CHAPTER 2: PERSPECTIVE ON THE WATER SITUATION IN THE VAAL RIVER SYSTEM AND STRATEGIES FOR WATER RESOURCE MANAGEMENT

2.1 INTRODUCTION

The Water Resources of the Vaal River System is an important asset to the country and it's people, supporting major economic activities and a population of about 12 million people. The boundaries of the Vaal River System, for the purpose of this document, include three water management areas (WMAs) namely the Upper Vaal, Middle Vaal and Lower Vaal. Due to the cascading orientation and the associated inter-dependency of the three water management areas, it is essential that the water resources of the Vaal River System are managed to achieve a balance in meeting specific requirements in each WMA as well as fulfilling the transfer obligations between the WMAs. The layout of the three Vaal and two Orange water management areas are presented geographically in **Figure B-1** of **Appendix B**.

The extent of the water resource infrastructure in the Vaal River System is best presented schematically, as shown in the figure in **Figure B-2** of **Appendix B**. The schematic shows the full extent of the *Integrated* Vaal River System which consists of the Vaal River System and other water resource systems (located in adjacent WMAs) that are linked to the Vaal River System. Also shown is the main infrastructure that is associated with the Upper Vaal, Middle Vaal and Lower Vaal WMAs. An important characteristic of the water resource is that substantial transfers occur from the Thukela River, the Usutu River and Senqu River (in Lesotho) into the Vaal River System. The Vaal River serves as conduit to transfer water among the three Vaal WMAs and significant transfers out of the Upper Vaal WMA occur through the distribution system of Rand Water to the Crocodile West and Marico WMA. (More detail on the transfers in and out of the three Vaal WMAs are presented respectively in **Sections 2.2, 2.3** and **2.4**)

The Upper Vaal WMA is highly developed, with major urban and mining land use activities contributing more than three times that of the Gross Domestic Product (GDP) of the other two Vaal WMA combined. These activities have significantly impacted on the quality of the water resources, and diligent management practices are necessary to ensure water of acceptable quality is available to users in the system. It is further expected that the land use will continue to grow in future, demanding even more intensive management interventions.

These main characteristics of the Vaal River System point to the need for water resources management activities that cut across WMA boundaries in order to achieve optimum solutions for issues that relate to the interdependency of the linked water resource systems.

Information on the water resource situation in the Vaal River System is available in reports from the many studies and investigations which the Department of Water Affairs and Forestry (DWAF) has commissioned over time. Of those the most recent publications, which serve as sources of information for this chapter, are the National Water Resources Strategy (NWRS), the supporting reports for each WMA with the common title "*Overview of the Water Resources Availability and Utilisation*", the Water Resource Situation Assessment Studies (WRSAS), and other technical reports.

General descriptions of the three Vaal WMAs are presented in **Sections 2.2, 2.3** and **2.4** which is followed by **Sections 2.5, 2.6** and **2.7**, presenting respectively the water resource availability, water requirements and water balance of the Vaal River System. Options for reconciling the water requirements with the availability are provided in **Section 2.8,** including discussions on allocation of available water and the necessity for Compulsory Licensing. **Section 2.9** gives the broad perspective on water quality management in the system, with the remaining sections, in **Chapter 2**, describing the main aspects regarding institutional issues, water infrastructure management, information management and finally the implementation of the ISP.

2.2 OVERVIEW OF THE UPPER VAAL WATER MANAGEMENT AREA

The location and general layout of the WMA is given in **Figure 2.1**. The Upper Vaal WMA covers part of four provinces viz. Gauteng, Free State, Mpumulanga, and North West provinces. The major rivers in the WMA are the Vaal and its tributary the Wilge River. Other significant tributaries are the Klip (Free State), Liebenbergsvlei, Waterval, Suikerbosrand, Klip (Gauteng) and Mooi Rivers.

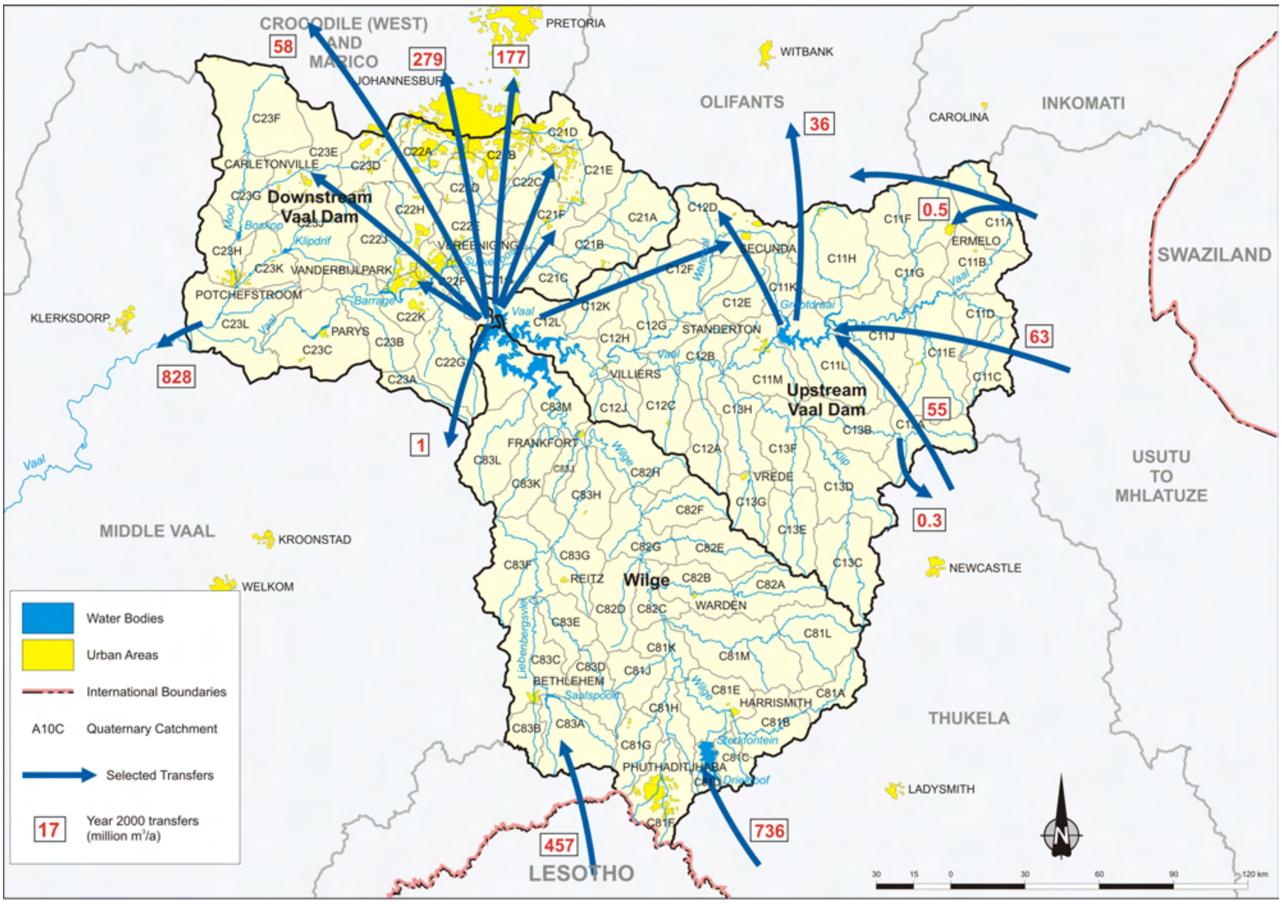

Figure 2.1 : Layout and location of the Upper Vaal WMA (DWAF, 2003a)

2.2.1 Physical Characteristics

The climate over the WMA is temperate and uniform. The rainfall is strongly seasonal with the rainfall occurring during the summer. The mean annual precipitation (MAP) decreases from 800 mm in the south east to 600 mm in the north west with the potential evaporation increasing from 1300 mm in the south east to 1700 mm in the north west. Vegetation is mostly savannah grassland with sparse bushveld. The geology is varied and is particularly complex in the west and north-west where the mineral deposits are found. Extensive dolomitic formations also occur in this part.

2.2.2 Land Use, Economic and Development Characteristics

Land use in the catchment is characterised by the sprawling urban and industrial areas in the northern and western parts. Most mining is also located in these areas although much of this is now inactive. Maize, wheat and other annual crops are grown on large areas under dry land cultivation in the central and south western parts. There are several large towns in the WMA, mainly to serve the mining and agricultural development.

The Upper Vaal WMA does not directly share any rivers with neighbouring countries. Large quantities of water are, however, transferred into the WMA from Lesotho and through inter catchment transfers to and from neighbouring WMAs. The transfer of water from Lesotho is done in accordance with a Treaty between South Africa and Lesotho. Through the inter-catchment transfers and the control of releases along the Vaal River, water management in the Upper Vaal WMA eventually impacts on all South Africa's neighbours.

Nearly 20% of the GDP of South Africa originates from the Upper Vaal WMA. This is the second largest contribution to the national wealth amongst all the WMAs. The manufacturing sector contributes over 30% to the Gross Geographic Product (GGP) generated in the WMA, followed by trade at just over 15% and both finance and mining slightly higher thatn 10%. Despite the large areas under cultivation, agriculture only contributes about 2% of the GGP. It nevertheless has important linkages to other sectors and provides livelihood to a large proportion of the rural population.

The potential for future economic growth in this WMA remains strong. Growth will largely be attracted to the already strong urban and industrial areas in the Johannesburg-Vereeniging-Vanderbijlpark complex. New gold mining developments will be replacing worked out mines, although a general long term decline is expected. Large coal reserves are present in the WMA and it is expected that the exploitation of these resources will occur over the medium to long term.

2.3 OVERVIEW OF THE MIDDLE VAAL WATER MANAGEMENT AREA

The Middle Vaal WMA is situated in the central part of South Africa, in the Free State and North West Provinces. The WMA lies between the Upper and Lower Vaal WMAs and borders on the Crocodile West, Marico and the Upper Orange WMAs. The main tributaries are the Skoonspruit, Rhenoster, Vals and Vet rivers.

2.3.1 Physical Characteristics

The climate is semi-arid with the MAP declining from 700 mm in the East to 500 mm in the West and a potential evaporation increasing from 1400 mm in the East to 1900 mm in the West. The vegetation is mainly grassland with sparse bushveld in patches. The topography is relatively flat with no distinct features. 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 location and general layout of the WMA is shown in **Figure 2.2.**

Figure 2.2 : General layout and location of Middle Vaal WMA (DWAF, 2003b)

2.3.2 Land Use, Economic and Development Characteristics

The land use in this area is characterised by extensive dry land agriculture. Irrigation is practiced downstream of dams along the main tributaries as well as at locations along the Vaal River. The largest urban areas are at Klerksdorp, Welkom and Kroonstad. Numerous inactive mines are found in the north and west of the WMA, many of which were small diamond claims.

The Middle Vaal WMA neither adjoins nor shares any rivers with any neighbouring countries and therefore has no international obligations to satisfy.

The economy of the Middle Vaal WMA contributes about 4% of the GDP of South Africa. The most dominant economic activity is the mining sector, generating more than 45% of the GGP in the WMA.

The dominant mining activity in the area is gold mining. Few of the gold mines in the area have a secure future beyond 2010, although the reserve base could support mining up to the year 2030. The future of gold mining will be strongly influenced by gold price, exchange rate, operating costs, tax regime and environmental requirements. The declining trend is however expected to continue. The agricultural sector is stable and is expected to continue making an important contribution to the economy of the WMA.

2.4 OVERVIEW OF THE LOWER VAAL WATER MANAGEMENT AREA

2.4.1 Physical Characteristics

The Lower Vaal WMA lies across the North West, Northern Cape and Free State provinces. The WMA borders on Botswana in the North. In the south east the Vaal River is the only main river and the Harts River the only significant tributary. The largest (north west) part of the WMA falls within the catchment of the Molopo River, which is a tributary of the Orange River. This river is however endoreic and water may only reach the Orange only under exceptionally high rainfall conditions. There are no distinct topographic features in the WMA with most of the terrain being relatively flat. The MAP declines from 500 mm in the east to 100 mm in the west with a potential evaporation reaching as high as 2800 mm/a. The location and layout of the WMA is given in **Figure 2.3**.

2.4.2 Land Use, Economic and Development Characteristics

The land use in the area is primary livestock farming, with some dry land cultivation in the north east. Intensive irrigation is practiced at Vaalharts as well as locations along the Vaal River. Diamond bearing intrusions occur near Kimberley and alluvial diamonds are found near Bloemhof. Iron ore and other minerals are found in the south-eastern parts of the WMA. Kimberley is the only significant urban area.

Figure 2.3 : General layout and location of Lower Vaal WMA (DWAF, 2003c)

The Molopo River forms the border between South Africa and Botswana. Utilisation of this shared resource by the two countries is regulated by the Joint Permanent Technical Committee. The Lower Vaal WMA also falls within the Orange River basin, which is shared by South Africa, Lesotho, Botswana and Namibia. Co-operation amongst the Orange River basin countries is facilitated by the Orange-Senqu River Commission. There is also a need for the better management of trans border groundwater aquifers shared by South Africa and Botswana.

The economy of the WMA is relatively small and contributes less than 2% of the GDP of South Africa. Mining and agriculture are the main primary production activities in the WMA.

2.5 WATER AVAILABILITY AND RESOURCE EXTENT

The surface water availability in the Integrated Vaal River System is estimated through a set of water resource models, each fulfilling a particular function in the management of the water resources. Combined, these models serve as a decision support tool that contains a large and comprehensive database of hydrological and physical system characteristics, required to simulate the water resource systems as realistically as possible. The network configuration of the models extends as far as necessary to include all the river systems, which supply the Vaal River System by means of transfers. This water resources modelling and physical network cuts across Provincial, WMA and International boundaries in order to simulate all the interdependencies that exist due to the inter-basin transfers.

The models include water quantity, and water quality in the form of Total Dissolved Solids (TDS) or salinity modelling. The hydrology and water requirement inputs to the models have recently been updated and the water quality model recalibrated. These models are applied to determine the water balance, assess operating rules, determined the need for restrictions during drought periods and evaluate water quality management options such as blending and/or dilution. The models are also used to determine the implementation dates for future augmentation schemes.

Due to the intensity of the hydrological study that produced the hydrology data for the water resource models, it can be stated that the water resource availability estimates for the large water resource system carry a high level of confidence. It is however important to note that the focus of the hydrological study was on the main stem of the Vaal River and that the networks of the tributary catchments were configured in limited detail. To analyse and resolve water balance problems at tributary catchment scale, it will therefore be required to increase the model resolution. The catchment where refined models are required was identified and included in the WMA specific ISPs reports.

Summarising the water resource availability of the Vaal River System, which has multiple abstraction points that are supported by various tributary and incremental catchments, requires considerable simplification of the analysis results that are obtained from the more complex models that are referred to above. This was undertaken as part of the compilation of the NWRS and the reader is referred to the series of reports “Overview of the Water Resources Availability and Utilisation” (**DWAF, 2003a, b and c**) for each of the three Vaal WMAs. Further details are provided in the “RESOURCE AVAILABILITY A.1.1” strategy presented in **Appendix A**. The water resources availability information from these reports was used to compile the water balance presented in **Section 2.7** in this report.

2.6 WATER REQUIREMENTS

Reliable data on requirements (current use and future scenarios) have to be available to undertake water resource operational and development planning activities. The water requirement scenarios that are currently used for planning originate from the development of the National Water Resources Strategy (NWRS). The scenario generation methodology made use of driver variables such as population growth as impacted on by HIV/AIDS, migratory patterns based on social economic factors, and economic growth for over 700 consumption centres in the country.

There are indications that the registered water use, mainly for irrigation purposes, is substantially more than what is currently used in the water resource models. It is therefore essential to compare the data in the model with verified use once the verification process is completed. (See Strategy “WATER REQUIREMENTS A.1.2**”** in **Appendix A** for the proposed management action)

Once a year the recorded water uses are compared to the scenarios and adjustments are made to the short-term projected values where appropriate. In addition, large bulk users such as Eskom, Sasol, Sedibeng Water, Midvaal Water and Rand Water also produce revised water requirement scenarios that are evaluated and considered for scenario analysis. Current data (March 2003) indicates that the water requirements for Eskom and Sasol are exceeding the scenarios used in previous planning studies (including the NWRS) and will bring the augmentation date of the Eastern Sub-system of the Vaal River System forward. (See the “WATER REQUIREMENTSA.1.2” strategy in **Appendix A** for details and proposed actions).

The water requirement scenarios of the Vaal WMAs and other related supply areas must be updated at regular intervals, preferably five yearly. This must be co-ordinated with overall scenarios of population and economic growth for the whole country.

2.7 WATER BALANCE

The water balance calculations presented in this report are based on a yield balance that is derived for a 1:50 year return period assurance level. This implies that the 1:50 year assured yields of the water resources are compared to water requirements that are converted (where appropriate) to an equivalent volume that have to be supplied at a reliability of 1:50 years.

The water balance of the Vaal River System is presented as a series of tables for each of the three Vaal WMA and considering the years 2000 and 2025 development levels. This information were obtained directly from the three Vaal WMA reports with the generic title "*Overview of the Water Resources Availability and Utilisation*" (**DWAF, 2003a, b & c**).

Due to the cascading layout of the three WMAs, the water balance connection or link between the WMAs is such that water shortages in a WMA can only be allocated in an upstream direction. It was therefore decided to present the balance results in the order: Lower Vaal, Middle Vaal and Upper Vaal. This is also the sequence in which the calculations are carried out, i.e. the main stem shortage in the down stream WMA is determined first, and then imposed as a transfer out of the immediate upstream WMA. The outcome of this balance calculation procedure for the three WMAs is that the overall water balance for the Vaal River System is reflected by the water balance of the Upper Vaal WMA. A surplus in the Upper Vaal WMA is therefore available for all three WMAs, along the main stem of the Vaal River.

In this document the water balance is viewed from an overarching perspective with the main focus on the water balance of the main stem of the Vaal River. Strategies regarding the surpluses and negative balances in the Sub-areas are dealt with in the WMA ISP specific documents and the reader is referred to those reports for further information on the sub-areas.

2.7.1 Water Balance for the year 2000

Table 2.1 below shows an overall surplus in the WMA of 30 million m^3/annum, which exist due to the return flows of 45 million m^3/annum from the Vaal Harts irrigation scheme. (see **Figure 2.3**) that is not fully utilised in the Vaal downstream of Bloemhof Sub-area. The transfer from the Middle Vaal WMA of 500 million m^3/annum is contained in the 545 million m^3/annum transfer into the Vaal downstream of Bloemhof Sub-area.

Table 2.1: Lower Vaal WMA: Reconciliation of requirements and available water for year 2000 (million m³/a)

Sub-area	Available water			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
Harts	136	419	555	494	45	539	16
Vaal downstream of Bloemhof	(46)	545	499	65	423	488	11
Molopo	35	4	39	36	0	36	3
Total	125	500	625	595	0	595	30

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

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

Changes made to the reconciliation balances for the year 2000

The following changes were made to derive the water balances that are presented in **Table 2.1**. The original balances were obtained from the "*Overview of the Water Resources Availability and Utilisation*" report for the Lower Vaal WMA (**DWAF, 2003c**).

Change 1: Due to the revised boundaries of the Lower Vaal WMA the water balance of the Vaal downstream of Bloemhof sub-area were changed by reducing both the "Transfers-in" and the "Local requirements" by 48 million m^3/annum.

Change 2: The transfer out of the Harts Sub-area to the Vaal downstream of Bloemhof sub-area was reduced from 62 million m^3/annum to 45 million m^3/annum. This change is due to an over estimation of the contribution of the return flows from the Vaalharts Irrigation Scheme to the system yield.

Description	Available water			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
Changes affecting the Vaal downstream of Bloemhof sub-area:							
Figures given in the DWAF, 2003c	(46)	610	564	113	423	536	28
Change 1	-	-48	-48	-48	-	-48	-
Revised figures (Change 1)	(46)	562	516	65	423	488	28
Change 2	-	-17	-17	-	-	-	-17
Revised figures (Change 1&2)	(46)	545	499	65	423	488	11
Changes affecting the Harts sub-area:							
Figures given in the DWAF, 2003c	136	419	555	494	62	556	(1)
Change 2	-			-	-17	-17	17
Revised figures (Change 2)	136	419	555	494	45	539	16

For the Middle Vaal WMA balance, shown in **Table 2.2,** the 500 million m^3/annum transfer to the Lower Vaal WMA is included in the 559 million m^3/annum transferred out of the Middle Vaal Sub-area. In turn the support from the Upper Vaal WMA of 828 million m^3/annum to the Middle Vaal WMA is the main transfer into the Middle Vaal Sub-area. The approximate balance for the Middle Vaal sub-area is attributable 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.

Table 2.2: Middle Vaal WMA: Reconciliation of requirements and available water for year 2000 (million m³/a) - (DWAF, 2003b)

Sub-area	Available water			Water requirements			Balance
	Local Yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
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 around numbers indicate negative balance. Surpluses are shown in the most upstream sub-area where they first become available.

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

Finally, the overall water balance of the Upper Vaal WMA and the Vaal River System is presented in **Table 2.3,** which shows a surplus of 19 million m^3/annum.

Table 2.3: Upper Vaal WMA: Reconciliation of requirements and available water for year 2000 (million m³/a) - (DWAF, 2003a)

Sub-area	Available water			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
Wilge	59	0	59	60	0	60	(1)
Upstream of Vaal Dam	184	118	302	216	67	283	19
Downstream of Vaal Dam	889	1 224	2 113	769	1 343(3)	2 112	1
Total	1 132	1 311	2 443	1 045	1 379	2 424	19

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

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

3) The transfer out of the Downstream of Vaal Dam Sub-area contains the transfer of 828 million m^3/annum to the Middle Vaal WMA.

Water Balance Qualifications:

- The surplus in the Upstream of Vaal Dam Sub-area is fully committed to support the projected growth in the water requirements of the existing users mainly Sasol and the Eskom power stations that are supplied from Grootdraai Dam. Furthermore, detailed system analysis results indicated that Grootdraai Dam and the sub-systems linked to it will require augmentation by the year 2010 or even earlier.

- The water balance presented in **Table 2.3** excludes the contribution of Phase 1b of the Lesotho Highlands Water Project (LHWP). Phase 1b consists of Mohle Dam, Matsoku Weir, and transfer tunnels to deliver additional water into Katse Dam from where it is transferred to the Upper Vaal WMA. This transfer scheme is to be commissioned towards the end of the year 2003 and will contribute an additional 320 million m^3/annum (after allowances for transfer losses) to the surplus presented in **Table 2.3**.

- The indicated surplus assumes that all the conduits transferring water into the Upper Vaal WMA is operated at full capacity. It will however be possible to manage the quantity of the surplus by controlling the volumes being transferred. This is especially the case where water is pumped as is for the Thukela-Vaal transfer scheme.

2.7.2 Projected Water Balance for the year 2025

Given that the water requirements in the Lower and Middle Vaal WMAs is not expected to increase significantly for the base scenario (See **DWAF,2003a** for a description), only the Upper Vaal WMA balance results are presented in this section for the year 2025 as shown in **Table** 2.4. The transfer to the Middle Vaal WMA of 837 million m^3/annum is reflected in the 1 561 million m^3/annum and represent a small increase from 828 million m^3/annum in the year 2000. These balance figures include the contribution from Phase 1b of the LHWP as indicated in note (4) below the table.

The projected shortfall of 44 million m^3/annum for the Vaal River System indicates that intervention will be required close to the year 2025.

Table 2.4 : Upper Vaal WMA: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a) – (DWAF, 2003a)

Sub-area	Available water			Water requirements			Balance
	Local yield (1)	Transfers In	Total	Local require-ments (2)	Transfers out	Total	(3)
Wilge	58	0	58	56	0	56	2
Upstream of Vaal Dam	184	118	302	256	74	330	(28)
Downstream of Vaal Dam	987	1 513(4)	2 500	957	1 561	2 518	(18)
Total	1 229	1 630	2 859	1 269	1 634	2 903	(44)

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.*
4) *Includes the yield contribution of 320 million m^3/annum (after allowances for transfer losses) from Phase 1b of the LHWP.*

2.8 WATER BALANCE RECONCILIATION OPTIONS

Given the surplus of 19 million m^3/annum in the year 2000 and the additional contribution from Phase 1b of the LHWP (to commence delivery in the latter part of 2003) it is estimated that a **conditional surplus** of about 300 million m^3/a exists in the Vaal River System. The available surplus 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. The quantity transferred (and the pumping costs) will thus increase over time to match the growth in the water requirements.

With respect to the projected water balance, considering the growth in water requirements that are estimated for the near future, analysis shows that the balance will be positive until close to 2025 (see **Table 2.4** above). However, although this holds true for the system as a whole, the Eastern Sub-system, consisting of Grootdraai Dam and supporting systems, will need augmentation by about 2010 as indicated in the following sections.

2.8.1 Reconciliation of the Eastern Sub-system

A pre-feasibility study to determine the need for augmentation of the Eastern Sub-system has been completed and it was found that even with water conservation and demand management measures in place, additional water resources have to be developed to be able to supply the growth in demand that is projected for the year 2030. Several augmentation options have been identified, including a dam and pipeline on the Klip River (Free State), pipeline from Vaal Dam, Vaderlands Dam in the Pongola River and Merikloof Dam in the Usutu River. Further planning actions are needed to select the most feasible supply option for implementation.

New revised water requirement scenarios (March 2003) were obtained from Eskom and Sasol early in 2003, which gives higher projected demands compared to the previous estimates that was used in the abovementioned pre-feasibility study. The implication thereof is that augmentation is already required in 2007. This places a very high priority on the design and implementation of the augmentation scheme to support the Eastern Subsystem.

[*NOTE: Subsequent to the ISP workshops, Eskom indicated that in order to minimise the total risk of water supply, the pipeline option to transfer water from Vaal Dam would be the preferred scheme to augment the Eastern Subsystem. The Vaal Dam pipeline option has the advantage that water can be accessed from both the Thukela River and Lesotho Highlands rivers, which decreases the vulnerability with respect to localised droughts in the catchments of the Eastern Sub-system. DWAF therefore accepted that the pipeline option is the preferred option and further planning, design and implementation activities has commenced.]*

A further perspective on augmenting the supply to the Eastern Sub-system is the possibility that severe drought conditions over the short term, before the proposed pipeline is completed, may require emergency intervention in the form of constructing the Vaal Dam to Grootdraai Dam weir transfer scheme as a temporary measure. The decision to implement such a scheme will, however, be delayed as late as possible to allow the maximum opportunity for recovery from the drought that will allow time for the completion of the proposed pipeline.

2.8.2 Reconciliation of the Vaal River System as a whole

a. Water Conservation and Demand Management

Due to the relative low growth rate of the projected water requirements (projected demand curve is relative flat) the impact of even small savings through Water Conservation and Demand Management could result in a substantial postponement of the date augmentation would be required (i.e. delay the date from 2025 to say 2030 or beyond). Therefore, with reference to the details provided in the "WATER CONSERVATION AND DEMAND MANAGEMENT STRATEGY A.4", it is essential to commission a WCDM study of the supply area of the Vaal River System with the aim to obtain a system wide plan of how WCDM will be implemented and what the impacts will be. The key to such a study will lie in collating information from the water users on planned WCDM measures and compile scenarios of water requirement and return flow for planning purposes.

Although a conditional surplus exists in the Vaal River System, benefits, other than postponing the next augmentation, provide sufficient motivation to continue with the implementation of WCDM measures over the short and medium term. There are numerous WCDM measures being implemented by Local Authorities and Service Providers, however, information regarding the effect these measures have on the Vaal River System demands is not readily available and will have to be obtained as part of the abovementioned study.

Due to the nature of the Vaal River System, return flows generated from the urban areas are indirectly used in the downstream portion of the system, with the result that WCDM measures that reduce return flows do not benefit the overall water balance of the system to the full extent of the water 'saved'. A further important aspect to consider when planning WCDM measures is the impact on water use charges with respect to the redemption of the capital invested in existing water supply infrastructure.

b. Water Resource Development Options

Various schemes to augment the supply of the Vaal River System (as a whole) have also been assessed and the most likely options are either the Thukela Water Project or a further phase of Lesotho Highlands Project. Although the required date of augmentation is far into the future it should be recognised that these schemes are capital intensive and require long lead times for implementation.

c. Perspective on the Ecological Reserve

The water balance presented above makes allowances for the Ecological Reserve using low confidence Desk Top estimates for the purpose of developing the National Water Resources Strategy (NWRS). Subsequent to the publication of the NWRS, a cursory assessment indicated that the positive water balance could decrease by as much as 300 million m^3/annum when using the flow requirements derived as part of the Vaal River System Analysis Update Study, also referred to as a Flow Management Plan for the Vaal River. 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. (See the strategy on "RESERVE AND RESOURCE QUALITY OBJECTIVES A.2.1" for further details.)

d. Combined impacts – WCDM and Reserve implementation

Since the two factors, releases for the Reserve and WCDM measures are at the opposite sides of the water balance equation, it may be possible in the short to medium term to maintain a balance between these two variables by allowing releases for the Reserve to occur with the savings from implementing WCDM measures. The first step towards such a strategy would be to obtain reliable planning information on both WCDM and the Reserve, so that sound motivations and informed decisions can be taken on the way forward.

2.8.3 Allocation of conditional surplus and licensing

Surpluses available in the Upper Vaal WMA (see **Section 2.7)** will also be available to the Middel and Lower Vaal WMAs and the allocation of the conditional surplus will be made at the National Level through the licensing process.

The allocation of the conditional surplus to new water abstraction users needs careful consideration. The applicants will have to prove efficient use through implementation or planned implementation of WCDM measures and consider local as well as system wide impacts on existing users both in terms of availability and water quality. Trading of water rights could also be considered in accordance with the National Trading Policy and guidelines.

Any new allocations from the system will carry the full Vaal River tariff on either the full allocation (if abstracted from the main stem or tributary carrying transfers) or the impact the abstraction will have on the yield of the system (if abstracted from any other tributary). The motivation for implementing the full cost is due to the fact that the surplus is only available under the condition that transfers occur from supporting systems. All water use charges are thoroughly described and will be implemented in accordance with the National Pricing Strategy.

It is the Departments view that the above strategy will go a long way to achieve the objective of encouraging the beneficial use of water in the Vaal River System.

As presented in **Section 2.8.1** and in the strategy "WATER BALANCE RECONCILIATION A.1.3**"** the conditional surplus is not available in the Grootdraai Dam catchment and no new licences can be considered in this area prior to the implementation of an augmentation scheme.

The possibility of allocating water from the available conditional surplus in the Vaal River System, to supplement the water resources of the Lower Orange WMA, has been identified as a potential option in the Lower Orange River Management Study. This is one of several options that are currently being investigated for feasibility and could possibly be a medium term solution to provide time for the implementation of infrastructural augmentation options.

2.8.4 Necessity for Compulsory Licensing:

Compulsory Licensing is a procedure defined in Section 43 of the National Water Act, which has the purpose of correcting imbalances in water allocations, making additional water available for the Reserve or to meet reasonable equity demands. Due to the conditional surplus estimated until the year 2025, reasonable quality water, and, no eminent need for allocation corrections (required by the Reserve or water for equity), there is *no immediate* need to enter into a compulsory licensing process for any of the Vaal WMAs as a whole. It may be required to implement Compulsory Licensing in selected sub-catchments, which are dealt with in the WMA specific ISPs.

Due to the extensive developments in and large water abstractions from the Vaal River System, it may however be required, when the Reserve is implemented fully eventually, to introduce Compulsory Licensing. It should be noted that it is generally accepted that the Vaal River is a “workhorse” river and will most likely be maintained as such when the Resource Classification is carried out.

One of the main objectives of DWAF is redressing inequities in water allocation that originated from past policies. Licensing, in particular Compulsory Licensing, are measures now embedded in the NWA to accomplish these goals. Although limited requirements for such water allocation have been received in the Vaal River System, it remains a priority policy of the DWAF to give preference to legitimate equity water allocation needs.

2.9 WATER QUALITY MANAGEMENT

The water quality situation in the Vaal River System is such that, through intensive management and the implementation of previous and existing legislation, reasonable (in most cases acceptable) quality water has been available at most locations in the Vaal River System. This achievement was only possible through extensive management interventions that were taken to counter pollution that inevitably accompany economic development and population growth.

The water quality varies from poor in the highly developed areas to good in the less developed areas. The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas. The area is also subject to atmospheric deposition due to emissions from coal fired power stations and industry in and around the catchment. Atmospheric deposition has been cited as a cause of increased salinity, mainly in the Upper Vaal WMA.

The current approach adopted in managing water quality is to apply the steps presented below on a sub-catchment basis. The first step is to carry out a situation assessment during which Water Quality Objectives (WQO) are established and water quality variables of concern and sources of pollution are identified. The WQO are based on the water quality requirements of the user sectors as well as the ecology. The subsequent phases in the process, following the situation assessment, are to develop water quality management plans or catchment management strategies. During this phase water management interventions such as source control, treatment and dilution are assessed. These phases also involve the revisiting of the WQO in an iterative manner to reach a balance between the water user requirements and achievable management strategies that do not impede continued economic growth.

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.

In order to deal with the situation it is required to commission the development of an Integrated Water Resource Management Strategy for the Vaal and Orange River systems. (See the "WATER QUALITY MANAGEMENT A.2.2" strategy's Management Actions that were identified in this regard.)

In summary the main challenges for water quality management in the Vaal River System will involve mitigating the future impacts particularly with respect to the following focus areas:

- Further expansion of the urban areas and industrial activities.
- Extension of coal mining activities (mainly in the Grootdraai Dam and Waterval River catchments).
- Managing potential decants from decommissioned gold and coal mines – the consequence of past economic activities.
- Addressing the problem of atmospheric deposition of sulfur (mainly occurring in the Upper Vaal WMA) that originates from the coal burning industries.

The general objective with any management intervention should be to balance the level of water resource protection measures that are implemented whilst allowing development to occur with the benefit being a sustainable economic, social and ecological environment.

2.10 INSTITUTIONAL ASPECTS

2.10.1 International and National Institutional Considerations

The only direct International Obligation affecting the water resources of the Vaal River System is in the Lower Vaal WMA, in particular the Molopo River catchment. Since these obligations have a minor impact on the water resources at an Overarching level, further reference to this aspect will be dealt with in the Lower Vaal WMA ISP.

A further important international institutional link to the Vaal River System is with Lesotho with regard to the transfer of water from the Lesotho Highlands Project. The communication of issues and any future planning will be done at the national level through existing structures.

2.10.2 Local and Catchment Level Institutional Considerations

The water management in the Vaal River System involves the three Vaal WMAs, the Orange River WMAs and the surrounding WMAs supplying or receiving water from the system. In addition communication with the local authorities, water supply and wastewater service providers (such as Rand Water and Erwat) as well as bulk users such as Sasol and Eskom are essential if the water resources of the Vaal River catchment are to be successfully managed. To this end, DWAF are active in several liaison forums with stakeholders on several fronts as well as promoting the establishment and continuation of Water Management Forums to create the structures for stakeholder participation. There is a need to co-ordinate these activities and encourage communications between the various government and regional and local authorities.

2.11 SYSTEM OPERATION

Due to the inter dependencies of the Vaal WMAs the operation of the infrastructure has to be undertaken in a coordinated way to achieve the best efficiencies and balance potential opposing objective among stakeholders. The main activities for system management include the following:

- Operation planning should be undertaken on an annual basis.
- Management during drought periods in accordance with a drought management plan.

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. More details are provider in the strategy on "SYSTEM MANAGEMENT A.6.2".

2.12 MONITORING AND INFORMATION MANAGEMENT

The successful operation of the Vaal River catchment requires effective monitoring networks and information management systems. There is an extensive network of flow, rainfall and water quality monitoring stations in the catchment. However, studies have highlighted the need to expand the monitoring network to include more gauges to determine river losses, bulk distribution system losses, and to track water requirements. Bio-monitoring should be included to assist with the determination and implementation of the ecological Reserve. A consolidated assessment needs to be made of all the monitoring and data management requirements of the Vaal River System. This process should identify all the water resource management activities that require monitoring information, and should focus on the integration of monitoring systems that are directly under control of the Department as well as from other institutions.

Coordination of all monitoring requirements is best undertaken by the WMA managers (currently the regional offices and in future the CMAs). All monitoring requirements for water resource management should be defined by each of the relevant agencies and feed to the WMA managers for coordination. For example, monitoring needs that are required for the overarching management and operation of the Vaal River System should be communicated to the each WMA. (More details can be found in the "MONITORING AND INFORMATION MANAGEMENT STRATEGY A.7".)

2.13 ISP IMPLEMENTATION STRATEGY

The implementation of the overarching ISP is expected to take place through the Central Cluster (Cluster Manager) as more than one WMA are under consideration. The Central Cluster incorporates the Gauteng, North West, Free State and Northern Cape Provinces and is responsible for Water Services and Forestry functions within these Provinces and Water Resources Management in the Vaal and Orange basin and the Crocodile-Marico WMA.

The ISP is intended to act as DWAFs perspective on how the Vaal River catchment's water resources should be managed. The final ISP will be put out 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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