Appendix D

ADDITIONAL INFORMATION AND STRATEGIC PERSPECTIVES WITH RESPECT TO WATER MANAGEMENT AREAS

The rationale behind Appendix D

Chapter 2 of the National Water Resource Strategy (NWRS) provides an overview of the water resources situation in South Africa, supported by information for each water management area as a whole. Pronounced differences are evident among the water management areas with respect to water availability and water requirements, which are attributable to the large spatial variations in climate, the level and nature of economic development and population characteristics. Similarly, there are large differences within water management areas with respect to hydro-meteorological conditions and economic activity which cannot be adequately represented or managed without further spatial differentiation.

Water management areas were therefore divided into sub-areas to enable improved representation of the water resources situation in the country and to facilitate the applicability and better use of information for strategic management purposes. Delineation of the sub-areas was based on practical considerations such as the size and location of sub-catchments, the homogeneity of natural characteristics, the location of pertinent water infrastructure such as dams, and economic development. It is foreseen that the catchment management agencies may later introduce smaller or alternative subdivisions.

An understanding of the information contained in this Appendix will be facilitated by the background information given in Chapter 2. It is therefore recommended that Chapter 2 is studied before the more detailed information on the individual water management areas given below is referred to.

The relationship between the National Water Resource Strategy and catchment management strategies

The purpose of the NWRS is to direct the management of water strategically from a national perspective. With the water management areas serving as the primary geographic elements for water resources management, the NWRS also directs the management of inter-water management area interdependencies in the national interest, in particular with respect to the provisions for the Reserve, water quality management and transfers of water between management areas. The directives of the NWRS are prescriptive in terms of the National Water Act, 1998 (Act No. 36 of 1998) and provide the overall framework within which catchment management strategies are to be developed by the catchment management agencies. Catchment management strategies must support the broad national vision portrayed by the NWRS and may not be in conflict with it, but they will be orientated towards practical implementation at catchment level. Catchment management agencies will, however, only become fully functional after several years. To make allowance for this, the Department of Water Affairs and Forestry (the Department) has, as an interim measure in the preparation of the NWRS, developed broad strategic perspectives for each water management area. These strategic perspectives are presented in separate water management area reports and will be used by the Department for the management of water resources at water management area level until they can be refined by the Department in the short to medium term and by the catchment management agencies when they are fully operational.

Only the essence of the broad strategic perspectives, which relate mainly to issues at a national level, are contained in this Appendix. Allowances for inter-water management area transfers and other reservations as stipulated here are mandatory in terms of the NWRS. More detailed strategic action plans, following from the options presented in the NWRS, will be described in the water management area reports. The data given in this Appendix constitutes a breakdown by sub-area of the data given in Chapter 2.

Yield and available water

Fresh water results from precipitation in the form of rain, fog, hail and snow. Water that can potentially be abstracted for use runs off the land surface to appear in streams and lakes, as well as infiltrating to become groundwater. In natural equilibrium, that is, before interference by humankind, the water that is seen on the land surface is the integrated result of surface and groundwater. The total quantity of surface flow which is the average annual runoff originating from a certain geographic area is referred to as the mean annual runoff (MAR).

Water that can reliably be withdrawn from a water source at a relatively constant rate is referred to as the yield. Owing to the erratic and unreliable nature of river flow in South Africa, only a small portion of the MAR is available as yield in its natural unregulated state. By storing water during periods of high flow for abstraction when natural stream flows are lower, the yield is increased. This is explained in more detail in Chapter 2, Box 2.1.

As indicated above, surface water and groundwater form part of the same hydrologic continuum - the hydrological cycle - and merely represent different manifestations of water in its natural state. Abstraction of groundwater therefore generally does not represent an additional source to surface water. However, groundwater does offer an alternative means of accessing the water resource and has the advantage of wide geographic availability and, typically, a smaller temporal variation than surface water. The combined use of surface and groundwater increases the proportion of water available as practical usable yield.

For the purposes of the NWRS, available water is defined as the total quantity of water that can be available for practical application to desired uses. It includes the yield from surface water and groundwater, as well as return flows from the non-consumptive use of water and water transferred from one catchment to another. The quantity of available water further depends on the location of use and the assurance of supply at which it is required, while the quality of water in relation to the quality requirements for particular uses has a direct bearing on the usability of the water. In the NWRS all yields and requirements have been standardised at a 98 per cent assurance of supply, that is, a risk of some level of failure during two out of 100 years on average. Actual water allocations must, however, take into account the required assurance of supply for specific uses.

In contrast to domestic and economic uses of water, where relatively constant availability is required, unregulated flows are preferred for ecological purposes, as these display the natural variability to which ecosystems have adapted. Water to meet ecological requirements is required to remain within the water body and is therefore not regarded as water that is available for other uses. In highly regulated systems the unregulated portion of streamflow that remains after other uses have been satisfied may not be sufficient to meet the requirements for the ecological component of the Reserve. These flows will then have to be augmented from the yield, which will result in a corresponding reduction of the water available for other purposes.

Standardised data base

To ensure compatibility of statistics among water management areas, standard national data bases were used, and standard approaches with regard to aspects such as mean annual runoff, ecological water requirements, water use by afforestation and alien vegetation, and the estimation of irrigation return flows. More accurate information in respect of specific catchments or selected areas may be available from other sources. This should not be viewed as being in conflict with the NWRS, but rather as being representative of a higher level of accuracy to be taken into account in more detailed work that may follow.

Since the information on water availability and water requirements presented in the tables in Chapter 2 this Appendix was derived small changes have been made the boundaries of the some of the water management areas (see Part 5 of Chapter 5 and Appendix E). These changes have insignificant impact on the statistics presented, and any discrepancies will be corrected at the first revision of the NWRS.

Interventions for the reconciliation of requirements and the availability of water

The main options that are available to achieve a balance between the availability of and the requirement for water are described in Section 2.5. The options include water demand management, which in most cases should receive priority, improved resource management and conservation, the increased use of groundwater, the re-use of water; the management of invasive alien vegetation, the re-allocation of water, the development of surface water resources and the inter-catchment transfer of water. Only those interventions that have particular relevance or importance with respect to a specific water management area are highlighted in the subsections that follow.

D1 WATER MANAGEMENT AREA 1: LIMPOPO

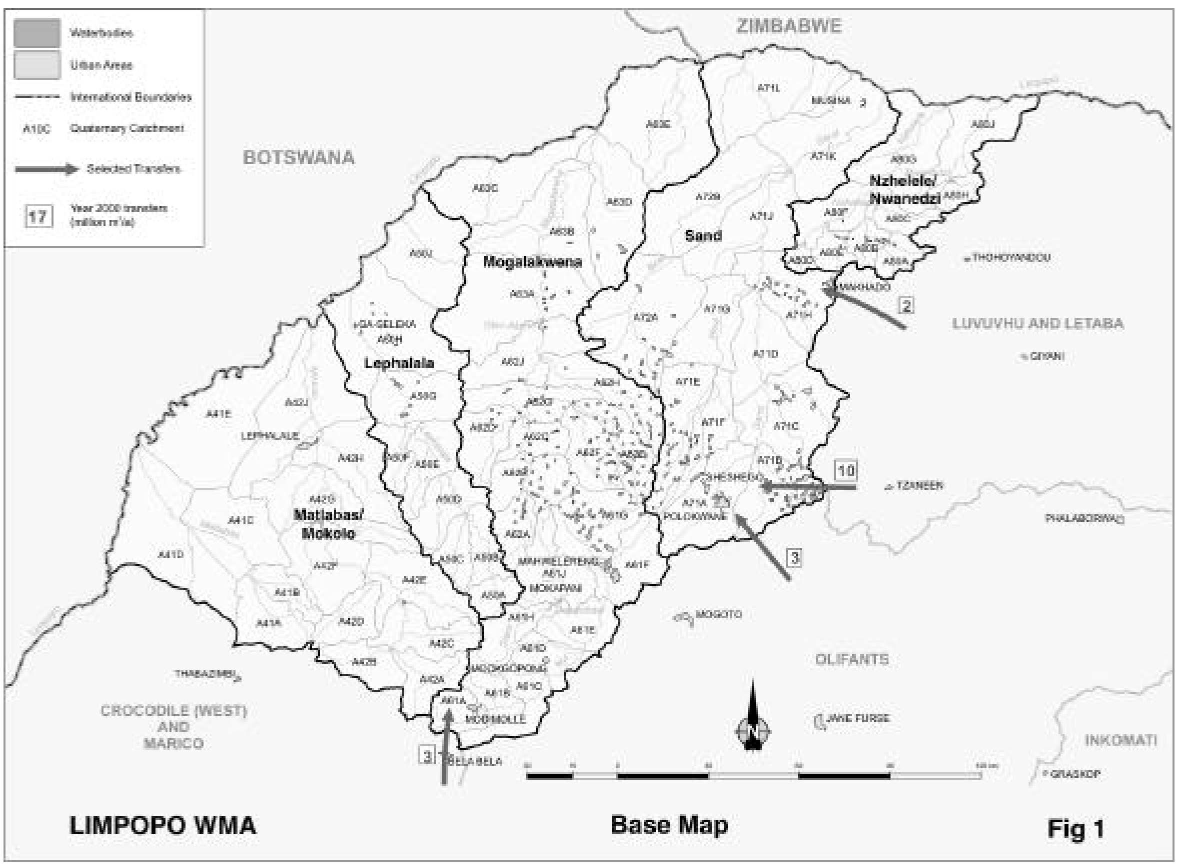
D1.1 Introduction

The Limpopo water management area (see Fig. D1) is the northern-most water management area in the country and represents part of the South African portion of the Limpopo Basin, which is also shared by Botswana, Zimbabwe and Mozambique. The water management area borders on Botswana and Zimbabwe, where the Limpopo River demarcates the entire length of the international boundaries before flowing into Mozambique. The region is semi-arid and the mean annual rainfall ranges from 300 mm to 700 mm over most of the WMA. Economic activity is mainly centred on game, livestock and irrigation farming, while mining activity is increasing. Approximately 200 rural villages are scattered throughout the area, with little local economic activity to support these population concentrations.

Due to the aridity and flatness of the terrain few sites are available for the construction of major dams and the surface water potential has largely been fully developed. Relatively favourable formations for groundwater are found in the area and groundwater is therefore used extensively. However, overexploitation occurs in localised areas. Several inter-water management area water transfers exist, as shown on Fig. D1, all of which bring water into the Limpopo water management area.

Demographic scenarios indicate a small growth in population until 2005 and little change thereafter. Significant growth in water requirements is expected from mining developments in the mineral-rich Bushveld Igneous Complex, which extends across the south-eastern part of the area, while the further exploitation of coal reserves near Ellisras could also increase water requirements. Further growth in economic activity is likely at established urban centres.

Fig. D1: Base map of the Limpopo water management area and its sub-areas



D1.2 Key statistics relevant to the Limpopo water management area

Tables D1.1 to D1.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Limpopo water management area. Data is provided for the South African land area only and is derived primarily from the standardised data base. Different information may be available from other sources.

Table D1.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Matlabas/Mokolo	382	76
Lephalala	150	17
Mogalakwena	269	41
Sand	72	10
Nzhelele/Nwanedzi	113	12
Total for WMA[3]	**986**	**156**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.
3) Total for RSA tributaries to the Limpopo only, excluding the main stream.

Table D1.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk industrial	
Matlabas/Mokolo	35	7	3	1	0	**46**
Lephalala	38	4	0	0	0	**42**
Mogalakwena	50	15	3	4	0	**72**
Sand	10	71	0	10	0	**91**
Nzhelele/Nwanedzi	27	1	2	0	0	**30**
Total for WMA	**160**	**98**	**8**	**15**	**0**	**281**

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

Table D1.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affore-station[4]	Total local require-ments
Matlabas/Mokolo	48	2	2	4	7	0	**63**
Lephalala	39	0	3	0	0	0	**42**
Mogalakwena	56	8	9	6	0	0	**79**
Sand	69	24	9	4	0	0	**106**
Nzhelele/Nwanedzi	26	0	5	0	0	1	**32**
Total for WMA	**238**	**34**	**28**	**14**	**7**	**1**	**322**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D1.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Matlabas/Mokolo	46	0	63	0	**(17)**
Lephalala	42	0	42	0	**0**
Mogalakwena	72	3	79	0	**(4)**
Sand	91	15	106	0	**0**
Nzhelele/Nwanedzi	30	0	32	0	**(2)**
Total for WMA	**281**	**18**	**322**	**0**	**(23)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D 1.5 and D 1.6.

Table D1.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Matlabas/Mokolo	45	0	62	0	**(17)**	0
Lephalala	42	0	43	0	**(1)**	0
Mogalakwena	73	3	101	0	**(25)**	7
Sand	92	15	107	0	**0**	0
Nzhelele/Nwanedzi	29	0	33	0	**(4)**	1
Total for WMA	**281**	**18**	**346**	**0**	**(47)**	**8**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation. A provisional allowance of 20 million m³/a has been made for mining in the Mogalakwena catchment.
3) Brackets around numbers indicate a negative balance.
4) Based on raising the Glen Alpine and Mutshedzi Dams and construction of the Groenvley Dam.

Table D1.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component / Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Matlabas/Mokolo	46	0	64	0	**(18)**	0
Lephalala	42	0	43	0	**(1)**	0
Mogalakwena	76	3	108	0	**(29)**	7
Sand	102	20	130	0	**(8)**	0
Nzhelele/Nwanedzi	29	0	33	0	**(4)**	1
Total for WMA	**295**	**23**	**378**	**0**	**(60)**	**8**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and a high impact of economic development. Assumes no general increase in irrigation. A provisional allowance of 20 million m³/a has been made for mining in the Mogalakwena catchment.
3) Brackets around numbers indicate a negative balance.
4) Based on raising the Glen Alpine and Mutshedzi Dams and construction of the Groenvley Dam.

D1.3 Key elements of the broad strategic perspectives for the Limpopo water management area

Water resources in the Limpopo water management area, although on the verge of stress, are broadly in balance with the area's water requirements. The deficits shown in Table D1.4 are attributable to the provision made for the ecological component of the Reserve. Of the total mean annual runoff of 986 million m^3/a, an estimated 717 million m^3/a on average still reaches the Limpopo River.

With only limited undeveloped resource potential remaining, the primary focus in the water management area should be directed towards more efficient, beneficial and equitable use of the water resources currently available. Some further development of groundwater may be possible, particularly in rural areas to supply basic human needs and for community gardens, but this should be preceded by appropriate investigations of the exploitable potential and be supported by improved management of the resource. New surface resource developments and inter-catchment transfers of water would most likely only be affordable for high value uses. Water to supply current deficits (including the ecological Reserve), as well as for rural development, poverty relief and to redress inequities, will therefore mostly have to be obtained from existing users.

Development of the rich, but largely unexploited mineral deposits of the Bushveld Igneous Complex holds the greatest potential for economic growth in the water management area. Although the timing and extent of development are still uncertain, it is prudent that water be reserved for this purpose. A provisional allowance of 20 million m³/a, an estimate based on current mining use in other areas, has therefore been included under the Mogalakwena sub-area for future mining development in this as well as in the Sand sub-area (refer to Tables D1.5 and D1.6.)

To ensure sufficient future availability of water for mining development and urban/industrial growth, while taking into account the options described in Section 2.5, the following water quantities must be held in reserve for transfer from other water management areas to the Limpopo water management area:

- Water from the Olifants River (Olifantspoort Weir) for transfer to Polokwane, up to the full capacity of the existing pipeline of 5,0 million m³/a – reserved in the Olifants water management area.
- The existing transfer of 18,5 million m³/a maximum capacity to Polokwane from the Ebenezer and Dap Naude Dams in the Luvuvhu and Letaba water management area – reserved in the Luvuvhu and Letaba water management area.
- The existing transfer of 2,4 million m³/a from Albasini Dam in the Luvuvhu and Letaba water management area to Makhado, supplemented by an additional 5 million m³/a from the Luvuvhu River – reserved in the Luvuvhu and Letaba water management area.
- About 45 million m³/a (assumed at half of Sasol II's requirements) of the growth in effluent return flows to the Crocodile River may be required for the development of coal reserves in the Lephalale area. Since considerable uncertainty still surrounds this possibility, this requirement is not included in Tables D1.5 and D1.6, or in Tables D3.5 and D3.6 – reserved in the Crocodile (West) and Marico water management area.
- Water from the development of the Rooipoort Dam on the Olifants River mainly to supply possible new mining-related developments in the Olifants water management area and the Mogoto to Mokopane area as well as for Polokwane. Other developments that could have a negative impact on the Rooipoort development will not be allowed – reserved in the Olifants water management area.
- The development of new dams or large water resource projects will be subject to national authorisation because of their possible impact on neighbouring countries - reservation with respect to the Limpopo water management area.
- Small transfer from the Crocodile (West) and Marico water management area to Modimolle in the Limpopo water management area – reserved in the Crocodile (West) and Marico water management area.

D2 WATER MANAGEMENT AREA 2: LUVUVHU AND LETABA

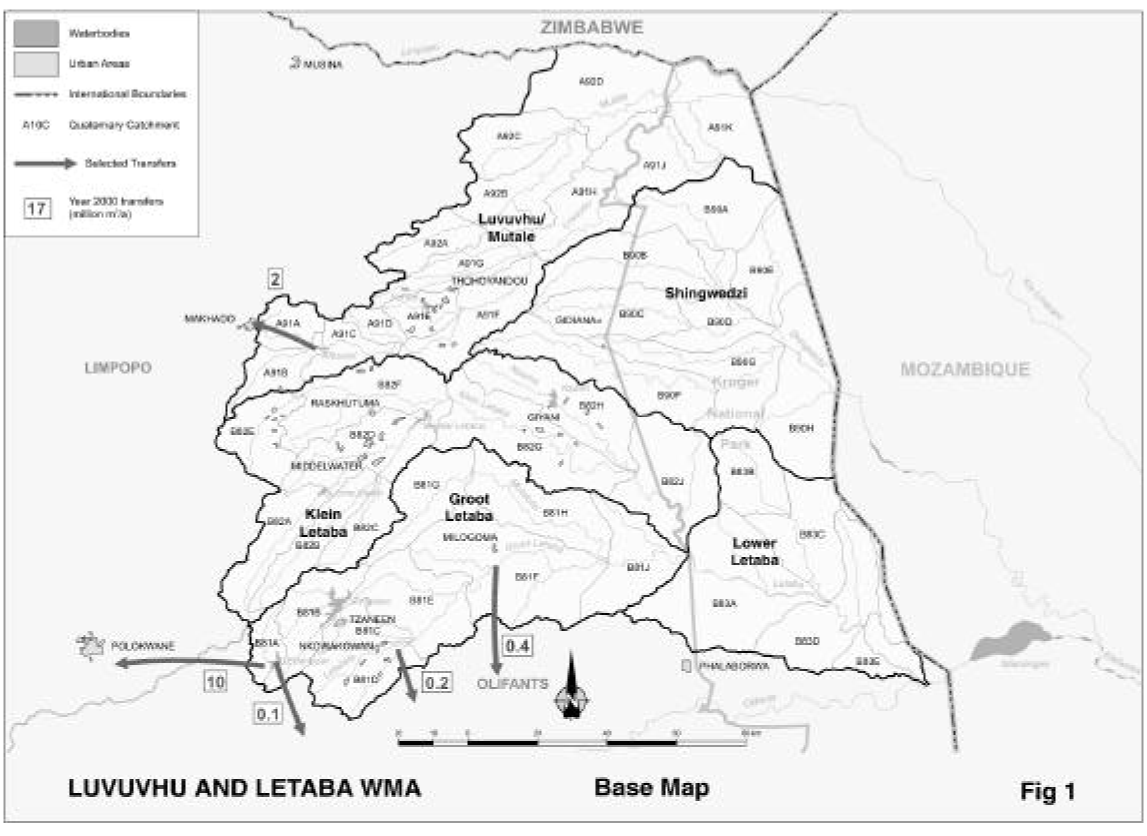
D2.1 Introduction

The Luvuvhu and Letaba water management area lies entirely within the Limpopo Province and borders on Zimbabwe and Mozambique. It forms part of the Limpopo Basin, which is shared by South Africa, Botswana, Zimbabwe and Mozambique. While the Luvuvhu River is a direct tributary of the Limpopo River, the Shingwedzi and Letaba Rivers flow into the Olifants River, which is a tributary of the Limpopo. A unique feature of this water management area is the Kruger National Park along its eastern boundary, which occupies approximately 35 per cent of the area and through which all the main rivers flow into Mozambique, as shown in Fig. D2. Due to the topography, rainfall varies from well over 1 000 mm/a to less than 300 mm/a. Economic activity is characterised by irrigation, afforestation, tourism and informal farming. Over 90 per cent of the area's population of about 1.5 million live in rural communities.

Surface water mainly originates in the mountainous areas and is regulated by several dams in the upper and middle reaches of the rivers. The Nandoni Dam is under construction on the Luvuvhu River and other sites have been identified as being feasible for the construction of dams in the future. Groundwater is utilised extensively and limited potential remains for further development. Significant over-exploitation of groundwater occurs in parts of the water management area, particularly near Albasini Dam and in the vicinity of Thohoyandou. Water transfers occur from this water management area to both neighbouring water management areas and some inter-catchment transfers within the water management area also take place.

Current expectations are that population growth in the area will be moderate, probably at less than 0,8 per cent per annum. New mining developments are foreseen in the Tzaneen/Gravelotte area and coal mining could possibly commence near Tshikondeni. A water allocation has been reserved from Nandoni Dam for the irrigation of 1 100 ha of farmland to be set aside for the purposes of rural development and poverty relief. It is doubtful whether any further expansion of irrigation will be economically viable. No dramatic growth in future water requirements is therefore expected, with the possible exception of developments related to mining.

Fig. D2: Base map of the Luvuvhu and Letaba water management area



D2.2 Key statistics relevant to the Luvuvhu and Letaba water management area

Tables D2.1 to 2.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Luvuvhu and Letaba water management area. The data is primarily derived from the standardised database and different information may be available from other sources.

Table D2.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Luvuvhu/Mutale	520	105
Shingwedzi	90	14
Groot Letaba	382	72
Klein Letaba	151	20
Lower Letaba	42	13
Total for WMA	**1 185**	**224**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with the impact on yield being a portion of this.

Table D2.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Luvuvhu/Mutale	88	20	5	2	0	**115**
Shingwedzi	1	2	0	0	0	**3**
Groot Letaba	133	12	13	1	0	**159**
Klein Letaba	21	9	1	1	0	**32**
Lower Letaba	1	0	0	0	0	**1**
Total for WMA	**244**	**43**	**19**	**4**	**0**	**310**

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

Table D2.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local requirements
Luvuvhu/Mutale	97	4	10	1	0	7	**119**
Shingwedzi	0	0	3	0	0	0	**3**
Groot Letaba	126	3	10	0	0	35	**174**
Klein Letaba	25	3	8	0	0	1	**37**
Lower Letaba	0	0	0	0	0	0	**0**
Total for WMA	**248**	**10**	**31**	**1**	**0**	**43**	**333**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D2.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers In[2]	Local requirements	Transfers out[2]	Balance[1]
Luvuvhu/Mutale	115	0	119	2	**(6)**
Shingwedzi	3	0	3	0	**0**
Groot Letaba	159	0	174	11	**(26)**
Klein Letaba	32	0	37	0	**(5)**
Lower Letaba	1	0	0	0	**1**
Total for WMA	**310**	**0**	**333**	**13**	**(36)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The 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 D2.5 and D2.6.

Table D2.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements [2]	Transfers out	Balance (3)	Potential for develop-ment[4]
Luvuvhu/Mutale	208	0	129	2	**77**	60
Shingwedzi	3	0	3	0	**0**	0
Groot Letaba	160	0	177	11	**(28)**	42
Klein Letaba	32	0	39	0	**(7)**	0
Lower Letaba	1	0	0	0	**1**	0
Total for WMA	**404**	**0**	**348**	**13**	**43**	**102**

1) Based on existing infrastructure and infrastructure under construction in the year 2000 (Nandoni Dam). Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Irrigation of an additional 1100 ha from the Nandoni Dam has been allowed for in the Luvuvhu/Mutale sub-area. .
3) Brackets around numbers indicate a negative balance.
4) Based on raising the Tzaneen Dam, construction of the Nwamitwa Dam and the possible construction of a dam on the Mutale River.

Table D2.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Luvuvhu/Mutale	208	0	129	2	**77**	60
Shingwedzi	3	0	3	0	**0**	0
Groot Letaba	161	0	179	11	**(29)**	42
Klein Letaba	33	0	39	0	**(6)**	0
Lower Letaba	1	0	0	0	**1**	0
Total for WMA	**406**	**0**	**350**	**13**	**43**	**102**

1) Based on existing infrastructure and infrastructure under construction in the year 2000 (Nandoni Dam). Also includes return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development. Irrigation of an additional 1100 ha from the Nandoni Dam has been allowed for in the Luvuvhu/Mutale sub-area.
3) Brackets around numbers indicate a negative balance.
4) Based on raising the Tzaneen Dam, construction of the Nwamitwa Dam and the possible construction of a dam on the Mutale River.

D2.3 Key elements of the broad strategic perspectives for the Luvuvhu and Letaba water management area

From Table D2.4 it is evident that there is no surplus yield available in the water management area and that an over-commitment of resources is shown to occur. This is mainly attributable to the provision made for the future implementation of the ecological component of the Reserve. The deficits in parts of the water management area will be relieved once the Nandoni Dam is commissioned. A surplus will then exist downstream of the dam, part of which is intended for use by emerging farmers. Of the mean annual runoff of 1 185 million m^3/a originating in the water management area, an estimated 790 million m^3/a on average still flows into Mozambique.

With due consideration for the options described in Section 2.5, the general perspective is that current shortfalls and the future growth in requirements will be supplied from water freed up as a result of water demand management and the re-allocation of irrigation water. Some further development of groundwater may be possible, but this should be preceded by appropriate investigations of the exploitable potential and be supported by improved management of the resource. Options also exist for the raising of Tzaneen Dam and construction of the proposed nWamitwa Dam. However, the construction of new dams will probably only be affordable for high-value uses, such as mining and related developments, and under certain conditions for irrigation. Water for poverty relief and rural development should be re-allocated from existing irrigation.

Implementation of the Reserve is of special importance with respect to the Kruger National Park and priority should be given to implementation planning. Provision for the Reserve should preferably be incorporated into the planning of possible future developments, thereby minimising the socio-economic impact.

The following reservations with respect to developments and water resources will apply to the Luvuvhu and Letaba water management area:

- Development of all new dams or large water resource projects will be subject to national authorisation because of possible impacts on Mozambique.
- Water reserved in the Luvuvhu and Letaba water management area for transfer to users in neighbouring water management areas:
  - The existing transfer of 2.4 million m^3/a from the Albasini Dam to Makhado in the Limpopo water management area.
  - An additional 5 million m^3/a to be reserved from either the Albasini or the Nandoni Dam for possible transfer to Makhado in the Limpopo water management area.
  - A maximum of 18.5 million m^3/a per year to be available from the Ebenezer and Dap Naude Dams for transfer to Polokwane in the Limpopo water management area. (Existing)
  - Existing transfers of approximately 0.7 million m^3/a from the Groot Letaba River to Gravelotte and other users in the Olifants water management area.

D3 WATER MANAGEMENT AREA 3: CROCODILE (WEST) AND MARICO

D3.1 Introduction

The Crocodile (West) and Marico water management area borders on Botswana to the north-west. Its main rivers, the Crocodile and Marico, give rise to the Limpopo River at their confluence. The climate is generally semi-arid, with the mean annual rainfall ranging from 400 mm to 800 mm. Extensive irrigation development occurs along the main rivers, with grain, livestock and game farming in other parts. A general orientation is given by Fig. D3.

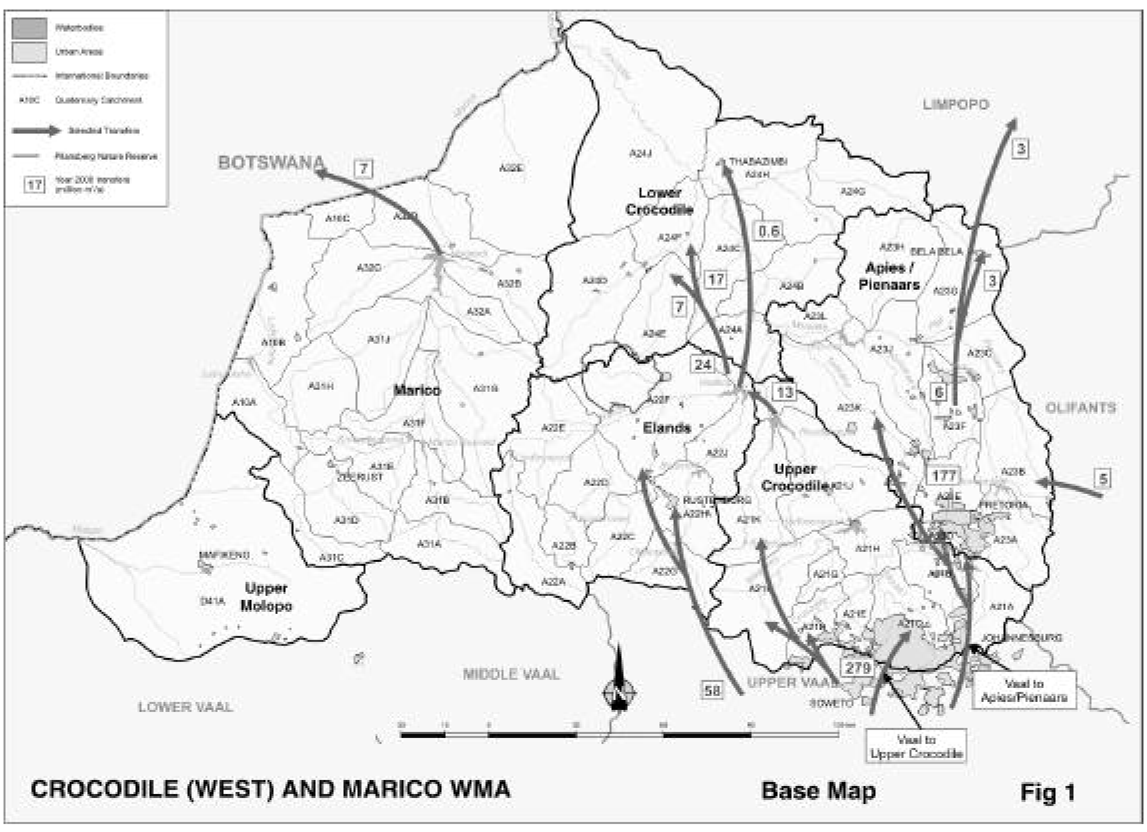
Economic activity in the water management area is dominated by the urban and industrial complexes of northern Johannesburg and Pretoria and platinum mining north-east of Rustenburg. It is the second most populous water management area in the country and has the largest proportionate contribution to the national economy.

Development and utilisation of surface water occurring naturally in the water management area has reached its full potential. Large dolomitic groundwater aquifers occur along the southern part of the area, which is the reason for part of the Upper Molopo River catchment being incorporated into the area. The aquifers are utilised extensively for urban and irrigation purposes. Localised over-exploitation of groundwater occurs in the Molopo area. Some aquifers also underlie the border with Botswana and are shared with that country. A substantial portion of the water used in the water management area is transferred from the Vaal River and further afield. Small transfers out of the water management area are to Gabarone in Botswana and to Modimolle in the Limpopo water management area.

Increasing quantities of effluent return flow from urban and industrial areas offer considerable potential for re-use, but the effluent is at the same time a major cause of pollution in some rivers.

Population and economic growth, centred on the Johannesburg-Pretoria metropolitan complex and mining developments, are expected to continue strongly in this area. Little change is foreseen in population and economic development in rural areas.

Fig. D3: Base map of the Crocodile (West) and Marico water management area



D3.2 Key statistics relevant to the Crocodile (West) and Marico water management area

Tables D 3.1 to 3.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Crocodile (West) and Marico water management area. The data is primarily derived from the standardised data base. Different information may be available from other sources.

Table D3.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Apies/Pienaars	142	34
Upper Crocodile	253	57
Elands	113	15
Lower Crocodile	138	25
Marico	172	29
Upper Molopo	37	4
Total for WMA	**855**	**164**

1) Quantities are incremental and refer only to the sub-area under consideration.
2) The total volume is based on preliminary estimates, with the impact on yield being a portion of this.

Table D3.2: Available water in year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Apies/Pienaars	38	36	4	106	2	**186**
Upper Crocodile	111	31	21	158	15	**336**
Elands	30	29	3	10	14	**86**
Lower Crocodile	7	29	14	1	8	**59**
Marico	14	12	2	3	1	**32**
Upper Molopo	3	9	0	5	2	**19**
Total for WMA	**203**	**146**	**44**	**283**	**42**	**718**

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

Table D3.3: Year 2000 water requirements (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation[4]	Total local requirements
Apies/Pienaars	41	211	7	6	15	0	**280**
Upper Crocodile	208	292	5	38	13	0	**556**
Elands	32	23	10	48	0	0	**113**
Lower Crocodile	137	3	3	28	0	0	**171**
Marico	24	5	9	2	0	0	**40**
Upper Molopo	3	13	3	5	0	0	**24**
Total for WMA	**445**	**547**	**37**	**127**	**28**	**0**	**1 184**

1) Includes Reserve component for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D3.4: Reconciliation of water requirements and available water for year 2000 (million m³/a)

Component/ Sub-area	Local Yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Apies/Pienaars	186	182	280	87	**1**
Upper Crocodile	336	279	556	17	**42**
Elands	86	71	113	24	**20**
Lower Crocodile	59	112	171	0	**0**
Marico	32	0	40	7	**(15)**
Upper Molopo	19	0	24	0	**(5)**
Total for WMA	**718**	**519**	**1 184**	**10**	**43**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the transfers per sub-area therefore does not necessarily correspond to the total of transfers into and out of the WMA. The same applies to Tables D3.5 and D3.6.

Table D3.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Apies/Pienaars	244	287	399	92	**40**	0
Upper Crocodile	399	382	673	13	**95**	0
Elands	90	71	124	24	**13**	0
Lower Crocodile	59	113	173	0	**(1)**	0
Marico	32	0	40	7	**(15)**	0
Upper Molopo	22	0	29	0	**(7)**	0
Total for WMA	**846**	**727**	**1 438**	**10**	**125**	**0**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements. It is assumed that water will be transferred into Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal water management area to meet the anticipated growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate negative balance.
4) No significant potential for the further development of local resources.

Table D3.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component / Sub-area	Local yield[1]	Transfers In	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Apies/Pienaars	360	517	630	95	**152**	0
Upper Crocodile	511	584	880	13	**202**	0
Elands	97	71	141	24	**3**	0
Lower Crocodile	62	116	179	0	**(1)**	0
Marico	33	0	42	7	**(16)**	0
Upper Molopo	21	0	27	0	**(6)**	0
Total for WMA	**1 084**	**1 159**	**1 899**	**10**	**334**	**0**

1) Based on existing infrastructure and infrastructure under construction in the year 2000 and includes return flows resulting from the growth in requirements. It is assumed that water to meet the anticipated growth in water requirements will be transferred into Apies/Pienaars and Upper Crocodile sub-areas from the Upper Vaal water management area.
2) Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) There is no significant potential for the further development of local resources.

D3.3 Key elements of the broad strategic perspectives for the Crocodile (West) and Marico water management area

The key considerations for the Crocodile (West) and Marico water management area are that its own water resources are already fully utilised, the importance of transfers and return flows in the water balance, and the continued strong growth expectations in the Pretoria-Johannesburg and the Platinum Belt regions. Inherently these factors will impact on flows and water quality along the Crocodile River and also on South Africa's international obligations. Compared to the natural mean annual runoff of 855 million

m^3/a that originates in the water management area, an estimated 549 million m^3/a still flows out of the area, 96 per cent to the Limpopo River.

Important considerations that will have to receive attention are the optimal use of return flows, the maintenance of an optimal balance between the urban re-use of return flows and transfers of water into the water management area, and water quality management. Water demand management, combined with the other options for the reconciliation of requirements and the availability of water, as described under Section 2.5, should receive due consideration. After that, growth in requirements in the Pretoria-Johannesburg area will mainly have to be supplied from transfers, while growth in the Elands and Lower Crocodile sub-areas can largely be supplied from increasing return flows. Much of the requirements of the ecological component of the Reserve can also be supplied from return flows, although intervention may be required to ensure the appropriate temporal distribution of flows.

The following reservations will apply with respect to the Crocodile (West) and Marico water management area:

- An additional 220 million m^3/a will have to be transferred from the Upper Vaal and water management areas beyond to the Pretoria-Johannesburg area in future. As an upper high-growth scenario, up to 750 million m^3/a may be required – reserved in the Upper Vaal water management area.
- Surplus effluent return flows that become available are to be reserved in the Crocodile (West) and Marico water management area for the following priorities:
  - Re-use for urban, industrial and mining purposes where this will feasibly contribute to reducing transfers into the water management area.
  - About 45 million m^3/a may be required for developments in the Lephalale area in the Limpopo water management area. This quantity is not included in Tables D3.5 and D3.6.
  - Small quantities may be required to augment supplies in the Limpopo and Olifants water management areas.
- The transfer of about 7 million m^3/a from the Molatedi Dam to Gabarone in Botswana – reserved in the Crocodile (West) and Marico water management area.
- Continuation of small transfers from the Olifants to the Crocodile (West) and Marico water management area, as well as from the Crocodile (West) and Marico to the Limpopo water management area – reserved in the Olifants, and Crocodile (West) and Marico water management areas respectively.
- Water resource developments that may negatively influence the flow of water towards neighbouring countries will be subject to national authorisation – reservation with respect to Crocodile (West) and Marico water management area.

D4 WATER MANAGEMENT AREA 4: OLIFANTS

D4.1 Introduction

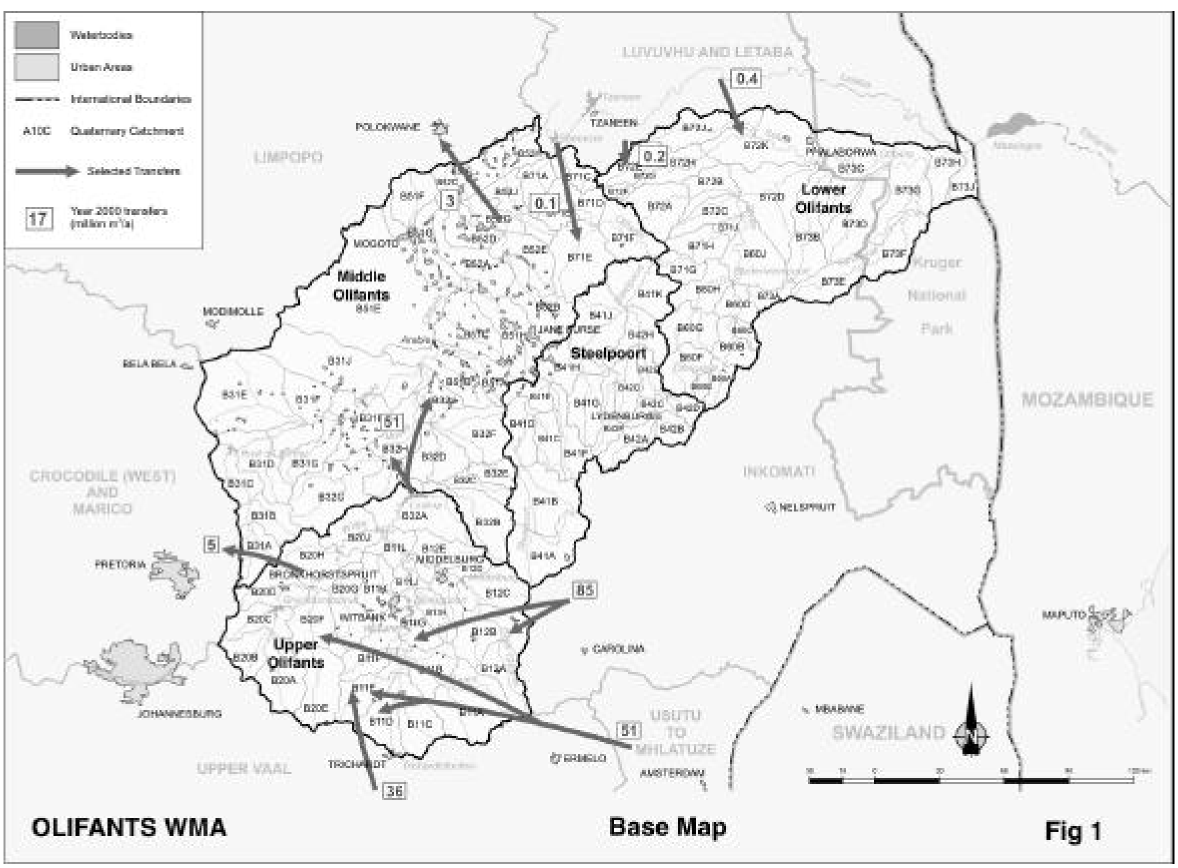
The Olifants River originates to the east of Johannesburg and initially flows northwards before gently curving eastwards towards the Kruger National Park (KNP), where it is joined by the Letaba River before flowing into Mozambique. As shown on Fig. D4, the Olifants water management area corresponds with the South African portion of the Olifants River catchment, excluding the Letaba River catchment, which is a tributary catchment to the Limpopo Basin shared by South Africa, Botswana, Zimbabwe and Mozambique. Distinct differences in climate occur; from cool Highveld in the south to subtropical east of the escarpment. Mean annual rainfall is in the range of 500 mm to 800 mm over most of the WMA.

Economic activity is highly diverse and ranges from mining and metallurgic industries to irrigation, dry land and subsistence agriculture, and eco-tourism. With one of the main rivers, the Olifants, flowing through the KNP, which is located at the downstream extremity of the water management area, the provision of water to meet ecological requirements is one of the controlling factors in the management of water resources throughout the water management area.

Most surface runoff originates from the higher rainfall southern and mountainous areas and is controlled by several large dams. The most promising options identified for the further development of surface water resources are the raising of Flag Boshielo Dam, the construction of a new dam at Rooipoort on the middle Olifants River and a dam on the Steelpoort River.

Large quantities of groundwater are abstracted for irrigation in the north-west of the water management area, as well as for rural water supplies throughout most of the area. Potential for increased groundwater utilisation has been identified on the Nebo Plateau north-east of Groblersdal. Substantial amounts of water are transferred into the water management area as cooling water for power generation, while smaller transfers are made to neighbouring water management areas.

Fig D4: Base map of the Olifants water management area



The scenarios for population growth show little if any increase in the rural areas beyond 2025. Economic growth and population increases are expected to be centred on the main industrial and mining towns of Witbank, Middelburg and Phalaborwa, as well as at new mining developments foreseen along the eastern limb of the Bushveld Igneous Complex in the Mogoto/Steelpoort area. Water requirements for power generation in the upper Olifants sub-area are also expected to increase. Water for mining developments in the Mokopane area (Limpopo water management area) may have to be supplied from the Olifants River.

D4.2 Key statistics relevant to the Olifants water management area

Tables D4.1 to D4.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Olifants water management area. Data is primarily derived from the standardised data base. Different information may be available from other sources.

Table D4.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR	Ecological Reserve[1]
Upper Olifants	465	83
Middle Olifants	481	69
Steelpoort	396	94
Lower Olifants	698	214
Total for WMA	**2 040**	**460**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D4.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Upper Olifants	194	4	2	34	4	**238**
Middle Olifants	100	70	34	5	1	**210**
Steelpoort	42	14	3	1	1	**61**
Lower Olifants	74	11	5	2	8	**100**
Total for WMA	**410**	**99**	**44**	**42**	**14**	**609**

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

Table D4.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation[4]	Total local requirements
Upper Olifants	44	62	6	20	181	1	**314**
Middle Olifants	336	15	28	13	0	0	**392**
Steelpoort	69	3	5	17	0	1	**95**
Lower Olifants	108	7	5	43	0	1	**164**
Total for WMA	**557**	**87**	**44**	**93**	**181**	**3**	**965**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower is generally available for other uses as well.)
4) Quantities refer to the impact on yield only.

Table D4.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Upper Olifants	238	171	314	96	**(1)**
Middle Olifants	210	91	392	3	**(94)**
Steelpoort	61	0	95	0	**(34)**
Lower Olifants	100	1	164	0	**(63)**
Total for WMA	**609**	**172**	**965**	**8**	**(192)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D4.5 and D4.6.

Table D4.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Upper Olifants	256	209	383	82	**0**	0
Middle Olifants	212	77	430	2	**(143)**	152
Steelpoort	62	0	96	0	**(34)**	87
Lower Olifants	100	1	165	0	**(64)**	0
Total for WMA	**630**	**210**	**1 074**	**7**	**(241)**	**239**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development, including an additional 25 million m³/a required for mining in the Middle Olifants sub-area. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the raising of the Flag Boshielo Dam and construction of the Rooipoort and De Hoop Dams.

Table D4.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out[5]	Balance[3]	Potential for develop-ment[4]
Upper Olifants	287	209	439	57	**0**	0
Middle Olifants	213	52	433	8	**(176)**	152
Steelpoort	63	0	98	0	**(35)**	87
Lower Olifants	102	1	171	0	**(68)**	0
Total for WMA	**665**	**210**	**1 141**	**13**	**(279)**	**239**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development, including an additional 25 million m³/a required for mining in the Middle Olifants sub-area. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the raising of the Flag Boshielo Dam and construction of Rooipoort and De Hoop Dams.
5) Not including possible future transfers to the Limpopo WMA for Polokwane and Mokopane as described below.

D4.3 Key elements of the broad strategic perspectives for the Olifants water management area

From the reconciliation in Table D4.4, deficits are apparent along the whole of the Olifants River, except for the upstream reaches. This is attributable to the provision for the ecological component of the Reserve, without which the system could generally be regarded as being in balance. Savings of approximately 20 per cent will be required to meet current shortfalls and provide for the ecological component of the Reserve. To meet these requirements, water will therefore need to be freed up by means of compulsory licensing and supporting measures such as water demand management. Judicious assessment of the Reserve together with careful implementation planning to minimise possible social disruption will be required. Of the total mean annual runoff of 2 040 million m^3/a, an estimated average of 1 137 million m^3/a still flows into Mozambique.

Water quality is highly impacted upon by coal mining in the Upper Olifants sub-area. Special remedial measures have been implemented to control the discharge of mine leachate and wash-off to within the assimilative capacity of the natural streams. Priority attention will continue to be needed to contain pollution from mines, also after the discontinuation of operations.

Further resource development through the construction of new infrastructure will be very expensive and is unlikely to be affordable by irrigation farming. Water for irrigation as a means of rural development and poverty relief will therefore have to be sourced largely through re-allocation from existing users. With water resources in the Upper Olifants already fully developed and utilised, a growth in power generation requirements will have to be provided for by increased transfers of water.

Water for new mining development in the Middle Olifants and Steelpoort sub-areas (reflected in the tables under the Middle Olifants) can be provided by raising the Flag Boshielo Dam, the construction of a dam on the Steelpoort River, or from the proposed Rooipoort Dam.

With due consideration of the options available for reconciling the requirements for and the availability of water, as described in Section 2.5, the following reservations will apply with respect to the Olifants water management area:

- Water from the Rooipoort Dam to be developed in the main stem of the Olifants River is to be reserved in the Olifants water management area primarily for supplying future mining developments within the water management area and for possible transfers to Polokwane and Mokopane in the Limpopo water management area. Water resource developments elsewhere in the catchment that could have a significant negative impact on this will not be permitted.

- Similar reservation will apply with regard to a large dam to be constructed on the Steelpoort River, possibly at De Hoop, in the Olifants water management area.
- Currently, 172 million m³/a of water is transferred from the Inkomati, Usutu to Mhlatuze and Upper Vaal water management areas to the Olifants water management area for strategic use in power generation. A further 38 million m³/a is to be reserved in the Upper Vaal water management area for this purpose. The Upper Vaal water management area will in turn source this water from other water management areas. Details of the reservations are given in the descriptions of the relevant source water management areas.
- The transfer of water from the Olifantspoort Weir to Polokwane in the Limpopo water management area at the maximum pipeline capacity of 5.0 million m³/a.– reserved in the Olifants water management area.
- The existing water transfer from the Wilge tributary of the Olifants River to Cullinan and Premier Diamond Mine in the Crocodile (West) and Marico water management area – reserved in the Olifants water management area.
- The existing water transfer from the Letaba River in the Luvuvhu and Letaba water management area to users in the Olifants water management area – reserved in the Luvuvhu and Letaba water management area.
- All water resource developments that could have a possible impact on Mozambique will be subject to national authorisation – reservation applicable to Olifants water management area.

D5 WATER MANAGEMENT AREA 5: INKOMATI

D5.1 Introduction

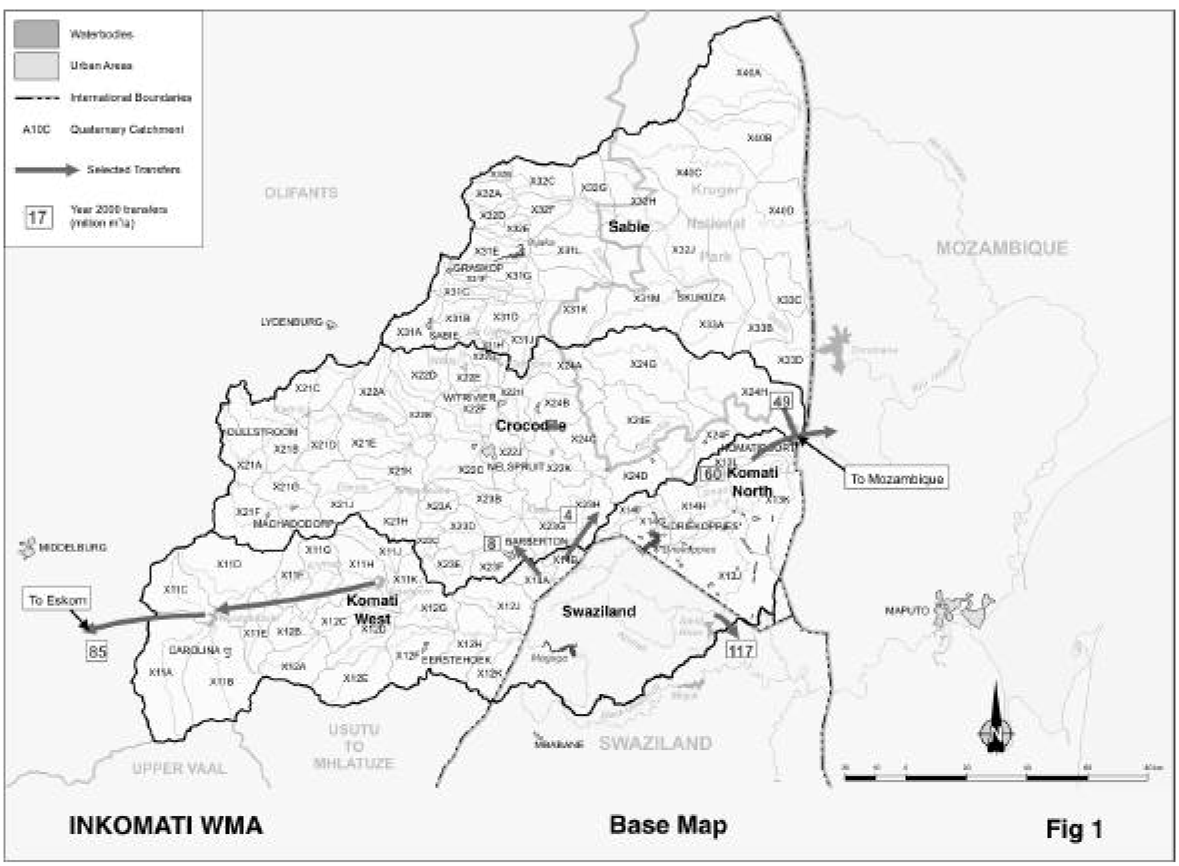
The Inkomati water management area is situated in the north-eastern part of South Africa and borders on Mozambique and Swaziland. As shown on Fig. D5, all the rivers from this area flow through Mozambique to the Indian Ocean. The Komati River flows into Swaziland and re-enters South Africa before flowing into Mozambique. Topographically the water management area is divided by the escarpment into a plateau in the west and a subtropical Lowveld in the east. Annual rainfall varies from close to 1 500 mm in the mountains to 400 mm in the lower-lying areas.

Economic activity is mainly centred on irrigation and afforestation, with related industries and commerce, and a strong eco-tourism industry. A key feature of the water management area is the renowned Kruger National Park. The Sabie River, which flows through the park, is ecologically one of the most important rivers in South Africa, while the Crocodile River forms the park's southern boundary.

Dams have been constructed on all the main rivers or their tributaries, and surface water resources in the water management area are generally well regulated. An important feature is the joint management by South Africa and Swaziland of part of the water resources of the Komati River by the Komati Basin Water Authority (KOBWA). Potential for further water resource development exists in the Kaap tributary of the Crocodile River, the Komati River and the Sand tributary of the Sabie River, although such development will probably only be feasible for domestic and high value uses. Because of the well-watered nature of most of the area, groundwater utilisation is relatively small. Most of the present yield from the Komati River west of Swaziland is transferred to the Olifants water management area for power generation.

Future population growth in the area is expected to be moderate and to be concentrated in the urbanised areas. In some rural areas the population could decline. With about 90 per cent of total water requirements within the water management area being utilised by the irrigation and forestry sectors, only a small natural growth in overall water requirements is foreseen.

Fig. D5: Base map of the Inkomati water management area



D5.2 Key statistics relevant to the Inkomati water management area

Tables D5.1 to D5.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Inkomati water management area. Although the water management area is restricted to South Africa, information is included for Swaziland to provide a more comprehensive perspective. The data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D5.1: Natural mean annual runoff and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Komati (W Swazi)	749	239
Swaziland[3]	517	100
Komati (N Swazi)	130	25
Crocodile	1 277	328
Sabie[4]	866	316
Total for WMA	**3 539**	**1 008**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, impact on yield being a portion of this.
3) Includes the Komati and Lomati catchments in Swaziland.
4) Includes the Uanetse and Mássintonto catchments in South Africa.

Table D5.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Komati (W Swazi)	116	1	0	1	0	**118**
Swaziland	183	1	1	0	0	**185**
Komati (N Swazi)	228	2	21	0	1	**252**
Crocodile	202	2	26	6	10	**246**
Sabie	87	3	5	0	0	**95**
Total for WMA	**816**	**9**	**53**	**7**	**11**	**896**

1) After allowance for the impacts on yield of the ecological component of Reserve, river losses, alien vegetation, rain-fed sugar cane and urban runoff. Includes Driekoppies Dam, but not the soon-to-be completed Maguga Dam.

Table D5.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Komati (W Swazi)	21	2	4	0	0	38	**65**
Swaziland	35	1	6	0	0	25	**67**
Komati (N Swazi)	215	3	6	1	0	7	**232**
Crocodile	257	35	7	23	0	42	**364**
Sabie	65	22	4	0	0	26	**117**
Total for WMA	**593**	**63**	**27**	**24**	**0**	**138**	**845**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 only refer to the impact on yield.

Table D5.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers In[2]	Local requirements	Transfers out[2]	Balance[1]
Komati (W Swazi)	118	0	65	97	**(44)**
Swaziland	185	0	67	117	**1**
Komati (N Swazi)	252	0	232	60	**(40)**
Crocodile	246	12	364	49	**(155)**
Sabie	95	0	117	0	**(22)**
Total for WMA	**896**	**0**	**845**	**311**	**(260)**

1) Brackets around numbers indicate a negative balance.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D5.5 and D5.6.

Table D5.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Komati (W Swazi)	118	0	64	97	**(43)**	40
Swaziland	250	0	95	156	**(1)**	0
Komati (N Swazi)	252	39	233	60	**(2)**	0
Crocodile	249	12	381	49	**(169)**	64
Sabie	159	0	141	0	**18**	0
Total for WMA	**1 028**	**0**	**914**	**311**	**(197)**	**104**

1) Based on existing infrastructure and infrastructure under construction in the year 2000, including the Maguga and Inyaka Dams. Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the construction of Boekenhoutrand and Mountain View Dams.

Table D5.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Komati (W Swazi)	119	0	67	97	**(45)**	40
Swaziland	250	0	95	156	**(1)**	0
Komati (N Swazi)	252	39	233	60	**(2)**	0
Crocodile	256	12	423	49	**(204)**	64
Sabie	159	0	139	0	**20**	0
Total for WMA	**1 036**	**0**	**957**	**311**	**(232)**	**104**

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

D5.3 Key elements of the broad strategic perspectives for the Inkomati water management area

Of primary importance for the Inkomati water management area is the implementation of the Reserve and the release of minimum flows to Mozambique. Of the total mean annual runoff of 3 539 million m³/a that originates in the water management area and the Swaziland portion of the Komati River catchment, an estimated 1 857 million m³/a on average currently flows into Mozambique.

According to an agreement between South Africa, Swaziland and Mozambique, the first two are obliged to release a minimum flow of 109 million m³/a to Mozambique at Komatipoort (55 per cent from the Komati River and 45 per cent from the Crocodile River). Water requirements in South Africa have, however, grown to the extent that the total available yield from these rivers could be absorbed by local requirements. The deficits reflected in Table D5.4 are therefore about equal to the requirements of the ecological component of the Reserve and the obligations to Mozambique. No quantitative agreements exist for the other rivers shared with Mozambique.

The bulk of water use in the water management area is for irrigation and afforestation, and the expectation is that new resource development is likely to be too costly for the expansion of these uses. It is evident that, with due consideration of the available options for reconciling the requirements for and availability of water as described under Section 2.5, compulsory licensing will have to be applied to reapportion water use in the water management area. This is to be preceded by the detailed determination and careful assessment of the requirements for the ecological component of the Reserve.

The following reservations and national authorisations apply to the Komati water management area:

- The transfer of water to the Olifants water management area for power generation at the current capacity of approximately 100 million m³/a. The treaty between South Africa and Swaziland accommodates a transfer of 132 million m³/a out of the catchment, which must be reserved in the Komati water management area.
- Water supplied to South Africa by the Komati Basin Water Authority, which includes releases for environmental purposes – reserved by international agreement for use in the Komati water management area.
- Water to be released to Mozambique to honour international commitments. This currently amounts to 109 million m³/a – reserved in the Komati water management area.
- All water resource developments that may impact on neighbouring countries will be subject to national authorisation – reservation applies to the Komati water management area.

D6 WATER MANAGEMENT AREA 6: USUTU TO MHLATUZE

D6.1 Introduction

The Usutu to Mhlatuze water management area falls predominantly within northern KwaZulu-Natal with a part in Mpumalanga, and bordering on Swaziland and Mozambique (refer to Fig. D6). Two rivers are shared with these countries. The Usutu River has its headwaters in South Africa and flows into Swaziland, while part of the Pongola River catchment lies in Swaziland. The two rivers flow together in South Africa just before entering Mozambique as the Maputo River. Climate in the region can be described as subhumid to humid, but varies considerably. Mean annual rainfall ranges between 600 mm and 1 500 mm. Economic activity is diverse and includes rain fed and subsistence farming, irrigation, afforestation, eco-tourism, and heavy industries in the Richards Bay/Empangeni area. Water resources in the Upper Usutu, Mkuze and Mhlatuze catchments have been well developed, while undeveloped potential exists in the Pongola and Mfolozi catchments. Ground water utilisation in most parts of the water management area is relatively small, and can thus be developed further.

Fig D6: Base map of the Usutu to Mhlatuze water management area

Strong interdependencies between surface and groundwater occur in many areas, with groundwater levels, together with surface flows, being particularly important to water balances in the ecologically sensitive coastal lakes and wetlands, some of which are internationally recognised conservation areas. Large quantities of water are transferred from the Upper Usutu to the Upper Vaal and Upper Olifants water management areas, and transfers are also made from the Thukela water management area to the Mhlatuze sub-area.

The expectations are that little change will occur in the overall population in the water management area within the period under consideration. A decline in rural population will likely be balanced by a growth in urbanisation in the Richards Bay/Empangeni area. Growth in water requirements will be dictated by the level of industrial activity in the Richards Bay area, which is difficult to estimate.

D6.2 Key statistics relevant to the Usutu to Mhlatuze water management area

Tables D6.1 to D6.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Usutu to Mhlatuze water management area.

In contrast to the situation for the Komati River, little information is available concerning the portions of the Usutu and Pongola Rivers within Swaziland. No statistics in respect of Swaziland other than the mean annual runoff are therefore provided in the tables. The data is derived primarily from the standardised data base and different information may be available from other sources.

Table D6.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Upper Usutu[3]	901	328
Pongola[4]	1 344	200
Mkuze	635	218
Mfolozi	962	275
Mhlatuze	938	171
Total for WMA	**4 780**	**1 192**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.
3) Excludes the Usutu River in Swaziland (MAR = 1 320 million m³/a).
4) Includes the Pongola and Ngwavuma Rivers in Swaziland (MAR = 213 million m³/a).

Table D6.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Upper Usutu	196	2	1	3	0	**202**
Pongola	616	8	21	0	0	**645**
Mkuze	15	12	6	0	0	**33**
Mfolozi	36	5	5	4	1	**51**
Mhlatuze	156	12	9	2	0	**179**
Total for WMA	**1 019**	**39**	**42**	**9**	**1**	**1 110**

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

Table D6.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affore-station[4]	Total local require-ments
Upper Usutu	13	8	5	0	0	43	**69**
Pongola	213	1	6	1	0	34	**255**
Mkuze	61	1	10	0	0	6	**78**
Mfolozi	51	12	11	4	0	2	**80**
Mhlatuze	94	28	8	86	0	19	**235**
Total for WMA	**432**	**50**	**40**	**91**	**0**	**104**	**717**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D6.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Upper Usutu	202	0	69	114	**19**
Pongola	645	0	255	30	**360**
Mkuze	33	30	78	0	**(15)**
Mfolozi	51	0	80	18	**(47)**
Mhlatuze	179	58	235	0	**2**
Total for WMA	**1 110**	**40**	**717**	**114**	**319**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D6.5 and D6.6.

Table D6.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Upper Usutu	203	0	74	114	**15**	0
Pongola	646	0	257	30	**359**	95
Mkuze	33	30	77	0	**(14)**	0
Mfolozi	51	0	79	18	**(46)**	15
Mhlatuze	180	58	241	0	**(3)**	0
Total for WMA	**1 113**	**40**	**728**	**114**	**311**	**110**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation requirements.
3) Brackets around numbers indicate a negative balance.
4) Based on the construction of Embiane and Vaderland Dams. Additional potential may also be developed in the Upper Usutu catchment.

Table D6.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Upper Usutu	205	0	79	114	**12**	0
Pongola	646	0	257	30	**359**	95
Mkuze	34	30	78	0	**(14)**	0
Mfolozi	54	0	86	18	**(50)**	15
Mhlatuze	185	58	312	0	**(69)**	0
Total for WMA	**1 124**	**40**	**812**	**114**	**238**	**110**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and a high impact of economic development. Assumes no general increase in irrigation requirements.
3) Brackets around numbers indicate a negative balance.
4) Based on the construction of Embiane and Vaderland Dams. Additional potential may also be developed in the Upper Usutu catchment.

D6.3 Key elements of the broad strategic perspectives for the Usutu to Mhlatuze water management area

Substantial surplus yield is available from the Pongolapoort Dam and there is potential for further water resource development in the upper reaches of the Pongola River. Suitable land is available downstream of the Pongolapoort Dam and the development of irrigation farming could make a substantial contribution to rural development and poverty eradication. However, concerns exist about the possible environmental impacts of such a venture. Undeveloped potential in the upper reaches of the Pongola River could also be used to augment shortfalls in the Vaal River System. It is prudent to ensure that future opportunities in this respect are not forfeited by more immediate, but less beneficial developments.

Although a surplus is shown in Table D6.4 in respect of the Upper Usutu catchment as a whole, a deficit will actually be experienced at the dams after implementation of the Reserve whilst a surplus will still exist downstream of the dams. As most of the yield from the Usutu dams is transferred to other water management areas, mainly for the strategic use of power generation, implementation of the Reserve could have significant impacts that may cascade down to other water management areas. Comprehensive implementation planning with respect to the Reserve will therefore be required.

The deficit reflected for the Mfolozi catchment is partly attributable to irrigation water requirements in excess of the yield, and partly due to the provision for the ecological component of the Reserve. The deficit shown in the Mkuze catchment is as a result of the provision for implementation of the Reserve, prior to which a surplus exists.

Of the mean annual runoff of 901 million m^3/a originating from the upper Usutu River catchment, an estimated 592 million m^3/a on average still flows into Swaziland. Of the mean annual runoff of 1 344 million m^3/a arising in the Pongola River catchment, including that derived from the Swaziland catchment, it is estimated that 968 million m^3/a on average currently flows into Mozambique.

A complex situation exists in the Mhlatuze catchment where current water use allowances for irrigation are well in excess of the actual quantity used. In the meantime water is transferred into the catchment from the Thukela water management area for urban and industrial use. Although the requirements for and availability of water in the sub-area as a whole are approximately in balance, some localised imbalances exist. Where necessary the situation will have to be rationalised by means of compulsory licensing, and transfer of water in the future will have to be optimised. Due consideration will also have to be given to the other options described in Section 2.5 for reconciling requirements and availability.

The following reservations will apply with respect to the Usutu to Mhlatuze water management area:

- Existing transfers from the Upper Usutu catchment to the Upper Vaal and Olifants water management areas up to the installed capacity of 114 million m^3/a – reserved in the Usutu to Mhlatuze water management area.
- Current transfers from the Thukela River into the Mhlatuze sub-area of 40 million m^3/a may be increased to a maximum of 94 million m^3/a – reserved in the Thukela water management area.

  Provisional planning has been completed for increasing water transfers from the Thukela to the Mhlatuze sub-area to about 252 million m^3/a, which would be dependent on the construction of additional storage in the Thukela River. No reservation is required at this stage.
- The construction of new dams in the Pongola River catchment, as well as developments in the Upper Usutu catchment, which may negatively impact on possible further transfers of water to the Upper Vaal water management area and beyond, will be subject to approval at national level – reservations applicable to the Usutu to Mhlathuze water management area.
- Water resource developments that may impact on neighbouring countries will be subject to national authorisation – reservation applies to Usutu to Mhlathuze water management area.

D7 WATER MANAGEMENT AREA 7: THUKELA

D7.1 Introduction

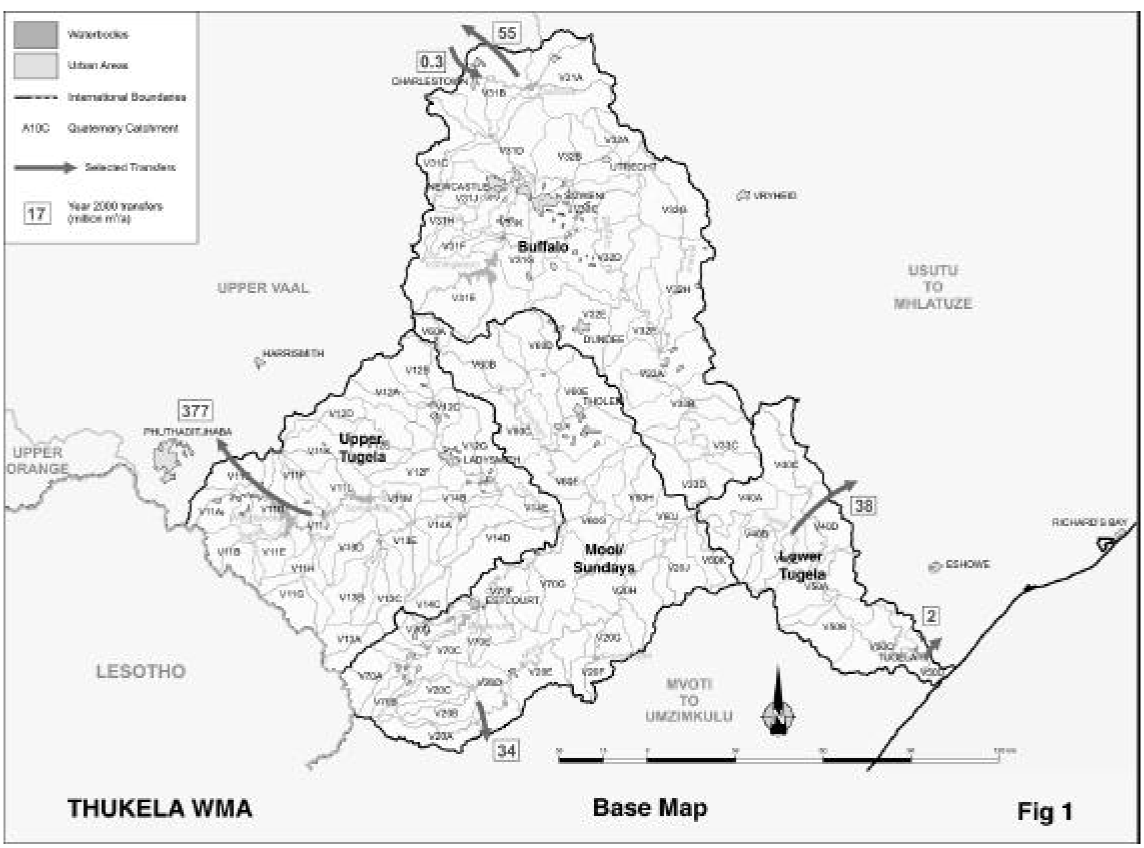
The Thukela water management area corresponds fully to the catchment area of the Thukela River and lies predominantly in the KwaZulu-Natal province. It is a funnel-shaped catchment, with several tributaries draining from the Drakensberg escarpment towards the Indian Ocean, as shown on the base map in Fig. D7. Parts of the Thukela water management area enjoy a high ecological status. It is characterised by mountain streams in the upper reaches, where several parks and conservation areas are located, as well as a number of important wetlands and vleis. Rainfall is highest near the mountains and along the coast, and the mean annual precipitation is in the range from 600 mm to 1 500 mm.

The Thukela water management area is predominantly rural in character with forestry, agriculture and eco-tourism as primary activities. Newcastle is the major industrial centre and the only other significant industrial activity at present is a large paper mill near Mandini.

Because of the high mean annual runoff and favourable topography, the Thukela basin offers some of the best opportunities for water resources development in South Africa. Although several large dams have already been constructed in the upper reaches of the Thukela River and on the main tributaries, substantial undeveloped resource potential remains. One of the largest inter-catchment transfer schemes in the country conveys water from the Upper Thukela River to the Upper Vaal water management area. Other water transfers are from the Mooi River to the Mgeni River in the Mvoti to Umzimkulu water management area, from the Buffalo River to the Upper Vaal water management area, and from the lower Thukela River to the Usutu to Mhlutuze water management area. Owing to the relatively well-watered nature of the catchment, only a small proportion of the water requirements is supplied from groundwater.

Expectations are that the area's population will remain relatively stable over the period of projection, with small growth or declines in localised areas. There are no major economic centres or stimuli in the water management area.

Fig. D7: Base map of the Thukela water management area



D7.2 Key statistics relevant to the Thukela water management area

Tables D7.1 to 7.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Thukela water management area. Data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D7.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Upper Thukela	1 502	392
Mooi/Sundays	992	213
Buffalo	941	182
Lower Thukela	364	72
Total for WMA	**3 799**	**859**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D7.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Upper Thukela	376	5	8	5	0	**394**
Mooi/Sundays	110	3	8	6	1	**128**
Buffalo	107	6	5	13	5	**136**
Lower Thukela	73	1	2	0	3	**79**
Total for WMA	**666**	**15**	**23**	**24**	**9**	**737**

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

Table D7.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation[4]	Total local requirements
Upper Thukela	71	11	6	0	0	0	**88**
Mooi/Sundays	76	13	9	4	0	0	**102**
Buffalo	38	27	11	14	1	0	**91**
Lower Thukela	19	1	5	28	0	0	**53**
Total for WMA	**204**	**52**	**31**	**46**	**1**	**0**	**334**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D7.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Upper Thukela	394	0	88	377	**(71)**
Mooi/Sundays	128	0	102	34	**(8)**
Buffalo	136	0	91	55	**(10)**
Lower Thukela	79	0	53	40	**(14)**
Total for WMA	**737**	**0**	**334**	**506**	**(103)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D7.5 and D7.6.

Table D7.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Upper Thukela	396	0	94	377	**(75)**	380
Mooi/Sundays	131	0	107	34	**(10)**	218
Buffalo	136	0	92	55	**(11)**	0
Lower Thukela	79	0	54	40	**(15)**	0
Total for WMA	**742**	**0**	**347**	**506**	**(111)**	**598**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a 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) Based on the construction of Jana, Mielietuin en Springgrove Dams.

Table D7.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Upper Thukela	401	0	104	377	**(80)**	380
Mooi/Sundays	140	0	129	34	**(23)**	218
Buffalo	155	0	133	55	**(33)**	0
Lower Thukela	80	0	54	40	**(14)**	0
Total for WMA	**776**	**0**	**420**	**506**	**(150)**	**598**

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

D7.3 Key elements of the broad strategic perspectives for the Thukela water management area

The resources of the Thukela River are largely used to support water requirements in other parts of the country, with close to 70 per cent of the current yield being transferred out of the water management area. There are no strong economic drivers in the water management area to stimulate development, while water resource development for the sole purpose of irrigation is unlikely to be economically viable. Considering the anticipated continued strong growth in water requirements in the Upper Vaal, Crocodile (West) and Marico, Mvoti to Mzimkulu and Usutu to Mhlatuze water management areas, all of which have insufficient own resources and already receive part of their requirements from the Thukela water management area. it would be prudent that future large-scale water resource developments in the Thukela basin be under control of the Minister to ensure the best development in the interest of the country. High value urban/industrial application of the Thukela's additional water resources would be the only use that would make such development viable, but it would have the subsidiary benefit of stimulating some concomitant local development.

The deficits indicated in Table D7.4 are all attributable to provisions made for implementation of the Reserve and do not reflect actual current shortages. Implementation of the Reserve should therefore be planned carefully as a priority and should form part of any future development planning. Due account also needs to be taken of the options for reconciling the requirements for and availability of water as described in Section 2.5.

A substantial portion of the water resources of the Thukela basin will be required for existing and future transfers to other water management areas. Reservations in the Thukela water management area for this purpose are:

- The transfer of a maximum of 630 million m³/a from the Upper Thukela River to the Upper Vaal water management area (equal to the current capacity). The average quantity transferred is about 530 million m³/a.
- The transfer of up to 55 million m³/a (current capacity) from the Assegaai tributary of the Buffalo River to the Upper Vaal water management area.
- The transfer from the Mooi River to the Mgeni River in the Mvoti to Umzimkulu water management area up to the current installed capacity of 100 million m³/a and up to 136 million m³/a with the addition of new infrastructure.
- The current transfer of 40 million m³/a to the Usutu to Mhlatuze water management area, which may be increased to a maximum of 94 million m^3/a.

Development of large new water resources infrastructure will be under control of the Minister, as this resource may be required to supply additional water to the Usutu to Mhlatuze, Mvoti to Mzimkulu and Upper Vaal water management areas.

D8 WATER MANAGEMENT AREA 8: UPPER VAAL

D8.1 Introduction

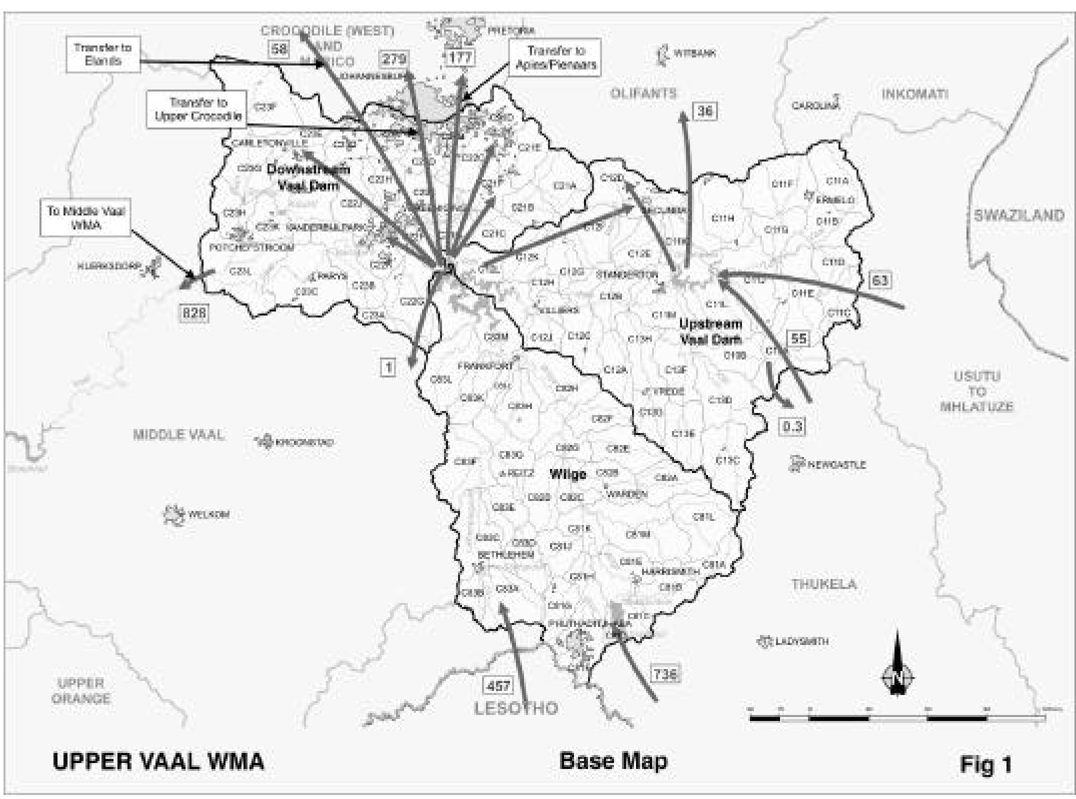
The Upper Vaal water management area lies in the eastern interior of South Africa. From a water resources management perspective it is a pivotal water management area in the country. Large quantities of water are transferred into the area from two neighbouring areas, as well as water sourced from the Upper Orange River via Lesotho. Similarly, large quantities of water are transferred out to three other water management areas, which are dependent on water from the Upper Vaal water management area to meet much of their requirements – see Fig. D8. The impacts of these transfers extend well beyond the four adjoining water management areas and eventually involve a total of ten water management areas and all the neighbouring countries of South Africa. Climate over the Upper Vaal water management area is fairly uniform, and the average rainfall varies between 600 mm and 800 mm per year.

Extensive urbanisation and mining and industrial activity, which relate to the rich gold and coal deposits in the area, occur in the northern part of the water management area. Similar mining and industrial development in the southern part of the Crocodile (West) and Marico water management area results in the two areas together producing 45 percent of South Africa's Gross Domestic Product (GDP). Economic activity in the remainder of the Upper Vaal water management area mainly relates to livestock farming and rain fed cultivation.

Because of the high level of urbanisation and economic activity in the area and its pivotal role as a water transfer point to other water management areas, water resources in the area are highly developed and regulated, and only marginal potential for further development remains. The total yield transferred into the catchment is in excess of 120 per cent of the yield from local surface resources, while virtually the same quantity of water is again transferred out of the area. Groundwater is mainly used for rural domestic needs and for stock watering, while a substantial quantity of water is also abstracted from dolomitic aquifers for urban use.

Projections show that population and economic growth will remain strong in the urban and industrialised parts of the water management area. A significant decline in population is, however, foreseen in the Qwa Qwa region in the southern extremity of the water management area.

Fig. D8: Base map of the Upper Vaal water management area



D8.2 Key statistics relevant to the Upper Vaal water management area

Tables D8.1 to 8.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Upper Vaal water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D8.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Wilge	868	116
Vaal Dam - upstream	1 109	126
Vaal Dam - downsream	446	57
Total for WMA	**2 423**	**299**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D8.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Wilge	46	4	2	7	0	**59**
Vaal Dam - upstream	154	8	3	11	8	**184**
Vaal Dam - downstream	399	20	7	325	138	**889**
Total for WMA	**599**	**32**	**12**	**343**	**146**	**1 132**

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

Table D8.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Wilge	18	27	15	0	0	0	**60**
Vaal Dam - upstream	29	32	17	99	39	0	**216**
Vaal Dam - downstream	67	576	11	74	41	0	**769**
Total for WMA	**114**	**635**	**43**	**173**	**80**	**0**	**1 045**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower is generally available for other uses as well.)
4) Quantities refer to the impact on yield only.

Table D8.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Wilge	59	0	60	0	**(1)**
Vaal Dam - upstream	184	118	216	67	**19**
Vaal Dam - downstream	889	1 224	769	1 343	**1**
Total for WMA	**1 132**	**1 311**	**1 045**	**1 379**	**19**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D8.5 and D8.6.

Table D8.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local require-ments[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Wilge	58	0	56	0	**2**	0
Vaal Dam - upstream	184	118	256	74	**(28)**	50
Vaal Dam - downstream	987	1 513	957	1 561	**(18)**	0
Total for WMA	**1 229**	**1 630**	**1 269**	**1 634**	**(44)**	**50**

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

Table D8.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component / Sub-area	Local yield[1]	Transfers in	Local require-ments[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Wilge	64	0	78	0	**(14)**	0
Vaal Dam – upstream	190	118	272	74	**(38)**	50
Vaal Dam - downstream	1 232	1 513	1 391	2 067	**(713)**	0
Total for WMA	**1 486**	**1 630**	**1 741**	**2 140**	**(765)**	**50**

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

D8.3 Key elements of the broad strategic perspectives for the Upper Vaal water management area

The Upper Vaal water management area is highly developed and impacted upon by human activity. The quantities of water transferred into and out of the area are largely dictated by the population needs and economic activity in this as well as similar needs in other recipient water management areas. It should be noted that the balance reflected in Table D8.4 for the sub area downstream of Vaal Dam will become a temporary surplus when the transfer of water from Mohale Dam in Lesotho is commissioned, and based on the assumption that all the transfers into the water management area are operated at nominal yield capacity. In practice, however, only the quantities of water actually required are transferred. (For simplicity, the transfers from Lesotho and the Upper Thukela are shown to be received in the sub-area downstream of Vaal Dam, where the water is actually used or from where it is transferred onwards). It is important to note that while large quantities of water are transferred into the Upper Vaal water management area, the yield available at Grootdraai Dam is limited by the existing infrastructure, and deficits may develop at that point.

Water quality in the Vaal River and in some tributaries downstream of Vaal Dam is seriously affected by urban and industrial and mining return flows and the intensive mining activity. The water resources are therefore carefully managed to maintain acceptable water quality standards. Particular attention is also to be given to the impacts that closure of mines may have on both surface and groundwater.

As the resources within the water management area essentially fully developed, future growth in the requirements for water will have to be met by increased water transfers from other water management areas. The successful implementation of water conservation and demand management measures are of particular importance in this area. The main water resource development options available in this regard are additional transfers from the Thukela water management area and the Orange River, the latter through additional transfers from Lesotho or from the Upper Orange water management area. Recent investigations have shown that a new dam on the Klip River could possibly be the best option to meet additional requirements in the sub-area upstream of Vaal Dam. Due consideration, however, must be given to all the options for reconciling water requirements and availability, as described in Section 2.5.

The following reservations apply with respect to the transfer of water into and out of the water management area, and the provision of water for future growth:

- The existing transfer of 491 million m^3/a from Lesotho, which is to be increased to 835 million m^3/a after the commissioning of Mohale Dam in Lesotho. – reserved by international agreement for use in and transfer from the Upper Vaal water management area.
- Existing transfers from the Thukela water management area up to the installed capacity of 630 million m^3/a. The yield benefit in the Vaal System is 736 million m^3/a – reserved in the Thukela water management area.
- Future large-scale water resources development on the Thukela River is reserved mainly for transfer to the Upper Vaal water management area. Current planning allows for an additional transfer of 475 million m^3/a – reserved in the Thukela water management area.
- Existing transfer of 55 million m^3/a from the Buffalo River in the Thukela water management area to the Upper Vaal water management area – reserved in the Thukela water management area.
- Transfers from the Usutu to Mhlatuze water management area at the current capacity of 63 million m^3/a – reserved in the Usutu to Mhlatuze water management area.
- Existing transfers from the Upper Vaal water management area to the Olifants water management area of 36 million m^3/a for power generation, plus an allowance of 38 million m^3/a for future growth. (Included in Tables D8.3 to D8.6.) – reserved in the Upper Vaal water management area.
- Transfers from the Upper Vaal water management area through the Rand Water distribution system to meet requirements in the Crocodile (West) and Marico water management area which are in excess of the capacity of the local resources in the Crocodile (West) and Marico water management area. Currently this amounts to 514 million m^3/a and is projected to increase to 723 million m^3/a. As an upper high growth scenario, transfers may need to increase to 1 125 million m^3/a. (Figures included in Tables D 8.5 and D 8.6.) – reserved in the Upper Vaal water management area.
- Releases from the Upper Vaal water management area along the Vaal River to users in the Middle Vaal and Lower Vaal water management areas to meet their realistic needs that cannot be supplied from own resources. Little change is expected from the current transfer of 828 million m^3/a, although it may increase to about 910 million m^3/a in 2025 under the high growth scenario – reserved in the Upper Vaal water management area.

- Current surplus transfer capacity into the Upper Vaal water management area is to be reserved for growth in urban, industrial and mining water requirements in the Upper Vaal and Crocodile (West) and Marico water management areas, and is not to be used for commercial irrigation.
- The allocation of surplus yield in the Upper Vaal water management area will be subject to national authorisation as it can be allocated to users in the Upper, Middle, Lower Vaal as well as Crocodile (West) and Marico and Olifants water management areas.
- The Upper Vaal water management area forms the central component of the Vaal River System, which extends over several water management areas. As water resources management in the Vaal River System impacts to some degree on the water quantity and quality in all the interlinked water management areas, management of the Vaal River System is to be controlled at a national level.

D9 WATER MANAGEMENT AREA 9: MIDDLE VAAL

D9.1 Introduction

The Middle Vaal water management area is situated in the Free State and North West Provinces in the central part of South Africa. It covers the middle reaches of the Vaal River, between the Upper Vaal and Lower Vaal water management areas (see Fig. D9). Rainfall is relatively low and ranges from 400 mm to 700 mm per year, while evaporation can be as high as 1 900 mm per year.

Fig. D9: Base map of the Middle Vaal water management area

There are no distinct geographic or topographic features and surface runoff is low. Activity in the water management area is typically extensive livestock farming and rain fed cultivation, with some irrigation farming. Economic activity, though, is dominated by gold mining in the vicinity of Klerksdorp and Welkom, which as a single sector contributes about 45 per cent of the Gross Domestic Product (GDP) in the water management area.

Dams have been constructed on all the main tributaries of the Vaal River. Any unregulated runoff is controlled by the Bloemhof Dam on the Vaal River in the Lower Vaal water management area immediately after the river exits the Middle Vaal water management area. No realistic potential for further development of surface water exists. Extensive use of groundwater for rural domestic and village supplies is made throughout the water management area. Large dolomitic aquifers are found in the northern part of the water management area, which extend into the adjoining water management areas and support large areas under irrigation.

Water along the Vaal River is highly saline and generally of poor quality as a result of the large quantities of effluent and urban runoff that is discharged into the river in the Upper Vaal water management area. Water quality is carefully managed by blending fresh water with the effluent.

Because of a decline in gold mining activity, a small decrease in population is projected for the area, with concomitant effects on economic activity. Little change in water requirements is therefore expected.

D9.2 Key statistics relevant to the Middle Vaal water management area

Tables D9.1 to 9.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Middle Vaal water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D9.1: Natural mean annual runoff and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Rhenoster-Vals	295	35
Middle Vaal	170	29
Sand-Vet	423	45
Total for WMA	**888**	**109**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D9.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Rhenoster-Vals	22	12	3	7	0	**44**
Middle Vaal	(201)	25	3	15	16	**(142)**
Sand-Vet	112	17	10	7	1	**147**
Total for WMA	**(67)**	**54**	**16**	**29**	**17**	**49**

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

Table D9.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Rhenoster-Vals	26	20	8	0	0	0	**54**
Middle Vaal	33	35	13	48	0	0	**129**
Sand-Vet	100	38	11	38	0	0	**187**
Total for WMA	**159**	**93**	**32**	**86**	**0**	**0**	**370**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D9.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Rhenoster-Vals	44	1	54	0	**(9)**
Middle Vaal	(142)	828	129	559	**(2)**
Sand-Vet	147	59	187	2	**17**
Total for WMA	**49**	**829**	**370**	**502**	**6**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D9.5 and D9.6.

Table D9.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment
Rhenoster-Vals	44	1	53	0	**(8)**	0
Middle Vaal	(136)	837	142	560	**(1)**	0
Sand-Vet	147	59	187	2	**17**	0
Total for WMA	**55**	**838**	**382**	**503**	**8**	**0**

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

Table D9.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component / Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment
Rhenoster-Vals	49	2	65	0	**(14)**	0
Middle Vaal	(131)	910	152	628	**(1)**	0
Sand-Vet	149	72	200	2	**19**	0
Total for WMA	**67**	**911**	**417**	**557**	**4**	**0**

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

D9.3 Key elements of the broad strategic perspectives for the Middle Vaal water management area

The Middle Vaal water management area is dependent on releases from the Upper Vaal water management area for meeting the bulk of the water requirements of its urban, mining and industrial sectors. Releases from the Upper Vaal water management area in support of the Lower Vaal water management area are transferred via the Middle Vaal water management area to the Bloemhof Dam, which is the uppermost control structure in the Lower Vaal area. Management of water quantity and quality in the Middle Vaal water management area is therefore integrally linked to both the Upper Vaal and Lower Vaal water management areas and commensurate management approaches will have to be followed in these water management areas. It is appropriate therefore that these aspects are managed at a national level.

The negative contribution from surface resources in the Middle Vaal sub-area, as reflected in Table D9.2, is a result of evaporation losses along this reach of the Vaal River being in excess of the yield from local tributaries. Owing to the intermittent nature of flow in the tributary rivers, provision for the ecological component of the Reserve has relatively little impact on the yield from the Rhenoster/Vals and Sand/Vet sub-areas.

Since no meaningful growth in requirements is foreseen in this water management area, the main issue of concern will be the management of water quality, which could be severely affected by further urban and industrial development in the Upper Vaal water management area, where the main sources of impact on water quality are located.

Due consideration must also be given to the implementation of appropriate demand management measures and to ensuring the most beneficial use of water.

The following quantities of water need to be reserved for transfers in to and out of the Middle Vaal water management area:

- Transfers from the Upper Vaal water management area for use in the Middle Vaal and Lower Vaal water management areas. Currently this amounts to 828 million m^3/a and may under a high growth scenario increase to 910 million m^3/a – reserved in the Upper Vaal water management area.
- Transfers from the Middle Vaal water management area to the Lower Vaal water management area. The current volume is 500 million m^3/a, which under a high growth scenario may increase to about 555 million m^3/a – reserved in the Middle Vaal water management area.
- Small existing transfers for domestic use from Vaal Dam in the Upper Vaal water management area to Heilbron in the Middle Vaal water management area – reserved in the Upper Vaal water management area.
- Small existing transfers for domestic use from Erfenis Dam in the Middle Vaal water management area to users in the Upper Orange water management area – reserved in the Middle Vaal water management area.

D10 WATER MANAGEMENT AREA 10: LOWER VAAL

D10.1 Introduction

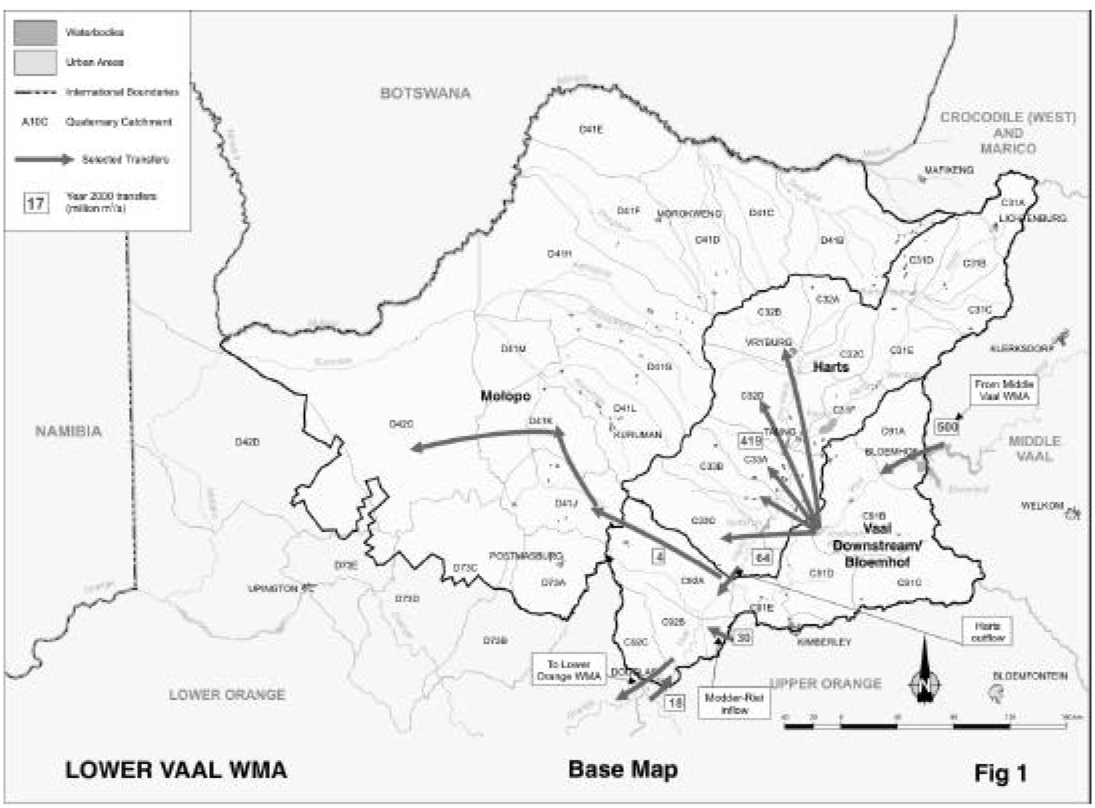
The Lower Vaal water management area lies in the north-western part of South Africa and borders on Botswana in the north. Climate in the region is semi-arid to arid, with rainfall ranging from 500 mm to as low as 100 mm per year and evaporation reaching 2 800 mm per year towards the west. Streamflow characteristics are distinctly different for the three sub-areas shown on Fig. D10. Flow in the Vaal River is perennial, fed by high rainfall and regulation upstream, the Harts River is characterised by highly intermittent runoff, and the Molopo and Kuruman Rivers are endorheic and typically cease to flow after some distance due to infiltration into the river bed and evaporation.

Iron ore, diamonds and manganese are mined in the water management area. Farming activity ranges from extensive livestock production and rain fed cultivation to intensive irrigation enterprises at Vaalharts. Kimberley, which straddles the divide between the Lower Vaal and Upper Orange water management areas, is the largest urban centre in the area.

Utilisable surface water resources in the water management area are limited to those supplied by the Vaal and Harts Rivers, both of which are fully regulated. Barberspan, an off-channel pan in the upper reaches of the Harts River, is a Ramsar wetland site. More than 50 per cent of the yield from natural water resources in the tributary catchments within the water management area is supplied from groundwater. At Sishen, groundwater abstracted in the process of de-watering the mine is also used for water supply, although it is recognised as being controlled mining of groundwater. Other localised over-exploitation of groundwater occurs in some areas. Water quality is of special concern in the lower reaches of the Harts and the Vaal Rivers because of the high salinity of leach water from the Vaalharts irrigation scheme. To counter this problem, better quality water is transferred from the Orange River to the Douglas Weir in the lower reaches of the Vaal River for blending purposes.

There is limited potential for strong economic development in the region and future population projections show little change in the demographics of the water management area. Little change in water requirements is therefore foreseen.

Fig. D10: Base map of the Lower Vaal water management area



D10.2 Key statistics relevant to the Lower Vaal water management area

Tables D 10.1 to 10.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Lower Vaal water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D10.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Harts	138	15
Vaal d/s Bloemhof[3]	43	5
Molopo	197[4]	29
Total for WMA	**181**	**49**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.
3) d/s Bloemhof = downstream of the Bloemhof Dam.
4) 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.

Table D10.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Harts	51	40	45	0	0	**136**
Vaal d/s Bloemhof[2]	(107)	54	7	0	0	**(46)**
Molopo	2	31	0	0	2	**35**
Total for WMA	**(54)**	**125**	**52**	**0**	**2**	**125**

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

2) d/s Bloemhof = downstream of the Bloemhof Dam.

Table D10.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local requirements
Harts	452	23	19	0	0	0	**494**
Vaal d/s Bloemhof[5]	73	32	8	0	0	0	**113**
Molopo	0	13	17	6	0	0	**36**
Total for WMA	**525**	**68**	**44**	**6**	**0**	**0**	**643**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.
5) d/s Bloemhof = downstream of the Bloemhof Dam.

Table D10.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Harts	136	419	494	62	**(1)**
Vaal d/s Bloemhof[3]	(46)	609	113	422	**28**
Molopo	35	4	36	0	**3**
Total for WMA	**125**	**548**	**643**	**0**	**30**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D10.5 and D10.6.
3) d/s Bloemhof = downstream of the Bloemhof Dam.

Table D10.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment
Harts	137	419	496	60	**0**	0
Vaal d/s Bloemhof[4]	(45)	631	112	422	**52**	0
Molopo	35	4	34	0	**5**	0
Total for WMA	**127**	**572**	**642**	**0**	**57**	**0**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a normal growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) d/s Bloemhof = downstream of the Bloemhof Dam.

Table D10.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development
Harts	137	419	504	52	**0**	0
Vaal d/s Bloemhof[4]	(45)	697	158	422	**72**	0
Molopo	35	4	41	0	**(2)**	0
Total for WMA	**127**	**646**	**703**	**0**	**70**	**0**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Assumes no increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) d/s Bloemhof = downstream of the Bloemhof Dam.

D10.3 Key elements of the broad strategic perspectives for the Lower Vaal water management area

Irrigation dominates water requirements in the Lower Vaal water management area and represents 80 per cent of total water use. Virtually all of this use is concentrated in the Vaalharts irrigation scheme, which relies on Vaal River water transferred from the Upper Vaal and Middle Vaal water management areas. 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.

The total quantity of water transferred into the Lower Vaal area represents about 80 percent of the local water requirements, and only return flows and spilling flood flows are discharged from the water management area. The positive yield balance shown in Table D10.4 with respect to the Vaal River downstream of the Bloemhof Dam is as a result of irrigation return flows in the lower reaches of the Vaal River.

The key issues with regard to water resources management in the water management area are the following:

- Operational management of water abstractions from the Vaal River is handled in close co-operation with the Middle Vaal and Upper Vaal Catchment Management Agencies to ensure the efficient overall management of the Vaal River System and efficient flood control in the Orange-Vaal system.
- Management of water quality in the Vaal and Harts Rivers.
- Management of groundwater, both from an abstraction and a recharge perspective, to ensure sustainability of use.

Due consideration is also to be given to the implementation of appropriate demand management measures and to ensuring the most beneficial use of water.

Reservations will apply in respect of water transfers into and out of the Lower Vaal water management area.

- Currently 500 million m³/a is transferred from the Middle Vaal water management area to the Lower Vaal water management area and may as an upper scenario increase to about 555 million m³/a during the period of projection – reserved in the Middle Vaal water management area.
- A reservation also applies to the transfer of 18 million m³/a from the Upper Orange water management area to Douglas Weir in the Lower Vaal water management area – reserved in the Upper Orange water management area.

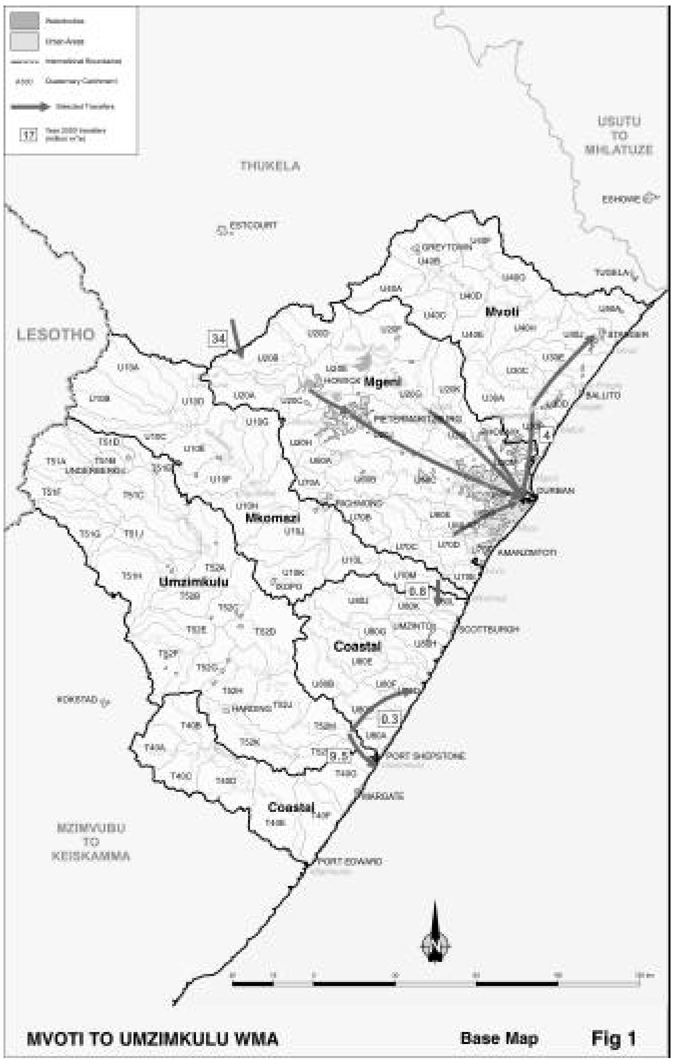
The Lower Vaal water management area forms part of the Vaal River System, which extends over several water management areas. As water resources management in this system impacts to some degree on water quantity and quality in all the interlinked water management areas, management of water resources in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

D11 WATER MANAGEMENT AREA 11: MVOTI TO UMZIMKULU

D11.1 Introduction

The Mvoti to Umzimkulu water management area lies along the eastern coast of South Africa, predominantly within the province of KwaZulu-Natal, and borders on Lesotho to the west. It is situated in a humid part of the country with a mean annual precipitation of 800 mm to 1 500 mm. The terrain is rolling, with the Drakensberg escarpment as the main topographic feature. Several parallel rivers drain the water management area, two of which originate in the Drakensberg Mountains at the border with Lesotho. Small coastal streams also abound, as shown in Fig. D11. Many of the estuaries are still in a relatively natural state.

Fig. D11: Base map of the Mvoti to Umzimkulu water management area



Economic activity in the water management area is diverse. The rural areas are characterised by both subsistence and commercial farming, with extensive cultivation of sugar cane along the coast and commercial forests in the higher rainfall areas. The Durban metropolitan area is the second largest commercial and industrial nucleus in the country, and is surrounded by satellite developments along the coast and inland towards Pietermaritzburg.

Large differences are noticeable in the degree to which water resources have been developed in the water management area. The Mgeni River, which is the main source of water for the Durban/Pietermaritzburg area, is fully regulated by several large dams in the catchment and is augmented with transfers from the Thukela water management area. In contrast, the potential of the Mkomazi and Umzimkulu Rivers remains largely undeveloped and various degrees of development apply to the remainder of the surface resources in the water management area. Because of the perennial nature of streamflow in the water management area, surface water, which includes springflow, is generally used for rural water supplies and there is only minimal abstraction of groundwater.

Strong population growth is projected for the Mgeni sub-area, commensurate with the expected economic growth in the Durban/Pietermaritzburg area as well as a general tendency towards urbanisation. It is anticipated that population in the rural areas will remain relatively unchanged, although there could be localised decreases.

D11.2 Key statistics relevant to the Mvoti to Umzimkulu water management area

Tables D11.1 to 11.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Mvoti to Umzimkulu water management area. Data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D11.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Mvoti	595	150
Mgeni	992	187
Mkomazi	1 080	295
Coastal	758	211
Umzimkulu	1 373	317
Total for WMA	**4 798**	**1 160**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D11.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Mvoti	68	1	8	5	4	**86**
Mgeni	316	1	6	52	1	**376**
Mkomazi	27	1	3	0	0	**31**
Coastal	11	2	1	0	0	**14**
Umzimkulu	11	1	3	0	1	**16**
Total for WMA	**433**	**6**	**21**	**57**	**6**	**523**

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

Table D11.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Mvoti	76	9	10	11	0	8	**114**
Mgeni	63	378	12	4	0	47	**504**
Mkomazi	33	1	5	53	0	6	**98**
Coastal	10	19	10	1	0	1	**41**
Umzimkulu	25	1	7	4	0	3	**40**
Total for WMA	**207**	**408**	**44**	**73**	**0**	**65**	**797**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D11.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Mvoti	86	0	114	4	**(32)**
Mgeni	376	38	504	0	**(90)**
Mkomazi	31	0	98	1	**(68)**
Coastal	14	11	41	0	**(16)**
Umzimkulu	16	0	40	10	**(34)**
Total for WMA	**523**	**34**	**797**	**0**	**(240)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D11.5 and D11.6.

Table D11.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local require-ments[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Mvoti	90	0	122	4	**(36)**	47
Mgeni	404	38	705	0	**(263)**	90
Mkomazi	31	0	99	1	**(69)**	481
Coastal	14	11	45	0	**(20)**	0
Umzimkulu	16	0	40	10	**(34)**	400
Total for WMA	**555**	**34**	**1 011**	**0**	**(422)**	**1 018**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation
3) Brackets around numbers indicate a negative balance.
4) Based on the raising of the Hazelmere and Midmar Dams, and construction of the Impendle, Smithfield and iSitungo Dams.

Table D11.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local require-ments[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Mvoti	94	0	131	4	**(41)**	47
Mgeni	459	38	1 103	0	**(606)**	90
Mkomazi	31	0	100	1	**(70)**	481
Coastal	14	11	62	0	**(37)**	0
Umzimkulu	16	0	41	10	**(35)**	400
Total for WMA	**614**	**34**	**1 437**	**0**	**(789)**	**1 018**

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

D11.3 Key elements of the broad strategic perspectives for the Mvoti to Umzimkulu water management area

Water resource management in the Mvoti to Umzimkulu water management area is dominated by the Mgeni System, which serves the Durban/Pietermaritzburg area and its coastal environs. The requirements for water in this area already exceed its availability and further growth in requirements is anticipated. Deficits are also experienced in the Mvoti and Mkomazi sub-areas and parts of the Coastal sub-area. These deficits occur mainly during low-flow periods as a result of insufficient storage and will be exacerbated by implementation of the Reserve. The deficit shown in Table D11.4 for the Umzimkulu sub-area is also attributable to the provision for the Reserve, which is still to be implemented.

Water quality in the lower Mgeni River and in the Msunduze tributary is highly affected by urban return flows and wash-off from insufficiently serviced residential areas, a situation that is of particular concern.

Great success in reducing the requirements for water has already been achieved in the Durban metropolitan area by the application of water demand management and the increased re-use of effluent. Action is being taken to bring about further improvements. Other interventions that could be applied to ensure an adequate supply of water in the future are described in Section 2.5.

The following options are of specific relevance to the Mvoti to Mzimkulu water management area:

- Additional transfers of water from the Mooi River in the Thukela water management area. Plans have already been developed to increase the transfer capacity from the existing 100 million m^3/a to 136 million m^3/a by constructing the Springgrove Dam on the Mooi River and increasing the pumping capacity.
- Increased re-use of return flows from the Durban metropolitan area. Although about 15 per cent of the return flows are currently re-used, some indirectly or for environmental purposes, the bulk is still discharged to the ocean.
- The transfer of water from the Mkomazi River to the Mgeni River within the water management area. As a future option water may also be transferred from the Umzimkulu River.

In support of the first option a volume of 135 million m^3 per year is reserved for transfer from the Mooi River in the Thukela water management area to the Mgeni River in the Mvoti to Umzimkulu water management area. The Springgrove Dam to be constructed on the Mooi River for the purpose of transferring water to the Mgeni River will therefore fall under national control – reserved in the Thukela water management area.

The Mkomazi River has been identified by planning studies as the most feasible next option for augmenting water supplies for the Durban/Pietermaritzburg area, and development of this river needs to be reserved for that purpose – reservation to apply within the Mvoti to Umzimkulu water management area.

D12 WATER MANAGEMENT AREA 12: MZIMVUBU TO KEISKAMMA

D12.1 Introduction

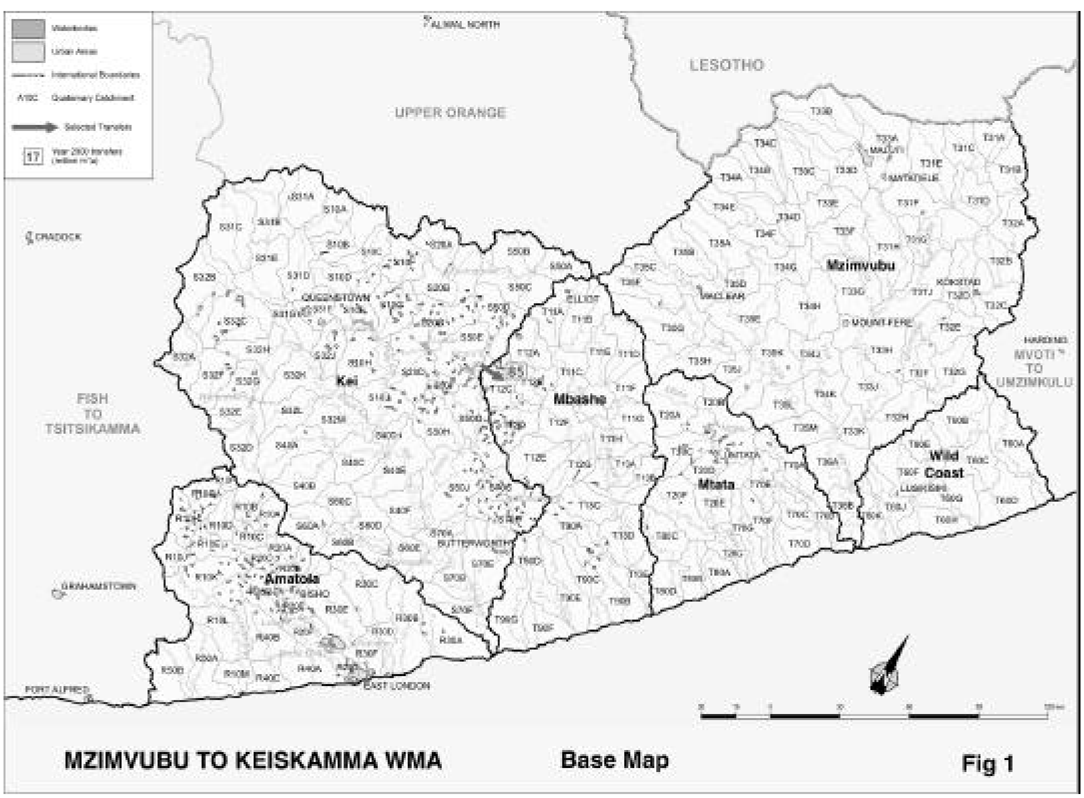
The Mzimvubu to Keiskamma water management area lies predominantly within the Eastern Cape Province and borders on Lesotho to the north (see Fig. D12). Climate over most of the area can be classified as sub-humid to humid, with rainfall in the range from 700 mm to nearly 1 500 mm/a, but reducing to as low as 400 mm/a in the west. The topography is rolling, with the highest points on the border with Lesotho, which also forms the divide with the Orange River catchment. Three main rivers flow from the inland divide to the coast, while smaller rivers and coastal streams abound. Many of the estuaries are still in a relatively natural state. The Mzimvubu River is the largest undeveloped river in South Africa.

Land use in the water management area is predominantly for livestock farming and subsistence agriculture. There are several irrigation developments, some of which are only partly operational, and timber is grown commercially in the higher rainfall areas. Economic activity is dominated by industrial development in the East London area, which is known for its automotive and textile industries.

The degree of water resources development in the water management area varies considerably. No noteworthy dams have been constructed in the Mzimvubu River catchment, where significant potential for water resource development remains. Development potential also exists in the Mbashe River. The Mtata River is well regulated by the Mtata Dam, while several dams have been constructed in the upper reaches of the Kei catchment and on the Buffalo River. Three small hydro-electric developments are in operation on the Mbashe and Mtata Rivers. Although inter-catchment transfers of water take place within the water management area, there are no inter-water management area transfers.

A moderate growth in population is expected for the East London/Bisho region (Amatola sub-area), while the area's rural population is projected to decline after the year 2005. Little change in the total population of the water management area is thus foreseen. Potential for economic development exists mainly in the East London/Bisho industrial zone, with tourism and commercial forestry as possible additional stimulants.

Fig. D12: Base map of the Mzimvubu to Keiskamma water management area



D12.2 Key statistics relevant to the Mzimvubu to Keiskamma water management area

Tables D 12.1 to 12.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Mzimvubu to Keiskamma water management area. Data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D12.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Mzimvubu	2 897	338
Mtata	836	163
Mbashe	1 126	203
Kei	1 027	154
Amatola	559	116
Wild Coast	796	148
Total for WMA	**7 241**	**1 122**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D12.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Mzimvubu	84	3	2	2	0	**91**
Mtata	129	1	0	6	0	**136**
Mbashe	112	1	0	1	0	**114**
Kei	325	14	14	6	0	**359**
Amatola	122	1	2	24	0	**149**
Wild Coast	4	1	0	0	0	**5**
Total for WMA	**776**	**21**	**18**	**39**	**0**	**854**

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

Table D12.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local requirements
Mzimvubu	15	6	9	0	0	3	**33**
Mtata	4	15	5	0	0	29	**53**
Mbashe	3	2	6	0	0	0	**11**
Kei	135	18	10	0	0	11	**174**
Amatola	33	57	5	0	0	4	**99**
Wild Coast	0	1	3	0	0	0	**4**
Total for WMA	**190**	**99**	**38**	**0**	**0**	**47**	**374**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D12.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Mzimvubu	91	0	33	0	**58**
Mtata	136	0	53	0	**83**
Mbashe	114	85	11	0	**188**
Kei	359	0	174	85	**100**
Amatola	149	0	99	0	**50**
Wild Coast	5	0	4	0	**1**
Total for WMA	**854**	**0**	**374**	**0**	**480**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D12.5 and D12.6.

Table D12.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Mzimvubu	91	0	34	0	**57**	1 200
Mtata	141	0	61	0	**80**	45
Mbashe	115	85	10	0	**190**	65
Kei	360	0	179	85	**96**	135
Amatola	159	0	125	0	**34**	55
Wild Coast	5	0	4	0	**1**	0
Total for WMA	**871**	**0**	**413**	**0**	**458**	**1 500**

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

Table D12.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Mzimvubu	92	0	35	0	**57**	1 200
Mtata	138	0	54	0	**84**	45
Mbashe	115	85	10	0	**190**	65
Kei	362	0	185	85	**92**	135
Amatola	174	0	161	0	**13**	55
Wild Coast	5	0	4	0	**1**	0
Total for WMA	**886**	**0**	**449**	**0**	**437**	**1 500**

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

D12.3 Key elements of the broad strategic perspectives for the Mzimvubu to Keiskamma water management area

From the reconciliation in Table D12.4 it appears that sufficient yield is available to meet all existing requirements for water. However, with most of the rural and village requirements for water being supplied from unregulated run-of-river yields, implementation of the ecological component of the Reserve may result in the occurrence of dry-season deficits. These will probably manifest themselves as insufficient ecological flows because of preference to be given to basic human needs and are not reflected in the annual average figures in the table. Careful investigation and judicious implementation of the Reserve is therefore required.

Similarly, the surplus shown for the Amatola sub-area masks the deficits experienced in the Buffalo River catchment. Serious water quality problems are also experienced along the lower reaches of the Buffalo

River, which are largely attributable to industrial effluent discharges into the river. As the Buffalo River, together with the Nahoon and Kubusi Rivers, are the main sources of water for the important East London/Bisho area, management of both water quantity and quality in the Buffalo River should be a special priority in this water management area.

Where deficits are experienced in localised cases, the options described in Section 2.5 for reconciling the requirements for and availability of water should be considered.

Other issues that should receive specific consideration are:

- refurbishment and improved utilisation of irrigation schemes that have fallen into disrepair; and
- the position with respect to insufficient streamflow measurement in many parts of the water management area.

In view of the fact that the Mzimvubu River is the largest undeveloped water resource in the country, the benefits to be derived from the development of this river will potentially be of national importance. It is prudent, therefore, for large-scale development of the Mzimvubu River to be made subject to authorisation at national level. With appropriate planning, new dams for hydropower generation and irrigation, for example, can be located and designed in such a way as to permit the abstraction of water for transfer to other water management areas. The possibility of such future developments of national importance should not be jeopardised unduly by other developments in the interim – reservation with respect to large-scale development of the Mzimvubu River therefore applies to the Mzimvubu to Keiskamma water management area.

D13 WATER MANAGEMENT AREA 13: UPPER ORANGE

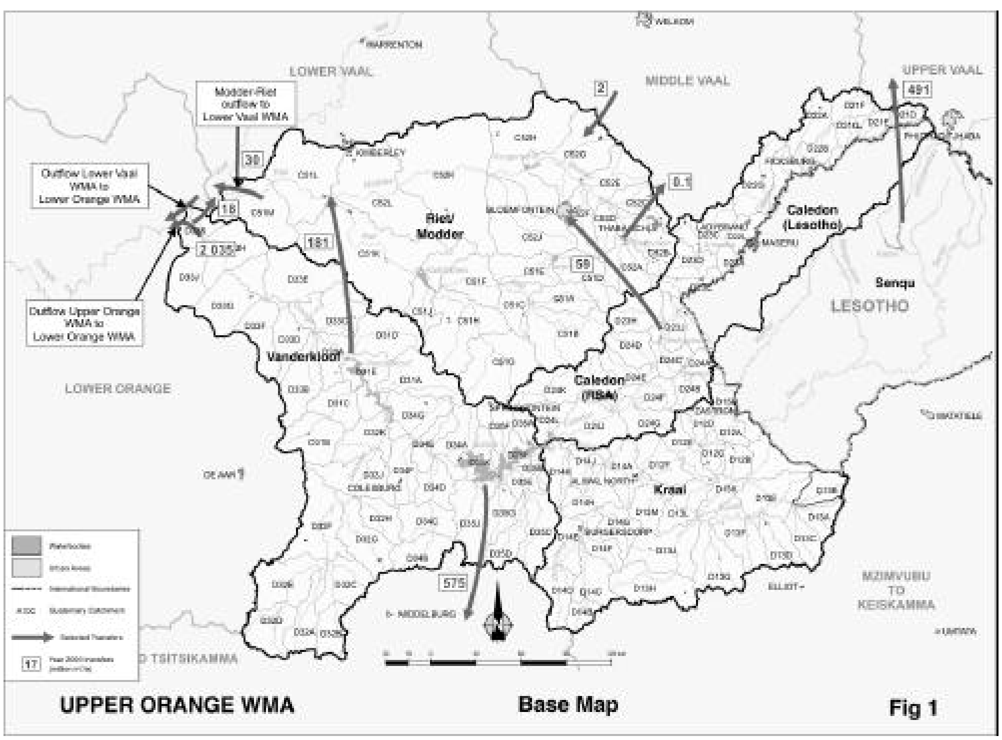
D13.1 Introduction

The Upper Orange water management area lies in the centre of South Africa and extends over the southern Free State and parts of the Eastern and Northern Cape provinces. It borders on Lesotho to the east, where the Orange River originates as the Senqu River (refer to Fig. D13). Draining the Highlands of Lesotho, the Senqu River contributes close to 60 per cent of the surface water associated with the Upper Orange water management area. The climate varies considerably over the region and rainfall ranges from over 1 000 mm/a in the foothills of the mountains to as little as 200 mm/a in the west. Vegetation is mainly grassland. Extensive sheep and cattle farming is characteristic throughout the area. Some dry-land cultivation occurs where the rainfall and soils are favourable, but sizeable areas are under irrigation below the main storage dams. Bloemfontein, as an administrative and commercial centre, is the only large urban development in the water management area.

Water resources management in the area mainly revolves around the Orange River. Two of the highest dams in Africa have been constructed in the Orange (Senqu) catchment in Lesotho for the purpose of transferring water to the Upper Vaal water management area. The Gariep and Vanderkloof Dams in the water management area, where the two largest conventional hydropower installations in the country are located, also command the two largest storage reservoirs in South Africa. From the Gariep Dam a major inter-water management area transfer occurs via the 80 km long Orange-Fish Tunnel to the Fish to Tsitsikamma water management area. A significant portion of the yield of the Orange River is also released down the river for use in the Lower Orange water management area and by Namibia. In total, close to 70 per cent of the yield realised in the Upper Orange water management area and in Lesotho is used in other water management areas. Even so, potential still exists for further large-scale development of the Orange River, with the most attractive sites for new dams being at the confluence of the Orange and Kraai Rivers, and at Mashai in Lesotho. The Modder and Riet tributaries have been fully developed. Significant quantities of groundwater are used in parts of the water management area.

Demographic projections show a small decline in rural population. As the expectations are that this will be balanced by population growth in the Bloemfontein area, little change in the total population of the water management area is anticipated within the period of projection. There are no strong stimulants for economic growth in the area.

Fig. D13: Base map of the Upper Orange water management area



D13.2 Key statistics relevant to the Upper Orange water management area

Tables D13.1 to 13.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Upper Orange water management area. Data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D13.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Senqu Lesotho	4 012	933
Caledon Lesotho	753	92
Caledon RSA	650	90
Kraai	956	158
Riet / Modder	407	45
Vanderkloof	203	31
Total for WMA	**6 981**	**1 349**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with the impact on yield being a portion of this.

Table D13.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Senqu Lesotho	523	0	0	0	0	**523**
Caledon Lesotho	28	1	0	2	0	**31**
Caledon RSA	167	5	4	2	0	**178**
Kraai	34	10	0	0	0	**44**
Riet / Modder	85	6	13	33	0	**137**
Vanderkloof	3 474	43	17	0	0	**3 534**
Total for WMA	**4 311**	**65**	**34**	**37**	**0**	**4 447**

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

Table D13.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local requirements
Senqu Lesotho	8	2	13	0	0	0	**23**
Caledon	12	22	6	0	0	0	**40**
Caledon RSA	88	4	13	0	0	0	**105**
Kraai	84	6	13	0	0	0	**103**
Riet / Modder	252	87	10	2	0	0	**351**
Vanderkloof	336	5	5	0	0	0	**346**
Total for WMA	**780**	**126**	**60**	**2**	**0**	**0**	**968**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D13.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Senqu Lesotho	523	0	23	491	**9**
Caledon Lesotho	31	0	40	0	**(9)**
Caledon RSA	178	0	105	59	**14**
Kraai	44	0	103	0	**(59)** [3]
Riet / Modder	137	242	351	29	**(1)**
Vanderkloof	3 534	0	346	2 809	**379**
Total for WMA	**4 447**	**2**	**968**	**3 148**	**333**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D13.5 and D13.6.
3) The negative balance for the Kraai sub-area is as a result of irrigation requirements that are not fully supplied from run-of-river.

Table D13.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Senqu Lesotho	867	0	23	835	**9**	300
Caledon	30	0	40	0	**(10)**	0
Caledon RSA	273	0	104	118	**51**	0
Kraai	45	0	138	0	**(93)**	0
Riet / Modder	160	301	410	52	**(1)**	0
Vanderkloof	3 359	0	347	2 883	**129**	600
Total for WMA	**4 734**	**2**	**1 062**	**3 589**	**85**	**900**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Water for a 5 000 ha expansion in irrigation farming in the Fish to Tsitsikamma WMA and an expansion of 4 000 ha each in the Upper and Lower Orange WMAs is to be sourced from the Upper Orange WMA. The water requirements of 36 million m^3/a and 54 million m^3/a for the Upper and Lower Orange respectively are provisionally allowed for under the Kraai sub-area and as a transfer from the Vanderkloof sub-area.
3) Brackets around numbers indicate a negative balance.
4) The potential of 900 million m^3/a could be realised by constructing the Mashai Dam in Lesotho in conjunction with the Boskraai Dam at the confluence of the Orange and Kraai Rivers, or by constructing a larger Boskraai Dam on its own.

Table D13.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Senqu Lesotho	867	0	23	835	**9**	300
Caledon	30	0	40	0	**(10)**	0
Caledon RSA	274	0	106	171	**(3)**	0
Kraai	45	0	141	0	**(96)**	0
Riet / Modder	180	354	463	72	**(1)**	0
Vanderkloof	3 359	0	351	2 952	**56**	600
Total for WMA	**4 755**	**2**	**1 124**	**3 678**	**(45)**	**900**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on growth in water requirements as a result of population growth and general economic development. Water for a 5 000 ha expansion in irrigation farming in the Fish to Tsitsikamma WMA and an expansion of 4 000 ha each in the Upper and Lower Orange WMAs is to be sourced from the Upper Orange WMA. The water requirements of 36 million m^3/a and 54 million m^3/a for the Upper and Lower Orange respectively are provisionally allowed for under the Kraai sub-area and as a transfer from the Vanderkloof sub-area.
3) Brackets around numbers indicate a negative balance.
4) The potential of 900 million m^3/a could be realised by constructing the Mashai Dam in Lesotho in conjunction with the Boskraai Dam at the confluence of the Orange and Kraai Rivers, or by constructing a larger Boskraai Dam.

D13.3 Key elements of the broad strategic perspectives for the Upper Orange water management area

An apparent sizeable quantity of the yield of the Orange River is still unutilised, as shown for the Vanderkloof sub-area in Table D13.4. However, this will be substantially reduced once impoundment commences at the Mohale Dam in Lesotho. The deficits in some tributary sub-areas are as a result of provisions for the ecological component of the Reserve, which still needs to be implemented. Large potential for further development exists, partly in Lesotho and partly in the Vanderkloof sub-area. Key issues with regard to the management of water resources in the Upper Orange water management area will therefore relate to the allocation of the surplus that was available in 2000 and the realisation of development potential. These are highly dependent on developments in other water management areas, as well as in Lesotho and Namibia.

A major impact on the water management area is the Lesotho Highlands Water Project. Although South Africa and Lesotho have only committed to Phase 1 of the project, which includes the Katse and Mohale Dams and the Matsoku diversion, the Treaty between the countries provides for the possibility of further phases up to a maximum diversion capacity of 2 200 million m^3/a. Because of the current dramatically lower population growth expectations for South Africa, combined with revised assessments of the hydrology and environmental water requirements, uncertainty exists about the feasibility of developing the Lesotho Highlands Water Project further. A final decision in this respect can only be taken after further investigations and in consultation with the other Orange River Basin countries. Another ongoing joint investigation concerns possible developments in the Caledon River catchment, which is shared by Lesotho and South Africa.

The development of 13 000 ha of new irrigated land for the purposes of rural development, poverty relief and the settlement of emerging farmers has in principle been sanctioned by the Minister of Water Affairs and Forestry. While these developments are to be located in the Upper Orange, Lower Orange and Fish to Tsitiskamma water management areas, most of the water will probably have to be sourced from the Upper Orange water management area. Other priorities are urban and industrial development in Bloemfontein/Botshabelo and the augmentation of supplies to the Port Elizabeth area in the Fish to Tsitsikamma water management area. Additional water may also have to be released from the Upper Orange water management area for use by Namibia. Water quality in the Riet River, as well as flood management in the Lower Orange water management area are also of importance. Although some surplus water is available in the Upper Orange water management area, this is likely to be fully taken up by the additional allowances for irrigation. Depending on the growth in requirements of other users, a deficit can easily result. Due consideration will therefore have to be given to appropriate demand management measures and to ensuring that the available water is used in the most beneficial manner.

Because of the Upper Orange water management area's central location and its linkages to other water management areas, much of the area's water resources are used in other water management areas. Accordingly specific reservations with regard to the use of water from the Upper Orange water management area are:

- The current transfer of 491 million m^3/a from the Senqu River in Lesotho to the Upper Vaal water management area, which is to be increased to 835 million m^3/a when Mohale Dam in Lesotho comes into operation by the year 2004 – reserved through Treaty with Lesotho.

  In view of the reduced projections of water requirements from the Lesotho Highlands Water Project, it is imperative that the minimum quantity of water to be delivered, as specified in Annexure 2 of the Treaty on the Lesotho Highlands Water Project, is revised.
- In view of the reduced projections of water requirements from the Lesotho Highlands Water Project, it is imperative that the minimum quantity of water to be delivered, as specified in Annexure 2 of the Treaty on the Lesotho Highlands Water Project, is revised.
- The transfer of water to the Fish to Tsitsikamma water management area, up to the maximum capacity of the transfer tunnel of approximately 600 million m^3/a, to serve current users as well as requirements for growth in the Port Elizabeth area – reserved in Upper Orange water management area.
- The transfer of 18 million m^3/a from Marksdrift to Douglas Weir in the Lower Vaal water management area for water quality purposes – reserved in Upper Orange water management area.
- The release of water down the Orange River, currently about 2 035 million m^3/a, to meet requirements in the Lower Orange water management area and for use by Namibia. A further 54 million m^3/a for a

possible 4 000 ha new irrigation project in the Lower Orange water management area must also be allowed for – reserved in Upper Orange water management area.

- The agreement with Eskom in respect of water for hydropower generation must be honoured. Revisions to the agreement are, however, required to address the impact of hydropower generation on the flow regime in the river and the impact of further resource developments on power generation more adequately – agreement at national level with Eskom imposes reservation on Upper Orange water management area.
- Large-scale water resource developments on the Orange River as well as on the Caledon and Kraai tributaries, that may impact on the above or on neighbouring countries (including the Senqu in Lesotho), will be subject to authorisation at national level – reservation applies to Upper Orange water management area.
- The allocation of all surplus water in the Upper Orange water management area will resort under national control as this water may be allocated to users in the Upper Orange or other water management areas.

D14 WATER MANAGEMENT AREA 14: LOWER ORANGE

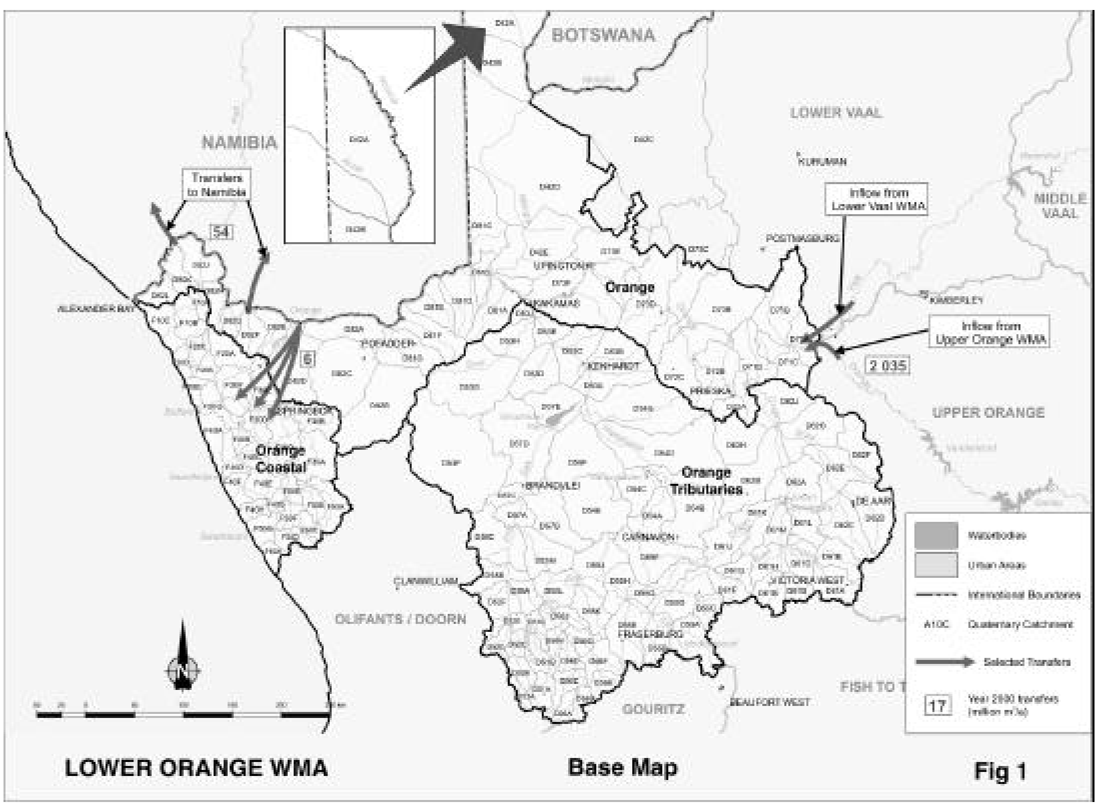
D14.1 Introduction

The geographic extent of the Lower Orange water management area largely corresponds to that of the Northern Cape Province. It is situated in the western extremity of South Africa and borders on Botswana, Namibia and the Atlantic Ocean (see Fig. D14). Climate over the region is harsh semi-desert to desert. Rainfall is minimal, ranging from 400 mm/a to a low of 20 mm/a and is characterised by prolonged droughts. With the exception of sparse and highly intermittent runoff from local tributaries and occasional inflows from the Fish River in Namibia, the Lower Orange water management area is totally dependent on flow in the Orange River from upstream water management areas. Because of the low rainfall, groundwater resources are also limited, although this source is well used for rural water supplies. Important conservation areas in the water management area include the Kgalagadi Transborder National Park, the Augrabies National Park, the Richtersveld National Park and a transboundary Ramsar wetland site at the Orange River mouth.

The largest contributions to the region's economy are made by mining and irrigated agriculture. Mining activities consist mainly of the extraction of alluvial diamonds and a variety of other mineral resources from locations both inland and along the coast. Extensive irrigation occurs along the Orange River, where the tendency is increasingly towards the growing of high-value orchard crops. Namibia also abstracts water from the river for domestic, mining and irrigation purposes. Sheep and other livestock farming is practised where the climate is favourable.

Water resources in the water management area are fully developed. Owing to the fact that water has to travel a distance of 1 400 km from the point of release at Vanderkloof Dam to the most downstream point of use, large operational and transmission losses are incurred in the process of ensuring that the requirements of users are met. Opportunity exists for this situation to be improved by constructing a new dam in the Lower Orange River for the purpose of providing re-regulation storage. Such a dam could serve a secondary function of regulating spills from dams in upstream water management areas. An unique development in the southern tributary catchments is the use of "soomwalle", or soil embankments that retain runoff from the land, as a means of rainfall harvesting.

Fig. D14: Base map of the Lower Orange water management area



Demographic projections show a steady population decline in the water management area over the next 25 years. Economic activity is likely to remain dependent on mining and irrigation farming in the foreseeable future, with modest contributions from eco-tourism. The potential also exists for the development of up to 4 000 ha of new irrigation land for the settlement of emerging farmers and as a means of poverty relief. Water for this purpose will be made available from the Upper Orange water management area.

D14.2 Key statistics relevant to the Lower Orange water management area

Tables D14.1 to 14.6 contain a breakdown of the data given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Lower Orange water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D14.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Orange[3]	198	32
Orange Tributaries	280	35
Orange Coastal	24	2
Total for WMA	**502**	**69**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.
3) Does not include the MAR of 466 million m³/a of the Fish River in Namibia.

Table D14.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield[1]
	Surface water	Ground-water	Irrigation	Urban	Mining and bulk	
Orange	(1 092)	9	96	1	0	**(986)**
Orange Tributaries	9	13	0	0	0	**22**
Orange Coastal	0	3	0	0	0	**3**
Total for WMA	**(1 083)**	**25**	**96**	**1**	**0**	**(961)**

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

Table D14.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Orange	961	12	9	7	0	0	**989**
Orange Tributaries	16	8	7	0	0	0	**31**
Orange Coastal	0	5	1	2	0	0	**8**
Total for WMA	**977**	**25**	**17**	**9**	**0**	**0**	**1 028**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial that 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 also available for other uses.)
4) Quantities refer to the impact on yield only.

Table D14.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in	Local requirements	Transfers out	Balance[1]
Orange	(986)	2 035	989	60	**0**
Orange Tributaries	22	0	31	0	**(9)**
Orange Coastal	3	6	8	0	**1**
Total for WMA	**(961)**	**2 035**	**1 028**	**54**	**(8)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D14.5 and D14.6.

Table D14.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Orange	(981)	2 082	1 042	60	**(1)**	150
Orange Tributaries	22	0	29	0	**(7)**	0
Orange Coastal	2	6	8	0	**0**	0
Total for WMA	**(957)**	**2 082**	**1 079**	**54**	**(8)**	**150**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on normal growth in water requirements as a result of population growth and general economic development. Includes a 4 000 ha increase in irrigated farming land in the Orange sub-area, which will require 54 million m³/a.
3) Brackets around numbers indicate a negative balance.
4) Based on construction of the Vioolsdrift Dam.

Table D14.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Orange	(980)	2 100	1 056	65	**(1)**	150
Orange Tributaries	22	0	33	0	**(11)**	0
Orange Coastal	2	11	13	0	**0**	0
Total for WMA	**(956)**	**2 100**	**1 102**	**54**	**(12)**	**150**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Includes a 4 000 ha increase in irrigated farming land in the Orange sub-area, which will require 54 million m³/a.
3) Brackets around numbers indicate a negative balance.
4) Based on construction of the Vioolsdrift Dam.

D14.3 Key elements of the broad strategic perspective for Lower Orange water management area

The Lower Orange water management area is without doubt the water management area most impacted upon by upstream development, since it lies furthest downstream of five water management areas covering the Orange/Vaal basin. There are extensive inter-catchment transfers between most of these areas. Water use in Lesotho, transfers from Lesotho to the Upper Vaal water management area, the need to share the river's water with Namibia, and the negative yield of the river resulting from evaporation losses, as indicated in Table D14.4, are other factors to be taken into account. Furthermore, water quality along the Lower Orange River is affected by upstream developments and usage, while salinity in this stretch of the river is increased further by irrigation return flows within the water management area itself. Regular liaison with the other Orange River Basin water management areas on issues of common interest is therefore vital, as is the need for the Lower Orange to be managed in a systems context with the Upper Orange and Vaal River water management areas. Water quality management and management of the Orange River estuary in conjunction with Namibia need to receive special attention.

With over 90 per cent of water use in the water management area being for irrigation, it is prudent that specific attention is given to the improvement of irrigation practices, which is a continuous issue, and maximisation of the benefits derived from irrigation. Improved control over abstractions also has to be implemented. Of more localised importance is the development of a plan for the management of the "soomwalle" in view of the impact these have on water availability downstream.

The following reservations apply with regard to the management of the Lower Orange water management area:

- The transfer of water from the Upper Orange water management area, which currently amounts to about 2 035 million m³/a. The water requirement of 54 million m³/a for 4 000 ha of new irrigation development has been included in Tables D14.5 and D14.6 – reserved in Upper Orange water management area.
- The abstraction of water by Namibia and all water-related negotiations and agreements with Namibia are subject to national authorisation. The current arrangement is for Namibia to abstract a firm 50 million m³/a, plus an additional maximum quantity of 60 million m³/a under a temporary arrangement valid until 31st December 2007. However, in the year 2000 only a small portion of the additional allowance was abstracted – international agreement with Namibia imposes reservation on Lower Orange water management area.
- Flood management in the Orange/Vaal catchment will resort under national control because of the interdependence of the Orange/Vaal water management areas in this respect.
- Any new control infrastructure on the Orange River is subject to national authorisation because of its potential impact on Namibia and the requirements for managing the Orange River mouth. Apart from

this, new infrastructure across much of the lower Orange River will involve Namibian territory – reservation applies to lower Orange water management area.

D15 WATER MANAGEMENT AREA 15: FISH TO TSITSIKAMMA

D15.1 Introduction

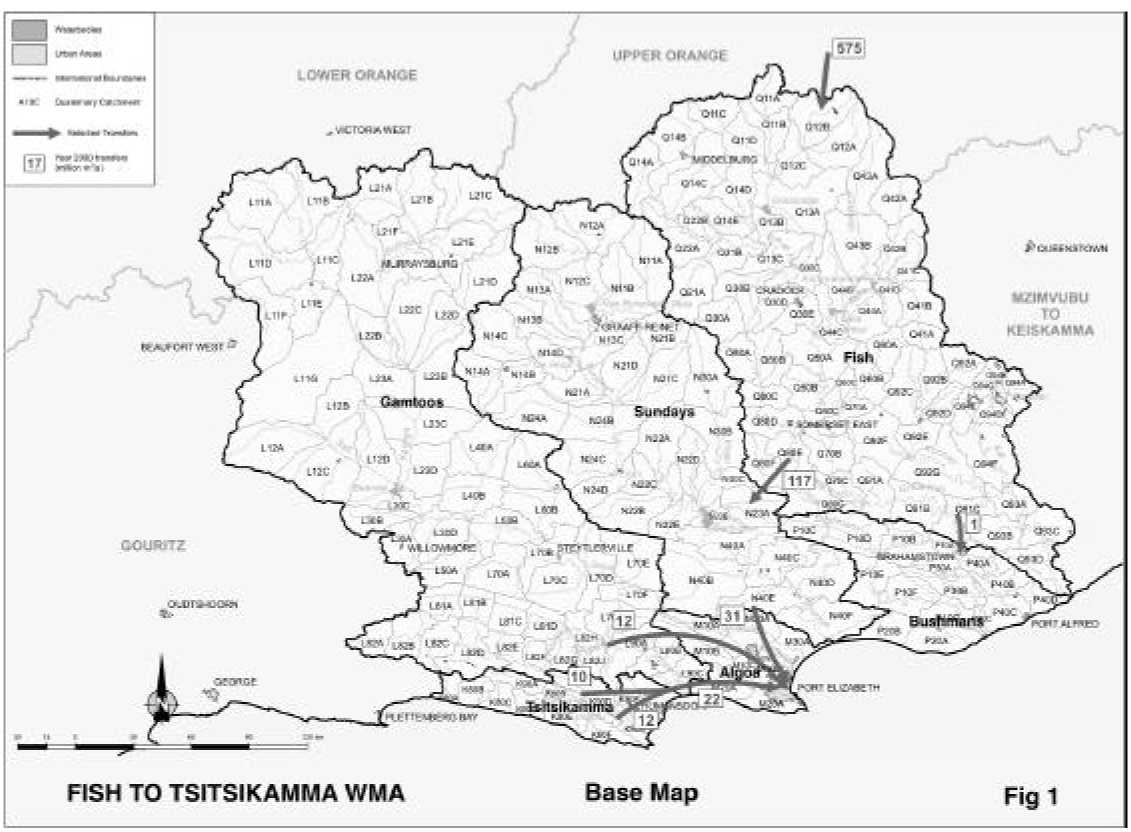
The Fish to Tsitsikamma water management area is situated in the south-eastern part of South Africa, mainly within the Eastern Cape Province. The south-western part of the area is characterised by several mountain ranges lying parallel to the coast, with undulating terrain and localised massives inland. Climate over the water management area is strongly influenced by its location and topography. Typical arid Karoo climate prevails over most of the interior, where annual rainfall ranges from 600 mm to less than 200 mm. Small areas along the coast experience rainfall in excess of 1 000 mm/a. Several national parks and conservation areas are found in the water management area.

Sheep and mohair farming is the main land use, although intensive cultivation of irrigated land occurs along the main rivers. Subsistence farming is practised in the former Ciskei region and timber plantations occupy the high rainfall areas. The economy of the region is dominated by industrial activities in Port Elizabeth and Uitenhage.

Several dams have been constructed in the water management area, but because of the natural poor quality of water draining from the inland areas there is only limited potential for further water resources development. The waters of the Fish and Sundays Rivers (see Fig. D15) are of natural high salinity, and because of this large quantities of good quality water are transferred from the Orange River in the Upper Orange water management area for blending with local resources. Irrigation return flows reaching the main streams contribute to further deterioration of water quality. Groundwater is utilised extensively to supply towns and rural areas and over-exploitation occurs on a localised basis.

Economic growth in the water management area will for the foreseeable future be concentrated in the Port Elizabeth/Uitenhage area (the Algoa sub-area), although an increase in tourism is anticipated along the coast. A strong growth in population is projected for the industrial hub. Economic activity in the inland areas is expected to remain largely unchanged and a small decline in population is projected for these parts.

Fig. D15: Base map of the Fish to Tsitsikamma water management area



D15.2 Key statistics relevant to the Fish to Tsitsikamma water management area

Tables D15.1 to 15.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Fish to Tsitsikamma water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D15.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Fish	518	47
Bushmans	174	15
Sundays	280	20
Gamtoos	491	39
Algoa	147	15
Tsitsikamma	544	107
Total for WMA	**2 154**	**243**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D15.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Fish	(4)	6	77	5	0	**84**
Bushmans	15	2	0	4	0	**21**
Sunday	61	16	22	2	0	**101**
Gamtoos	137	5	2	1	0	**145**
Algoa	10	6	1	6	0	**23**
Tsitsikamma	41	6	1	1	0	**49**
Total for WMA	**260**	**41**	**103**	**19**	**0**	**423**

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

Table D15.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation[4]	Total local requirements
Fish	453	12	6	0	0	2	**473**
Bushmans	11	9	2	0	0	0	**22**
Sunday	174	5	3	0	0	0	**182**
Gamtoos	104	3	3	0	0	1	**111**
Algoa	12	78	1	0	0	0	**91**
Tsitsikamma	11	5	1	0	0	5	**22**
Total for WMA	**765**	**112**	**16**	**0**	**0**	**8**	**901**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 is available for other uses as well.)
4) Quantities refer to the impact on yield only.

Table D15.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Fish	84	575	473	117	**69**
Bushmans	21	1	22	0	**0**
Sunday	101	117	182	31	**5**
Gamtoos	145	0	111	12	**22**
Algoa	23	64	91	0	**(4)**
Tsitsikamma	49	0	22	22	**0**
Total for WMA	**423**	**575**	**901**	**0**	**97**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D15.5 and D15.6.

Table D15.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Fish	95	603	525	145	**28**	25
Bushmans	25	1	29	0	**(3)**	0
Sunday	102	145	184	59	**4**	0
Gamtoos	146	0	112	12	**22**	60
Algoa	36	92	118	0	**10**	0
Tsitsikamma	52	0	24	22	**6**	0
Total for WMA	**456**	**603**	**992**	**0**	**67**	**85**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Includes a provision of 50 million m^3/a for a 5 000 ha increase in irrigated farming land in the Fish sub-area, which may have to be sourced from the Upper Orange water management area.
3) Brackets around numbers indicate a negative balance.
4) Based on construction of the Foxwood and Guerna Dams. Unquantified potential also exists in the Tsitsikamma sub-area.

Table D15.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-men[4]
Fish	97	653	530	195	**25**	25
Bushmans	25	1	33	0	**(7)**	0
Sunday	102	195	185	109	**3**	0
Gamtoos	146	0	113	12	**21**	60
Algoa	28	142	169	0	**1**	0
Tsitsikamma	52	0	27	22	**3**	0
Total for WMA	**450**	**653**	**1 057**	**0**	**46**	**85**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on high growth in water requirements as a result of population growth and the high impact of economic development. Includes a provision of 50 million m^3/a for a 5 000 ha increase in irrigated farming land in the Fish sub-area, which may have to be sourced from the Upper Orange water management area.
3) Brackets around numbers indicate a negative balance.
4) Based on construction of the Foxwood and Guerna Dams. Unquantified potential also exists in the Tsitsikamma sub-area.

D15.3 Key elements of the broad strategic perspectives for the Fish to Tsitsikamma water management area

The dominant feature in respect of water resource management in the Fish to Tsitsikamma water management area is the large transfer of water from the Upper Orange water management area into the catchments of the Fish and Sundays Rivers, equal to nearly 10 times the local surface water yield in these sub-areas. Furthermore, about 96 per cent of the water used in these sub-areas is for irrigation, which is virtually fully supported by water from the Orange River. Since most of the irrigation canals are unlined, large distribution losses are experienced and this contributes to large volumes of irrigation return flows. Management of water quality in the Fish and Sundays Rivers is also a particular priority.

Currently all water requirements can be supplied in full, including the provisions for the ecological component of the Reserve. Most of the surpluses shown in Table D15.4 result from return flows being discharged to the ocean and of which the salinity may be too high for direct application to most uses without blending or treatment.

Further growth in water requirements in this water management area will be concentrated in the greater Port Elizabeth area. Options for reconciling water requirements and availability are described in Section 2.5. Priority is to be given to water demand management. The best options for augmenting supplies are an increase in the use of water from the Orange River, as well as the possible construction of a new dam on the Kouga River. The Minister has also given approval in principle for the development of a maximum of 5 000 ha new irrigation for poverty relief and the settlement of emerging farmers. Water for this development is to be sourced from the Upper Orange water management area and the water requirement has been included in Tables D15.5 and D15.6.

Key elements in respect of the management of water resources in the Fish to Tsitsikamma water management area therefore relate to:

- the efficient use of transferred water and the proper management of water quality;
- the achievement of improved irrigation efficiencies and the maximisation of the benefits derived; and
- ensuring sufficient future water supplies to the Port Elizabeth area.

A reservation will apply to the Upper Orange water management area with regard to the transfer of up to a maximum of 600 million m^3/a of water from the Upper Orange water management area to serve current allocations in the Fish to Tsitsikamma water management area. Additional water from the Orange River will be subject to national authorisation. A reservation is also placed on the Fish to Tsitsikamma water management area with respect to the construction of the proposed Guerna Dam, which will be subject to national authorisation because of its inter-dependence with transfers from the Orange River.

D16 WATER MANAGEMENT AREA 16: GOURITZ

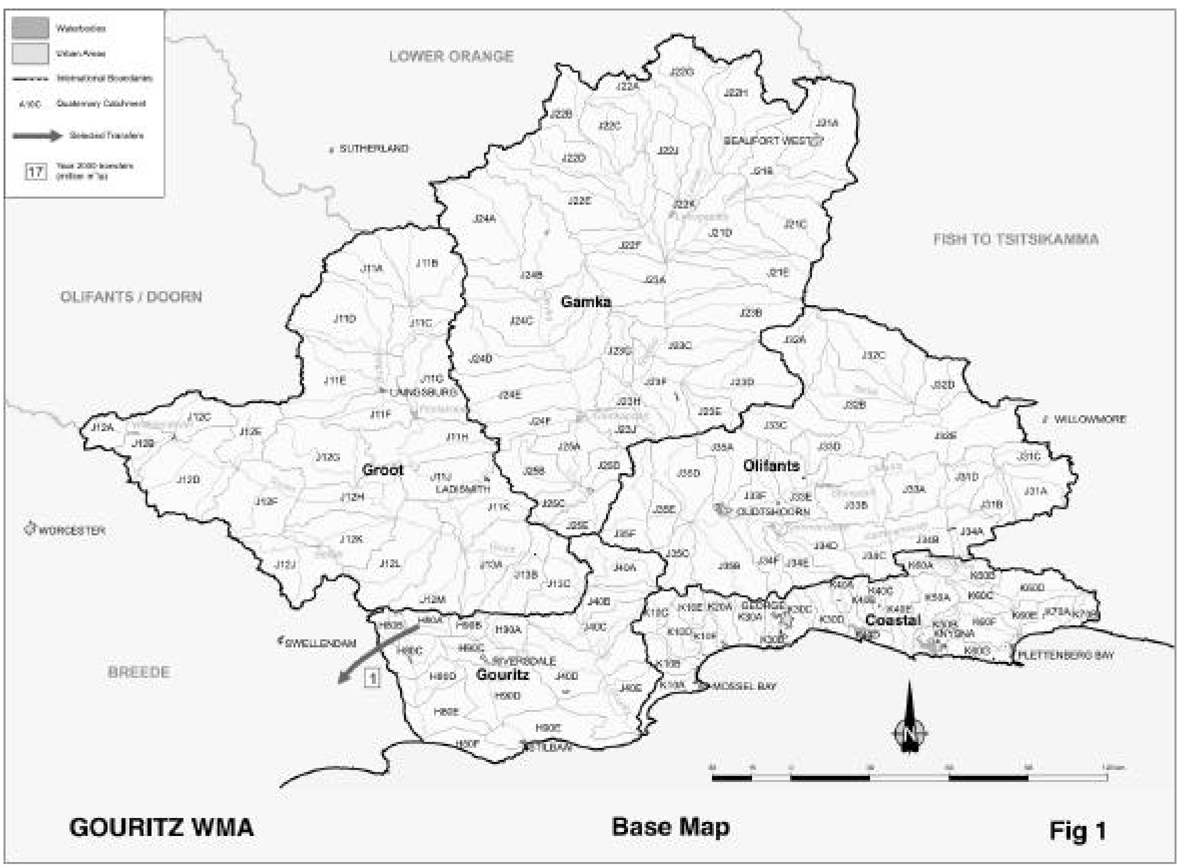
D16.1 Introduction

The Gouritz water management area is situated along the southern coast of South Africa and extends inland across the Little Karoo and into the Great Karoo. The area has two primary climatic regions that display distinctly different characteristics: the large arid inland Karoo area drained by the Gouritz River and the smaller humid strip of land along the coastal belt to the south of the Outeniqua Mountains which is drained by several small rivers (see Fig. D16). Rainfall ranges from less than 200 mm/a to over 1 000 mm/a. Economic activity is centred on sheep and ostrich farming in the arid areas, with extensive irrigation farming of lucerne, grapes and deciduous fruit in the Little Karoo, and on forestry, tourism and petrochemical industries in the coastal region. Indigenous forests, wetlands and estuaries of high conservation status are found in the humid areas. The water in the arid areas is naturally of high salinity as a result of the geology and climate.

Several dams control the Gouritz River and its tributaries. Dams have also been constructed on some of the coastal rivers, where potential for further regulation remains. A substantial proportion of the yield is from groundwater and there is strong interdependence between surface water and groundwater in the Olifants River valley. The potential of utilising the deep groundwater from the Table Mountain Group aquifers is being investigated. A small quantity of water - 0.7 million m³/a - is transferred to the Breede water management area for rural water supply.

A decline in population is foreseen in the inland areas, with little change in the requirements for water. However, a strong potential for growth, related to tourism, eco-tourism and possible further petrochemical developments based on offshore gas-field exploration exists in the coastal area.

Fig D16: Base map of the Gouritz water management area



D16.2 Key statistics relevant to the Gouritz water management area

Tables D16.1 to D16.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Gouritz water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D16.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Gamka	227	19
Groot	105	5
Olifants	229	17
Gouritz	347	56
Coastal	771	228
Total for WMA	**1 679**	**325**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D16.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Gamka	24	24	0	0	0	**48**
Groot	19	23	0	0	0	**42**
Olifants	49	15	3	4	0	**71**
Gouritz	54	1	3	1	0	**59**
Coastal	45	1	2	1	6	**55**
Total for WMA	**191**	**64**	**8**	**6**	**6**	**275**

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

Table D16.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Gamka	49	5	1	0	0	0	**55**
Groot	49	2	2	0	0	0	**53**
Olifants	62	10	2	0	0	0	**74**
Gouritz	51	3	3	0	0	1	**58**
Coastal	43	32	3	6	0	14	**98**
Total for WMA	**254**	**52**	**11**	**6**	**0**	**15**	**337**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D16.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Gamka	48	0	55	0	**(7)**
Groot	42	0	53	0	**(11)**
Olifants	71	0	74	0	**(3)**
Gouritz	59	0	58	1	**0**
Coastal	55	0	98	0	**(43)**
Total for WMA	**275**	**0**	**338**	**1**	**(64)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D16.5 and D16.6.

Table D16.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Gamka	48	0	55	0	**(7)**	0
Groot	43	0	52	0	**(9)**	0
Olifants	71	0	75	0	**(4)**	0
Gouritz	60	0	58	1	**1**	10
Coastal	56	0	116	0	**(60)**	100
Total for WMA	**278**	**0**	**356**	**1**	**(79)**	**110**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Provisional estimates, subject to detailed investigations of environmental impacts and feasibility of developments.

Table D16.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Gamka	48	0	60	0	**(12)**	0
Groot	43	0	53	0	**(10)**	0
Olifants	78	0	90	0	**(12)**	0
Gouritz	61	0	61	1	**(1)**	10
Coastal	58	0	181	0	**(123)**	100
Total for WMA	**288**	**0**	**445**	**1**	**(158)**	**110**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Provisional estimates, subject to detailed investigations of environmental impacts and feasibility of developments.

D16.3 Key elements of the broad strategic perspectives for the Gouritz water management area

At current levels of development, deficits occur in all the sub-areas with the exception of the lower Gouritz River (refer to Table D16.4). The deficits are mainly the result of irrigation requirements that are in excess of the available water, but where farming practices have been adapted accordingly. Particularly in the dry inland areas irrigation is at a very low assurance of supply and large areas are only cultivated in years when water is available. The deficit reflected for the coastal region is mostly attributable to the provision made for implementation of the Reserve. Under current conditions, without formal provision for the full Reserve, all urban/industrial uses can be fully supplied. However, the total irrigation requirements cannot always be supplied from run-of-river. Careful assessment of Reserve requirements and proper implementation planning is therefore necessary.

With future growth expected to be concentrated along the coastal belt, a strong growth in water requirements could be experienced in this region. Although significant potential exists for the further development of surface resources, the occurrence of the resources in an area that is very important environmentally and ecologically sensitive is likely to be a limiting factor. Apart from the general options for reconciling water requirements and availability, as described in Section 2.5, the utilisation of groundwater from the Table Mountain Group aquifers, which currently spills directly into the ocean, may hold good promise and should be investigated further.

It is essential for the proper management of water resources in the water management area that the surface water/groundwater interrelationship in the Olifants River valley is clearly understood and quantified. Priority should be afforded to research in this area.

A reservation will apply to the Gouritz water management area with respect to the transfer of 0.7 million m^3/a of water to the Breede water management area.

D17 WATER MANAGEMENT AREA 17: OLIFANTS/DOORN

D17.1 Introduction

The Olifants/Doorn water management area lies on the west coast of South Africa along the Atlantic Ocean and is shared by the Western Cape and Northern Cape provinces. It is one of the most diverse water management areas in the country with respect to its natural characteristics and water resources. Prominent topographic features are the Cederberg range and the narrow Olifants River valley. Rainfall varies from over 1 000 mm/a in the extreme south to less than 100 mm/a in the north, and a harsh and arid climate prevails over most of the water management area.

Virtually all the surface flow originates from the small, high-rainfall area around the Cederberg and is carried to the ocean by the Olifants River and its main tributary, the Doring River (see Fig. D17). A unique flow and water quality regime is created by the natural characteristics of the region, which provides a habitat for aquatic species of high conservation importance.

Fig D17: Base map of the Olifants/Doorn water management area

Economic activity in the water management area is centred on irrigated agriculture and 95 per cent of total water use is for irrigation. Intensive production of deciduous fruits, citrus and grapes occurs in the Koue Bokkeveld and along the Olifants River. The arid areas remote from the rivers are sparsely populated, with sheep and goat farming as the main activity. There are no large towns or urban areas in the water management area.

Surface water in the Olifants River is regulated by the Clanwilliam Dam and the Bulshoek Barrage. There are no large dams on the Doring River, although a large number of farm dams have been constructed on the upper tributaries. Significant potential for further water resource development exists, mainly on the Doring River, but is tempered by serious concerns about the potential impacts of such development on the sensitive ecosystems. Groundwater is used extensively in the water management area. In particular large quantities are abstracted for irrigation in the Sandveld area. The potential has also been identified for the possible abstraction of sizeable quantities of water from the deep Table Mountain Group aquifers.

Demographic projections show a future population decline in the water management area. Economic development is likely to be modest and will depend mainly on further irrigation development and the development of tourism.

D.17.2 Key statistics relevant to the Olifants/Doorn water management area

Tables D 17.1 to 17.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Olifants/Doorn water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D 17.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1, 2]
Koue Bokkeveld	279	29
Sandveld	60	8
Olifants	514	77
Knersvlakte	27	3
Doring	228	39
Total for WMA	**1 108**	**156**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D 17.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Koue Bokkeveld	59	5	3	0	0	**67**
Sandveld	2	30	0	0	0	**32**
Olifants	196	4	19	2	0	**221**
Knersvlakte	1	3	0	0	0	**4**
Doring	8	3	0	0	0	**11**
Total for WMA	**266**	**45**	**22**	**2**	**0**	**335**

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

Table D 17.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation[4]	Total local requirements
Koue Bokkeveld	65	0	1	0	0	0	**66**
Sandveld	35	2	1	0	0	0	**38**
Olifants	240	4	2	0	0	1	**247**
Knersvlakte	3	0	1	3	0	0	**7**
Doring	13	1	1	0	0	0	**15**
Total for WMA	**356**	**7**	**6**	**3**	**0**	**1**	**373**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower generally is available for other uses as well.)
4) Quantities refer to the impact on yield only.

Table D 17.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Koue Bokkeveld	67	0	66	0	**1**
Sandveld	32	0	38	0	**(6)**
Olifants	221	0	247	3	**(29)**
Knersvlakte	4	3	7	0	**0**
Doring	11	3	15	0	**(1)**
Total for WMA	**335**	**3**	**373**	**0**	**(35)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown for 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. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D17.5 and D17.6.

Table D 17.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Koue Bokkeveld	67	0	66	0	**1**	0
Sandveld	32	0	38	0	**(6)**	0
Olifants	221	0	247	3	**(29)**	10
Knersvlakte	4	3	7	0	**0**	0
Doring	11	3	15	0	**(1)**	175
Total for WMA	**335**	**3**	**373**	**0**	**(35)**	**185**

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

Table D 17.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Koue Bokkeveld	67	0	65	0	**2**	0
Sandveld	32	0	42	0	**(10)**	0
Olifants	223	0	251	3	**(31)**	10
Knersvlakte	4	3	7	0	**0**	0
Doring	11	3	15	0	**(1)**	175
Total for WMA	**337**	**3**	**380**	**0**	**(40)**	**185**

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

D.17.3 Key elements of the broad strategic perspectives for the Olifants/Doorn water management area

The requirement for and availability of water are generally in balance over most of the water management area. Exceptions are in the Olifants River valley upstream of Clanwilliam Dam, where irrigation requirements have outstripped availability, and in the Sandveld area where some over-exploitation of groundwater is known to occur. The shortages in the Olifants River will be exacerbated by the implementation of the ecological component of the Reserve, which accounts for close to half of the deficit shown in Table D 17.4.

Options for reconciling water requirements and availability are described in Section 2.5. The following key aspects need to be considered in the management of the Olifants/Doorn water management area:

- The unique seasonal salinity regime of the Olifants/Doring River system and its importance to riverine species and fish breeding in the estuary. Much of the Doring River is still in a relatively pristine state and specific caution is warranted.
- Further research needs to be undertaken of the characteristics of the Sandveld aquifers to facilitate their proper management and to ensure that future priority requirements for water can be met.
- The deep Table Mountain Group aquifers may hold good potential for the abstraction of large quantities of groundwater. Many unknowns still exist, however, and these need to be clarified before any large-scale development can be embarked upon.

Water needs to be reserved in the Breede water management area with respect to the existing inter-water management area transfer to the Olifants/Doorn water management area. Currently this involves the transfer of 2.5 million m^3/a to the Inverdoorn canal for irrigation purposes – reserved in the Breede water management area.

Considering the possible implications of climate change, and indications that its impacts may be manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede water management areas are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.

D18 WATER MANAGEMENT AREA 18: BREEDE

D18.1 Introduction

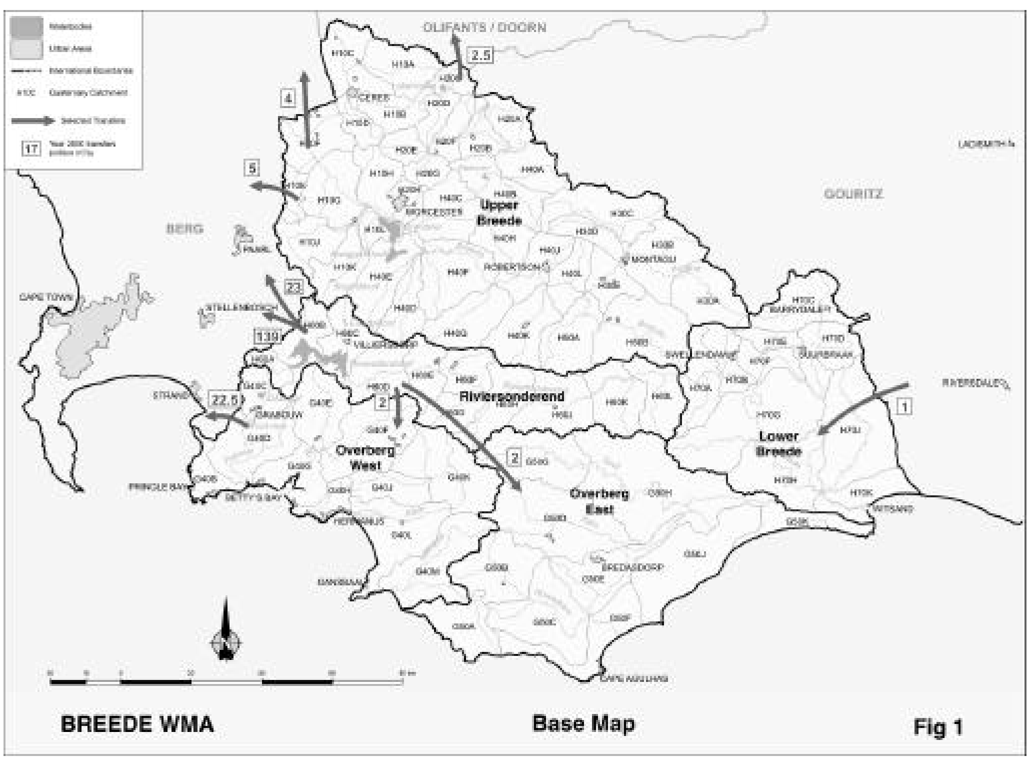
The Breede water management area is the southern-most water management area in South Africa and lies entirely in the Western Cape Province. The climate in the area varies considerably. In the western mountainous regions rainfall can exceed 1 500 mm/a, while in the lower eastern parts of the area the rainfall decreases to about 300 mm/a. Rainfall occurs during the winter. The greater part of the water management area is drained by the Breede River and its main tributary, the Riviersonderend River (see Fig. D18). Several small coastal rivers drain the southern part of the water management area, while vleis with no outflow to the sea are found in the south-east. The lower Palmiet River and the vlei areas are of high conservation importance.

The economy of the region is mainly agriculture-based, with tourism at resort towns along the coast. Extensive vineyards and fruit orchards are grown under irrigation, fed by water from mountain streams and the Breede River as well as groundwater. Dryland wheat is cultivated between the Riversonderend and the coastal mountains, while livestock farming is practised throughout the region.

Several large dams, some of which are off-channel, and many farm dams have been constructed in the water management area. A unique feature is the operation of Theewaterskloof Dam. Water is transferred into the dam from the Berg water management area for seasonal storage and is then transferred back to that area during the dry season together with a larger quantity of additional water from the Breede water management area. Water is also transferred from the Palmiet River to the Berg water management area via the Palmiet Pumped Storage Scheme. Water in the lower Breede River is highly saline. This is attributable to natural mineralisation because of the geology of the region and irrigation return flows, which renders the water unfit for further irrigation use. Strong inter-dependence exists between groundwater and surface water in parts of the water management area. A sizeable potential for resource development remains in the area.

Demographic projections indicate population growth in the coastal areas, but a decline in inland areas, as a result of which the total population is anticipated to remain relatively constant. Because of the poor performance of the region's agricultural sector in recent times, no significant economic growth is foreseen over the short term, but this may change.

Fig. D18: Base map of the Breede water management area



D18.2 Key statistics relevant to the Breede water management area

Tables D18.1 to D18.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Breede water management area. Data is derived primarily from the standardised database. Different information may be available from other sources.

Table D18.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Upper Breede	1 212	178
Riviersonderend	460	65
Lower Breede	210	34
Overberg East	110	13
Overberg West	480	94
Total for WMA	**2 472**	**384**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D18.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
Upper Breede	348	97	44	12	0	**501**
Riviersonderend	220	4	2	0	0	**226**
Lower Breede	30	4	1	1	0	**36**
Overberg East	1	1	0	0	0	**2**
Overberg West	88	3	6	2	0	**99**
Total for WMA	**687**	**109**	**53**	**15**	**0**	**864**

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

Table D18.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local requirements
Upper Breede	435	26	4	0	0	0	**465**
Riviersonderend	49	1	2	0	0	1	**53**
Lower Breede	28	2	1	0	0	0	**31**
Overberg East	0	2	2	0	0	0	**4**
Overberg West	64	8	2	0	0	5	**79**
Total for WMA	**576**	**39**	**11**	**0**	**0**	**6**	**632**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D18.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Upper Breede	501	0	465	35	**1**
Riviersonderend	226	0	53	174	**(1)**
Lower Breede	36	33	31	0	**38**
Overberg East	2	2	4	0	**0**
Overberg West	99	2	79	23	**(1)**
Total for WMA	**864**	**1**	**632**	**196**	**37**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to total transfers into and out of the WMA. The same applies to Tables D18.5 and D18.6.

Table D18.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Upper Breede	503	0	467	35	**1**	79
Riviersonderend	227	0	52	174	**1**	24
Lower Breede	36	33	31	0	**38**	12
Overberg East	3	2	3	0	**2**	0
Overberg West	100	2	83	23	**(4)**	9
Total for WMA	**869**	**1**	**636**	**196**	**38**	**124**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a 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 a negative balance.
4) Based on the construction of various schemes in the Breede WMA (Mitchells Pass diversion, Upper Molenaars diversion, Wit River Dam, the raising of the Buffeljags Dam, small schemes in the Breede catchment and Campanula Dam on the Palmiet River).

Table D18.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers In	Local requirements[2]	Transfers out	Balance[3]	Potential for development[4]
Upper Breede	525	0	513	11	**1**	79
Riviersonderend	228	0	54	173	**1**	24
Lower Breede	38	8	34	0	**12**	12
Overberg East	3	2	7	0	**(2)**	0
Overberg West	103	2	95	23	**(13)**	9
Total for WMA	**897**	**1**	**703**	**196**	**(1)**	**124**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the construction of various schemes in the Breede WMA (Mitchells Pass diversion, Upper Molenaars diversion, Wit River Dam, the raising of the Buffeljags Dam, small schemes in the Breede catchment and Campanula Dam on the Palmiet River).

D18.3 Key elements of the broad strategic perspectives for the Breede water management area

In general, there is sufficient yield available in the Breede water management area to meet all existing water requirements. Small surpluses currently exist in the Upper Breede and Riviersonderend catchments, but will be taken up with the implementation of the Reserve. Substantial potential for further water resources development exists.

With over 90 per cent of water used in the area being for irrigation, it would be prudent for specific attention to be given to the continuous improvement of irrigation practices and the maximisation of the benefits derived.

Priority considerations in respect of water resources management in the Breede water management area include:

- Improvement of irrigation efficiencies.
- The management of salinity levels in the Breede River.
- The improved management of groundwater abstraction. Greater knowledge is needed of aquifer and recharge characteristics, and in particular the interdependencies between groundwater and surface water.
- Additional transfers are likely to be required in future, possibly even within the period under consideration, to serve the greater Cape Town area in the Berg water management area. Although water does not specifically need to be reserved for this purpose at this stage, it would be prudent not to forfeit this option unintentionally by the development of less beneficial projects. Care must therefore be taken that the construction of any new large infrastructure does not prejudice future water transfer options to the Berg water management area.
- No further afforestation should be allowed without the impacts on the ecological component of the Reserve, groundwater recharge and the sensitive salinity balance having been determined and found acceptable.

Water that has to be reserved in the Breede WMA for transfers include the following:

- The transfer of water between the Breede and Berg water management areas via the Riviersonderend/Berg River Scheme. This involves a net transfer of 162 million m^3/a to the Berg water management area.
- The transfer of a maximum of 50 million m^3/a from the Palmiet River to the Berg water management area. The average transfer is about 22.5 million m^3/a.
- Smaller transfers to the Berg water management area amounting to 9 million m^3/a.
- The transfer of a maximum of 2.5 million m^3/a to the Olifants/Doorn water management area through the Inverdoorn Canal.
- A maximum of 2 million m^3/a is reserved in the Gouritz water management area for transfer to the Breede water management area for rural water supply.
- A reservation also applies to the Breede water management area with respect to any new large scale water resource developments which may impact on future transfers to the Berg water management area.

Considering the possible implications of climate change, and indications that its impacts may manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede water management areas are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.

D19 WATER MANAGEMENT AREA 19: BERG

D19.1 Introduction

The Berg water management area commands the south-western corner of South Africa. The Berg River is the only major river in the water management area, although there are several smaller rivers and streams draining to the ocean, as shown in Fig. D19. High mountain ranges characterise the east and south-east of the water management area, from where most of the runoff originates, the most well-known being Table Mountain and the Cape Peninsula mountains in the south-west. Sandy lowlands, with minimal runoff, extend across the central and western part of the water management area. Rainfall occurs in winter and is highly varied, ranging from a high of over 3 000 mm/a in the mountains to less than 300 mm/a in the north-west. The Cape Fynbos represents a unique floral kingdom of World Heritage status.

A strong and diversified economy exists in the water management area, which is dominated by industrial and other activities in the Cape Town metropolitan area. However, a close interdependency, particularly with respect to tourism and agriculture, exists with the economic activities of the surrounding area and further inland.

Fig D19: Base map of the Berg water management area

Intensive viticulture and fruit farming, under sophisticated irrigation, are found in the valleys and foothills of the mountains. This changes to extensive rain-fed wheat cultivation in the central regions.

Several large dams and numerous farm dams regulate the surface runoff from the water management area. Regulation will be increased by the addition of the new dam on the Berg River near Franschoek (the Berg Water Project), which has been approved for construction. Significant quantities of groundwater are also abstracted, mainly in the central and western parts of the water management area, with small-scale artificial recharge of groundwater being practised in the vicinity of Atlantis. Large quantities of water are transferred into the area from the Breede water management area via the Riviersonderend/Berg River Scheme and the Palmiet Pumped Storage Scheme (also refer to D18 - Breede water management area). Further potential for the development of water resources exists mainly with respect to the Berg River, although salinity in the lower reaches of the river is becoming a problem, largely as a result of irrigation return flows. Potential may also exist for the abstraction of significant quantities of groundwater from the Table Mountain Group aquifers in the foothills to the east.

Strong economic growth in the Cape Town metropolitan area and vicinity is expected in the foreseeable future. This area is thus likely to form the nucleus for population growth in the water management area.

D19.2 Key statistics relevant to the Berg the water management area

Tables D19.1 to 19.6 contain a breakdown of the information given in Tables 2.1 to 2.6 of Chapter 2 for each sub-area of the Berg water management area. Data is derived primarily from the standardised data base. Different information may be available from other sources.

Table D19.1: Natural mean annual runoff (MAR) and ecological Reserve (million m³/a)

Component/ Sub-area	Natural MAR[1]	Ecological Reserve[1,2]
Greater Cape Town	373	61
Upper Berg	849	124
Lower Berg	207	32
Total for WMA	**1 429**	**217**

1) Quantities are incremental and refer to the sub-area under consideration only.
2) The total volume is based on preliminary estimates, with impact on yield being a portion of this.

Table D19.2: Available yield in the year 2000 (million m³/a)

Component/ Sub-area	Natural resource		Usable return flow			Total local yield
	Surface water[1]	Ground-water	Irrigation	Urban	Mining and bulk	
GreaterCape Town	66	20	0	22	0	**108**
Upper Berg	284	15	8	15	0	**322**
Lower Berg	30	22	0	0	0	**52**
Total for WMA	**380**	**57**	**8**	**37**	**0**	**482**

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

Table D19.3: Water requirements for the year 2000 (million m³/a)

Sector/ Sub-area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Affores-tation[4]	Total local require-ments
Greater Cape Town	46	343	5	0	0	0	**394**
Upper Berg	202	23	4	0	0	0	**229**
Lower Berg	53	23	5	0	0	0	**81**
Total for WMA	**301**	**389**	**14**	**0**	**0**	**0**	**704**

1) Includes component of Reserve for basic human needs at 25 l/c/d.
2) Mining and bulk industrial water uses that 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 refer to the impact on yield only.

Table D19.4: Reconciliation of water requirements and availability for the year 2000 (million m³/a)

Component/ Sub-area	Local yield	Transfers in[2]	Local requirements	Transfers out[2]	Balance[1]
Greater Cape Town	108	269	394	0	**(17)**
Upper Berg	322	32	229	125	**0**
Lower Berg	52	18	81	0	**(11)**
Total for WMA	**482**	**194**	**704**	**0**	**(28)**

1) Brackets around numbers indicate a negative balance. Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. The addition of the quantities transferred per sub-area does therefore not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables D19.5 and D19.6.

Table D19.5: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Greater Cape Town	111	350	508	0	**(47)**	27
Upper Berg	405	32	235	206	**(4)**	100
Lower Berg	52	18	87	0	**(17)**	0
Total for WMA	**568**	**194**	**830**	**0**	**(68)**	**127**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes the Berg Water Project and return flows resulting from a growth in requirements.
2) Based on a growth in water requirements as a result of population growth and general economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the raising of the Voëlvlei Dam, and potential diversions from Lourens River and Eerste River.

Table D19.6: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Component/ Sub-area	Local yield[1]	Transfers in	Local requirements[2]	Transfers out	Balance[3]	Potential for develop-ment[4]
Greater Cape Town	124	350	913	0	**(439)**	27
Upper Berg	422	32	270	206	**(22)**	100
Lower Berg	56	18	123	0	**(49)**	0
Total for WMA	**602**	**194**	**1 306**	**0**	**(510)**	**127**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes the Berg Water Project and return flows resulting from a growth in requirements.
2) Based on a high growth in water requirements as a result of population growth and the high impact of economic development. Assumes no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.
4) Based on the raising of the Voëlvlei Dam, and potential diversions from Lourens River and Eerste River.

D19.3 Key elements of the broad strategic perspectives for the Berg water management area

Water requirements in the greater Cape Town sub-area are already well in excess of water availability. Part of the deficits reflected in Table D19.4, however, is attributable to the provision made for the implementation of the ecological component of the Reserve at a later stage. With Cape Town as one of the main growth centres in the country, its strong economic and population growth is projected to continue and this will impact on the future requirements for water. Given the lucrative nature of irrigated agriculture in the water management area, continuous pressure also exists for more water to be made available for irrigation.

Ensuring the sufficient future supply of water to the Cape Town area should be the highest priority for water resource management in the Berg water management area. In an effort to alleviate the situation while implementation planning for the construction of the Berg Water Project is in progress, vigorous initiatives are being taken with regard to water demand management. There will nevertheless be an ongoing need to continue augmenting water resources, and options identified to meet future requirements include the further development of local surface water resources, the exploration of deep groundwater from Table Mountain Group aquifers, increased re-use of urban effluent, additional transfer of water from the Breede River water management area and desalination of sea water.

To facilitate a more accurate assessment of the extent to which local resources may still be developed, priority should be given to determining the ecological component of the Reserve. Until clarity has been gained on the most beneficial use of the remaining resource potential, consideration should be given to imposing a temporary embargo on the construction of new farm dams in the Berg River catchment and on increased pumping from the river. Investigations should also continue to improve knowledge on the potential for utilisation of groundwater from the Table Mountain Group aquifers.

Reservations will apply to the Breede water management area with respect to the transfer of water from the Breede to the Berg water management area. Current transfers are as follows:

- 162 million m^3/a from the Riviersonderend catchment.
- 22.5 million m^3/a on average from the Palmiet River, with a maximum capacity of 50 million m^3/a.
- Smaller transfers from the Breede water management area amounting to 9 million m^3/a.

The construction of any large new water infrastructure in the Breede water management area that may impact materially on future water transfers to the Berg water management area will be subject to national approval in order to ensure that options for future water transfers are not inadvertently jeopardized – a reservation in this respect applies to the Breede water management area.

Considering the possible implications of climate change, and indications that its impacts may manifest first in the south-western parts of the country, it is important that the hydrological parameters in the Berg and Breede water management areas are monitored closely. No development or investment decisions should be made that neglect to take into account the actual or potential affects of climatic change on water resources.