water management area to Heilbron in the Middle Vaal water management area, and a small transfer also exists from Erfenis Dam in the Middle Vaal water management area to Brandfort in the Upper Orange water management area."

"Additional regulations of surface water have been considered for water quality management. However, further development of surface resources is not regarded as feasible."

2.3.2 Groundwater

Large dolomitic aquifers occur in the northern part of the water management area. These extend from Stilfontein in a northern direction and across the water management area in the vicinity of Ventersdorp. The aquifers, which occur in different compartments, also underlay large parts of the Upper Vaal, Middle Vaal, and Crocodile (West) and Marico water management areas. The remainder of the water management area is mostly underlain by fractured rock aquifers, which are well utilised for rural water supplies and with little undeveloped potential remaining. Groundwater is essentially used for mining, agriculture and domestic use in this WMA.

Mining plays a major role in the economic development of this WMA, especially in the KOSH area (Klerksdorp-Orkney-Stilfontein-Hartbeesfontein area). The impacts from the gold mining activities on groundwater has been recognised as early as 1960 when localised dewatering became an issue at Stilfontein Gold Mine. Only more recently have the impacts on the quality of the groundwater and the interaction with the Vaal River become a concern.

There are five major gold mines active in the area and several diamond mine activities (varying from small scale one man operations to larger scale operations). Groundwater is abstracted for different uses at these mines. The largest volumes are abstracted at Stilfontein Gold Mine's Margaret Shaft. Although Stilfontein's underground operations has ceased for more than ten years, pumping at Margaret shaft continues for the safety of the downstream mines. The volume of water abstracted daily is estimated at 32 Ml/d. The water is utilized by a number of users and any excess is discharged to the Koekemoer Spruit. Groundwater is also abstracted from other operating shafts in the KOSH mining area for safety and the water is utilized as process water.

The second largest abstraction of groundwater is from "scavenger" boreholes on the northern banks of the Vaal River. These boreholes serve as a barrier for polluted groundwater emanating from tailings and waste rock deposits in a high permeability zone of the dolomites. This water is utilised in the gold recovery processes. Some small-scale abstraction is also done for the purpose of irrigation at recreational and sports parks on the mine properties. Skeat mine located north-west of Klerksdorp is totally dependent on groundwater and numerous other mines and diamond diggings also utilize large amounts of water from alluvial type aquifers in the catchment.

Although mining has reduced significantly from the boom in the 1980s there are still five major mining houses currently involved in gold mining and diamond mining. Due to the large quantities of water present in the mined Witwatersrand rocks, a large quantity of water (120 -150 Ml/d) is pumped to the surface for accessibility each day. This groundwater however has average conductivities of 500 mS/m and cannot be used for drinking or irrigation purposes. A small portion is diluted with potable water and used as process water and the remainder is pumped to evaporation areas and pans. This has a negative impact on the localized shallow aquifers in the area. The yields of the shallow aquifers are very low and thus little abstraction takes place for other uses by the mines. Both in the KOSH and Free State Goldfields areas the only industrial activities utilizing groundwater is related to the mining industry.

As previously stated in the ISP document agriculture also plays a major role in terms of economic development in this WMA. Almost every farm unit in the WMA is dependent on groundwater for domestic and stock watering use. The areas where large-scale irrigation takes place from groundwater resources are the Ventersdorp dolomitic compartment and from the Karoo aquifers north of Wesselsbron. The Ventersdorp compartment has been

studied in several investigations since its declaration as a Government Subterranean Water Control Area and the latest figures on water use are 40.9 million m^3/a for irrigation and 1.3 million m^3/a for mining activities.

Groundwater is also utilized for individual domestic use in most rural and farming areas. Certain towns are dependent on groundwater either solely or partially in this WMA, namely Ventersdorp, Hartbeesfontein, Coligny, Leeudoringstad, Makwassie, Hartbeesfontein, Dominiumville, Bultfontein, Marquard, Verkeerdevlei, Paul Roux, Petrus Steyn, Steynsrus, Edenville and several rural/ tribal villages in the Ventersdorp municipal area. There are also several private boreholes in urban areas that are often utilized for garden irrigation and domestic uses such as filling of swimming pools, etc.

Water quality of groundwater in this WMA is generally poor and is characterised by higher than normal salinity. The poor quality groundwater that is abstracted from the deep mining areas in the Free State Goldfields is another example of natural occurring poor quality water. The old Vierfontein colliery is currently decanting into the Vierfontein Spruit, which flows north into the Vaal River east of Orkney, the quality of which is characterised with high salinity and sulfate values. There are several sources of point and diffuse groundwater pollution in the WMA. Most of these sources are related to mining activities, in particular abandoned mines, but agriculture and urban activities also influence the quality of groundwater.

In terms of agriculture, the contribution to pollution of each farm on a local scale is often fairly small but the contribution on a catchment scale needs to be included in assessing any pollution situation. In urban areas, poor management of sewage treatment works contribute to the groundwater pollution by discharging raw sewage directly into evaporation pans. Other sources of pollution are landfill sites, on-site sanitation (especially in informal settlements) and spills resulting from accidents or leaking underground tanks.

Groundwater quality is monitored on three levels in the Middle Vaal WMA, namely the National monitoring network (level 1), Regional networks (level 2) and compliance monitoring (Level 3). The national monitoring network, which has the purpose of measuring ambient groundwater quality and samples for macro chemical analyses, are taken once every six months in 7 monitoring boreholes located in the Middle Vaal WMA. On regional level (level 2) there are boreholes in the Schoonspruit dolomitic compartment, Wesselsbron and KOSH areas, and for the purpose of compliance monitoring there are site-specific boreholes at mines and municipalities.

This WMA exhibits certain regions where there is pronounced interaction between surface and groundwater. A relatively good understanding of groundwater and surface water is available separately, but the current understanding of the impact of groundwater abstraction on downstream surface water resources is inadequate. It is believed that the groundwater/ surface water interaction between the dolomites in the Schoonspruit area

results in approximately 73.1Ml/day (26.7 million m^3/annum) of water contributing to the Vaal River with the associated salt load to the river system.

A study needs to be undertaken to improve the modelling of the Schoonspruit and to provide answers with regard to the relationship between dolomitic water and surface water. This study should take cognisance of the catchment management strategy that is presently being developed for the Schoonspuit sub-catchment. The study should include an assessment of the availability in the Johan Neser Dam which is located downstream of the dolomites and is possibly being negatively affected by the abstractions from the dolomites.

The flow of groundwater between aquifers is also an area that requires better understanding. A study has therefore started in the dolomitic compartments of the Schoonspruit and Crocodile/Marico areas to investigate groundwater resources that straddle the aquifers of these catchments in order to understand the flow of groundwater in these areas as well as to ensure that resource availability is not duplicated and the management of the resource is allocated to one of the CMAs.

Often groundwater is an inexpensive resource to develop for domestic water supply for communities that are located far from existing surface water bulk supply systems. The utilisation of this resource should be encouraged and investigations on the expansion of the water resources should include assessments of the available groundwater. The utilisation of groundwater in areas outside of the boundaries of municipalities should also be investigated. Emerging farmers can also benefit by the exploitation of groundwater for irrigation and livestock farming and the WUAs could play an active role in this regard.

A groundwater report for the Middle Vaal WMA is included as **Appendix D** to this report.

2.3.3 Overall Water Availability

The total water available for use in the Middle Vaal water management area at the year 2000 development levels, is summarised in **Table 2.4**.

Of the total yield available in the water management area, 80% is attributable to inflows from the Upper Vaal water management area, 60% of which flows through the Middle Vaal water management area into the Lower Vaal water management area. Therefore, only 40% of the yield transferred into the Middle Vaal water management area is used locally, the bulk of which is in the Klerksdorp-Orkney and Welkom-Virginia areas.

A significant quantity of water is also lost through evaporation and riparian vegetation along the Vaal River, which is in excess of the run-of-river yield contributed by local inflows, resulting in a negative yield for the Middle Vaal sub-area as shown in **Table 2.4**.

Table 2.4 : Available water in year 2000 (million m³/a)

Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers In	Grand Total
	Surface water	Ground-Water	Irrigation	Urban	Mining and bulk			
Rhenoster-Vals	22	12	3	7	0	**44**	1	**45**
Middle Vaal	(201)	25	3	15	16	**(142)**	828	**686**
Sand-Vet	112	17	10	7	1	**147**	59	**206**
Total	**(67)**	**54**	**16**	**29**	**17**	**49**	**829**	**878**

1. After allowance for the impacts on yield of ecological component of Reserve, river losses, alien vegetation, rain-fed agriculture and urban runoff.

2.4 Water Requirements

2.4.1 Current Water Requirements (Year 2000)

According to the Middle Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "About 40% of the total water requirements in the WMA is for irrigation, nearly 30% for urban and industrial use, about 20% for mining and 10% for rural requirements. Most of the irrigation occurs in the Sand-Vet area, where it is supplied from the Allemanskraal and Erfenis Dams, with the remainder split roughly equally between the other two sub-areas. Water from urban, industrial and mining use is mainly required in the Klerksdorp-Orkney-Stilfontein and Welkom-Virginia area, with urban water requirements at Kroonstad. A summary of the sectoral water requirements in each of the sub-areas is given in **Table 2.5**. at a standard 98% assurance of supply."

Table 2.5: Year 2000 Water Requirements (million m³/a)

Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining And bulk industrial (2)	Power generation (3)	Affore-station	Total local requirements	Transfers out (4)	Grand Total
Rhenoster-Vals	26	20	8	0	0	0	**54**	0	**54**
Middle Vaal	33	35	3	48	0	0	**129**	559	**688**
Sand-Vet	100	38	11	38	0	0	**187**	2	**189**
Total	**159**	**93**	**32**	**86**	**0**	**0**	**370**	**502**	**872**

1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
2) Mining and bulk industrial water uses which are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
4) Transfers into and out of sub-catchments may include transfers between sub-catchments as well as transfers between WMAs. Addition of the transfers per sub-catchment therefore does not necessarily correspond to the total transfers into and out of the WMA.

"Although most of the water in the Sand-Vet sub-area is used for irrigation, large quantities are also required for urban and mining use. Water use in the Rhenoster-Vals sub-area is mainly for irrigation and urban use, with a smaller component for rural domestic supplies and stock watering. The water requirements for the Middle Vaal WMA are mainly supplied by Sedibeng Water and Midvaal Water Company with Rand Water contributing to a lesser extent."

2.4.2 Future Water Requirements

According to the Middle Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "There are many factors that influence the requirements for water. These include climate, nature of the economy (i.e. irrigated agriculture, industrialised) and standards of living. Of these, climate is relatively stable, while in most cases control can be exercised over the growth in irrigation water requirements. Population and economic activity, however, have their own inherent growth rates, which are dependent on a wide spectrum of extraneous influences. Population growth and economic growth, which also relates to socio-economic standards, are therefore regarded as the primary determinants with respect to future water requirements."

"Based on the scenarios for population and economic growth outlined in the NWRS, initial estimates of possible future water requirements were made for the period until 2025. In addition, provision was made for known and probable future developments with respect to power generation, irrigation, mining and bulk users as described under the respective sub-areas where applicable. (Specific quantities, rather than a general annual growth rate, were allowed for in these sectors.)"

"Within the spectrum of population and economic growth scenarios, a base scenario was selected for estimating the most likely future water requirements. This is built on the high scenario of population growth and more equitable distribution of wealth leading in time to higher average levels of water services. The ratio of domestic to public and business (commercial, communal, industrial) water use for urban centres in the year 1995, for the respective centres, is maintained."

"A possible upper scenario of future water requirements, is also given, based on the assumption that there will be high population growth and a high standard of services (socio-economic development); together with a strong increase in the economic requirements for water, where the public and business use of water would increase in direct proportion to the gross domestic product. The purpose of the upper scenario is to provide a conservative indicator in order to prevent the occurrence of possible unexpected water shortages. No adjustments have been made for reflecting the impacts of increased water use efficiency."

"General trends in the Middle Vaal water management area are the decline expected in water requirements by the mining sector, and associated declines in the urban requirements for water in the vicinity of mine closures. Indications are that the Welkom-Virginia area may be most affected."

"No meaningful change is foreseen with respect to irrigation and rural water requirements. However, it has been recorded that fields have been taken out of irrigation in certain areas, due to poor financial viability."

In broad terms, the requirements for water are expected to remain at the current levels over most of the water management area in terms of the base scenario while only a 11% growth in water requirements is forecast in terms of the high growth scenario.

2.5 Water balance

2.5.1 Year 2000 Water Balance

A reconciliation of available water and total requirements for the year 2000, including transfers between water management areas, is given in **Table 2.6**.

The only major transfers into and out of this WMA relate to flows in the main stem of the Vaal River, from the Upper Vaal through the Middle Vaal into the Lower Vaal WMA. The remaining transfers that occur into and out of this WMA are small but are significant for the users concerned, namely:

1. There is an import from Vaal Dam in the Upper Vaal WMA to Heilbron (Rhenoster sub-catchment). The bulk water supply of Heilbron TLC was taken over by Rand Water in 1998 and the transfer is by pipeline via Sasolburg TLC.
2. There is an export from Erfenis Dam in the Middle Vaal WMA to Brandfort (Modder River catchment in the Upper Orange WMA).

There are two significant transfers within the WMA, namely:

1. MidVaal Water Company transfers from the Vaal River to Klerksdorp, Orkney and to Buffelsfontein, Stilfontein and Vaal Reefs Goldmines.
2. Sedibeng Water transfers from the Vaal River to Welkom, Virginia, etc and to Harmony, Avgold, Beatrix, Joel, etc, Gold Mines.

From **Table 2.6**, it is evident that the Middle Vaal sub-area is approximately in balance. This is due to the fact that just enough water is released from the Upper Vaal water management area to ensure that the requirements in the Middle Vaal (and Lower Vaal) water management areas can be met. The deficit is shown for the Rhenoster-Vals sub-area is attributable to ideal irrigation water requirements in excess of what can reliably be

supplied. However, actual irrigation practices have adjusted to the actual water availability. The small surplus in the Sand-Vet sub-area is as a result of return flows from irrigation downstream of the points of use as well as due to some decline in irrigation. **[DWAF (2003a)]**.

Table 2.6: Reconciliation of requirements and available water for year 2000 (million m³/a)
Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Available water			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	
Rhenoster-Vals	44	1	45	54	0	54	**(9)**
Middle Vaal	(142)	828	686	129	559	688	**(2)**
Sand-Vet	147	59	206	187	2	189	**17**
Total	**49**	**829**	**878**	**370**	**502**	**872**	**6**

(1) Brackets indicate a negative balance.
Surpluses are shown in the most upstream sub-area where they first become available.

(2) Transfers into and out of sub-catchments may include transfers between sub-catchments as well as transfers between WMAs. Addition of the transfers per sub-catchment therefore does not necessarily correspond to the total transfers into and out of the WMA**.**

A “conditional” surplus is available in the Vaal River System as a whole. The details of this “conditional surplus” is explained in the Vaal Overarching ISP report. However, what is important to recognise is that this estimated excess in supply is qualified as “**conditional**” since it is only available if all the transfers are fully operational. In practice the volume of water conveyed through the Thukela-Vaal Transfer scheme will be determined annually, effectively operating the system such that the water demands are in balance with the supply in order to save pumping costs. The quantity transferred will thus increase over time in line with the growth in the water requirements. The management of the surplus is discussed in more detail in the Vaal Overarching ISP.

2.5.2 Future Water Balance

According to the Middle Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), “A perspective on the possible future water supply situation is given by **Table 2.7** for the base scenario and by **Table 2.8** for a possible high water use scenario. In both cases it was assumed that transfers from the Upper Vaal water management area would be equal to the requirements for augmentation of local resources, with a balance being maintained with respect to abstractions and the yield available from the Vaal River.”

“Similarly, water will be transferred from the Vaal River to the Welkom-Virginia area as required for urban, industrial and mining purposes. Virtually no change in water requirements is foreseen with respect to the Rhenoster-Vals and Sand-Vet sub-areas for the base scenario, with the assumption that mining use of water will remain approximately

at the current levels. Growth in water requirements in the Rhenoster-Vals sub-area for the high scenario is mainly associated with growth at Kroonstad."

Table 2.7: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Available water			Water requirements			Balance
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)
Rhenoster-Vals	44	1	45	53	0	53	**(8)**
Middle Vaal	(136)	837	701	142	560	702	**(1)**
Sand-Vet	147	59	206	187	2	189	**17**
Total	**55**	**838**	**893**	**382**	**503**	**885**	**8**

(1) Based on existing infrastructure and under construction in the year 2000. Also includes return flows resulting from growth in requirements.
(2) Based on normal growth in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.
(3) Brackets around numbers indicate negative balance.

Table 2.8: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Source : Middle Vaal Water Management Area: Overview of Water Resources Availability, September 2003

Sub-area	Available water			Water requirements			Balance
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)
Rhenoster-Vals	49	2	51	65	0	65	**(14)**
Middle Vaal	(131)	910	779	152	628	780	**(1)**
Sand-Vet	149	72	221	200	2	202	**19**
Total	**67**	**911**	**978**	**417**	**557**	**974**	**4**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from growth in requirements.
2) Based on high growth in water requirements as a result of population growth and high impact of economic development. Assumed no general increase in irrigation.
3) Brackets around numbers indicate negative balance.

2.6 Water Reconciliation Options

2.6.1 Allocation of Conditional Surplus

The water reconciliation situation in the Vaal River system is one of a conditional surplus until 2025. The future schemes needed to augment the water resources of the Middle Vaal WMA will be derived from the Upper Vaal WMA which will largely be decided at the National Level with the development of the next augmentation scheme. The management of the surplus is discussed in more detail in the Vaal Overarching ISP report (Report No.: RSA C000/00/0103).

2.6.2 Intervention Measures

The options that can be considered within the WMA are :-

- The implementation of Water Conservation and Demand Management (WC&DM). The water requirements that are used in the development of the WMA water balance do not include WC&DM. A study quantifying the reduction in the water requirements, return flow volumes and the changes in return flow water quality of implementing WC&DM has been identified and prioritised in the Vaal Overarching ISP. However Regional Office/CMA must play an active role together with the Water Service providers such as Sedibeng Water and Midvaal Water Company in the WMA to ensure the implementation of WC&DM.
- Trading of water allocations between users.
- Further development of the local surface water resource to meet local water requirements. In this process the impact on the yield of system must be determined and the reduction in yield must be covered at full cost as this will have to be replaced with transferred water.
- Further development of groundwater. Although the exact quantity of the exploitable groundwater is uncertain, groundwater represents a large potential resource particularly for local supply in areas that are distant from the main river system. Due to the fact that the availability of groundwater is largely dependent on localised sub-surface characteristics, estimates of the potential of the resource should be area specific.

2.6.3 Necessity for Compulsory Licencing

Given that there is a conditional surplus, there is no immediate need for compulsory licensing in the Middle Vaal WMA. Certain issues (See **Compulsory Licensing Strategy A1.5 in Appendix A**) were raised at the ISP workshops where intervention may be required in areas such as Klerksdorp, Ventersdorp and the Schoonspruit Dolomitic Compartment. The approach to be adopted in addressing the issues in these areas is to fully understand the issues and to use the available regulations and communication with

the water users to resolve the issues before compulsory licensing is pursued.

The determination of a Comprehensive Reserve is an important prerequisite for compulsory licensing. To date only low confidence Desk Top estimates of the Ecological Reserve have been undertaken for the purpose of developing the National Water Resources Strategy (NWRS). Although no urgent Reserve issues were identified during the Overarching Workshops, the above factors point to the need for careful planning and implementation of the Ecological Reserve to balance, among other things, the economic consequences and ecological benefits. Due to the interdependencies of the tributaries with the main stem of the Vaal River, it will be required to undertake the determination of the Reserve in an integrated way, balancing tributary contributions with the flow requirements of the main stem.

2.7 Water Quality Management

The water quality situation of the Vaal River main stem and the tributaries are discussed below. The water quality of the main stem of the Vaal River is not only affected by the water quality of the flow from the tributaries within the WMA but also by the water quality of the water received from the upstream Upper Vaal WMA. The water quality received from Upper Vaal WMA is considered to be relatively poor. Despite the blending practiced in the Upper Vaal WMA, with releases from Vaal Dam used to maintain the TDS concentration in the Vaal Barrage at 600 mg/l, salinity has been reported as a problem in the Vaal river main stem. Nutrients are also a water quality variable of concern. There is also the carry over of hyacinth to the Middle Vaal WMA from the Upper Vaal WMA.

The water quality of the Vaal main stem is impacted on by mining activities in the Schoonspruit, Koekemoerspruit and the Sand-Vet systems in the Middle Vaal WMA. The sources are mine dewatering discharges and seepage from tailings dams located close to the Vaal River. There are also large areas of the catchment where the runoff water quality is good. This water serves as dilution water, which results in an acceptable water quality in Bloemhof Dam.

The land uses in the WMA are largely agriculture, mining and urban areas with the larger urban centres located in the mining areas. There are significant areas of irrigation in the WMA. The sources of supply are both surface and groundwater. The return flow volume and qualities from the irrigation areas are not well quantified.

Groundwater also serves as an important source of water for domestic use. It is therefore important to protect the water quality of the groundwater through groundwater management plans and the setting of Resource Quality Objectives for groundwater.

Many of the sewage works and sanitation systems of towns in the WMA are inadequate and in a poor state. The reasons for this are both poor management and the overloading of treatment

plants and reticulation systems. The overloading is often due to the replacement of pit latrines with waterborne sewerage systems without upgrading the sewage works. This practice is to be discouraged in future and the effluent treated to a suitable level for discharge back to the river.

The approach adopted by the Department of Water Affairs and Forestry in managing the water quality in the Vaal River catchment is to set water quality objectives (WQO) for the sub-catchments. The WQO are based on the water user requirements in the catchments. The WQO include ideal, tolerable and unacceptable objectives for the water quality variables. A phased approach has been adopted for the development of strategies to manage the water quality in the sub-catchments of the Vaal River Catchment. The first phase is a situation assessment, which is followed by further phases to develop catchment management strategies. This approach has been applied to the Middle Vaal WMA with the development of Catchment Management Strategies (CMSs) for the major areas of concern in the WMA viz the mining areas in the Sand/Vet and Schoonspruit/Koekemoerspruit catchments. A CMS has been developed for the Sand/Vet system and has been implemented over the last 5 years. A CMS is currently being developed for the Schoonspruit and Koekemoerspruit catchments. These plans will result in the setting of WQO, model development, identification of pollution sources, waste load allocations and monitoring programs.

The cascading characteristic of the three Vaal WMAs has the consequence that the water quality of the main stem of the Vaal River in the downstream WMAs is impacted on, not only by the activities in the WMA itself, but also by the water received from upstream. In addition, the water quality in the Vaal River will also impact on the water quality of the Orange River in the Lower Orange WMA. Due to this inter-dependency it was identified that the current process of managing water at sub-catchment level should be expanded to integrate management activities across sub-catchments to meet shared water quality objectives in major tributaries and in the main stem of the Vaal River. To this end Integrated Water Quality Management Plans (IWQMPs) for the Vaal and Orange River systems will be developed. The CMSs developed for sub-catchments in the Middle Vaal WMA must be integrated with the IWQMP for the Vaal River.

2.8 Infrastructure System Management

Due to the interlinked configuration of the water resource components in the Vaal River System the responsibility of the operation and management of the main elements will be a function of a dedicated DWAF operations division or a possible Utility. The operation and management of tributary catchments in each WMA will be the responsibility of the CMA. The operation and management of tributary dams such as Allemanskraal and Erfenis will be the responsibility of the CMA in terms of floods, droughts and normal operation.

There is a well-established set of hydrological and water use databases as well as water resource analysis models available for the analysis of the Vaal River System. Annual operating runs are undertaken using the models and decisions made on system operation.

The description of these systems is given in the Vaal Overarching ISP. These models are run at the national level with the decisions being passed to the Middle Vaal WMA for implementation.

The local infrastructure that the Middle Vaal CMA may have to run in the future are the treatment plants and collection systems for the mine dewatering and the treatment/re-use options as far as the management of sewage treatment plant discharges are concerned. The future of these schemes will be decided as part of the Integrated Water Quality Study for the Vaal River System.

2.9 Monitoring and Information Systems

The Middle Vaal water managers will be required to co-ordinate all the monitoring and information requirements within the WMA. This will include the compliance and other monitoring requirements of the WMA itself as well as the monitoring requirements of the Vaal River System to be used by the National body carrying out the overarching management.

2.10 Institutional Aspects

The Middle Vaal WMA is part of a larger supply system which includes adjacent WMAs. The Middle Vaal WMA acts as a conduit for the transfer of water from the Upper Vaal WMA to the Lower Vaal WMA. Due to this interdependence, the operations and planning of the Vaal River system will not be undertaken by the Middle Vaal CMA or Regional Office but at the national level by the Department's Head Office or a utility which may be established to undertake these tasks. The management at this level is described in the Vaal Overarching ISP and includes, among others, Water Reconciliation and Water Quality Strategies.

The role of the Middle Vaal WMA CMA will be:

- To manage the water quality by setting WQOs and developing CMS as per the Water Quality Management Strategy (A2.2) included in **Appendix A**. The setting of the WQOs will be within the framework of the Integrated Water Quality Management Plan for the Vaal River System.

- The monitoring of the system to provide management information for water quality management, abstraction control and input to the overarching operations and planning processes.

- Provide input into the supply of local authorities from local groundwater and surface water resources. This will be in the form of strategic level guidance as to where water can be obtained and the level of study needed to be submitted with the licence application.

- A very important communication role between the Water Users, CMA and the utility.

- Promotion of WC&DM through the water service providers and local authorities/DWAF Head Office to achieve efficient use of water. Only once efficient use has been achieved can further transfers be considered.

- Management and control of water abstractions.

- Management of groundwater and local surface water resources.

- Management and Operation of Local dams, viz. Allemanskraal, Erfenis, Johan Neser, Rietspruit.

2.11 ISP Implementation Strategy

The implementation of the Middle Vaal ISP is expected to take place through the Middle Vaal Catchment Management Agency.

The ISP is intended to act as DWAFs perspective on how the Vaal River catchment's water resources should be managed, in particular the Middle Vaal WMA. The final ISP will be published and be open to comments from local authorities, water user associations and other water related forums and interested stakeholders. Mechanisms are to be put in place to capture anomalies and it is intended that formal updates of the document will occur periodically until such time as the Catchment Management Agency is technically functional and a Catchment Management Strategy developed.

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