Report No. P WMA 10/000/00/0203

DEPARTMENT OF WATER AFFAIRS
AND FORESTRY

LOWER VAAL WATER MANAGEMENT AREA

Overview of Water Resources Availability and Utilisation

SEPTEMBER 2003

Title:	***Lower Vaal Water Management Area*** ***Overview of Water Resources Availability and Utilisation***
Authors:	*MS Basson, JD Rossouw*
Project Name:	*National Water Resource Strategy*
Status of report:	*Final*
BKS Report No:	*H141410*
DWAF Report No:	*P WMA 10/000/00/0203*
First Issue:	*July 2002*
Final Issue:	***September 2003***

Approved for BKS (Pty) Ltd by:

....

Dr MS Basson
Project Leader

Approved for Department of Water Affairs and Forestry
Directorate National Water Resource Planning

....	....
J A van Rooyen	***JI Rademeyer***
Manager : National	*Chief Engineer : National*
Water Resource Planning	*Water Resource Planning Central*

PREFACE

This overview of the water resources availability and utilisation in the Lower Vaal water management area, is one of a series of similar reports covering all 19 water management areas in the country, and results directly from work performed in preparation of the First Edition National Water Resource Strategy, which is to be published in its final form during 2003. It is further complemented by a report giving a national perspective on the water resources of the country.

The information contained in this series of reports, reflects the combined efforts and contributions by a wide spectrum of people. Most of the data follow from water resource situation assessments with respect to each of the water management areas as well as from demographic, economic, environmental and other related studies, which were performed under assignment of the Department of Water Affairs and Forestry. The reports also summarise the knowledge and insights gained through a series of workshops (several per water management area) conducted during the years 2000 and 2001, in which strategic perspectives were developed with respect to the reconciliation of requirements for and availability of water, then and into the future.

It is the objective of the report to, in a non-technical style, provide an overview of the current and expected future water resources situation in the Lower Vaal water management area, highlight the key issues of relevance and provide broad strategies with regards to the management of water resources in the water management area. Although an internal document by the Department of Water Affairs and Forestry, it should also serve as valuable background to officials from other government departments and institutions, members of catchment management agencies and water user associations, regional and local authorities, consultants and others.

It is important to note that the information, strategies and priorities given are not static. All relate to a certain point in time, and should be regularly reviewed in future as improved information becomes available and to adjust to changing circumstances. Greater technical detail can be obtained from the documentation referenced.

ACKNOWLEDGEMENTS

Invaluable contributions to the contents of the water management area reports were made by several individuals and through the combined knowledge and wisdom of many others. Only a few can be named here, and this note serves as a rather incomplete recognition to them and our other professional colleagues for what they have done and for what the authors have learned from them.

- *Mr Johan van Rooyen, Manager : National Water Resource Planning, for his guidance, support and many original ideas and perspectives.*

- *Mr Frans Stoffberg, Project Manager for Department of Water Affairs and Forestry, for his commitment, co-operation and wisdom on many matters.*

- *The Chief Engineers : National Water Resource Planning: Beyers Havenga, Niel van Wyk, Seef Rademeyer and Frans Stoffberg, for sharing their intimate knowledge of the water management areas and editing of the reports.*

- *Officials from the Regional Offices and of the other Directorates of the Department of Water Affairs and Forestry for the priority which they afforded this work, their supportive co-operation and valuable contributions.*

- *Consultants to the Department of Water Affairs and Forestry on work related to this assignment, for sharing of information, participation in workshops and unconditional support to the BKS project team.*

- *Colleagues in BKS who directly contributed to the work, or who may have been inconvenienced through the priorities given to the National Water Resource Strategy; particularly the graphics, GIS, secretarial and word processing staff for their professional assistance.*

LOWER VAAL
WATER MANAGEMENT AREA

OVERVIEW OF WATER RESOURCES AVAILABILITY AND UTILISATION

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LOWER VAAL WATER MANAGEMENT AREA

OVERVIEW OF WATER RESOURCES AVAILABILITY AND UTILISATION

1. GENERAL DESCRIPTION OF WATER MANAGEMENT AREA

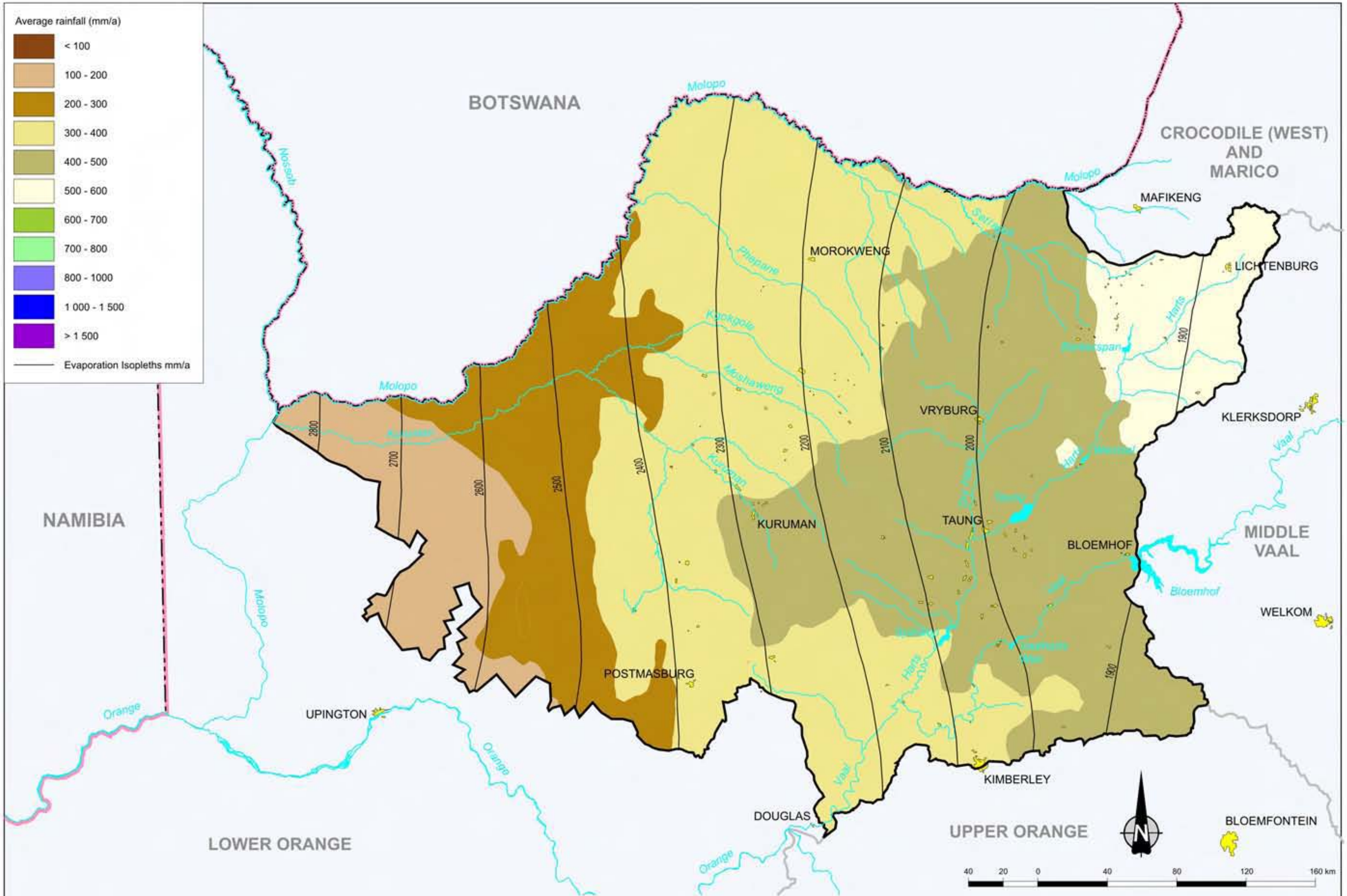
1.1 Natural characteristics

The Lower Vaal water management area is one of five water management areas in the Orange River Basin. It lies in the North West and Northern Cape Provinces, with the south-eastern corner in the Free State, and borders on Botswana in the north, as well as on the Crocodile (West) and Marico, Middle Vaal, Upper Orange and Lower Orange water management areas. The Vaal River is the only major river in the water management area. It flows across the south-eastern corner of the water management area, connecting it to the Middle Vaal and Lower Orange water management areas. The Harts River is the only significant tributary to the Vaal River from the Lower Vaal water management area. The largest part of the water management area falls within the catchment of the Molopo River, a tributary to the Orange River. However, the Molopo is an endorheic river, which ceases as surface flow before it reaches the Orange River. Refer to **Figure 1** for the location and general layout of the water management area.

There are no distinct topographic features in the water management area and most of the terrain is relatively flat with no climatic barriers. Climate over the water management area therefore varies gradually according to the larger regional patterns. Annual rainfall ranges from about 500 mm in the east to as low as 100 mm in the west. Potential evaporation can be as high as 2 800 mm per year, which greatly exceeds the rainfall as shown on **Figure 2**. As a result of the generally arid climate, vegetation over the water management area is sparse, consisting mainly of grassland and some thorn trees, notably the majestic camel thorns. Different geological formations occur over the south-eastern part of the water management area, giving rise to a variety of soil types. The northern and western part, which corresponds remarkably well with the catchment of the Molopo River, is mainly underlain by sedimentary formations and covered by Kalahari sands. A large part of the central area is underlain by dolomite. Rich diamond bearing intrusions occur near Kimberly with alluvial diamonds found in the vicinity of Bloemhof. Iron ore and a variety of other minerals are found in the central to south-western parts of the water management area.

Barberspan is an off-channel pan in the upper reaches of the Harts River, known for its rich bird life. It has been declared a Ramsar wetland.

LOWER VAAL WMA Base Map Fig 1



LOWER VAAL WMA

Rainfall and Evaporation

Fig 2

1.2 Development

San people lived in the area as nomadic hunters as early as 120 000 years ago and rock art depicting the rich wild life of the era are found at locations throughout the water management area. The first permanent settlements came towards the end of the 19th century. Large-scale cultivation was established during the first half of the 20th century. The discovery of diamonds near Kimberly in 1869 (following on the discovery of alluvial diamonds on the banks of the Orange River in 1866), and later in the Bloemhof/Christiana area, had a major impact on the early development in the water management area. Over the next 15 years, South Africa yielded more diamonds than India (the only source until then) had in 2 000 years. Another major development was the establishment of the Vaalharts irrigation scheme, following the depression of the 1930's.

Most of the land in the water management area remains under natural vegetation as shown in **Figure 3**, with extensive livestock farming as main activity. The north eastern part is characterised by large scale rain fed cultivation. Recently, some of the fields have been converted back to grazing land because of economic reasons. Intensive irrigation is practised at Vaalharts as well as at locations along the Vaal River. No afforestation or large infestations of alien vegetation occur in the water management area. The city of Kimberley on the border with the Upper Orange water management area represents the only significant urban area in the water management area. Several towns as well as scattered rural settlements are found mainly in the central and eastern part of the water management area. There are no power stations.

1.3 International

The Molopo River forms the border between South Africa and Botswana, and is shared by the two countries. Utilisation of shared water resources by the two countries is regulated by the Joint Permanent Technical Committee between the countries. The Lower Vaal water management area 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 through the Orange-Senqu River Commission (ORASECOM), with membership by the basin countries.

A need exists for the better management of transborder groundwater aquifers shared by South Africa and Botswana.

1.4 Sub-areas

Significant spatial variations in climate, water availability, level and nature of economic development and growth are typical of South Africa, and are also evident in the Inkomati water management area. To enable improved representation of the water resource situation in the water management area under such varied conditions, and to facilitate the applicability and better use of information for strategic management purposes, the water management area was divided into sub-areas. Delineation of the sub-areas was judgementally based on practical considerations such as size and location of sub-catchments, homogeneity of natural characteristics, location of pertinent water infrastructure (e.g. dams), and economic development. The catchment management agency may later introduce smaller or alternative subdivisions.

Consequently, three sub-areas were identified to facilitate the presentation and management of key issues in the water management area. These sub-areas as shown on Figure 1, are :

- The Harts sub-area, which corresponds to the catchment of the Harts River.
- The “Vaal downstream of Bloemhof” sub-area, comprising the catchment of the Vaal River between Bloemhof Dam and Douglas Weir near the confluence with the Orange River at the downstream end of the water management area.
- The Molopo sub-area, which comprises the portion of the Molopo River catchment in South Africa together with the Kuruman River catchment.

2. NATIONAL PERSPECTIVE

South Africa is located in a predominantly semi-arid part of the world. The climate varies from desert and semi-desert in the west to sub-humid along the eastern coastal area, with an average rainfall for the country of about 450 mm per year, well below the world average of about 860 mm per year, while evaporation is comparatively high. As a result, South Africa's water resources are, in global terms, scarce and extremely limited in extent. More than 90% of the water use in the country is supplied from surface resources, whereas groundwater plays a pivotal role in especially rural water supplies. Due to the predominantly hard rock nature of the South African geology, few major groundwater aquifers exist that could be utilised on a large scale.

Attributable to poor spatial distribution of rainfall over South Africa, the natural availability of water across the country is also highly uneven. This is compounded by the strong seasonality of rainfall over virtually the entire country as well as the high within-season variability of rainfall and consequently of runoff. As a result, streamflow in South African rivers is at relatively low levels for most of the time, with sporadic high flows occurring; characteristics which limit the proportion of streamflow that can be relied upon to be available for use. To aggravate the situation, most urban and industrial development, as well as some dense rural settlements, have been established in locations remote from large watercourses; dictated by the occurrence of mineral riches and influenced by the political dispensation of the past, rather than by the plentiful availability of water. As a consequence, the requirements for water already far exceed the natural availability of water in several river basins. Widely spread and often large-scale transfers of water across catchments have, therefore, been implemented in South Africa in the past.

Of the 19 water management areas in the country, only the Mzimvubu to Keiskamma water management area is currently not linked to another water management area through inter-catchment transfers, giving effect to one of the main principles of the National Water Act which designates water as a national resource. Eleven water management areas share international rivers.

A graphical comparison of the natural occurrence of water, the population and the economic activity per water management area is given in **Figure 4**, clearly demonstrating the exceedingly varied conditions among the water management areas.

Water, which is naturally of poor quality, also occurs in some areas, which limits its utilisation. This applies to both surface and groundwater. Where feasible, special management techniques may be applied to improve water quality to appropriate standards for particular uses.

Most of the economic activity is concentrated in Kimberley as well as at other major mining areas. Mining activities in the water management area include diamonds, iron ore, manganese, lead, zinc and other minerals such as limestone and asbestos. Kimberley remains an important centre for diamond mining and trade in diamonds, and is know for its high quality diamonds. The Sishen Mine, south-west of Kuruman, currently is the major supplier of iron ore in the country. Plans are for the Sishen Mine to be linked via rail to the Coega industrial and harbour development at Port Elizabeth. Relatively little of the mining production is beneficiated locally.

The importance of the government sector can be attributed to Kimberley as the seat of the Northern Cape provincial government.

The trade sector is concentrated in wholesale of primary products and related services to the community. Main products of trade in the water management area are diamonds (for export) as well as food and relevant retail products.

Agricultural activities include the cultivation of grains and fodder crops (dryland and under irrigation) as well as livestock farming, mainly production of beef. Linkages between the agricultural sector and other sectors of the economy are important.

Of the work force of 343 000 people in the water management area in 1994, 54% were active in the formal economy and 38% were unemployed, which was higher than the national average of 29%. The remaining 8% participated in the informal economy. Of those formally employed 34% worked in the government sector, 29% were involved in agriculture and 10% in trade.

No significant changes in the economy of the region is foreseen over the medium term. The mineral and ore bodies generally being large enough to support mining at the current levels over an extended period of time. Agriculture in the water management area is also relatively stable, which is largely attributable to the variety of products and flexibility for adjustment. Although the agriculture and mining sectors are relatively strong, growth in the overall economy of the water management area is expected to be modest or neutral.

3.2 Demography

A detailed study of the population distribution in the country and of the expected future demographic and economic changes was conducted to serve as background to the estimation of future water requirements. Different scenarios were developed as described in Addendum 1. Demographic information pertinent to the Lower Vaal water management area is captured below.

The Lower Vaal water management area is home to about 2,7% of the country's population which, when compared to the economic production in the water management area, indicates a per capita economic contribution of well below the average for the country. The population predominantly lives in rural areas. Nearly 60% are classified as rural and about 40% as urban. Corresponding to the arid climate, population density in the Molopo sub-area is very sparse, particularly in the western parts.

Similar to the national demographic trends, and mainly attributable to the impacts of HIV/AIDS and of increasing urbanisation, little if any increase in population in the rural areas is expected beyond the year 2005. As applies to the current population distribution, the future demography of the water management area will also largely be influenced by economic opportunities and potential. As a result of the lack of economic stimulants in the water management area, expectations are for no significant change in the urban population as well. The total population for the water management area is therefore expected to remain close to the current levels over the medium term, as also shown in **Figure 6**.

4. WATER REQUIREMENTS

4.1 Current requirements (year 2000)

Water use in the water management area is dominated by irrigation, which represent 80% of the local requirements for water. About 12% of the requirements is for urban and industrial use, 7% for rural domestic supplies and stock watering, and the remainder for mining purposes. A summary of the sectoral water requirements in each of the sub-areas is given in **Table 1** and is diagrammatically shown in **Figure 7**. All the requirements are given at a 98% assurance of supply, as explained in Addendum 3.

Table 1: Year 2000 Water Requirements (million m³/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	23	19	0	0	0	494	62	556
Vaal downstream of Bloemhof	73	32	8	0	0	0	113	422	535
Molopo	0	13	17	6	0	0	36	0	36
Total	525	68	44	6	0	0	643	0	643

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) Quantities given refer to impact on yield only.

Over 85% of the requirements for irrigation are in the Harts sub-area, mainly at the Vaalharts irrigation scheme, with the balance being along the Vaal River. Requirements for water in the Molopo sub-area are relatively small and constitute only 6% of the total water requirements within the water management area. Only limited irrigation from groundwater is practised in this sub-area.

Also shown in Figure 7 are requirements for transfers between sub-areas and to other water management areas, which are described in more detail under 6.1.

Because of salinisation problems experienced at the Vaalharts irrigation scheme an efficient subsurface drainage system was installed, resulting in large quantities of irrigation effluent being returned to the river and which could potentially be re-used downstream. The resultant balance at the downstream end of the water management area is reflected as a surplus for the Lower Vaal water management area, and not as a transfer to the Lower Orange water management area.

A substantial proportion of water used in the urban and industrial sectors is used non-consumpatively and again becomes available as effluent. At the larger centres, most or all of the effluent is discharged back to the rivers after appropriate treatment, from where it can potentially be re-used. Effluent from smaller towns typically evaporates from maturation ponds, or may be absorbed by irrigation and infiltration.

Estimates of return flows for the urban sector are given in Appendix 1, which also shows the quantities of water estimated to be lost through the urban distribution systems. Similar information with respect to irrigation is contained in Appendix 3.

4.2 Future requirements

There are many factors which 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, 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 2000, 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.

Due to the negligible to negative population growth and economic growth in the water management area, a small decrease in the domestic (urban and rural) and industrial requirements for water is expected in the Lower Vaal water management area. No change is foreseen with respect to the water requirements for irrigation. Water requirements for mining purposes, which are more of localised importance, are also expected to remain relatively unchanged.

Quantification of the projected future requirements for water is presented in **Tables 2** and **3** for the base and high scenarios respectively, and is further discussed in Section 6.

Table 2: Year 2025 base scenario water requirements (million m³/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	25	19	0	0	0	496	60	556
Vaal downstream of Bloemhof	73	31	8	0	0	0	112	422	534
Molopo	0	10	18	6	0	0	34	0	34
Total	525	66	45	6	0	0	642	0	642

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) Quantities given refer to impact on yield only.

Table 3: Year 2025 high scenario water requirements (million m³/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	33	19	0	0	0	504	52	556
Vaal downstream of Bloemhof	73	77	8	0	0	0	158	422	580
Molopo	0	17	18	6	0	0	41	0	41
Total	525	127	45	6	0	0	703	0	703

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) Quantities given refer to impact on yield only.

5. WATER RESOURCES

5.1 Surface water

As a result of the low rainfall, flat topography and sandy soils over much of the water management area, little usable surface runoff is generated in the water management area. The runoff which does occur, is highly variable and intermittent. Although occasional runoff occurs in the upper reaches of the Molopo River, no record exists of flow having reached the Orange River. Previous recordings of flow in the lower reaches of the Molopo and/or Kuruman Rivers were in 1933 and again in the 1974/5 and 1975/76 seasons. Flow in the Vaal River, which is the main source of water in the water management area, virtually all originates from the Upper Vaal and Middle Vaal water management areas. A summary of the mean annual runoff (MAR), together with the estimated requirements for the ecological component of the Reserve, is given in **Table 4**. More detail on the estimation of the Reserve is given in Addendum 4.

The only lake and wetlands of note are at Barberspan in the upper Harts River catchment, which has been given Ramsar status as a wildlife conservation area. There are no commercial forests in the water management area. Infestations of invading alien vegetation occur along some watercourses, and is particularly serious in parts of the Molopo River catchment.

Table 4: Natural Mean Annual Runoff and Ecological Reserve (million m^3/a)

Sub-area	Natural MAR (1)	Ecological Reserve (1, 2, 3)
Harts	138	15
Vaal downstream of Bloemhof	43	5
Molopo	197 (3)	29
Total	181	49

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 being a portion of this. Refer to Appendix 4.
3) Estimated runoff from catchment, which is lost through evaporation and infiltration before reaching the Orange River. This runoff therefore does not add to the total for the water management area.

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), and which should also be referred to with respect to detail planning and design work. In this respect, the mean annual runoff given for the Molopo River catchment is to be viewed as rather theoretical.

In the natural state the quality of surface water in the water management area is of acceptable standard, although typical of high turbidity.

Water quality in the Vaal River is seriously impacted upon by urban and industrial use as well as mining activities in the Upper and Middle Vaal water management areas, and is of relative high salinity. The Vaalharts irrigation scheme serves the purpose of beneficially utilising lower quality water discharged from the Upper Vaal water management area and thus prevents the build up of salinity in the lower reaches of the Lower Vaal water management area. Water in the Harts River downstream of the Vaalharts irrigation scheme is of exceptional high salinity as a result of saline leachate from the irrigation fields (± 1 100 mg/ℓ salinity), and needs to be carefully managed through blending with fresher water. Water quality in the lower reaches of the Vaal River is also impacted upon by irrigation return flows from the Harts River as well as from the Riet/Modder River further downstream, necessitating further blending with low salinity water from the Orange River at the Douglas weir.

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, for which more details are given in Appendix 5, are:

- Bloemhof Dam on the Vaal River. The dam wall and outlet works are located within the Lower Vaal water management area immediately where the river enters the water management area from the Middle Vaal water management area. Most of the reservoir basin falls in the Middle Vaal water management area. The yield from the dam, however, is available in the Lower Vaal water management area.

- Vaalharts Weir is a main diversion weir on the Vaal River while the Douglas Weir falls just inside the water management area, immediately upstream of the confluence of the Vaal River with the Orange River.

- Wentzel, Taung and Spitskop Dams on the Harts River.

No large dams occur in the Molopo sub-area.

The bulk of the surface water found in the water management area is in the Vaal River, most of which is transferred along the river from the Upper Vaal water management area and via the Middle Vaal water management area, to the Lower Vaal water management area. Water is also transferred into the water management area at Douglas Weir, from the Upper Orange water management area, for water quality management purposes. More details on the existing transfers are given in Appendix 6.

There are no feasible options for meaningful further development of surface water resources in the water management area.

5.2 Groundwater

Groundwater utilisation is of major importance in the Lower Vaal water management area and constitutes the only source of water over much of the water management area. Large dolomitic aquifers occur in the uppermost reaches of the Harts River and Molopo River. These aquifers extend north and eastwards into the Crocodile (West) and Marico, Upper Vaal and Middle Vaal water management areas.

Groundwater is mainly used for rural domestic supplies, stock watering, water supplies to several towns in the water management area and in some instances for irrigation, such as at Tosca. Significant quantities of groundwater are abstracted in all three the sub-areas, with the total yield from groundwater in the water management area well more than double that obtainable from the local surface water resources. Localised over-exploitation of groundwater due to excessive use for irrigation, occurs in some areas.

Much of the groundwater abstraction in the Molopo sub-area is in the vicinity of dry sandy riverbeds. With a substantial part of the recharge of groundwater assumed to be from these watercourses, concern exists about the impacts of upstream farm dams as well as invasive alien vegetation along the watercourses, on the sustainable yield from groundwater.

Major de-watering of groundwater aquifers for mining purposes occurs at Sishen, where up to 28 million m^3 per year is planned to be abstracted from groundwater. Expectations are that this will stabilise at about 18 million m^3 per year by the year 2027.

The quality of groundwater in the water management area is generally good, although brackish (mineralised) water is found in the drier areas. Pollution of dolomitic groundwater is experienced at the Pering Mine near Reivilo as a result of the mining activities.

5.3 Summary

The total water available for use in the Lower Vaal water management area at the year 2000 development levels, is schematically presented in **Figure 8** and summarised in **Table 5**. Details on factors which influence the yield such as the impacts of the Reserve, invasive alien vegetation, river losses and urban runoff are contained in Appendix 4.

Table 5: Available water in year 2000 (million m³/a)

Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers in	Grand Total
	Surface water	Ground-water	Irrigation	Urban	Mining and bulk			
Harts	51	40	45	0	0	136	419	555
Vaal downstream of Bloemhof	(107)	54	7	0	0	(46)	609	563
Molopo	2	31	0	0	2	35	4	39
Total	(54)	125	52	0	2	125	547	672

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

Particularly evident from Figure 8 is the strong dependence of the Lower Vaal water management area on water from the Upper and Middle Vaal water management areas. In total, over 90% of the current water available in the water management area, is from upstream water management areas. There are also significant transfers of water within the water management area, most notably with respect to the Vaalharts irrigation scheme. The negative yield for the Vaal River within the Lower Vaal water management area as shown in Table 5, is as a result of evaporation losses from this reach of river which are in excess of the run-of-river yield contributed by local inflows.

The quality of surface water in the Harts and Vaal Rivers is highly impacted upon by irrigation return flows as well as by water use in the Upper and Middle Vaal water management areas, which limits the usability of water in the lower reaches of these rivers.

Due to the intermitted nature of surface runoff in the water management area, provision for the ecological component of the Reserve has no impact on the yield from local resources.

6. RECONCILIATION OF REQUIREMENTS AND AVAILABILITY

6.1 Water balance

A reconciliation of the available water and total requirements for the year 2000 (and 2025), including transfers between water management areas, is graphically presented in **Figure 9** with quantifications given in **Table 6**. The main transfers with associated quantities are also shown on Figure 1 and are summarised in Appendix 6.

Table 6: 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	62	556	(1)
Vaal downstream of Bloemhof	(46)	609	563	113	422	535	28
Molopo	35	4	39	36	0	36	3
Total	125	548	673	643	0	643	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. The same applies to Tables 7 and 8.

An appropriate balance exists for the Harts River sub-area as only enough water is transferred into the sub-area to meet the requirements, while return flows from the sub-area are available for use along the lower Vaal River. The irrigation potential downstream of Taung Dam has, however, not been fully developed and surplus yield from this dam is being used in lieu of using the full transfer capacity from the Vaal River. The surplus with respect to the Vaal River sub-area is a reflection of the estimated irrigation return flows to the lower Vaal River, including return flows from the Riet and Modder Rivers. A small surplus is also shown for the Molopo sub-area, which relates to mine pumpage which is not being beneficially utilised.

A perspective on the possible future situation is given by **Table 7** for the base scenario, and **Table 8** as representative of a possible high water use scenario. (Refer to Addendum 1.) These are also graphically presented in Figure 9. The base scenario shows a small decline in water requirements which corresponds to the projected decline in population, while irrigation and mining activities are assumed to remain at the current levels. Should the high scenario materialise, a moderate increase in the requirements for water can be experienced as a result of the expected stronger economic activity. In both cases it can be assumed that water transfers will be adjusted according to the requirements.

Table 7: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Sub-area	Available water			Water requirements			Balance	Potential for develop-ment
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)	(4)
Harts	137	419	556	496	60	556	0	0
Vaal downstream of Bloemhof	(45)	631	586	112	422	534	52	0
Molopo	35	4	39	34	0	34	5	0
Total	127	572	699	642	0	642	57	0

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

Sub-area	Available water			Water requirements			Balance	Potential for develop-ment
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)	(4)
Harts	137	419	556	504	52	556	0	0
Vaal downstream of Bloemhof	(45)	697	652	158	422	580	72	0
Molopo	35	4	39	41	0	41	(2)	0
Total	127	646	773	703	0	703	70	0

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 increase in irrigation.
3) Brackets around numbers indicate negative balance.

Compared to the natural MAR of 181 million m^3 per year (excluding the Molopo River) which originates from the Lower Vaal water management area together with the average annual inflow (2 519 million m^3 per year) into the water management area, which constitute 2 700 million m^3 per year in total, an estimated 2 146 million m^3 per year, or 79%, flows out of the water management area into the Lower Orange water management area, mainly as flood water.

6.2 Key issues

Key considerations with respect to the Lower Vaal water management area are:

- The already full development and high utilisation of the water resources which naturally occur in the water management area; both surface and groundwater.
- The dominant influence of water from upstream water management areas on water resource management in the Lower Vaal water management area.
- Concerns about water quality in the Vaal River as a result of upstream activities (urban, industrial, mining) and the additional impacts of irrigation return flows on salinity concentrations.
- Recent assessments that the yield from the Vaal River System is substantially lower than previously determined, and the affects thereof on users from the Vaal River.
- Expected decline in rural domestic and some urban requirements for water.
- Impacts of alien vegetation on groundwater availability. Also the sharing of across-border aquifers with Botswana.
- Impacts of mining activities on groundwater as well as localised over-exploitation of groundwater.
- Unutilised yield from Taung Dam.

6.3 Strategic perspectives

Most of the primary economic production in the water management area is by the mining sector with a significant contribution also from irrigated agriculture, both sectors being largely reliant on water from the Vaal River. With water availability in the Vaal River being a function of the management of the Vaal River System which extends over several water management areas, it is evident that water resource management in the Lower Vaal water management area should be well co-ordinated with other inter-dependent water management areas, and be viewed in an integrated systems context. The main interdependencies with other water management areas relate to flow volume, flow regime and water quality. Management of water resources in the Lower Vaal water management area should also be within the framework of the recently established Orange-Senqu River Commission (ORASECOM) by South Africa, Lesotho, Botswana and Namibia.

As a result of the projected future decline in population in parts of the water management area and with no significant changes in economic activity foreseen, little change in the requirements for water is expected. The most likely stimulant for large new economic development in the water management area would be through mining developments, which could probably economically be supplied with water from the Vaal River should other local resources not be available.

Strategic perspectives on the main interventions and options with respect to the future availability and optimal utilisation of water in the Lower Vaal water management area are concisely described below. A general description of options for the reconciliation of the requirements for and availability of water is given in Addendum 5.

Harts sub-area

No meaningful change is foreseen with respect to the requirements for water in the Harts sub-area. Management of water quality (salinity) at the Vaalharts irrigation scheme and downstream of Spitskop Dam remains of primary importance.

The surplus yield from Taung Dam could be applied for the settlement of emerging irrigation farmers, or to replace some of the requirements for transfer from the Vaal River. (In both cases the impacts on water quality need to be considered.) It should be noted that the economic viability of irrigation farming in the region is declining, while the high salinity of the irrigation water is a restricting factor when considering alternative higher value crops.

Vaal sub-area (downstream of Bloemhof Dam)

The Vaal sub-area downstream of Bloemhof Dam is an integral part of the Vaal River System. Both the management of quantity and quality in the sub-area as well as transfers to other sub-area, should be addressed in the context of the Vaal River System. In this respect, compulsory licensing is required to bring existing water use (in all the Vaal water management areas) in balance with the yield of the Vaal River System. Consideration should also be given to the "polluter pays" principle with respect to the management of water quality in the system as well as in other inter-dependent water management areas.

Since the inception of the Douglas irrigation scheme water quality in the Lower Vaal River has deteriorated dramatically. The layout of the scheme as well as the position where the water transferred from the Orange River is discharged upstream of the weir, are poorly suited for water quality management purposes and the continued feasibility of the scheme is suspect. Without excess releases from Bloemhof Dam the scheme would not be sustainable.

Management of flood releases at Bloemhof Dam are to be co-ordinated with releases from other dams in the Orange River Basin in order to minimise overall flood damage in the basin.

Molopo sub-area

The bulk of the water used in this sub-area is from groundwater. Compulsory licensing is required to prevent the over-exploitation of groundwater experienced in localised areas (also in the Harts sub-area). De-watering of mines and possible pollution of groundwater through mining activities need to be carefully managed, based on appropriate scientific investigations and monitoring. Consideration should be given to the possible beneficial utilisation of excess water from the de-watering operations.

The impacts of farm dams and of invasive alien vegetation on the groundwater resources need to be investigated. Joint management of the transborder aquifers with Botswana is to be addressed at a national level.

6.4 Transfers and reservation of water

The transfer of water between water management areas and arrangements with neighbouring countries resort under national control. The following reservations are made in the National Water Resource Strategy with respect to water transfers in to and out of the Lower Vaal water management area:

- Currently 500 million m^3 per year is transferred from the Middle Vaal water management area to the Lower Vaal water management area. As an upper scenario this may increase to about 555 million m^3 per year during the period of projection – Reserved in the Middle Vaal water management area.

- A reservation applies to the transfer of 18 million m^3 per year from the Upper Orange water management area to the Douglas Weir in the Lower Vaal water management area – Reserved in the Upper Orange water management area.

- The Lower Vaal water management area also forms part of the Vaal River System which extends over several water management areas. As water resource management in the Vaal River System impacts to some degree on water quantity and quality in all the inter-linked water management areas, management of water resources in the Vaal River System is to be controlled at a national level.

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Report No. P WMA03000/00/0203

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Report No. P WMA04000/00/0203

12.5 Inkomati Water Management Area
Report No. P WMA05000/00/0203

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APPENDICES

APPENDIX 2

Rural Water Requirements (year 2000) - WMA 10: Lower Vaal

Sub-area	Rural population	Domestic	Stock watering	Total	Rural human per capita
		million m³/a			ℓ/c/d
Harts	291 971	2.7	16.2	18.9	25
Downstream of Bloemhof	55 658	0.5	7.9	8.4	25
Molopo	378 439	5.5	11.8	17.3	40
Total	**726 068**	**8.7**	**35.9**	**44.6**	**33**

APPENDIX 3

Irrigation water requirements (year 2000) - WMA 10: Lower Vaal

Sub-area	Irrigation area		Unit requirement	Irrigation requirement	Convey-ance losses	Total irrigation requirement		Irrigation return flows
	Green cover	Harvested	Green cover			No assurance	1:50 assurance	
	ha		m^3/ha/a	million m^3/a	%	million m^3/a		%
Harts	40 210	45 302	10 450	420.2	25.0	525.2	451.7	10.0
Downstream of Bloemhof	11 820	13 988	6 800	80.4	10.0	88.4	73.4	10.0
Molopo	0	0	8 000	0.0	0.0	0.0	0.0	n/a
Total	**52 030**	**59 290**	**8 417**	**500.6**	**22.6**	**613.6**	**525.1**	**10.0**

APPENDIX 4

Factors influencing runoff and yield (year 2000) - WMA 10: Lower Vaal

Sub-area	MAR (naturalised, incremental)	Reserve		Alien vegetation			Afforestation			Sugar cane			River losses	Urban runoff
		Reduction in runoff	Reduction in yield	Area	Reduction in runoff	Reduction in yield	Area	Reduction in runoff	Reduction in yield	Area	Reduction in runoff	Reduction in yield	Reduction in yield	Increase in yield
	million m^3/a	million m^3/a		ha	million m^3/a		ha	million m^3/a		ha	million m^3/a		million m^3/a	
Harts	128	14	0	3 827	1	0	0	0	0	0	0	0	0	3
Vaal downstream of Bloemhof	43	5	0	2 788	1	0	0	0	0	0	0	0	200	7
Molopo	197	29	0	38 440	4	0	0	0	0	0	0	0	0	1
Total	368	48	0	45 055	6	0	0	0	0	0	0	0	200	11

APPENDIX 5

Major dams data - WMA 10: Lower Vaal

Dam name	Quaternary catchment	River	Year completed	Purpose	Natural MAR million m^3/a	FSC million m^3
Bloemhof	C91A	Vaal	1970	Irrigation	3 315.0	1 218.0
Boegoeberg	D73B	Oranje	1931	Irrigation	10 710.0	20.3
Douglas	C92B	Vaal	1977	Information	3 908.0	16.7
Spitskop	C33B	Harts	1968	Irrigation	136.4	56.6
Taung Dam	C31F			Irrigation	59.0	6.6
Vaalharts Weir	C91B	Vaat	1938	Domestic	3 322.0	48.7
Wentzel	C31E	Harts	1934	Irrigation	52.0	6.6

APPENDIX 6

Details of main inter-WMA transfers (year 2000) - WMA 10: Lower Vaal

From quaternary	To quaternary	User group	Volume (million m^3/a)	Description
Transfers In				
D33K	C92B		18.0	Orange-Vaal transfer from Marksdrift (Upper Orange WMA)
Total in			**18.0**	

APPENDIX 1

Urban Water Requirements (year 2000) - WMA 10: Lower Vaal

Sub-area	Urban population	Domestic (direct)	Indirect	Urban losses	Total	Proportion indirect: direct	Urban per capita (domestic)	Urban return flow
		million m^3/a					ℓ/c/d	%
Harts	218 716	9.6	5.5	7.5	22.6	0.57	120	0
Downstream of Bloemhof	311 935	13.2	11.8	6.8	31.8	0.90	116	0
Molopo	81 068	7.2	3.2	2.9	13.3	0.44	244	0
Total	**611 719**	**30.0**	**20.5**	**17.2**	**67.7**	**0.68**	**134**	**0**

ADDENDA

ADDENDUM 1 : BACKGROUND ON DEMOGRAPHIC AND ECONOMIC STUDIES

A detailed study of the expected demographic and socio-economic changes in the country, and the associated impacts on water requirements, was conducted to serve as background to the NWRS. The main outcome was the expectation of lower population growth rates than previous, mainly due to the impact of HIV/AIDS, as well as reduced reproduction rates linked to urbanisation and economic growth. High and low population scenarios were developed as reflected in Fig. 6.

Estimates of the future population were initially made for the country as a whole, and then subdivided into smaller geographic units to facilitate the estimation of future water requirements on a regional basis. Because of the trend towards urbanisation as well as the expected stronger economic growth in the major urban and industrial centres, the greatest long-term uncertainty about future water requirements exists with respect to these user sectors. Greater attention was consequently given to the main urban centres in the subdivision of population, with possible lesser substantiation of the population projections for smaller centres and some rural areas. The representatives of population projections for the latter areas should therefore be reconsidered during the development of catchment management strategies

Scenarios were also developed for economic growth, and of the influence of economic growth on future water requirements, in an attempt to cautiously narrow the uncertainties which the future holds. Multi-variate analyses were performed in order to develop scenarios of possible low and high economic growth for different geographic regions in the country. Gross Geographic Product (GGP) was considered the most relevant economic indicator for the purposes of the National Water Resource Strategy because of relationships which can be established to water usage. In general, economic growth is expected to be substantially higher in the larger urban and industrialised areas and which are favourably located with respect to resources and transportation routes than in the rural areas. Consideration was given to the trend towards growth in service and manufacturing industries, and the expected impact of changing trade patterns on manufacturing, transport infrastructure and export facilities.

Within the spectrum of population and economic growth scenarios, a base scenario was selected for estimating the most likely future water requirements. This comprises the high scenario of population growth and higher average levels of urban domestic water requirements resulting from a more equitable distribution of wealth. The ratio of domestic to commercial, communal and industrial water use for urban centres in the year 2000 is maintained. A possible upper limit scenario is also proposed. This scenario is based on the same assumption of high population growth and a high standard of service provision flowing from rapid socio-economic development, with the distinction that these be combined with strong economic growth in which commercial, communal and industrial water use increases in direct proportion to growth in GDP. The upper scenario is intended to serve as a conservative indicator to prevent the occurrence of possible unexpected water shortages. No adjustments have been made to reflect the impact increased water use efficiency would have.

Caution should be exercised that possible temporary migration from rural areas to towns, which may be an interim step towards migration to cities, not wrongly be interpreted as a long term sustainable growth.

ADDENDUM 2 : ECONOMIC SECTOR DESCRIPTION (for GGP and Labour Distribution)

From Urban Econ – Reference 5

- **Agriculture :** This sector includes agriculture, fishing, forestry, hunting and related services. It comprises activities such as growing of crops, market gardening, horticulture, mixed farming, production of organic fertiliser, forestry, logging and related services and fishing, operation of fish hatcheries and fish farms.
- **Mining :** This section entails the mining and quarrying of metallic minerals (coal, lignite, gold, cranium ore, iron ore, etc); extraction of crude petroleum and natural gas, service activities incidental to oil and gas extraction; stone quarrying; clay and sand pits; and the mining of diamonds and other minerals.
- **Manufacturing :** Manufacturing includes, inter alia, the manufacturing of food products, beverages and tobacco products; production, processing and preserving of meat, fish, fruit, vegetables, oils and fats, dairy products and grain mill products; textile and clothing; spinning and weaving; tanning and dressing of leather, footwear, wood and wood products; paper and paper products; printing and publishing; petroleum products; nuclear fuel; and other chemical substances.
- **Electricity & Water :** Utilities comprise mainly three elements, namely electricity, water and gas. The services rendered to the economy include the supply of electricity, gas and hot water, the production, collection and distribution of electricity, the manufacture of gas and distribution of gaseous fuels through mains, supply of steam and hot water, and the collection, purification and distribution of water.
- **Construction :** This sector includes construction; site preparation and building of complete constructions or parts thereof; civil engineering; building installation; building completion; and the renting of construction or demolition equipment with operators all form part of the construction sector.
- **Trade :** Trade entails wholesale and commission trade; retail trade; repair of personal household goods; sale; maintenance and repair of motor vehicles and motor cycles; hotels; restaurants; bars canteens, camping sites and other provision of short-stay accommodation.
- **Transport & Comms :** The transportation and communication sector comprises land transport; railway transport; water transport; transport via pipelines; air transport; activities of travel agencies; post and telecommunications; courier activities; and storage.
- **Finance :** The economic activities under this category include, inter alia, financial intermediation; insurance and pension funding; real estate activities; renting of transport equipment; computer and related activities; research and development; legal; accounting, book-keeping and auditing activities; architectural, engineering and other technical activities; and business activities not classified elsewhere.
- **Government :** This sector includes public administration, defence and other government services at central, provincial and local level. (Note: for Labour figures this sector is included under Community Services below)
- **Community Services :** This sector includes social and related community services (education, medical, welfare and religious organisations), recreational and cultural services and personal and household services.
- **Other :** Private households, extraterritorial organisations, representatives of foreign governments and other activities not adequately defined. (Note: for Labour figures there is no “Other” category)

The labour distribution provides information on the sectoral distribution of formal economic activities, as do the GGP figures, but in addition, information is provided on the extent of informal activities, as well as dependency. Dependency may be assessed from unemployment figures, as well as by determining the proportion of the total population that is economically active.

- **Total :** The total economically active population consists of those employed in the formal and informal sectors, and the unemployed.
- **Formal sector :** Includes employers, employees and self-employed who are registered taxpayers.
- **Informal sector :** Includes people who are employers, employees or self-employed in unregistered economic activities, i.e. businesses not registered as such.

  Unemployed : Includes people who are actively looking for work, but are not in any type of paid employment, either formal or informal.

ADDENDUM 4 : ECOLOGICAL COMPONENT OF RESERVE

The ecological component of the Reserve refers to that portion of streamflow which needs to remain in the rivers to ensure the sustainable healthy functioning of aquatic ecosystems, while only part of the remainder can practically and economically be harnessed as usable yield. (Refer Addendum 2)

A summary of the mean annual runoff and the estimated average annual requirements for the ecological component of the Reserve per sub-area is given in Table 4. In the determination of water available for abstraction, allowance was made for maintaining the ecological flow requirements as pertain to drought conditions, which closely relates to the impact of the ecological component of the Reserve on the yield. All quantities relate to a particular sub-area only, that is, quantities reflect water that originates or is required in that particular sub-area. Where more than one sub-area or water management area is located along the same river, such as along the Vaal and Orange Rivers, the quantities from upstream have to be added to those of the area under consideration to reflect the actual, cumulative situation for the area under consideration.

Quantification of the water requirements for the ecological component of the Reserve, is based on the currently still incomplete understanding of the functioning of ecosystems and their habitat requirements. These figures are therefore subject to improvement as better insights are gained through monitoring, studies and improved assessment methodologies. Current provisional assessments indicate that, as a national average, about 20 per cent of the total river flow is required as ecological Reserve which needs to remain in the rivers to maintain a healthy biophysical environment. This proportion, however, varies greatly across the country, from about 12 per cent in the drier parts to 30 per cent in the wetter areas. Owing to a lack of better factual data, it has provisionally been assumed that provision of the ecological water requirements in the lowest reach of a river will be sufficient to meet estuarine freshwater requirements as well.

The component of the Reserve required for basic human needs has to be abstracted from the water resource and is therefore catered for under water requirements in Section 4.

ADDENDUM 5 : RECONCILIATION INTERVENTIONS

In line with the objectives of equitable and sustainable social and economic development, government has progressively adopted a more comprehensive and holistic approach to the planning of interventions to resolve problems of inadequate water availability. This approach accords with the requirements of national policies and legislation relating to the environment, and is informed by internationally accepted best practice.

Whenever there is a water shortage, all possible solutions will be investigated, taking account of the availability of surface and groundwater and the interactions between them, and the integration of water quality and water quantity issues. Options will include the following:

- Demand-side measures to increase water availability and improve the efficiency of water use, considered from the start of the planning process in parallel with other solutions.
- Re-allocations of water, including the possibility of moving water from lower to higher benefit uses by trading water use authorisations.
- The construction of new dams and related infrastructure, including inter-catchment transfers. Where infrastructure construction is indicated as an optimal solution, a range of alternative developments, including the implications of no development, will be presented.

The significant impacts of all development options and other interventions will be assessed and social and environmental considerations will be accorded the same attention as those of a technical, financial and economic nature. The social, environmental and economic impacts of all development options will be evaluated to ensure that the benefits arising from such actions will exceed the costs, that the benefits will be distributed equitably and that the negative impacts will be minimised or mitigated so that no-one is disadvantaged to any unreasonable extent.
In terms of the NWA comprehensive impact assessments may be required to determine the effect of proposed water uses on the water resource, and will be mandatory before a major government water work is constructed. Impact assessments will be undertaken in accordance with the regulations to the Environment Conservation Act, 1989, which are still in force under the National Environmental Management Act, 1998, until replaced by new regulations.

Water users, other stakeholders and the public a need to be involved at all stages of a development project or a scheme.

The main reconciliation interventions as given in the National Water Resource Strategy are :

- Demand management
- Improved water resource management
- Managing groundwater resources
- Re-use of water
- Control of invasive alien vegetation
- Re-allocation of water
- Development of surface water resources
- Inter-catchment transfers

Water quality considerations

ADDENDUM 6 : PRIORITIES FOR ALLOCATING WATER

Water is one of the most fundamental natural resources and it is one of the primary principles of the National Water Act that the nation's water resources are managed in such a manner that their use will achieve optimum long-term social and economic benefits for all people. Water is also a finite resource, and it is recognised that water allocations may have to change over time to meet this objective on an ongoing basis.

The NWA gives highest priority to water for the Reserve, which includes water for basic human needs and for the natural environment. Thereafter international obligations as agreed with neighbouring countries must be respected and honoured.

Beyond this, water should be allocated to ensure that the greatest overall social and economic benefits are achieved. But consideration must not only be given to this primary aim, but also to potential disbenefits to society where water is made available to competing optional uses. This applies both to long-term allocations for water use as well as to short-term curtailments in supply during periods of drought and temporary shortage. Where surplus or unused water exists, prioritisation need not apply, provided that the water is not used wastefully.

To facilitate the most beneficial utilisation of water, a general guide on priorities for water use is given below. The priorities are listed in descending order of importance, although the order may vary under particular circumstances.

- Provision for the Reserve.
- International agreements and obligations.
- Water for social needs, such as poverty eradication, primary domestic needs and uses that will contribute to maintaining social stability.
- Water for Strategic use.
- Water for general economic use, which includes commercial irrigation and forestry. In this category, allocation is best dictated by the economic efficiency of use. With the introduction of water trading, demand will automatically adjust over time to reflect the value of water in particular uses.
- Uses of water not measurable in economic terms. This may include convenience uses and some private water uses for recreational purposes, which are likely to be of low priority.

Additional factors to be considered in assessing priorities for the allocation of water are the level of assurance of supply required, the consumptiveness of use and the quality of return flows.

It is important to realise that all water use by a particular sector or user is unlikely to be of the same priority. Water to maintain primary production functions, for example, would be of higher value and priority than the additional water required for other uses in the same enterprise. This also relates to the efficiency of water use, with greater efficiency leading to a higher value of water. The same principle applies to a greater or lesser extent to all uses of water.

ADDENDUM 7 : INTER-CATCHMENT TRANSFER OF WATER

The National Water Act recognises both the relative scarcity of water in South Africa and the uneven and often unfavourable distribution of water resources in both space and time. The national government is therefore entrusted with the responsibility to effect the equitable allocation of water for beneficial use and to ensure that sufficient water is available to support the continued growth and wellbeing of the country. This includes the preparation of guidelines for the spatial redistribution of water as well as the actual implementation of inter-catchment transfer projects, where applicable.

An inherent benefit of linking the country's water resources over a large geographic area is that it can, in certain circumstances, help to manage the consequences of climatic variability through the transfer of water supplies to areas that may be suffering from severe drought conditions, from areas where the prevailing conditions are less critical. This not only helps to prevent disasters, but also provides the opportunity of operating the available resources in a systems context, thereby achieving an overall yield that is greater than the sum of the component parts.

The same technical, environmental, social and economic considerations as are applicable to any water resource development and use of water are applicable to inter-catchment transfers of water. Key considerations and items of specific relevance to inter-catchment transfers can be summarised as follows:

- Priorities for water use are stipulated in the NWA and are also contained in the NWRS. The highest priority in a catchment is to be afforded to the provision of water for the Reserve and to honouring international rights and obligations. Thereafter, consideration is to be given to the most beneficial use of water (actual and potential), both within the source and the (potential) recipient basins.
- The allocation of water away from a catchment can only be justified if it results in an overall benefit from a national perspective. Any negative impacts, or the loss of opportunity as a result of the transfer, must be outweighed by the advantages that are created. Full consideration must be given to any possible negative impacts in the source basin and all reasonable measures must be taken to mitigate such impacts in the interest of those affected.
- The maintenance of environmental integrity is of particular importance in all water resource developments. The inter-catchment transfer of water may have unique impacts on natural ecosystems that extend beyond those associated with in-catchment developments, and these need to be considered and provided for. In addition to comprehensive environmental impact assessments being undertaken in both the source and receiving areas, specific consideration must be given to the possible transfer of organisms and changes in habitat conditions.
- Interbasin transfers will only be permitted subject to water conservation and demand management by the relevant authorities and user organisation in the receiving region, conforming to the applicable criteria in this regard. Similarly, inefficient or non-beneficial use of water in a source basin cannot serve as reason for not transferring water.
- The transfer of water for the express purpose of meeting the requirements of the ecological component of the Reserve in the receiving catchment will not be considered.
- Water should not unduly be reserved over long periods of time for possible future use within or outside a catchment, in this way foregoing opportunities for the interim beneficial use of such water. Where appropriate, water use licences of short duration may be issued.
- In determining the volumes of water to be transferred from one catchment to another, water that is not already gainfully utilised and water resource potential still to be developed will be considered first. The re-allocation and inter-sectoral redistribution of water from existing to more beneficial uses should only be effected where merit can be demonstrated clearly on an economic and social basis.
- Conforming to the principle in the NWA that water is a national resource that belongs to all people, no payment is to be made to a source catchment for the actual water transferred. A portion of the water resource management charge raised in the recipient catchment will, however, revert to the source catchment and opportunities will be sought to mitigate any negative impact that may result.
- All costs associated with the transfer of water will be borne by the users of the transferred water. These include normal water use charges in terms of the prevailing pricing policy together with project and operational costs, as well as the cost of possible mitigatory measures.
- The national government will normally initiate, plan and authorise inter-water management area transfers.