



**DEPARTMENT OF
WATER AFFAIRS AND FORESTRY**
Directorate: National Water Resource Planning

Internal Strategic Perspective Upper Orange Water Management Area



April 2004

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**INTERNAL STRATEGIC PERSPECTIVE
FOR THE
UPPER ORANGE WATER MANAGEMENT AREA (WMA No 13)**

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INVITATION TO COMMENT

This report will be updated on a regular basis until it is eventually superseded by the Catchment Management Strategy. Water users and other stakeholders in the Upper Orange WMA and other areas are encouraged to study this report and to submit any comments they may have to the Version Controller (see box overleaf).

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- Internal Strategic Perspective Upper Orange WMA (*This Report*)
(Report No: P WMA 13/000/00/0304)
- The National Water Resource Strategy, First Edition 2004
- The Upper Orange WMA - Overview of Water Resources Availability and Utilisation (Report No: P WMA 13/000/00/0203)
- The Upper Orange WMA – Water Resources Situation Assessment (Report No: P WMA 13/000/00/0101)
- Internal Strategic Perspective for the Orange River System Overarching (Report No: P RSA D000/00/0104)

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Internal Strategic Perspective

Upper Orange River Water Management Area

EXECUTIVE SUMMARY

Introduction

The Internal Strategic Perspective (ISP) for the Upper Orange Water Management Area (WMA) is described in this document, and represents the Department of Water Affairs' (DWAF) view on how Integrated Water Resource Management (IWRM) should be practiced in the WMA.

The emphasis in this document is on aspects that are specific to Upper Orange WMA. The Upper Orange WMA is part of a greater water supply system, which includes a number of neighbouring WMAs and Lesotho. The strategies for IWRM for the greater system are presented in the Orange Overarching ISP. The Upper Orange ISP should be read in conjunction with the Orange Overarching ISP to get a complete understanding of the strategies and issues.

The information in the report has been compiled from past studies, but more importantly, it captures the knowledge of DWAF officials that are active in the different spheres of water resource management of the Orange River System. In the drafting of the perspectives or strategies contained in this document, cognisance was taken of the legal requirements of the National Water Act and the strategic direction or framework given by the National Water Resource Strategy (NWRS).

Water resource management is carried out in a changing environment and it should be recognised that this ISP is based on the prevailing situation and conditions at the time of compiling the document. It is the intention of DWAF to regularly update this document to keep the information and strategies relevant.

Overview of the Upper Orange Water Management Area

The Upper Orange Water Management Area lies predominantly within the Free State, but also occupies portions of the Eastern and Northern Cape provinces. It borders on Lesotho in the east as well as on six other water management areas. The Orange River, which rises in the eastern highlands of Lesotho where it is known as the Senqu River, is the main river in the water management area and is also the largest and longest river in South Africa.

Climate over the water management area is cool to temperate and ranges from semi-arid to arid. Rainfall mainly occurs as summer thundershowers, and reduces dramatically from as high as 1 000 mm per year in South Africa at locations in the east to about 200 mm per year in the west. In Lesotho, which is the source of most of the water in the Upper Orange Water Management Area, rainfall varies between 600 mm per year to about 1 500 mm per year. Potential evaporation over most of the WMA is well in excess of the rainfall.

Bloemfontein and Thaba 'Nchu represent the main urban and industrial development in the Water Management Area. Two large hydropower stations were constructed at Gariiep and Vanderkloof Dams in the Orange River. Mining activities have significantly declined and currently mainly relate to salt works and small diamond mining operations.

Approximately 5% of the Gross Domestic Product (GDP) of South Africa originates from the Upper Orange WMA. Potential for growth can be found in the agricultural sector converting to higher value products, such as from grains to orchard crops and cut flowers, and through further processing and packaging. The largest economic sectors (in 1997) in terms of GGP are Government, finance, trade and transport.

From a water resource management perspective this is a pivotal WMA as some of the largest dams in Africa have been built on the rivers of the Senqu catchment in Lesotho and on the main stem of the Orange River in South Africa. The Orange River in this area is characterized by the transfer of large quantities of water, both within and out of the WMA. Transfers out of the WMA include transfers to the Upper Vaal WMA (Lesotho Highlands Water Project), to the Fish / Tsitsikamma WMA (Orange-Fish Transfer), to the Lower Orange WMA (Orange-Vaal Transfer) and downstream releases to the Lower Orange WMA and for use by Namibia. Transfers within the WMA occur from the Orange and Caledon Rivers to the adjacent Modder / Riet catchment.

The main storage dams in the Upper Orange River WMA and Lesotho are:

- Katse Dam in the Senqu sub-area in Lesotho, used for the transfer of water to the Upper Vaal WMA. Mohale Dam, recently completed in the same sub-area, started to impound water in 2003, and is also used for the transfer of water to the Upper Vaal WMA via Katse Dam.*
- Gariep and Vanderkloof Dams on the Orange River (Vanderkloof sub-area), which command the two largest reservoirs in South Africa. Hydropower for peaking purposes is generated at both sites.*
- Armenia and Egmont Dams on tributaries in the Caledon sub-area. Welbedacht Dam lays on the main stem of the Caledon River, with Knellpoort Dam an off-channel storage dam that supplements the water supply to Bloemfontein.*
- Rustfontein, Mockes and Krugersdrift Dams are situated on the Modder River, and the Tierpoort and Kalkfontein Dams on the Riet River.*

Resource Availability

Nearly 70% of the total surface runoff, which would flow through the water management area under natural conditions, originates from Lesotho territory, and just more than 30% from within the water management area.

In the natural state the quality of surface water in the water management area is good, particularly for the water which flows from the Highlands of Lesotho in the Senqu River. Water in the Caledon River is naturally of high turbidity and carries a concerning high sediment load. Irrigation return flow has a major impact on salinity in the lower Riet River. Water is transferred to the Riet River from Vanderkloof Dam, partly for blending and water quality management purposes. A natural pan below Krugersdrift Dam also adds salinity to the Modder River.

Despite all the existing dams in the WMA, a substantial proportion of the still undeveloped water resource potential in South Africa lies in the Upper Orange WMA (and Lesotho). Sites for harnessing this potential through the construction of a large dam exists at the confluence of the Orange and Kraai Rivers (at the farm Bosberg) provisionally referred to as Boskraai Dam, as well as at the possible Mashai Dam in Lesotho on the Senqu River.

The surface water resources of the Orange River Catchment have been the subject of various studies aimed at developing and maintaining a reliable hydrological database. The hydrological data that are currently used to operate the system typically covers the period October 1920 to September 1988. There is a fairly high level of confidence in the in the yield estimates of the surface water in the system, although some of the hydrology is relatively old.

The surface water availability in the Orange River System is estimated through a set of water resource models, each fulfilling a particular function in the management of the water resources. Combined, these models serve as a decision support tool that contains a large and comprehensive database of hydrological and physical system characteristics, required to simulate the water resource systems as realistically as possible. Due to the interdependencies, the management and planning of the Orange River System is undertaken at the national level and not by the Upper Orange water managers (CMA when it is established until then the DWAF Regional Office).

The Upper Orange water managers will be responsible for the assessment of the availability of the local groundwater and surface water resources used to supply local authorities and district councils without access to the Orange River System water supply infrastructure.

The water resource models, as configured for the Orange River System, are not at a high enough resolution to define the availability of local water resources at a sufficient level of confidence. These local resources are used to support water users that are mostly located in tributary catchments that do not have access to the main river reaches

The groundwater availability estimated volume (exploitable volume not contributing to surface base flow) of $1\,020 \times 10^6$ m³/year for this WMA is significant. The registered volume of groundwater use as obtained from the WARMS database shows a total volume of 98.3×10^6 m³/year, which represents approximately 10% of the harvest potential. The groundwater represents a large potential resource, particularly for local supply in areas that are distant from the main river system. Groundwater is widely used in the area for domestic and agricultural purposes. Studies undertaken by DWAF in the Upper Orange area revealed that the Petrusburg region abstracts approximately 14×10^6 m³/year, while Bainsvlei region abstracts approximately 33×10^6 m³/year for irrigation. Groundwater plays a major role in the sustainability and economy of the Modder River catchment..

Water Requirements

Irrigation water requirements (780 million m³/a) represent approximately 80% of the local requirements (968 million m³/a). When the transfers out of the area (3 148 million m³/a) are also taken into account the total requirement increase to 4 116 million m³/a. Included in the transfers is the release obligation to the Lower Orange WMA which amounts to 2 035 million m³/a. The bulk of the urban/industrial requirements are located in the Riet/Modder catchment, with the main demand centres being Bloemfontein and Botshabelo.

The total water requirements for the Upper Orange are projected to reach 4 688 million m³/annum by the year 2025, for the base growth scenario. Expected future growth will mainly be as result of the 12 000 ha earmarked to resource poor farmers (only 4 000 ha to the Upper Orange WMA) and limited growth in urban/ industrial and mining sectors which will mainly be as result of developments in the Bloemfontein, Botshabelo, Thaba 'Nchu area. New transfer schemes out of this area is not expected before 2025, although the completion of phase 1 of the LHWP in 2003 resulted in an increase in transfers of 344 million m³/a to the Upper Vaal WMA.

Water Balance Reconciliation

The latest water balance from the Orange River system indicated a surplus of 333 million m³/a in 2000. This reduces to 158 million m³/a in 2003 when Mohale Dam is commissioned due to the fact that more water can now be transferred out of the system to the Upper Vaal WMA.

When the effect of the 12 000 ha earmarked for resource poor farmers (4000ha Upper Orange WMA, 4000ha for Lower Orange WMA and 4000ha for Fish-Tsitsikamma WMA) is included, the surplus will reduce further to only 44 million m³/a.

This remaining surplus of 44 million m³/a is not sufficient to cover the expected growth in urban/industrial/mining requirement as a deficit of nearly 50 million m³/a is expected by 2025. The remaining surplus of 44 million m³/a is therefore reserved for high priority users only.

For the management of the long-term water supply along the Orange River main stem, reconciliation can be obtained by means of several options of which all are of an overarching nature and are therefore discussed in detail in the Overarching ISP. The options are briefly listed below:

- *Measures to reduce the operating losses.*
- *Water conservation and demand management measures.*
- *Vanderkloof Dam, utilising the lower level storage.*
- *Boskraai Dam upstream of Gariep Dam.*
- *Possible developments from Lesotho Lowlands Study.*
- *Possible options that are currently investigated in the LORMS.*

Given that the water resource availability and water requirements for the Integrated Orange River System is effectively in balance, it is required to closely monitor the water balance situation on an ongoing basis. This will ensure that intervention planning can be adjusted to account for any changes that may have an impact on the projected water balance. The reader is referred to the Orange River Overarching for more detail with regards to the management and planning of the Integrated Orange River system.

The Upper Orange WMA has a large commitment to support the local water requirements and transfers to the Upper Vaal WMA, the Fish to Tsitsikamma WMA as well as release obligations to the Lower Orange WMA. Measures to improve the water supply in the Upper Orange WMA include the adjustment of hydropower operating rules, reduction of operating losses, implementation of WCDM and using the lower level storage in Vanderkloof Dam. See the Orange River Overarching ISP for more detail.

The Caledon/ Modder transfer scheme is the largest Urban/Industrial water supply scheme used to supply requirements within the WMA. This scheme is used to supply the main urban centres such as Bloemfontein, Botshabelo, Thaba 'Nchu and other smaller users. The water supply system includes Welbedacht and Knellpoort dams located in the Welbedacht RSA and Welbedacht Lesotho sub-catchments. Although the existing water supply system, which includes the first phase of the Novo transfer scheme, can provide sufficient water to the users to even beyond 2025, short term shortages

are experienced due to severe siltation problems in the Caledon part of the system, as well as due to limitations on the internal distribution system and insufficient internal balancing storage.

Towns not supplied from the main river or large water supply schemes rely in most cases on local ground or surface water resources. Most of these towns depend on groundwater or small dams or a combination thereof. Shortages in the water supply are fairly common for some of these towns. Based on inputs obtained during the ISP Workshops and from the DWAF Regional office, it seems that shortages can be expected at approximately 28 of the 62 towns located in the WMA.

The role of the Upper Orange CMA will largely be WC&DM, trading of water allocations and assisting with the water balances of the local authorities and district municipalities who are dependent on local resources for their supply and not the main water supply infrastructure supported by the Orange River System.

The measures of reconciling the water balance in areas removed from the Orange River and other main water supply systems should include the following:

- Implement water conservation and demand management measures as a first option to extend the supply capability of the existing water resources.
- Investigate the utilisation of local water resources, particularly groundwater. Exploration investigations for groundwater and surface water resources should cover areas wider than the boundaries of the towns.
- The priority for compulsory licensing for localised stressed areas such as the Petrusburg/Bainsvlei area with regards to groundwater, should be evaluated. Due to the low interaction between groundwater and surface water in this area, it should be possible to do the compulsory licensing for the two sources separately. Other ways to manage the situation should be found first. This should typically include the verification of law full use, eliminating of illegal users, checking on the availability, imposing of curtailments, educating people and make them aware of the problem, improve the management of the groundwater system, etc.

Water Quality

The water quality in the Upper Orange WMA varies from poor in the highly developed areas to good in those that are less developed. The Upper Orange WMA contributes directly to the flows and water quality in the Lower Orange WMA. The Upper Orange WMA also receives water from Lesotho and any further development of the Lesotho Highlands Scheme could influence the water quality in Upper and Lower Orange WMAs as result of the reduction in the inflow of good quality water.

Most of the sewage works within the WMA are inadequate and are in a poor state. The reasons for this are both management and the overloading of the plants due to the replacement of pit latrines with water borne sewerage systems. Systems are audited on a two yearly basis and feedback is given to local government.

The approach adopted for the management of the water quality in the WMA is on a sub-catchment basis. The Modder-Riet is presently being addressed through the development of a CMS for the river system (currently in phase 2). These plans involve the setting of water quality objectives (WQO), identification of pollution sources, and the modelling and development of management actions. These plans for the individual areas need to be linked to an assessment of the overall water quality management of the Orange River.

The groundwater in the Riet / Modder catchment is polluted at specific sites, elsewhere the groundwater quality is generally good. This is partly due to the use of pit latrines, cited as a source of pollution in some areas. Some of the boreholes in the Thaba 'Nchu area cannot be used because of poor quality due to nutrients and microbiological quality. The extensive irrigation in this catchment has also resulted in the pollution of the groundwater resources. The elevated salinity levels that were reported for the Jacobsdal area already indicated this. The water quality problems are mainly salinity and nutrient enrichment.

The water quality and the water infrastructure in the Caledon River catchment are impacted on by sedimentation. The soils have a moderate to high erosivity index, which coupled with poor land use practices, has resulted in high erosion rates. This is reflected in the sedimentation of Welbedacht Dam and the operating rules that have to be adopted for the water supply infrastructure in this area.

Ecological Reserve Determination

A comprehensive Reserve has not been determined for the entire Orange River. An intermediate level ecological Reserve is in the process of being determined for the Riet/Modder catchment as part of the development of a CMS for the area. Preliminary groundwater Reserves for the Petrusburg and Bainsvlei areas (C52H, J & K) in the Riet/Modder catchment have been determined. Instream Flow Requirements have recently been completed for Lesotho and is in the process of being implemented and tested by means of the water resource models. For detail on the ecological requirements for the Orange River Main stem downstream of Vanderkloof Dam the reader is referred to the Orange River Overarching ISP.

Ecological requirements were not yet determined for the catchment upstream of Vanderkloof Dam and downstream of the Lesotho. This catchment includes the Caledon, Kraai and Seekoei rivers.

When a Reserve determination becomes necessary the RDM and Regional office should assess whether the Reserve for the entire catchment needs to be determined or only sections of the catchment and when this determination should take place. The Reserve determination should also be coordinated with the Reserve determination for the Vaal River System and the compulsory licensing process.

System Management

The utilisation of the water resource (Main Orange River System) is optimised by allowing maximum hydropower generation, without adversely impacting on the long-term reliability of supply to the users in the system. For this purpose operating analysis are undertaken on an annual basis to determine the surplus available in the Orange River System, which can be used for the generation of hydro-power over and above that released for normal downstream requirements. (See Orange River Overarching ISP for more detail of the overarching system).

Significant variation in the releases from Gariep and Vanderkloof dams occur as result of hydropower releases. There is an existing communication strategy in place, which notifies DWAF as well as the affected downstream users of the hydropower releases.

The Caledon/Modder transfer system as well as other sub-systems within the Riet/Modder catchment are not analysed on an annual basis. Models and the required data already exist for this purpose, and these systems should in future be included as part of the annual or a separate analysis.

Monitoring and Information systems

The successful operation of the Orange River catchment requires effective monitoring networks and information management systems. There is an extensive network of flow, rainfall and water quality monitoring stations in the catchment. However, studies have highlighted the need to expand the monitoring network to include more gauges to determine river losses, bulk distribution system losses, track water requirements and include bio monitoring to assist with the determination and implementation of the ecological Reserve. It is critical to have a coordinated monitoring to avoid duplications and waste of resources. Also with regard to Reserve compliance monitoring, it needs to be sorted out clearly whose responsibility it will be.

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

Institutional Development and Support

For a description of the strategy at International level, the reader is referred to the Orange River Overarching ISP document.

On national level, co-operative governance (i.e. liaison and integration of planning between government departments, district and local authorities) needs to be factored into the overall integrated water resources management arena, to ensure a compounded benefit to all users in the catchment.

Institutions at District and Local Municipal level are relatively new on the scene and water resource and water service capacity is slowly being built in these institutions. Liaison between the various institutions needs to be encouraged in the interest of integrated water resources management in the Upper Orange WMA.

There are 4 sub-areas in the Upper Orange WMA and a logic starting point would be to have a representative catchment management forum in place for each sub-area. These forums are normally made up of interested and concerned citizens, as well as the major water users, and play an active role in the practical review and implementation of the various water resource management issues in the catchments. Currently interested and affected parties are however included on a study basis.

ISP Implementation Strategy

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

Internal Strategic Perspective

Upper Orange Water Management Area

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Appendix D: Water Supply to Urban/Industrial Centres

Appendix E: Principles and Methods for the Implementation of the MIG

Appendix F: Irrigation Development Detail Description

Acronym	Meaning
BPs	Business Plans
CEIMP	Consolidated Environmental Implementation and Management Plan
CMA	Catchment Management Agencies
CMS	Catchment Management Strategy
DWAF	Department of Water Affairs and Forestry
DPLG	Department of Provincial and Local Government
ECA	Environmental Conservation Act
EFR	Environmental Flow Requirement
EIMP	Environmental Implementation and Management Plan
GDP	Gross Domestic Product
GGP	Gross Geographic Product
IAC	Irrigation Action Committee
IB	Irrigation Board
IDP	Integrated Development Plan
IFR	Instream Flow Requirement
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resource Management
IWRP	Integrated Water Resource Planning
LHWP	Lesotho Highlands Water Project
LORMS	Lower Orange River Management Study
MIG	Municipal Infrastructure Grant
MITT	Municipal Infrastructure Task Team
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act
NWA	National Water Act
NWRS	National Water Resource Strategy
ORASECOM	Orange Senqu River Commission
ORRS	Orange River Development Project Replanning Study
ORS	Orange River System
RO	Regional Office
SAPWAT	Irrigation Requirements and Scheduling Strategies SA
URV	Unit Reference Value
VAPS	Vaal Augmentation Planning Study
VRSAU	Vaal River System Analysis Update Study
WDM	Water Demand Management
WC	Water Conservation
WCDM	Water Conservation and Demand Management
WMA	Water Management Area

Acronym	Meaning
WQO	Water Quality Objectives
WR90	Water Resources 1990 Project
WSA	Water Service Authorities
WSAM	Water Situation Assessment Model
WRC	Water Research Commission
WRSAS	Water Resources Situation Assessment
WRSAS	Water Resources Situation Assessment Study
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WSDP	Water Services Development Plan
WSP	Water Services Plans
WUA	Water User Association

CHAPTER 1: BACKGROUND TO THE UPPER ORANGE WMA INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE UPPER ORANGE WMA

Figure 1.1 shows the location of the Upper Orange WMA, which lies predominantly within the Free State, but also occupies portions of the Eastern and Northern Cape Provinces.

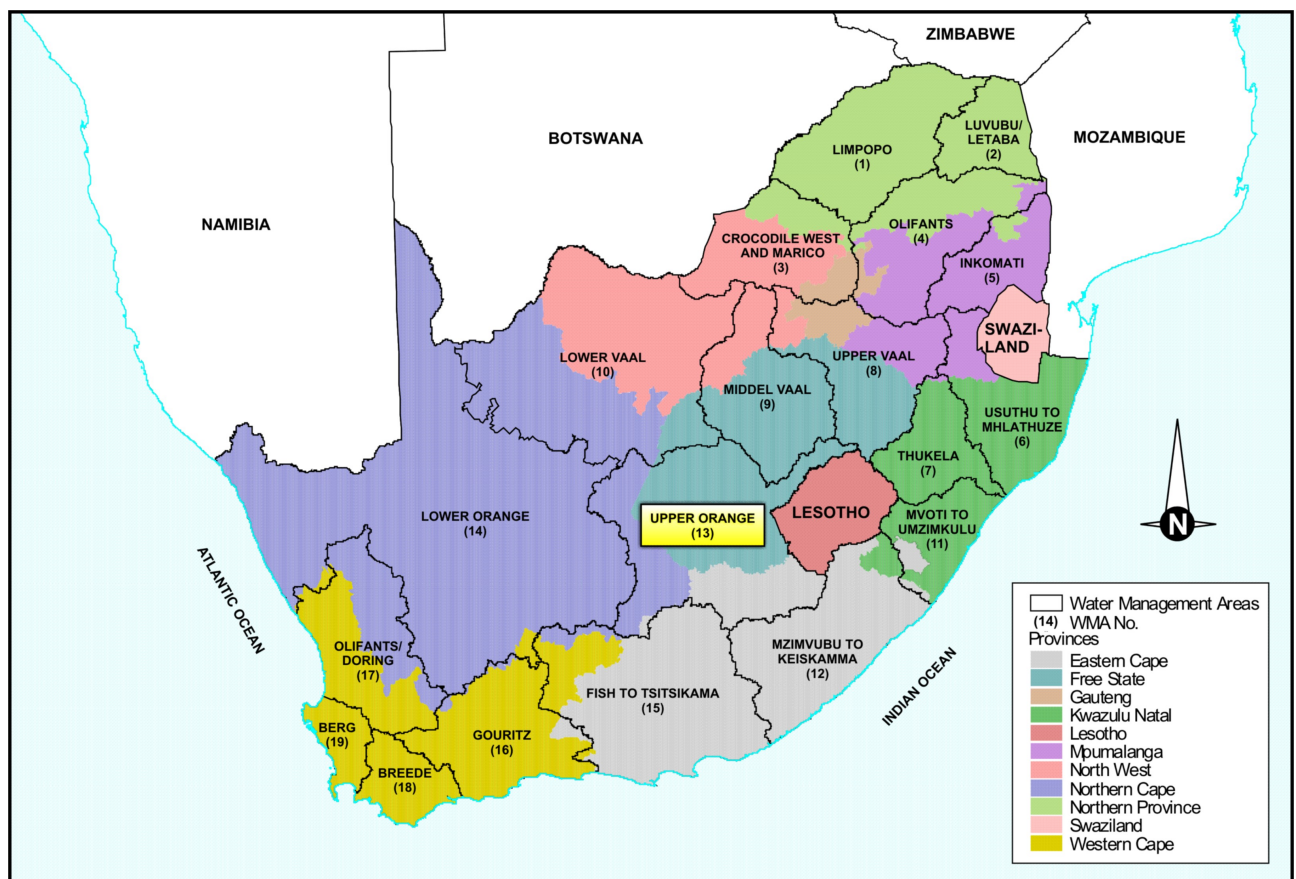


Figure 1.1: Location of the Upper Orange WMA

1.2 WATER LEGISLATION AND MANAGEMENT

Water is one of the most fundamental and indispensable of all natural resources. It is fundamental to life and the quality of life, to the environment, food production, hygiene, industry, and power generation. The availability of affordable water can be a limiting factor for economic growth and social development, especially in South Africa where water is a relatively scarce resource that is distributed unevenly, both geographically and through time, as well as socio-politically.

Prosperity for South Africa depends upon sound management and utilisation of our many natural and other resources, with water playing a pivotal role. South Africa needs to manage its water resources optimally in order to further the aims and aspirations of its people. Current government objectives for managing water resources in South Africa are set out in the National Water Resource Strategy (NWRS) as follows:

- **To achieve equitable access to water.** That is, equity of access to water services, to the use of water resources, and to the benefits from the use of water resources.
- **To achieve sustainable use of water,** by making progressive adjustments to water use to achieve a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources and the natural environment.
- To achieve efficient and effective water use for optimum social and economic benefit.

The NWRS also lists important proposals to facilitate achievement of these policy objectives, such as:

- Water will be regarded as an indivisible national asset. The Government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of administrative authorisations.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions, with appropriate community, racial and gender representation, to enable all interested persons to participate.

1.2.1 The National Water Act (NWA)

The NWA of 1998 is the principal legal instrument relating to water resource management in South Africa. The Act is now being implemented incrementally. Other recent legislation, which supports the NWA includes the Water Services Act (Act 108 of 1997) and the National Environmental Management Act (Act 107 of 1998).

1.2.2 The National Water Resource Strategy (NWRS)

The NWRS is the implementation strategy for the NWA and provides the framework within which the water resources of South Africa will be managed in the future. All authorities and institutions exercising powers or performing duties under the NWA must give effect to the NWRS. This strategy sets out policies, strategies, objectives, plans, guidelines, procedures and institutional arrangements for the protection, use, development, conservation, management and control of the country's water resources. The purpose of the NWRS is to provide the following:

- The National framework for managing water resources.
- The framework for preparation of catchment management strategies in a nationally consistent way.
- Information, in line with current legislation, regarding transparent and accountable public administration.
- The identification of development opportunities and constraints with respect to water availability (quantity and quality).

1.2.3 Catchment Management Strategies (CMS)

The country has been divided into 19 Water Management Areas (WMAs). The delegation of water resource management from central government to catchment level will be achieved by establishing Catchment Management Agencies (CMAs) at WMA level. Each CMA will progressively develop a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management and control of water resources within its WMA.

The Department's eventual aim is to hand over certain water resource management functions to CMAs. Until such time as the CMAs are established and are fully operational, the Regional Offices (ROs) of DWAF will have to continue managing the water resources in their areas of jurisdiction. Furthermore, the way in which the resources are protected, used, developed, conserved, managed and controlled needs to form an integral part of other planning initiatives at provincial, district and local authority level. These relationships are shown in **Figure 1.2** below.

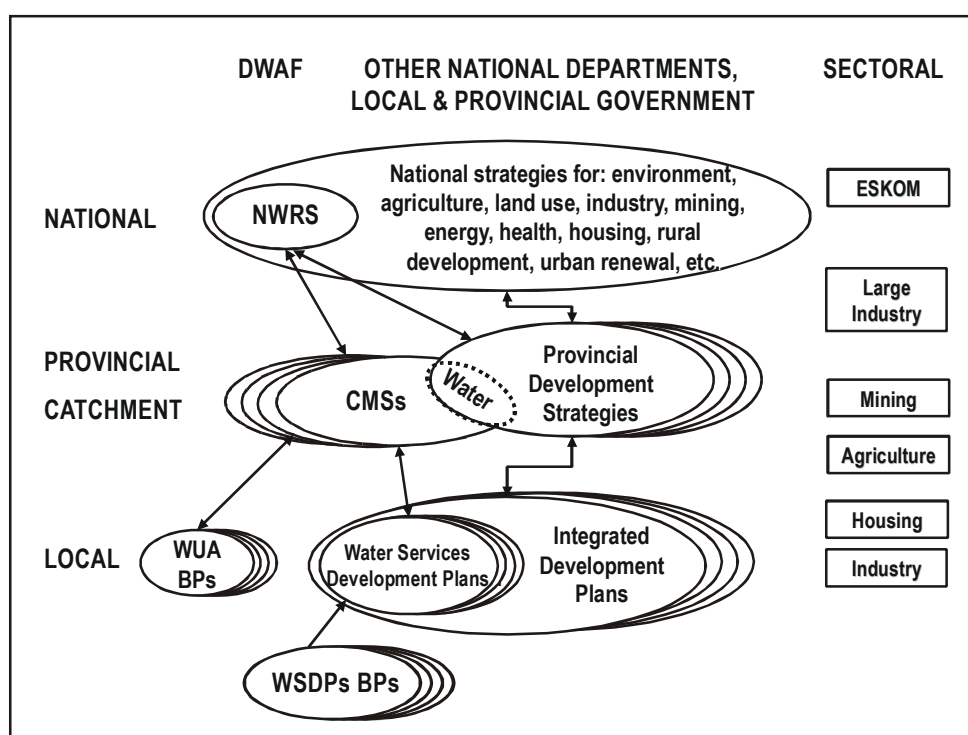


Figure 1.2 : Integrated planning approach at various levels of government in South Africa

1.3 INTERNAL STRATEGIC PERSPECTIVES (ISPs)

1.3.1 The Objectives of the ISP Process

The objective of the ISP will be to provide a framework for DWAF's management of the water resources in each Water Management Area, until such time as the Regional Offices can hand over the management functions to the established CMA. This will ensure consistency when answering requests for new water licences, and informing existing water users (including authorities) on how the Department will manage the water resource within the area of concern. Stakeholders must be made aware of the bigger picture as well as the management detail associated with each specific water resource management unit.

1.3.2 Approach Adopted in Developing the ISP

The detail Water Management Area ISPs for the WMAs in the Central Planning Region was preceded with a process where an Overarching ISP was compiled for the Orange River System. The purpose of the Overarching ISP was to develop strategies that cover issues related to both of the Orange River WMAs and relates to the interdependency that exists among the WMAs due to their geographical locations relative to each other. The overarching ISPs fall in the same category as the NWRS as it guides the management of water resources affecting more than one WMA while the ISPs for each individual WMA fall in the category of a CMS.

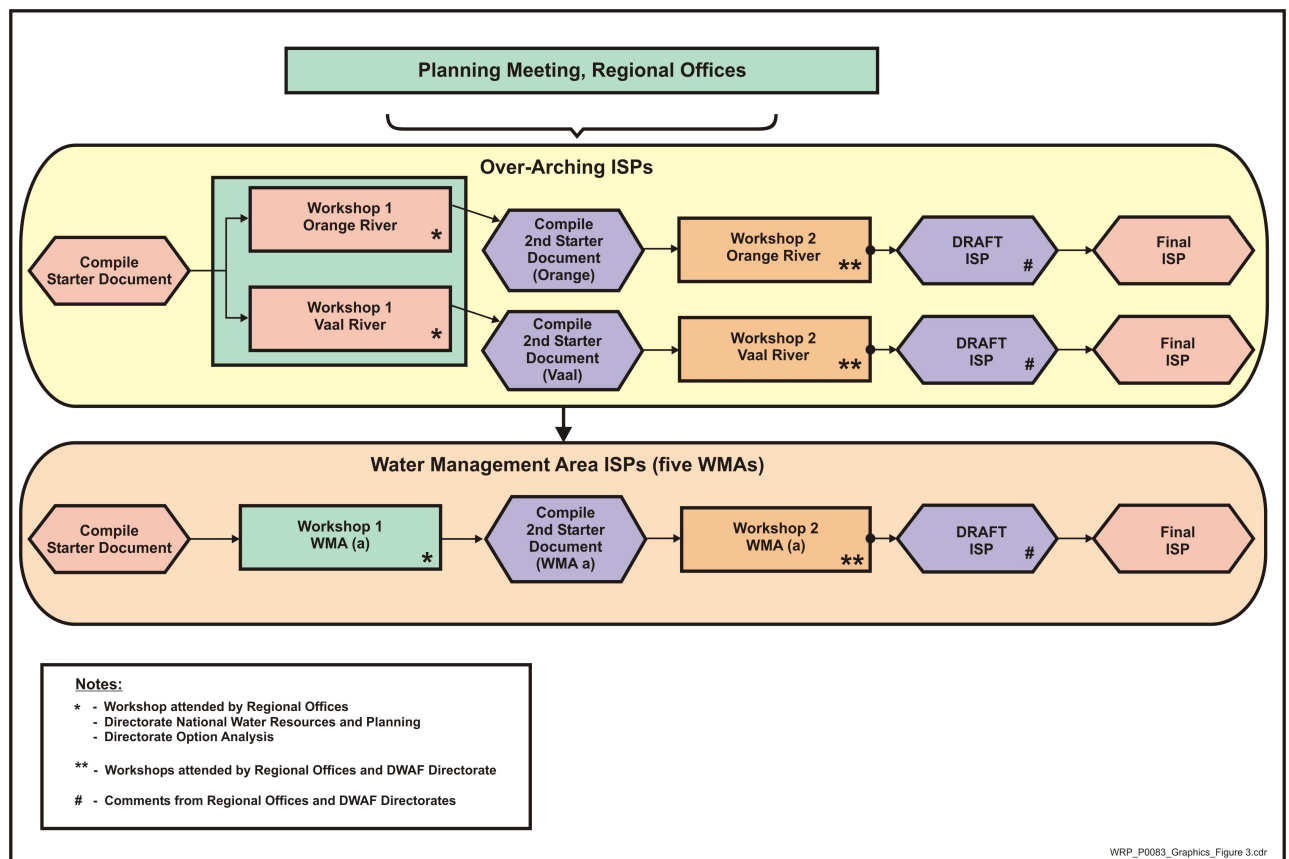


Figure 1.3 : Schematic showing ISP development process

The process for the development of the overarching and the individual ISPs for the Orange River system is shown in **Figure 1.3**. The ISP for the Upper Orange WMA was developed in five stages as follows:

- i) Determining the current status of water resource management and relevant water resource management issues and concerns in the Upper Orange WMA. This was achieved through interviews with individual members of DWAF's RO in Bloemfontein and by collating information from the NWRS, WMA reports, Water Resource Situation Assessment (WRSA) reports and other catchment study reports. The following topics were discussed with Regional Office staff and their issues and concerns documented:
 - Water Situation.
 - Resource Protection.
 - Water Use.
 - Water Reconciliation.
 - Water Infrastructure.
 - Monitoring and Information.
 - Water Management Institutions.

- Co-operative Governance.
- Planning Responsibilities.

A starter document of the identified issues and concerns was produced as a discussion document for the first workshop.

- ii) The first workshop was held with attendees from the Regional Office, the Integrated Water Resource Planning (IWRP) Chief Directorate of the Department as well as the consulting team. The workshop focussed on the lists of general issues in the WMA as well as area-specific issues. The issues were clarified and refined during the workshop. Strategies were discussed and developed to address the issues.
- iii) The third stage involved the preparation of the second workshop document to be used for refining strategies to address the various issues and concerns, during the second workshop.
- iv) The fourth stage was the second workshop. During this workshop the overall management of the water resources in the catchment was discussed along with the ISP management strategies and the relevant issues and concerns. The priorities and responsibilities for carrying out the strategies were identified. First workshop attendees were again involved, as were representatives of several DWAF Head Office directorates.
- v) The fifth stage was the finalisation of the ISP document.

As can be deduced from the above this Upper Orange ISP was prepared internally within the Department, and captures the Department's perspectives. Once approved by DWAF Management, it is intended that the Regional Office will make the ISP available to Water User Associations (WUAs), Water Service Providers (WSPs), Water Service Authorities (WSAs) and other forums for discussion and comment. These comments will be considered and worked into later versions of the ISP. By adopting this procedure this ISP becomes a working document, which will be progressively updated and revised by DWAF. Public participation forms part of the CMS process, for which the ISP serves as a foundation (see **Paragraph 1.6**).

The ISP does not formulate all the details pertaining to every strategy but provides a suggested framework for each strategy around which the details will be developed by the responsible authority. Where relevant and readily available, certain details have been included in the strategies. The responsible authority for the further development of each strategy is indicated. This is predominantly the Regional Office, which remains responsible for involving the relevant DWAF directorates.

1.3.3 Updating of the ISP Report

The ISP strategies should not lag behind national developments, become outdated or differ from related ISPs regarding trans-boundary management. There is therefore a need to have a standard process for updating strategies, and to prevent strategies becoming outdated by ensuring adequate feedback from national developments. Furthermore, the proposal and introduction of new strategies needs to be accommodated. It is suggested that each strategy has a version-control system. The following is necessary:

- Keep abreast of changes in national legislation and policy changes or refinements by keeping a list of all relevant legislation and supporting documents relevant to the ISP.
- Ensure consistency between the ISP strategies and national strategies through a regular review-and-update procedure.
- Annually review and ensure consistency and agreement regarding trans-boundary ISP management issues by liaising with the responsible managers of other areas and updating relevant ISP strategies if necessary.
- Annually review the priorities of required management actions and align budgets accordingly.
- Monitor the implementation of the ISP (review actions, progress, implementation and stumbling blocks).
- Incorporate feedback from stakeholders.
- Rigorously apply ISP version control.

Updating and Version Control

The actual frequency of ISP revision will be determined by the number and extent of revisions to management approaches as reflected in Strategy amendments. All updates to this report, particularly with respect to amendment to the Strategies, need to be passed on to and vetted by the Catchment Manager for the Upper Orange WMA. The current incumbent is Ms T Malaka, who has been delegated the task of managing version control.

1.3.4 The Authority of Information Contained in the ISP

The NWRS is a statutory document, subject to a high level of public scrutiny and input, and signed off by the Minister. The information contained in the NWRS is the best information and knowledge available at the time. The information in **Chapter 2** and **Appendix D** of the NWRS Strategy on water requirements, availability and reconciliation was updated with comments received from the public participation process in the second half of 2002. To enable the finalisation of the NWRS, these figures were “closed” for changes in February 2003.

Underlying the figures in **Chapter 2** and **Appendix D** is a set of 19 reports “Overview of Water Resources Availability and Utilisation”, one for each WMA. These reports contain more detailed information on each WMA than was summarised for the NWRS and are referred to, in short, as “WMA Reports”. The WMA reports were also finalised with the February 2003 information.

Still deeper in the background lies another set of reports (one per WMA), the so-called Water Resource Situation Assessment Reports. These reports contain a wealth of information on each WMA, but the figures on requirements, availability and reconciliation have been superceded by the WMA report and the NWRS.

The ISPs for all WMAs used the information contained in the NWRS and WMA reports as the point of departure. However, an inevitable result of the ISP process has been that better information has emerged in some cases. The reason is that the level of study is more detailed and intense for the ISP. This included very close scrutiny of the numbers used in the NWRS, and in some cases a reworking of base data and some re-modelling. Where the ISPs contain

yield balance data, which differs from the NWRS, these discrepancies are carefully explained. Where other differences from the NWRS are necessary these are also detailed in the ISP, with accompanying explanations.

It is required that the Department work with the best possible data so that the best possible decisions can be taken. Where the ISPs have improved upon the NWRS then this is the data that should be used. The new data contained in the ISP will also be open to public scrutiny as the ISP reports will be published on the Internet and in hardcopy, and will be presented and discussed at WMA forums. Comments received will be considered and worked into subsequent versions of the ISP on a regular (yearly) basis. The NWRS will be updated to reflect the latest understanding in each new edition.

1.4 INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

It is imperative that the natural, social, economic, political and other environments and their various components are adequately considered when conducting water resources planning and management. Water as a strategic component also interacts with other components in all environments. For example, human activities such as the use of land, the disposal of waste, and air pollution can have major impacts on the quantity and quality of water, which is available for human use and for proper life support to natural biota.

Taking an even broader view, water must also be managed in full understanding of its importance for social and economic development. It is important to ensure that there is conformity between the water-related plans and programmes of the CMAs, and the plans and programmes of all other role players in their management areas. The CMAs must therefore establish co-operative relationships with a wide range of stakeholders, including other water management institutions, water services institutions, provincial and local government authorities, communities, water users ranging from large industries to individual irrigators, and other interested persons.

This integrated planning and management approach is intended, through co-operative governance and public participation, to enable water managers to meet the needs of all people for water, employment, and economic growth in a manner that also allows protection and, where necessary, rehabilitation of aquatic ecosystems. Above all, Integrated Water Resource Management (IWRM) will enable water managers to use our precious water resources to assist us in poverty eradication and removal of inequity.

One of the big opportunities to formally integrate a large number of actions in water resource management presents itself during the compulsory licensing process.

Compulsory licensing is identified in the NWRS as a very important action for implementing the NWA. However, it is not a simple action of issuing licences but a complex process of closely related and interdependent activities that will in itself formalise IWRM to a great extent. The process of IWRM is diagrammatically depicted in **Figure 1.4**.

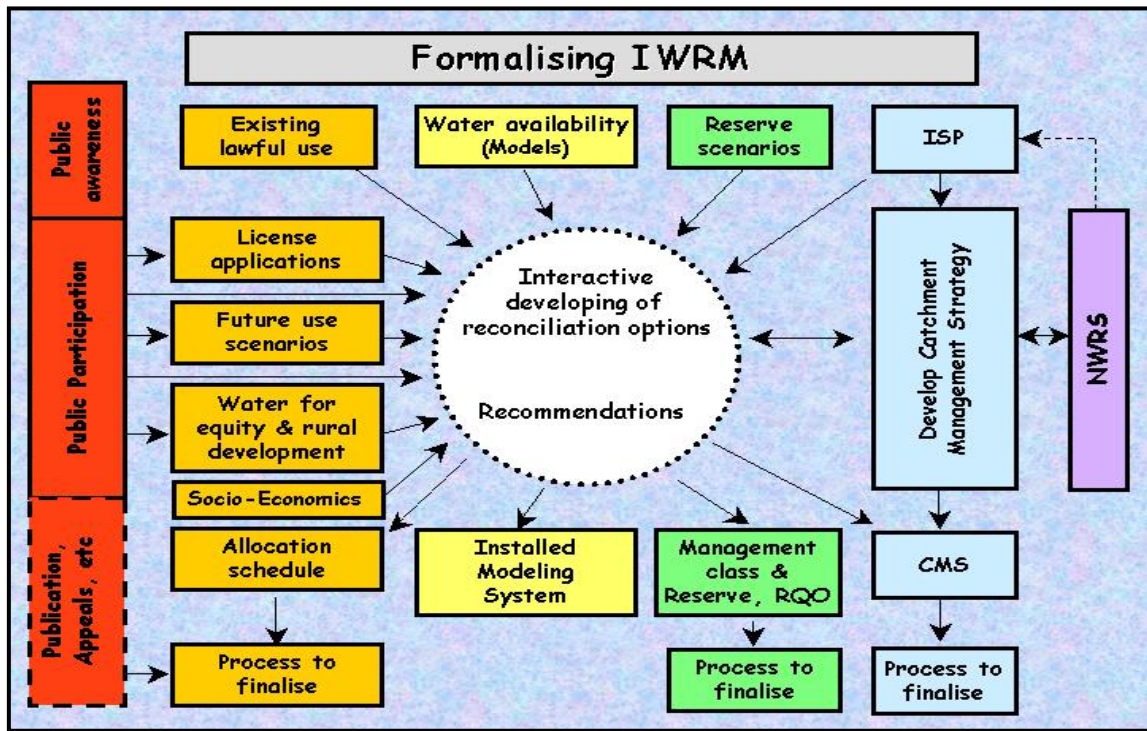


Figure 1.4: Diagram showing DWAF Integrated Water Resources Management approach

Before an allocation schedule can be determined and the legal steps followed to finalise compulsory licensing (through the issuing of licences to all users), many other aspects must be addressed:

- Existing use and the lawfulness of that use must be verified, all users (existing and new) must apply for licences, a good understanding of future use scenarios must be developed and water required for equity purposes and rural development must be clearly understood.
- Water availability must be understood as thoroughly as possible with "best available" existing information used to model all possible reconciliation options.
- Reserve scenarios must be developed for all significant resources in the catchment, for instance, the river flow requirements for all possible classes that may be considered.
- The development of strategies for implementing the licensing (abstraction controls, for example), the Reserve and Resource Quality Objectives (i.e. incrementally over time) must go hand in hand with the rest of the processes to ensure that practical, workable solutions are found.

The processes will then enter a very intensive, interactive phase of developing realistic reconciliation options. This would entail, for example, the selection of a specific management class to be scrutinised for its impact on the number of licences that could be issued for use, with its concomitant impacts on the social and economic structure of the catchment.

The active participation of stakeholders in this process will then hopefully crystallise clear recommendations on an allocation schedule, management classes for the various reaches of the rivers and the resultant ecological Reserve and Resource Quality Objectives, as well as strategies for the implementation.

Although the Department will play a very strong role in guiding this process, it is extremely important to have the CMA actively involved. Preferably, at least the Board of the CMA must be in place to drive the public participation for the process.

It will be difficult to classify the rivers before this process, as the implications will be almost impossible to determine. Reserve determinations (regardless of how comprehensively they may have been done), will remain at the preliminary level until the classification is formalised in this process.

1.5 CARING FOR THE ENVIRONMENT

DWAF is responsible for water resource development and management in terms of the NWA, and within the broader framework of other environmental legislation. The Department also strongly reflects the will to make sound decisions which ensure the development of society and the economy whilst maintaining, and where possible enhancing, ecological integrity. The concept of management of the environment has evolved from the exclusivity of protection of plants and animals to balancing the complex interaction of society, the economy, and ecology. "Environmental management is the integration of social, economic and ecological factors into planning, implementation and decision-making so as to ensure that development serves present and future generations" (NEMA).

The key legislative Acts to which DWAF is required to refer are the National Environmental Management Act (NEMA, Act 107 of 1998) and the Environment Conservation Act (ECA, Act 73 of 1989). DWAF has prepared a Consolidated Environmental Implementation and Management Plan (CEIMP) as a requirement of NEMA. This describes the Department's functions, policies, plans and programmes, and states how these comply with environmental legislation. Through the CEIMP the Department has committed itself to developing and implementing an integrated Environmental Management Framework (EMF) to ensure that its approach is aligned with the principles prescribed in NEMA and the ECA. The EMF will inform the Department at a strategic decision-making level, bring about environmental legal compliance, and help in achieving environmental sustainability through the promotion of sound environmental management practices. Integrated Environmental Management is a co-operative governance effort with DWAF as a full partner in the process.

This ISP has the responsibility of raising and maintaining the environmental consciousness of the Department's water resource planners and managers. The control over water has a very broad range of influence and impact for which strategies and planning need to account. Impacts come from many different angles.

Some of these angles of impact which are considered through this ISP are noted below:

- The direct impact of physical structures (environmental constraints to construction e.g. of weirs or dams).
- The implications of allocating and licensing water for use. Forestry and irrigation are examples of users where development based on water can mean the transformation of extensive areas of otherwise 'natural' environments.

- The allocation of water for equity. Here we can include approaches towards the application of Schedule 1 Use, General Authorisations, the revitalisation of irrigation schemes, etc.
- Failure to support equity, or appropriate development – noting the consequential impacts of poverty.
- Sanitation systems and the impacts on groundwater quality.
- The implementation of the Reserve.
- The ability to monitor and manage compliance, thus protecting the resource and with it the environment.

All decisions regarding water are critical to the environment. Decisions must be made on a balance of social, economic and ecological costs and benefits, considering both the immediate and the long-term, and always with an eye out for the unintended consequence. It is the intention of the ISP to provide the basis for integrated decision-making. The principles of environmental management underpin every strategy developed in this document.

There are a number of strategic areas with a particularly strong biophysical/ ecological emphasis. These include:

- The Reserve (groundwater, rivers, wetlands and estuaries).
- Water quality - surface and groundwater.
- The approach towards the clearing of Invasive Alien Plants.
- The management of wetlands.
- Land degradation. Erosion and sedimentation (land care).
- Land use and especially how this is impacted by land reform and the re-allocation of water.

The roles of Co-operative Governance and the need for awareness raising and capacity building are key strategic elements of many strategies.

In reality all strategies and all aspects of management have a strong interaction with the biophysical environment. This ISP endeavours to capture all of these concerns in discussion and through a strategic approach, which emphasises the will of the Department to manage the environment to the best benefit of the country and its people.

The approach set out above applies to all Water Management Areas and associated ISPs, and is not repeated within the Strategy Tables (**Appendix A** of this ISP). It reflects the way the Department views Integrated Water Resource Management and the importance of the biophysical aspects of decision-making. There may nevertheless be specific ecological and biophysical aspects of management, which require specific attention and which may not be captured in the above-mentioned or other strategies. The ISP therefore still includes an

Environmental Strategy, which serves to make pertinent those issues of the environment, which might not otherwise be covered.

1.6 THE SOCIAL ENVIRONMENT

The utilisation of water resources is aimed at the benefit of society, and at society through the economy. As noted in Section 1.5 this should not be at undue cost to ecological integrity.

Impacts on society are a core element of this ISP, and decisions are often complicated by the risk of unintended consequence. As a typical example the over-zealous implementation of the ecological Reserve may benefit the river, to the intended benefit of society, but the cost of lack of use of that water to employment and to livelihoods may lead to other strains on natural resources that undo the benefits.

The implementation of the NWA requires that society be kept at the forefront of all decision-making. This principle is now deep-seated within the Department and is integral to all strategies. Water resource allocation and use has critical social impact, as does water quality management. But pivotal to the social component is the question of equity. What can be done and what is being done to redress past inequities? Within this, strategies have been developed to consider the provision of water to Resource Poor Farmers, the use of water under Schedule 1, Licensing and General Authorisations, etc. Whilst water supply and sanitation are not part of the brief of the ISP, the provision of water to meet these needs most certainly is. The urban poor, and the poor in rural villages, are as important in the consideration of the distribution and use of water resources as are the rural subsistence poor, and this should not be forgotten in the urgencies of land reform and the enthusiasm to establish a substantial class of farmers from amongst the previously disadvantaged.

This ISP aims to see water benefiting society. This can be through access to water in livelihood strategies, through small-farmer development programmes, through water supply and sanitation and especially the provision of good quality drinking water, and through the maintenance and growth of income-producing, job creating, and tax paying agricultural, commercial and industrial strategies.

Consultation and public participation are cornerstones of the social component of any strategic document. These requirements are repeatedly stressed throughout the National Water Act. This ISP has been prepared as DWAF's position statement with respect to the management of water resources and, although strategies and plans have been captured without consultation with the stakeholders, it remains an open and transparent document where the understanding of the Department, its visions and its principles are made clear for all to see and to interact with. This is amplified in the Implementation Strategy (**Appendix A**: Strategy no 10) of this ISP.

1.7 WATER QUALITY MANAGEMENT

Much of the emphasis in water resource management has revolved around ensuring that users have sufficient quantities of water. However, as more water gets used and re-used, as quantities get scarce and feedback loops get even tighter, it is quality that begins to take on a dominant role.

Water availability is only as good as the quality of that water. Both quantity and quality need to be considered at the correct level of detail, and this can mean that at times they should be considered with similar emphasis and with similar expenditure of resources. Too often we have failed to integrate the issues of quantity and quality – both with regard to surface water and groundwater. The concept of Available Assimilative Capacity, the ability of the water resource to absorb a level of pollution and remain 'serviceable', is as important in water resource management as is the concept of Systems Yield.

Quantity and quality can no longer be managed in isolation of each other. Not that this isolation has ever been total. The importance of releasing better quality water from Gariep Dam for freshening the saline water Fish and Sundays rivers in the Eastern Cape, and of the addition of freshening releases from Vaal Barrage to bring water back to an acceptable quality has, inter alia, long been standard practice. The consequences of irrigation, the leaching of fertilisers, and more importantly the leaching of salts from deeper soil horizons can render both the lands themselves and the receiving rivers unsuitable for use. Diffuse agricultural 'effluent' may be less visible than direct discharges of sewage or industrial effluent, but are no less pernicious.

Direct discharges to rivers are licensed and managed on the basis of assimilative capacities of those rivers, and on Receiving Water Quality. Where these limits are exceeded, often through the cumulative impact of diffuse discharges, water becomes unavailable to some, or even all, users downstream. DWAF will licence users to take water, and again to discharge it in recognition that there is generally a cost to the resource in terms of a reduction in quality and a reduction in its further assimilative capacity. It is for this reason, and in order to bring about additional management and a strong incentive, that the Waste Discharge Charge System is being developed. Discharge users will be obliged to pay, depending on the quantity and quality of their discharge.

Surface water quality is affected by many things including sediment and erosion, the diffuse discharges from irrigated farmland (both fertilisers and salinity through leaching), domestic and urban runoff, industrial waste, and sewage discharges. Of these, industrial waste and sewage discharges are the easiest to licence and control, but this does not mean that this is problem-free. The Department has found that the situation with regard to sewage discharges often far exceeds the standards and conditions demanded by licences. There is a problem of compliance with regard to Local Authorities and private operators responsible for waste management systems. Diffuse discharges only compound the problem by reducing the assimilative capacity until the water becomes unfit for use, very expensive to purify, and a danger to human health.

Groundwater quality requires equal attention, and more so as we recognise the importance of groundwater in supplementing our meagre resources, and providing water to remote communities. Although our groundwater resources are for the most part to be found at a relatively deep level (50-100m is quite typical) this water can easily be polluted by surface activity. The leaching of fertilisers is one such problem but of greater concern is the influx of nitrates, primarily a consequence of human habitation and sanitation. Pit latrines are on the one hand so necessary, and have the huge advantage of not requiring volumes of water, but disposal is 'on-site', and often responsible for the longer-term pollution of the underlying aquifers which feed and water the communities above.

Water quality is a very important aspect of strategy within this ISP – considered primarily within the Water Quality Strategy and also under Groundwater. Industrial wastewater discharge,

diffuse agricultural discharges, wastewater treatment works, the location and management of solid waste disposal sites, the siting of new developments, informal settlements and the impacts of sanitation systems, are all elements considered with great concern in this and other ISPs. Despite this attention it may be that Water Quality has still not taken its rightful place in the integrated management of the water resource. But the Department is moving towards IWRM and the integration of quantity and quality issues. Managers have now been given crosscutting responsibilities that will ensure a far more integrated approach in future.

Actions recommended within the Department include:

- The need to actively workshop the integration process. Resource Management, Planning and Allocations of Groundwater and Surface Water Quantity and Quality.
- The review and incorporation of knowledge from recent Water Research Commission Studies on both radioactivity and nitrates (groundwater quality issues).
- A review of all water quality literature reflecting situational knowledge and understanding within this WMA (and each and every WMA).
- Ensure that Water Quality monitoring is fully integrated into WMA water resources monitoring.
- Refer particularly to strategies 2.2, and 8 in **Appendix A** of this ISP.

1.8 GROUNDWATER

The ISP process in all of the Water Management Areas of South Africa has highlighted the role and importance of groundwater as part of the total water resource. Although groundwater has always been important in some areas this overall vision is a significant advance on our previous understanding of the potential for groundwater use. With the surface water resources in many WMAs now fully utilised, almost the only opportunity left for further development lies in the exploitation of groundwater. More particularly it is recognised that many of the more remote towns and villages, far from surface supplies, can in fact supply or supplement existing sources through groundwater, and that this must become a priority option. So, too, many small communities and subsistence farmers can avail themselves of groundwater when it would otherwise be impossible or impractical to lay on piped supplies. This can also reduce the pressure on existing users and perhaps even circumvent the need for Compulsory Licensing. The Department will be developing its capacity to explore and encourage the use of groundwater.

Of obvious concern is the likelihood of an interaction between groundwater and surface water. If the interaction is strong then additional use of groundwater may simply be reducing the surface water resource already allocated to someone else. In some instances (such as in the case of dolomitic aquifers) this interaction can indeed be very strong, whilst across many areas of the country it is so weak as to be negligible. In these circumstances groundwater comprises a huge pool of available water, which is only of benefit if it is utilised. Care must always be taken with the issuing of licenses to ensure that both the Groundwater Reserve and other downstream users do not end up being the losers.

The realisation in this and other ISPs is that groundwater offers a huge resource of water, which can be tapped, and that this can be a very significant supplement to the national water resource.

See also Groundwater Strategy No 1.1, in **Appendix A** of this ISP.

1.9 PUBLIC RECREATION - THE USE OF DAMS AND RIVERS

The use of water for recreational purposes is one of the 11 water uses regulated in terms of the NWA (Section 21 j). The Department is developing a national policy towards 'Recreation on Dams and Rivers' and this should, in the first instance, be adhered to. Recreational use can take many forms and only occasionally has any direct impact on the water resource. Most obvious are activities such as power-boating, sailing and swimming which can have quality / pollution impacts. Far more significant in terms of both quantity and quality is the release of water to allow for canoeing and other water sports downstream (The Upper Vaal, Dusi and Fish River canoe marathons being prime examples). These activities can bring very significant economic benefits to the WMAs concerned, and where water releases can be accommodated, particularly through alignment with the needs of the ecological Reserve or other downstream users, then so much the better.

It is noted in this ISP that water resources offer a very significant recreational outlet and that recreation is an important public and social asset necessary for national health and productivity. A central philosophy is that recreational opportunity should not be unreasonably and unnecessarily denied to users, and that the implementation of policy should ensure that disadvantaged and poor people should also be able to avail themselves of opportunities.

The Department has already transferred responsibility for the management of many public waters to Local Authorities and will continue with this process. Responsibility will therefore devolve upon these Authorities, but within the broad principles as laid down by the Department.

1.10 CO-OPERATIVE GOVERNANCE – the place of the ISP

The ISP is DWAF's approach to the management of water resources within the WMA. This will, in the longer term, be replaced by a fully consultative Catchment Management Agency. What is most important, in the medium term is that the ISP has a good fit with the Provincial Growth and Development Plan, with regional and other Environmental Management Plans, with plans and expectations of the Departments of Agriculture, Land Affairs, the Environment and others. It must also be aligned with the Integrated Development Plans and Water Services Development Plans now required for each District Municipality. Water is very often a constraining feature in development and co-operative governance planning and implementation is essential in matching what is wanted with what is possible.

CHAPTER 2: BROAD PERSPECTIVE OF THE WATER SITUATION IN THE UPPER ORANGE RIVER WMA

2.1 Introduction

This chapter presents summarised information from the NWRS (DWAF, 2003c) and the “Overview of Water Resources Availability and Utilisation” (DWAF, 2003a) reports for the Upper Orange River WMA to provide the required background of the water situation in the Orange River catchment. This information will enable the reader to better understand the strategies developed through the ISP process. The Orange River Overarching Report (DWAF, 2004) should be read in parallel with this ISP for a full understanding of the overarching strategies, mainly between the Upper and Lower Orange WMA. When more detailed background information is required the reader is referred to the NWRS (DWAF, 2003c) chapter 2 of the document and secondly to the “Overview of Water Resources Availability and Utilisation” (DWAF, 2003a & 2003b) reports for each WMA. These reports should in general provide sufficient detail for most readers. The reader is also strongly advised to read these two reports. Even more detail can be obtained from the “Water Resources Situation Assessment Study” (DWAF, 2002b) for each Water Management Area.

This chapter is structured to capture the background and related strategies on a logic and descriptive basis. A broad overview of the all the strategies that were identified in the Upper Orange River WMA is also included. This will at the same time serve as an introduction to the actual strategies, presented in **Appendix A**. The tables in **Appendix A** present the strategies in a structured format that includes management objectives, background information in support of the motivation for the strategies, management actions required for implementation, as well as lists of related issues that were raised at the workshops or captured from study reports. The tables also indicate the priority or relative importance of each strategy as well as which of the DWAF directorates would be responsible for implementation.

The strategies developed in **Appendix A** cover water resource issues and related water management concerns specific to the Upper Orange WMA. Issues have also been raised in the Upper Orange, which are applicable to all WMAs. These have been taken up nationally, and reported on at this level. A National workshop was held in October 2003 and task teams appointed to address these issues and to develop principals, guidelines and strategies as required. These items typically cover aspects that should be under the Minister’s control, relate to national policy, or were identified in several other WMAs and therefore require a high level of coordination.

The development of strategies has been formulated with the IWRM process in mind (see **Figure 1.4**) and the generic structure, used for these strategies follows the broad framework of the National Water Act.

2.2 General Description of the WMA

2.2.1 Overview

The Upper Orange water management area lies predominantly within the Free State, but also occupies portions of the Eastern and Northern Cape provinces (See **Figure C1** in **Appendix C**). It borders on Lesotho in the east as well as on six other water management areas. The Orange River, which rises in the eastern highlands of Lesotho where it is known as the Senqu River, is the main river in the water management area and is also the largest and longest river in South Africa.

From the Upper Orange water management area, the river flows through the Lower Orange WMA and discharges into the Atlantic Ocean some 2 300 km from its origin in Lesotho. The Caledon River, which forms the border between South Africa and Lesotho over most of its length, is the largest tributary to the Orange River within the Upper Orange water management area. Other sizeable tributaries are the Kraai and Riet Rivers. The Riet River, however, first flows into the Vaal River, which then joins the Orange River a short distance further downstream. Refer to **Figure C1** in **Appendix C** for the location and general layout of the water management area. Since the completion of the WMA Reports and Chapter 2 and Appendix D of the NWRS, there were some adjustments made to the borders of the WMAs. The latest up to date borders are used in **Figure C1** for the purpose of this ISP.

Climate over the water management area is cool to temperate and ranges from semi-arid to arid. Rainfall mainly occurs as summer thundershowers, and reduces dramatically from as high as 1 000 mm per year in South Africa at locations in the east to about 200 mm per year in the west. In Lesotho, which is the source of most of the water in the Upper Orange water management area, rainfall varies between 600 mm per year to about 1 500 mm per year. Potential evaporation over most of the WMA is well in excess of the rainfall.

Savannah grassland covers the eastern part of the water management area, making way to Karoo shrubland towards the south and west. From the foothills of the Maluti Mountains at the border with Lesotho, the topography opens into wide plains in the west, with characteristic flat-topped hills.

2.2.2 Land use and development

The history of human presence in the water management area can be traced back to at least 40 000 years through the Florisbad skull which was discovered near Dealesville in the 1930's. Major impetus to modern economic development was given by the discovery of the first diamond in June 1870 near a fountain frequented by early transport riders. This prompted a diamond rush (about 3 years before Kimberley) and led to the establishment of the towns Koffiefontein and Jagersfontein. Bloemfontein, the capital of one of the former boer republics, later developed into the only city in the water management area. (Kimberley, which is situated on the divide with the Lower Vaal water management area, is administratively regarded as within the latter water management area.) Irrigation development was stimulated by the construction of several dams in the water management area, the most recent and notable being the Gariep and Vanderkloof Dams on the Orange River.

Livestock farming (sheep, cattle and some game) is the main economic activity in the WMA, much of which is still naturally vegetated. Extensive areas under dry land cultivation, mostly for

the production of grains, are found to the north-east. Ficksburg is famous for its cherry orchards. Large areas under irrigation for the growing of grain and fodder crops have been developed along the main rivers, mostly downstream of irrigation dams. There is no afforestation in the water management area.

Bloemfontein and Thaba 'Nchu represent the main urban and industrial development in the water management area. Two large hydropower stations were constructed at Gariep and Vanderkloof Dams. Mining activities have significantly declined and currently mainly relate to salt works and small diamond mining operations (DWAF, 2003a).

From a water resource management perspective this is a very important WMA as some of the largest dams in Africa have been built on the rivers of the Senqu catchment in Lesotho and on the main stem of the Orange River in South Africa. The Orange River in this area is characterized by the transfer of large quantities of water both within and out of the WMA. Transfers out of the Upper Orange include transfers to the Upper Vaal WMA (Lesotho Highlands Water Project), to the Fish / Tsitsikamma WMA (Orange-Fish Transfer), to the Lower Vaal WMA (Orange-Vaal Transfer) and downstream releases to the Lower Orange WMA and for use by Namibia. Transfers within the WMA occur from the Orange and Caledon Rivers to the adjacent Modder / Riet catchment.

Through its inter-dependence with other water management areas, it is essential that water resource management in the Upper Orange WMA should be well co-ordinated with these WMAs, particularly in the Orange/Vaal Basin, and that it be viewed in an integrated systems context. Management of water resources in the basin should also be within the framework of the Orange-Senqu River Commission recently established by South Africa, Lesotho, Namibia and Botswana.

2.2.3 Economic Characterisation of the WMA

Approximately 5% of the Gross Domestic Product (GDP) of South Africa originates from the Upper Orange WMA. The composition of the economy in the water management area in terms of contribution to the Gross Geographic Product (GGP) is shown in **Figure 2.1**. The largest economic sectors (in 1997) in terms of GGP are:

Government	24,6%
Finance	16,0%
Trade	15,7%
Transport	14,4%

Geographically, nearly 64% of the GGP is produced at Bloemfontein with the second largest district contribution being 4,2% from the Thaba 'Nchu decentralised development zone, approximately 60km east of Bloemfontein.

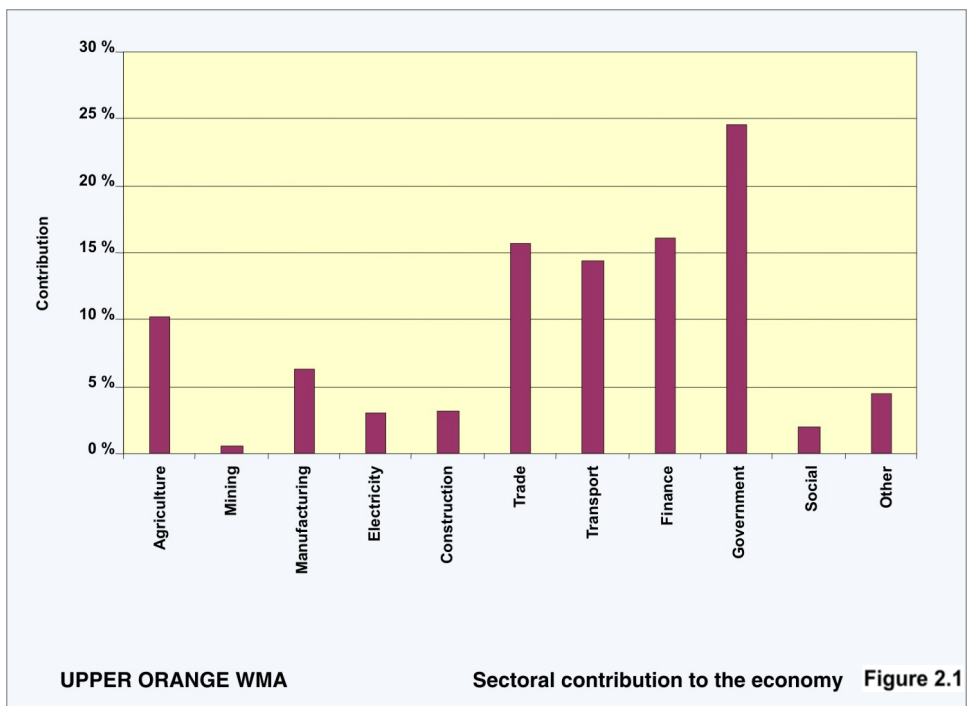
Bloemfontein, as the capital of the Free State, fulfils an important government function with many provincial government departments located in this area. The activities of the University of the Free State, the Free State Technikon, the Appeal Court and the major hospitals further

enhance the role of this sector. Bloemfontein also serves as a regional centre with close linkages to economic activities, such as generated by the agricultural sector, in the surrounding rural areas.

The importance of the transport sector is attributable to transport companies taking advantage of the fact that Bloemfontein is a major model interchange and stopover for cargo travelling on the routes from Gauteng or Durban to Cape Town or Port Elizabeth. It is also supported by the Bloemfontein airport and is central to the national rail network.

The strength of the finance and trade sectors is largely as a result of the other economic activities in the region.

Manufacturing occurs mainly in Bloemfontein, while manufacturing activities at Thaba 'Nchu have seriously declined since the cancellation of the previous government's decentralisation policy. This may be reversed through establishment of the Thaba 'Nchu Industrial Development Zone.



Of the work force of 376 000 people in the water management area in 1994, 59% were active in the formal economy, 31% were unemployed, which is close to the national average of 29%. The remaining 10% participated in the informal economy. Of those formally employed, 33% were in the government sector, 17% in agriculture and 12% in trade. (DWAF, 2003a)

There are no distinct strong primary drivers to stimulate economic growth in the water management area. Potential for growth can be found in the agricultural sector converting to higher value products, such as from grains to orchard crops and cut flowers, and through further processing and packaging. Growth in the transport sector, given the strategic central location of Bloemfontein, is likely to be stimulated by increasing economic activity elsewhere in the country. (DWAF, 2003a)

2.2.4 International

The Upper Orange WMA is part of the Orange River Basin, with South Africa, Lesotho, Botswana and Namibia as co-basin countries.

Bilateral arrangements on water issues by South Africa and Lesotho are addressed through the Lesotho Highlands Water Commission and in terms of the treaty between the countries on the Lesotho Highlands Water Project. Co-operation amongst the Orange River Basin countries is facilitated through the Orange-Senqu River Commission (ORASECOM), with membership by the basin countries.

2.2.5 Sub-areas

The WMA shows significant spatial variations in climate, water availability, level and nature of economic development and growth and is therefore divided into sub-areas for more detailed consideration. This results in improved representation of the water resource situation and better use of information for strategic management purposes.

Delineation of the sub-areas was based on practical considerations such as size and location of sub-catchments, homogeneity of natural characteristics, location of pertinent water infrastructure (e.g. dams), and economic development. These sub-areas have no administrative weighting and the catchment management agency may later introduce smaller or alternative subdivisions.

The Upper Orange water management area was divided into sub-areas comprising the following catchments as used in the NWRS:

- Catchment of the Caledon River in South Africa (Caledon RSA sub-area).
- Catchment of the Kraai River together with that of Orange River between the Lesotho border and the Caledon River confluence (Kraai sub-area).
- Orange River catchment between the Caledon confluence and the Vaal River confluence (Vanderkloof sub-area).
- Catchment of the Riet River together with Modder tributary (Riet/Modder sub-area).

Refer to **Figure C-2** in **Appendix C** for the location of the sub-areas.

Some of the sub-areas have been further sub-divided into sub-catchments. The hydrological sub-catchments showing numbered quaternary sub-catchments, sub-catchment boundaries, rivers, dams and main towns are shown in **Figure C-3** in **Appendix C**.

2.3 Resource availability

2.3.1 Surface Water

Nearly 70% of the total surface runoff, which would flow through the water management area under natural conditions, originates from Lesotho territory, and just more than 30% from within the water management area. There are no natural lakes or wetlands of note in the water management area, a consequence of both topography and climate.

In the natural state the quality of surface water in the water management area is good, particularly water which flows from the Highlands of Lesotho in the Senqu River. Water in the Caledon River is naturally of high turbidity and carries a concerning high sediment load. Irrigation return flow has a major impact on salinity in the lower Riet River, and water is transferred to the Riet River from Vanderkloof Dam, partly for blending and water quality management purposes. A natural pan below Krugersdrift Dam also adds salinity to the Modder River.

The surface water resources, from within the WMA and Lesotho are well developed, and with a high degree of utilisation. The main storage dams in the WMA are:

- Katse Dam in the Senqu sub-area in Lesotho, used for transfer of water to the Upper Vaal water management area. Mohale Dam, in the same sub-area, and started to impound water in 2003. This dam is also used to transfer water to the Upper Vaal water management area.
- Gariep and Vanderkloof Dams on the Orange River (Vanderkloof sub-area) are the two largest reservoirs in South Africa. Hydropower for peaking purposes is generated at both sites.
- Armenia and Egmont Dams on tributaries in the Caledon sub-area. Welbedacht Dam lies on the main stem of the Caledon River, with Knellpoort Dam an off-channel storage dam that supplements the water supply to Bloemfontein.
- Rustfontein, Mockes and Krugersdrift Dams are situated on the Modder River, and the Tierpoort and Kalkfontein Dams on the Riet River.

Despite all these dams, a substantial proportion of the still undeveloped water resource potential in South Africa lies in the Upper Orange WMA and Lesotho. A site for harnessing this potential through the construction of a large dam exists at the confluence of the Orange and Kraai Rivers (at the farm Bosberg), provisionally referred to as Boskraai Dam, (DWAf, 2003a) and at the proposed Mashai dam site in Lesotho.

The surface water resources of the Orange River Catchment have been the subject of various studies aimed at developing and maintaining a reliable hydrological database. The hydrological data that are currently used to operate the system typically covers the period October 1920 to September 1988.

There is a fairly high level of confidence in the in the yield estimates of the surface water in the system, although some of the hydrology is relatively old. Extending the hydrology for the Gariep and Vanderkloof incremental records will not include a more severe drought than that already captured in the October 1920 to September 1988 record period. The observed records at Oranjedraai and Roodewal gauging stations for the period 1989 to 2000 confirmed this.

Although this hydrology can be extended by 15 years it is expected to have a relative small impact on the system yield. When updating the hydrology the whole Orange River catchment should be considered to bring all hydrology data to the same level. The reader is therefore also referred to the Orange River Overarching ISP (**DWAF, 2004**).

The water resource models, as configured for the Orange River System, are not at a high enough resolution to define the availability of small local water resources at a sufficient level of confidence. These local resources are used to support water users that are mostly located in tributary catchments. Based on inputs obtained during the ISP Workshops and from the DWAF Regional office, it seems that shortages can be expected at approximately 28 of the 62 towns located in the WMA. (Results are provided in **Appendix D**)

Factors having significant impacts on the available surface water resources are discussed in detail in the Orange River System Overarching Report (**DWAF, 2004**) and briefly listed below:

- Storage control curves and other relevant hydropower operating rules for Gariep & Vanderkloof dams. (Currently using the surplus available in the system, see **Section 2.7.2** for detail).
- Operational losses with regards to releases from Vanderkloof Dam.
- Diffuse irrigation and small dams. (Diffuse irrigation is irrigation that is not supported by releases from large reservoirs and is usually in the form of run-of-river irrigation.)
- Irrigation Return Flows. Very little data is available but return flows commonly amount to 10% of irrigation water. Return flows also have a negative influence on water quality. WCDM will reduce return flows and therefore affect water quality.
- Recently updated and increased environmental flow requirements (EFR) for the LHWP. (This is expected to result in an increase in yield of approximately 30 to 60 million m³/a for Gariep / Vanderkloof combination.)
- Implementation of the Reserve for the Orange River.
- Sedimentation in the Caledon River Catchment.

The Upper Orange WMA is part of the extended Vaal and Orange River systems. A comprehensive modelling system has been set up for both the Vaal and Orange River systems to account for the complex interdependencies that exist due to the various inter-basin transfers. Operational analysis is carried out on an annual basis to determine the surplus available for hydropower generation. The Upper and Lower Orange WMAs are both included in these analyses. The decision support system for the Orange is described in the Orange Overarching ISP (**DWAF, 2004**) document.

The results obtained with regards to the water resource availability for the whole water resource system are reliable and carry a high level of confidence. For more detail the reader is also referred to the Orange River Overarching ISP (**DWAF, 2004**) documents. There are however some issues at the sub-area level within the WMA giving rise to local uncertainties. These are related to the availability of groundwater, old hydrological data in some areas, the hydrological information at local level for which more detailed hydrological models are required, uncertainties

with regards to areas irrigated from groundwater resources and a lack of understanding of the interaction of ground and surface water resources. (see **Table A.1.1** in **Appendix A** for detail on the available hydrology).

2.3.2 Groundwater

The Upper Orange WMA Overview report (DWAF, 2003a) indicates a total groundwater use of 64×10^6 m³/year for the Upper Orange WMA at 2000 development level. The registered volume of groundwater use as obtained from the WARMS database shows a total volume of 98.3×10^6 m³/year, which represents approximately 10% of the harvest potential. The registered data must however still be verified.

The theoretical groundwater availability is estimated to be $1\,020 \times 10^6$ m³/year. This value was calculated from the Harvest Potential Map (DWAF, 2002b) for this WMA and represents a significant volume. The average harvest potential is 10 000 m³/km²/year. This means that on average, one will require approximately 100 ha “groundwater area” to irrigate 1 ha. In practice it might however be that within a single 100 ha area, almost no groundwater can be utilised, while in another 100 ha area, more than sufficient groundwater might be available. Although the groundwater represents a large potential resource, particularly for local supply in areas that are distant from the main river system, the uneven distribution of the resource must always be taken into account.

Groundwater is widely used in the area to supply small towns (approximately 35 towns) either as the sole source of supply or in combination with surface water resources (Detail is given in **Appendices B & D**.) The De Beers mining company supplies Jagersfontein with water, which is pumped from a decommissioned mine from a depth of 220m below surface. Unfortunately the development and management of groundwater is seldom done properly. Municipalities tend to restrict their search for water to municipal boundaries. The municipalities should also investigate groundwater potential outside town boundaries as a possible source. Un-scientific borehole siting often results in dry holes being drilled. Borehole siting needs to be based on proper geo-technical work to limit the drilling of unsuccessful boreholes and to improve the yield from the boreholes (More detail on groundwater is included in **Appendix B** of this report).

Boreholes and abstraction from boreholes are seldom managed properly and therefore the failure of boreholes in the Southern Free State is a common experience. Proper management and monitoring of groundwater sources by municipalities and other users are of vital importance.

The main agricultural activity in the WMA is mixed farming, although various crops are irrigated with groundwater. Small-scale irrigation from groundwater is found in the Koffiefontein and Luckhoff districts. The main areas of concern related to large-scale irrigation from groundwater are the Bainsvlei and Petrusburg areas. Studies undertaken by DWAF in the Upper Orange area revealed that the Petrusburg region abstracts approximately 15×10^6 m³/year, while Bainsvlei region abstracts approximately 33×10^6 m³/year for irrigation. Over abstraction was and still is a problem at some sites within the two areas.

Groundwater therefore plays a major role in the economy of the Modder River catchment. This sub-area has particularly high-yielding aquifers on which agriculture is strongly dependant.

The geohydrology is not yet very well understood. Current indications are that the over abstractions need to be managed and a high level of protection and management is therefore required for this sub-area. Groundwater users in the Bainsvlei and Pertusburg areas have applied for the establishment of a WUA (Kalkveld WUA) and are currently awaiting approval.

Groundwater monitoring and data on the availability of groundwater in general is insufficient. There is a need to provide groundwater information and to create an improved understanding of groundwater at a local level. (See strategy tables in **Appendix A** for detailed management actions)

2.3.3 Water Quality

The water quality in the Upper Orange WMA varies from poor in the highly developed areas to good in those that are less developed. The Upper Orange WMA contributes directly to the flows and water quality in the Lower Orange WMA. The Upper Orange WMA also receives water from Lesotho and any further development of the Lesotho Highlands Scheme could influence the water quality in Upper and Lower Orange WMAs as result of the reduction in the inflow of good quality water.

Most of the sewage works within the WMA are inadequate and are in a poor state. The reasons for this are both management and the overloading of the plants due to the replacement of pit latrines with water borne sewerage systems. Systems are audited on a two yearly basis and feedback is given to local government.

The approach adopted for the management of the water quality in the WMA is on a sub-catchment basis. The Riet/Modder is presently being addressed through the development of a CMS for the sub-system (currently in phase 2). These plans involve the setting of water quality objectives (WQO), identification of pollution sources, and the modelling and development of management actions. These plans for the individual areas need to be linked to an assessment of the overall water quality management of the Orange River.

The groundwater in the Riet / Modder catchment is polluted at specific sites, elsewhere the groundwater quality is generally good. This is partly due to the use of pit latrines, cited as a source of pollution in some areas. Some of the boreholes in the Thaba 'Nchu area cannot be used for human consumption because of poor quality due to nutrients and microbiological quality. The extensive irrigation in this catchment has also resulted in the pollution of the groundwater resources. The elevated salinity levels that were reported for the Jacobsdal area already indicated this. The water quality problems are mainly salinity and nutrient enrichment.

The water quality and the water infrastructure in the Caledon River catchment are impacted on by sedimentation. The soils have a moderate to high erosivity index, which coupled with poor land use practices, has resulted in high erosion rates. This is reflected in the sedimentation of Welbedacht Dam and the operating rules that have to be adopted for the water supply infrastructure in this area. (See strategy tables in **Appendix A** for detailed management actions)

2.3.4 Reserve

A comprehensive Reserve has not been determined for the Orange River. The Instream Flow Requirements (IFR) has recently been determined for Lesotho based on their IFR Policy Procedures and is in the process of being implemented and tested by means of the water

resource models. For detail on the main stem of the Orange River the reader is referred to the Orange River System Overarching Report (**DWAF, 2004**).

Water to meet the ecological requirements as determined in the ORRS is currently released from Vanderkloof Dam for the main stem of the Orange River and for the Orange River mouth. The ecological requirements from the ORRS are more or less at intermediate level but the methodology differs from that currently used and accepted. These volumes however seem inadequate in comparison with modified desktop estimates as obtained from the current Lower Orange River management Study (See Orange River Overarching ISP (**DWAF, 2004**) for more detail).

Ecological requirements were not yet determined for the catchment upstream of Vanderkloof Dam and downstream of the Lesotho. This catchment includes the Caledon, Kraai and Seekoei rivers.

An intermediate level ecological Reserve is in the process of being determined for the Riet/Modder catchment as part of the development of a CMS for the area. The preliminary groundwater Reserves for the Petrusburg and Bainsvlei areas (C52H, J & K) in the Riet/Modder catchment has been determined.

No significant infestations of alien vegetation occur in the WMA.

When a Reserve determination becomes necessary the RDM and Regional office should assess whether the Reserve for the entire catchment needs to be determined or only sections of the catchment and when this determination should take place. The Reserve determination should also be coordinated with the Reserve determination for the Vaal River System and the compulsory licensing process. (See strategy tables in **Appendix A** for detailed management actions)

2.4 Water Requirements

2.4.1 Current Requirements

Reliable water requirement data (current and future projections) have to be available to undertake water resource operational and development planning activities. Irrigation water requirements represent approximately 80% of the requirements in the WMA. The bulk of the urban/industrial requirements are located in the Riet/Modder catchment, with the main demand centres being Bloemfontein and Botshabelo.

A significant number of towns in the WMA are supplied by Bloem Water or have allocations from nearby large inter-basin transfer schemes. Other towns are located close to the main river or have access to water from a large upstream storage dam. The water requirements for these towns are included in the water balance of the Integrated Orange River System, and the water supply to seems to be adequate in most cases. A third supply situation exists where towns rely partially or fully on local ground or surface water resources. Most of these towns depend on groundwater or surface water in small dams or a combination thereof.

Water use registration has been completed in this WMA. Verification of this registered water use is currently underway and will also be used to determine the existing lawful use. This process is expected to be completed by 2006.

Although a fairly reliable and up to date database exists with regards to the water use in the system, there are some issues, which should be addressed. These include:

- Actual irrigation water use for comparison with scheduled areas / quotas and/or allocations.
- Lack of data with regards to the water requirements for small towns.

The Upper Orange WMA is part of the total Orange River System and planning and operations must be considered as part of the whole system. The water requirements of the larger system are described in the Orange Overarching ISP document (**DWAF, 2004**).

The water requirements at a 98% assurance (1 in 50 year) level are summarised for the year 2000 development level in **Table 2.2**. This information was obtained from the Overview report for the Upper Orange WMA (DWAF, 2003a). When the 12 000 ha earmarked to resource poor farmers is taken into account the total water requirement will increase to the volumes as indicated in brackets (See **Section 2.4.3** for more detail).

Table 2.2: Year 2000 Water Requirements (million m³/a)

Sub-area	Irrigation (4)	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Total local requirements (4)	Transfers out (5)	Grand Total
Caledon RSA	88	4	13	0	0	105	59	164
Kraai	84	6	13	0	0	103	0	103
Riet / Modder	252	87	10	2	0	351	29	380
Vanderkloof	336	5	5	0	0	346	2 809	3 155
Total (4)	760 (795)	102	41	2	0	905 (940)	2 897 (2 975)	3 802 (3 915)

- 1) Includes component of Reserve for basic human needs at 25 l/c/d.
- 2) Mining and bulk industrial water uses, which are not part of urban systems.
- 3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
- 4) The water requirement for 4 000ha of irrigation earmarked to resource poor farmers in the Upper Orange is included in the value given in brackets. See **Section 2.4.3** for more detail.
- 5) The water requirement for 4 000ha of irrigation earmarked to resource poor farmers in the Lower Orange and 4 000ha earmarked to resource poor farmers in the Fish-Tsitsikama WMA are included in the value given in brackets. See **Section 2.4.3** for more detail.

2.4.2 Future Water Requirements

In this ISP the future water requirement scenarios as developed for the NWRS and documented in DWAF 2003a are used. The base scenario from the NWRS shows that there is a continued concentration of economic development and population in the Bloemfontein region, and a decline in rural population in the WMA. A growth in urban/industrial water requirements can therefore be expected in the Riet/Modder sub-area, and a possible decrease in domestic/rural requirements elsewhere. No new irrigation schemes or large mining developments are being planned, and no meaningful change in the requirements for water by these sectors is foreseen,

except for the development of 4 000ha of irrigation, for which water has already been earmarked to resource poor farmers (See **Section 2.4.3** for more detail). Strong possibilities for the transfer of additional water to other water management areas have however been identified.

Quantification of the projected future requirements for water is presented in **Table 2.3** (DWAf, 2003a). The increase in the Vanderkloof transfers is due to urban/industrial/mining growth as well as the 4 000 ha earmarked for the Lower Orange WMA for resource poor farmers (See **Section 2.4.3** for more detail).

Table 2.3: Year 2025 base scenario water requirements (million m³/a)

Sub-area	Irrigation	Urban	Rural	Mining and bulk industrial	Power generation	Total local requirements	Transfers out	Grand Total
		(1)	(1)	(2)	(3)			
Caledon RSA	88	6	10	0	0	104	118	222
Kraai	119	7	12	0	0	138	0	138
Riet / Modder	252	146	10	2	0	410	52	462
Vanderkloof	336	6	5	0	0	347	2 878	3 225
Total	795	165	37	2	0	999	3 048	4 047

Notes: (1), (2) (3) as for Table 2.2

For the purpose of the ISP, slight adjustments were however made to the year 2025 demand projection. These changes include the following:

- The water requirement for the 4 000 ha earmarked for to the Upper Orange WMA should rather be allocated to the Vanderkloof sub-area and not to the Kraai sub-area as shown in **Table 2.3**.
- The water requirement for the 4 000 ha earmarked for the Lower Orange WMA is included in the transfer volume from the Vanderkloof sub-area as shown in **Table 2.3**, but not the 4 000 ha earmarked for the Fish-Tsitsikama WMA. It is however important that it should also be included in the projected 2025 transfer (See **Section 2.4.3** for more detail).

Table 2.4 includes the required changes for the projected year 2025 requirements as described above. Due to different crop requirements and climatic conditions the requirement for the 4 000 ha allocated to the Fish-Tsitsikama WMA requires a slightly higher volume of 38 million m³/a.

Table 2.4: Year 2025 base scenario water requirements (million m³/a)

Sub-area	Irrigation	Urban	Rural	Mining and bulk industrial	Power generation	Total local requirements	Transfers out	Grand Total
		(1)	(1)	(2)	(3)			
Caledon RSA	88	6	10	0	0	104	118	222
Kraai	84	7	12	0	0	103	0	103
Riet / Modder	252	146	10	2	0	410	52	462
Vanderkloof	371	6	5	0	0	382	2 916	3 298
Total	795	165	37	2	0	999	3 086	4 085

Notes: (1), (2) (3) as for Table 2.2

Planning for cities and larger towns should include scenarios for future requirements with different levels of growth and the likely impact of WCDM. DWAf should request of Local

Authorities that urban water demand projections be checked on an annual basis and that a full update of the projections be made on a 5-year basis, after the completion of a National Census.

2.4.3 Poverty eradication and its effect on water requirements

Although poverty is an overall problem in most areas, the Orange River upstream of Gariiep, and specifically with reference to the Kraai River catchment has been highlighted in this regard as the previous homeland areas are found in this catchment.

Poverty eradication is one of the central themes of government policy. The Department is therefore taking up opportunities to implement or support poverty eradication initiatives. As important as new initiatives or projects is, is ensuring that the supply of water and protection of water resources do not unduly restrict the economic development of the country.

Capital expenditure on water supply and sanitation projects in the financial year ending March 2002 was R 28.5 million for the Upper Orange (assuming that the expenditure can be split evenly across each of the provinces). R 26.5 million for water supply and R 2.0 million for sanitation. This is in addition to the provision of free basic water.

Surplus water available within the Orange River System (Gariiep & Vanderkloof dams) was earmarked for use by resource poor farmers for the development of 12 000 ha of irrigation. Of the total allocation, 4 000ha is located in the Upper Orange WMA, 4000ha in the Fish to Tsitsikamma WMA and 4000ha in the Lower Orange WMA. Detail of the areas earmarked for the WMA and provinces are shown in **Table 2.5**. The 1 000 ha from the Upper Orange WMA that is earmarked for the Eastern Cape Province, is located within the Kraai River catchment.

This means that 5 000 ha is earmarked for the Eastern Cape Province of which 4 000 ha is in the Fish to Tsitsikamma WMA and a 1 000 ha in the Upper Orange WMA. There is not sufficient water available in the Kraai River to irrigate the full 1 000 ha and water will most probably be obtained from the main stem of the Orange River for this purpose.

There is some flexibility around the figures given in **Table 2.5** as Northern Cape Province may for example decide to develop irrigation just downstream of Vanderkloof Dam in an area falling in the Upper Orange WMA and not in the Lower Orange WMA.

The aim of this allocation is for poverty relief and rural development. None or very little of these developments have yet taken place, although some are in progress. Potential irrigation areas were identified in the ORRS for possible future development and in the LORMS investigations for potential irrigation areas and crops are focussed on the area along the RSA-Namibian border. The final allocation of these irrigation areas should take place through the Co-ordinating Committee for Agriculture and Water (CCAW) to ensure that developments are viable and sustainable. (The Irrigation Action Committees (IACs) are in the process to be transformed into the CCAWs (See **Section 2.7.4** for detail).)

Table 2.5: Summary of areas earmarked for resource poor farmers for irrigation development (million m³/a)

WMA	Provinces			Total
	Free State	Northern Cape	Eastern Cape	
Upper Orange	3 000 ha (26 million m ³ /a)		1 000 ha (9 million m ³ /a)	4 000 ha (35 million m ³ /a)
Lower Orange		4 000 ha (40 million m ³ /a)		4 000 ha (40 million m ³ /a)
Fish to Tsitsikama			4 000 ha (38 million m ³ /a)	4 000 ha (38 million m ³ /a)
Total	3 000 ha (26 million m ³ /a)	4 000 ha (40 million m ³ /a)	5 000 ha (47 million m ³ /a)	12 000 ha (113 million m ³ /a)

Note : The volume of water required is based on the typical allocation in the areas and represent the net requirement at 1 in 50 year assurance level.

The establishment of community nurseries to provide trees for various purposes has already started in the WMA (one located in Thaba 'Nchu).

2.4.4 Transfers

There are two existing transfers of water out of the Upper Orange WMA. These transfers include the transfer through the Orange/Fish tunnel from Gariiep Dam to the Fish to Tsitsikamma WMA as well as the release obligation (or transfer as it is referred to in the NWRS) from the Upper Orange WMA to the Lower Orange WMA by means of releases from Vanderkloof Dam. These releases are the main source of water for the Lower Orange and users along the Orange River are totally dependent on them. This release amounts to ±2 075 million m³/a. This includes an as yet unused 40 million m³/a of water for the 4 000ha earmarked to resource poor farmers in the Lower Orange WMA. These releases are sufficient to supply all the users along the Lower Orange River main stem, including the environmental and river evaporation requirements.

Transfers within the WMA include the transfer from the Caledon River (Welbedacht and Knellpoort dams) to the Modder River (Rustfontein and Mockes dams) to support Bloemfontein, Botshabelo and other towns/small users, as well as the transfer from Vanderkloof Dam via the Orange-Riet canal to supply mainly irrigation in the Riet/Modder catchment.

2.5 Yield Balance

The Upper Orange WMA is a component of the extended Orange and Vaal River System. This has been the subject of various water balance and reconciliation studies. The latest water

balance from the Orange River system indicated a surplus of 333 million m³/a for the year 2000. This reduces to 158 million m³/a in 2003 when Mohale Dam is commissioned, due to the fact that more water can now be transferred out of the system to the Upper Vaal WMA (See **Tables 2.7 & 2.8** data as obtained from the Overview Report Upper Orange (DWAf, 2003a)).

Table 2.7: Year 2000 water balance for the Upper Orange WMA (million m³/a)

Sub-area	Available water			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local requirements	Transfers out (2)	Total	
Senqu Lesotho	523	0	523	23	491	514	9
Caledon Lesotho	31	0	31	40	0	40	(9)
Caledon RSA	178	0	178	105	59	164	14
Kraai	44	0	44	103	0	103	(59)
Riet / Modder	137	242	379	351	29	380	(1)
Vanderkloof	3 534	0	3 534	346	2 809	3 155	379
Total	4 447	2	4 449	968	3 148	4 116	333

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

Table 2.7 represents the water balance as obtained from the Overview report, Upper Orange (**DWAf, 2003a**). Most of the year 2000 surplus will be taken up on the commissioning of Mohale Dam in 2003. Although Mohale Dam increases the local yield in the Upper Orange, the increase in yield is transferred to the Upper Vaal WMA and cannot be used in the Upper or Lower Orange WMAs. The effect of Mohale Dam is illustrated in **Table 2.8** and it can be seen that the surplus is reduced from 333 million m³/a to 158 million m³/a.

Table 2.8: Year 2003 water balance for the Upper Orange WMA with Mohale Dam included (million m³/a)

Sub-area	Available water			Water requirements			Balance
	Local yield	Transfers in	Total	Local requirements	Transfers out (2)	Total	
Senqu Lesotho	867	0	867	23	835	858	9
Caledon Lesotho	31	0	31	40	0	40	(9)
Caledon RSA	178	0	178	105	59	164	14
Kraai	44	0	44	103	0	103	(59)
Riet / Modder	137	242	379	351	29	380	(1)
Vanderkloof	3 359	0	3 359	346	2 809	3 155	204
Total	4 616	*2	4 618	968	*3 492	4 460	158

Note: * - The total transfers in and out do not represent the sum of transfers for all the sub-areas, but the total volume out or into the WMA, as some of the transfers are within the WMA between two sub-areas. For example 240 million m³/a is transferred from Vanderkloof sub-area into Riet/Modder sub-area and only 2 million m³/a is transferred from outside the WMA into the Riet/Modder sub-area.

When the effect of the 12 000 ha earmarked for resource poor farmers (4000ha Upper Orange WMA, 4000ha for Lower Orange WMA and 4000ha for Fish-Tsitsikamma WMA) is included, the surplus of 158 million m³/a will reduce further to only 44 million m³/a.

This surplus is reserved for the growth in demands in the urban, industrial and mining sectors in the Upper Orange WMA, the Lower Orange and the Fish to Tsitsikamma WMAs.

The water balance for the year 2025 as obtained from the Upper Orange WMA Overview Report (**DWAF, 2003a**) is shown in **Table 2.9** and indicates a surplus of 90 million m³/a. At 2025 development level it is expected that the 12 000 ha earmarked for resource poor farmers will have been developed in full. It is therefore not possible to have a surplus of 90 million m³/a available in year 2025, when the year 2003 water balance with the effect of the 12 000ha and Mohale Dam included, already showed a surplus of only 44 million m³/a.

Table 2.9: Year 2025 water balance for the Upper Orange WMA as obtained from the Overview Report (million m³/a)

Sub-area	Available water			Water requirements			Balance (3)
	Local yield (1)	Transfers in	Total	Local requirements (2)	Transfers out	Total	
Senqu Lesotho	867	0	867	23	835	858	9
Caledon Lesotho	30	0	30	40	0	40	(10)
Caledon RSA	273	0	273	104	118	222	51
Kraai	45	0	45	138	0	138	(93)
Riet / Modder	160	301	461	410	52	462	(1)
Vanderkloof	3 359	0	3 359	347	2 878	3 225	134
Total	4 734	2	4 736	1 062	3 589	4 646	90

After some investigation to clarify the anomaly, the following adjustments were made:

- The transfer to the Eastern Cape through the Orange Fish tunnel was increased by 38 million m³/a to accommodate the 4 000 ha allocated to the Fish-Tsitsikamma WMA. This requirement was not included in the volume given for the transfer out of the Vanderkloof sub-area in **Table 2.9**.
- The local yield in the Caledon RSA sub-area was increased in **Table 2.9** to represent the increase in yield of the Novo transfer scheme. The effect of this increase in yield on the Vanderkloof sub-area yield was however not taken into account in the figures given in **Table 2.9**.

- The 4 000ha allocated to the Upper Orange WMA was included in the Kraai sub-area in **Table 2.9** and it was decided that it should rather be included under the Vanderkloof sub-area. This will not impact on the overall surplus in the WMA but will impact on the surplus/deficit in the Vanderkloof and Kraai sub-areas.

The adjustments as described above were included and the results are shown in **Table 2.10**. From the adjusted water balance it is evident that there will be a deficit in the system at the year 2025 of approximately 50 million m³/a. When a linear water demand growth pattern is assumed between 2003 and 2025, the available water from the existing system will be fully utilised by 2020. It is important to note that for the purpose of the water balances used in the NWRS, all the demands and yields were converted to a 1 in 50 year assurance level. The deficit given in **Table 2.10** is therefore also representative of a 1 in 50 year risk level.

The remaining surplus of approximately 44 million m³/a at 2003 (effect of 12 000 ha included) is clearly not sufficient to cover the expected growth in urban/industrial/mining requirement as a deficit of nearly 50 million m³/a is expected by 2025. (The remaining surplus of 44 million m³/a is therefore reserved for high priority users).

Table 2.10: Year 2025 adjusted water balance for the Upper Orange WMA (million m³/a)

Sub-area	Available water			Water requirements			Balance (3)
	Local yield (1)	Transfers in	Total	Local requirements (2)	Transfers out	Total	
Senqu Lesotho	867	0	867	23	835	858	9
Caledon Lesotho	30	0	30	40	0	40	(10)
Caledon RSA	273	0	273	104	118	222	51
Kraai	45	0	45	103	0	103	(58)
Riet / Modder	160	301	461	410	52	462	(1)
Vanderkloof	3 264	0	3 264	384	2 918	3 302	(38)
Total	4 639	2	4 641	1 064	3 629	4 688	(47)

Towns not supplied from the main stem of the Orange River or large water supply schemes rely in most cases on local ground or surface water resources. Most of these towns depend on groundwater or small dams or a combination thereof. Shortages in the water supply are fairly common for most of these towns. DWAF Regional office provided a first indication of the supply situation for these towns, with additional information added during the ISP workshops. The results from this process are given in **Appendix D** of this document.

The Upper Orange WMA has a large commitment to support the local water requirements and transfers to the Upper Vaal WMA, the Fish to Tsitsikamma WMA as well as release obligations to the Lower Orange WMA. Measures to improve the water supply in the Upper Orange WMA include the adjustment of hydropower operating rules, reduction of operating losses, implementation of WCDM and using the lower level storage in Vanderkloof Dam. To be able to overcome the projected shortage in 2025 it will be required to partially implement one or two of

the proposed measures. See the Overarching ISP (**DWAF, 2004**) for the Orange River catchment for more detail.

Issues that need to be addressed include the uncertainties with regards to the water availability from the smaller water supply systems in the WMA as well as from groundwater.

The factors that can have a significant impact on the water balance are mainly of an overarching nature and are all listed in the Overarching ISP (**DWAF, 2004**) for the Orange River.

System analysis is required for the smaller water supply systems mainly in the Riet/Modder and Caledon catchments, to determine the water availability and to identify the shortages and surplus within these smaller sub-systems.

2.6 Water Reconciliation Options

Details with regards to overarching related options are discussed in detail in the Overarching ISP (**DWAF, 2004**) for the Orange River. A brief summary of the findings is however included in this document.

For the management of the medium term surplus along the Orange River main stem downstream of Gariep Dam, it should be taken into account that currently (year 2003), none of the 12 000ha allocation to resource poor farming has yet been developed. The result is that a temporary surplus in supply is available until such time as the resource poor farmers are established. The temporary surplus can be utilised to maximize hydropower generation over the medium term at Gariep and Vanderkloof Dams to the benefit of Eskom. The remaining surplus of approximately 44 million m³/a at 2003 (effect of 12 000 ha included) is clearly not sufficient to cover the expected growth in urban/industrial/mining requirement as a deficit of nearly 50 million m³/a is expected by 2025. The remaining surplus of 44 million m³/a is therefore reserved for high priority users.

For the management of the long-term water supply along the Orange River main stem, reconciliation can be obtained by means of several options of which all are of an overarching nature and are therefore discussed in detail in the Overarching ISP (**DWAF, 2004**). The options are briefly listed below:

- Measures to reduce the operating losses.
- Water conservation and demand management measures.
- Vanderkloof Dam, utilising the lower level storage.
- Boskraai Dam upstream of Gariep Dam.
- Possible developments from Lesotho Lowlands Study.
- Possible options that are currently investigated in the LORMS.

Given that the water resource availability and water requirements for the Integrated Orange River System is effectively in balance, it is required to closely monitor the water balance

situation on an ongoing basis. This will ensure that intervention planning can be adjusted to account for any changes that may have an impact on the projected water balance. The reader is referred to the Orange River Overarching ISP (**DWAF, 2004**) for more detail with regards to the management and planning of the Integrated Orange River system.

The Caledon/Modder transfer scheme is the largest Urban/Industrial water supply scheme used to supply requirements within the WMA. This scheme is used to supply the main urban centres such as Bloemfontein, Botshabelo, Thaba 'Nchu and other smaller users. The water supply system includes Welbedacht and Knellpoort dams located in the Caledon River and in a tributary of the Caledon, respectively. Water is transferred from Welbedacht Dam to Bloemfontein through the Welbedacht Bloemfontein transfer pipeline (several of the small users are also connected to this pipe line) and from Knellpoort to Rustfontein Dam through the so-called Novo Transfer scheme. Rustfontein and Mockes dams are part of the water supply system and are located the Modder River catchment upstream of Krugersdrift Dam.

Although the existing water supply system, which includes the first phase of the Novo transfer scheme, can provide sufficient water to the users to even beyond 2025, operational problems are experienced due to severe siltation problems in the system, as well as due to limitations on the internal distribution system and insufficient internal balancing storage.

The measures of reconciling the water balance in areas removed from the Orange River and other main water supply systems should include the following:

- Implement water conservation and demand management measures as a first option to extend the supply capability of the existing water resources. Any new development should be designed with sound water conservation and demand management practices in place. Management actions with regards to WC&DM should focus on irrigation water use, as it is by far the largest consumer of water in the WMA.
- Investigate the utilisation of local water resources, particularly groundwater. Exploration investigations for groundwater and surface water resources should cover areas wider than the boundaries of the towns.
- The priority for compulsory licensing for localised stressed areas such as the Petrusburg and Bainsvlei area with regards to groundwater, should be evaluated. Due to the low interaction between groundwater and surface water in this area, it should be possible to do the compulsory licensing for the two sources separately. Other ways to manage the situation should be found first, before we get down to compulsory licensing. This should typically include the verification of law full use, eliminating of illegal users, checking on the availability, imposing of curtailments, educating people and make them aware of the problem, improve the management of the groundwater system, etc.

Detailed assessments of local water balances and reconciliation measures will be the responsibility of the Local Authorities with support (on request) from the DWAF. These assessments will only be undertaken for specific situations where there are specific water supply problems.

2.7 Infrastructure Development & Management

2.7.1 Infrastructure Development

A holistic planning effort will be required to identify the optimum bulk water storage and supply infrastructure layout that will make optimal use of the local water resources in the Upper Orange River WMA. With regards to the main Orange River System infrastructure development the reader is referred to the Orange River Overarching ISP (**DWAF, 2004**).

There are a high number of towns, particularly in the southern Free State area, for which the growth and development of these towns will require the improvement of services, including water and sanitation.

Sedimentation is a real problem in terms of dam operation in the Upper Orange River (mainly Caledon River) catchment. Sedimentation results in wear and tear on plant & equipment with the result that downtime increases and the reliability of supply is decreased in areas that have inadequate storage facilities, e.g. Bloemfontein.

Consideration needs to be given to economic factors in deciding whether locally available water should be recycled (through the construction of treatment plants) or whether needs should be met by 'importing' potentially more expensive water. Water Conservation and Demand management has to be linked with the allocation of surplus water.

2.7.2 System Management

The Upper Orange WMA is a significant catchment in the context of South Africa's economy as the impacts of water resource management within the basin directly extend to other WMAs and to neighboring countries. Consequently the integrated management of this catchment is important and it is very important that all the role players are fully informed and aware of their responsibilities. For a detailed description of the management of the main Orange River system, the reader is referred to the Orange River Overarching ISP (**DWAF, 2004**). Operating analyses are for the main system undertaken on an annual basis to determine the surplus available for the generation of hydropower over and above that released for normal downstream requirements. A hydropower-operating rule was developed to allow for the specific needs set by Eskom, but to simultaneously supply the existing users at their required assurance of water supply.

The surplus as given in **Section 2.5** is based on the assumption that the hydropower generation and related rules has no effect on the surplus yield and only utilises the releases from Gariep and Vanderkloof dams for downstream users, to generate hydropower.

Significant variation in the releases from Gariep and Vanderkloof dams occur as result of hydropower releases. There is an existing communication strategy in place, which notifies DWAF as well as the affected downstream users of the hydropower releases.

The Caledon/Modder transfer system as well as other sub-systems within the Riet/Modder catchment are not analysed on an annual basis. Models and the required data already exist for this purpose, and these systems should in future be included as part of the annual analysis.

The Department's current commitments with regards to public health and safety are associated with:

- Managing floods and drought disasters by direct intervention on the ground.
- Reducing pollution and preventing serious or hazardous pollution events.
- Promoting dam safety.

2.7.3 Monitoring and Information systems

The CMA is responsible to co-ordinate the monitoring and information management systems to ensure that gaps do not exist and to eliminate unnecessary duplication. The successful operation of the Upper Orange River WMA requires effective monitoring networks and information management systems. There is an extensive network of flow, rainfall and water quality monitoring stations in the catchment. However, studies have highlighted the need to expand the monitoring network to include more gauges to determine river losses, bulk distribution system losses, track water requirements and include bio monitoring to assist with the determination and implementation of the ecological Reserve. It is critical to have a coordinated monitoring to avoid duplications and waste of resources. Also with regard to Reserve compliance monitoring, it needs to be sorted out clearly whose responsibility will it be. Aquatic Ecosystem Biomonitoring Programme (in short RHP) cannot be used to monitor compliance as it is designed to pick up status and trends and not cause-effect relationship. However, RHP tools can be adapted and used for compliance (cause –effect relationship) monitoring.

The following weak points with regards to the monitoring and information management were identified:

1. Limited, almost no observed data available with regards to the actual irrigation water use.
2. Several key points in the Modder/Riet river catchment requires stream flow gauging or a significant improvement on the accuracy of existing gauging.
3. Problems were experienced with the gauging at Gariep and Vanderkloof dams and resulting water balance between the two dams. These are two of the most important sites and require accurate gauging.
4. The accuracy of the observed low flows in the Orange River downstream of Vanderkloof Dam need to be improved.
5. Problems were experienced with water quality data, which resulted in difficulties with regards to the previous calibration of the salinity model.
6. Groundwater monitoring is inadequate.

As part of the Overarching ISPs, a need was identified to undertake an assessment of all the monitoring needs to support the Integrated or Overarching Water Resource Management activities in the Vaal and Orange River catchments. The most important needs are given in the situation assessment of this strategy (see **Strategy A.8**). More detail can be obtained from the recommendations given in the relevant study reports as well as inputs from the Regional Office and CMAs. Coordination is the key and responsibilities, infrastructure and catering for emerging monitoring networks in the strategy (CMS/ISP).

2.7.4 Institutional development and support

On national level, co-operative governance (i.e. liaison and integration of planning between government departments, district and local authorities) needs to be factored into the overall integrated water resources management arena, to ensure a compounded benefit to all users in the catchment.

Two thirds of the total yield realised by the dams in Lesotho and in the Upper Orange WMA, is transferred to the Upper Vaal, the Fish / Tsitsikamma WMAs, and released to the Lower Orange WMA, partly for use by Namibia.

The existing Departmental and international communication systems should be used to keep track of the proposed water resource developments and land use planning as they affect water quality and erosion sedimentation. The silt surveys of the impacted dams should be continued and reviewed to monitor the extent of the silt problem. (For a description of the strategy at International level, the reader is referred to the Orange River Overarching ISP document (**DWAF, 2004**)).

There are 4 sub-areas in the Upper Orange WMA. A logic starting point would be to have a representative catchment management forum in place for each sub-area. These forums are normally made up of interested and concerned citizens, as well as the major water users, and play an active role in the practical review and implementation of the various water resource management issues in the catchments. Problems with representivity at forums, however, in general threaten their effective existence. Currently interested and affected parties are however included on a study basis, as there is no catchment management forum yet in place.

DWAF should continue assisting in the establishment and empowerment of the local water resource management authorities. More support needs to be considered to the founding of forums, since they fulfil a key role in the establishment of these institutions. Promotion of these forums is crucial in order to ensure that the forums are representative of all the role players / stakeholders in the catchment.

Institutions at District and Local Municipal level are relatively new on the scene and water resource and water service capacity is slowly being built in these institutions. Liaison between the various institutions needs to be encouraged in the interest of integrated water resources management in the Upper Orange WMA. Valuable documents to be used in this communication process between the parties are the WSDP as prepared by the Municipalities as requested by DWAF and the ISP documents prepared by the DWAF.

Cabinet approved the Municipal Infrastructure Grant (MIG) on 5 March 2003. Although the Department of Provincial and Local Government (DPLG) will administer the MIG, the involvement of DWAF is extremely important. The DPLG will administer the MIG subject to the oversight of the Municipal Infrastructure Task Team (MITT), which consists of nominated representatives from various Departments including DWAF. Any development funded by the MIG must also be reflected in the WSDPs and communicated to DWAF. The involvement and responsibilities of the DWAF with regards to the MIG should be in line with the document Principles and Methods for the implementation of the MIG" (Draft Version 1 is currently available and a copy of the document is included in **Appendix E**).

Irrigation boards are currently being transformed to Water User Associations. This process will continue and these institutions will fulfil their roles in line with the NWA, WSA and the NWRS.

The Irrigation Action Committees (IACs) are in the process to be transformed into the Coordinating Committees for Agricultural Water (CCAWs.) As the IACs, they will provide a forum for technical planning and streamlined liaison between relevant departments, but now with a broadened focus on agriculture water use (not only irrigation) and a widened participation by relevant role-players and disciplines.

2.8 ISP Implementation Strategy

The ISP is intended to act as DWAFs perspective on how the Orange River catchment's water resources should be managed. The Implementation of the ISP is an enormous task. It is recognised that it is quite impossible to immediately launch into, and achieve, all that is required by this ISP. Funds and capacity are, and will always be, blocks that must be climbed over. The approach is to take the ISP and to use it as instruction, guidance, and motivation in the development of yet clearer management and action plans. These must be built into Departmental Business Plans, and budgeted for as part of Departmental operating costs. This will necessarily be in a phased manner as dictated by available resources, but it is important that the ISP be used to leverage maximum funds, maximum capacity, and to bring optimum management to the WMA.

The final ISP will be put out and be open to comments from local authorities, water user associations and other water related forums and interested stakeholders. Mechanisms are to be put in place to capture anomalies and it is intended that formal updates of the document will occur periodically until such time as Catchment Management Agencies are technically functional and Catchment Management Strategies developed.

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Appendix A
Upper Orange WMA Strategies

Appendix A: Upper Orange Water Management Area Strategies

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Appendix A: INTRODUCTION TO STRATEGY TABLES

The first 2 chapters of the Upper Orange WMA ISP describe the ISP process, paint a broad perspective of the water situation in the WMA and provide a description of the key issues that have to be dealt with. The crux of the ISP is located in a series of strategy tables presented in **Appendix A**. The strategy tables for each area present the management objective (what we are trying to achieve); an assessment of the situation along with a motivation as to why the strategy is required; the required actions; responsibilities; priorities; and relevant supporting references. A version control is attached for future versions of this Internal Strategic Perspective (ISP).

Some issues are clearly applicable to all WMAs in the country and for some a national policy to guide the strategy needs to be developed first. These issues and aspects were identified and flagged for consideration at **National Level**.

The table below provides a brief description of the elements contained in the strategy tables and was included to create some common understanding of what is meant by these elements.

Definitions of terminology used in the Strategy Tables

Management Objective	Description of what DWAF is trying to achieve
Situation assessment	Description of the current situation and motivation to support the specific elements listed below.
Management actions (M)	Solutions to fill information gaps, adhere to directives and to meet requirements.

A.1 WATER BALANCE AND WATER RESOURCE RECONCILIATION STRATEGIES

A.1.1 RESOURCE AVAILABILITY

<p>Management objective:</p>	<p>Ensure that reliable estimates of the water resources (surface and groundwater) are available to effectively conduct Integrated Water Resources Management. The factors impacting on the water resources needs to be clearly defined and understood.</p>
<p>Situation Assessment:</p>	<p>Surface water resources</p> <p>The Upper Orange WMA is a component of the extended Vaal and Orange River Systems. Integrated systems models have been compiled to account for the complex interdependencies that exist due to the various inter-basin transfers. The system is currently well modelled using both the WRPM and WRYM models. For detail on the main water supply system the reader is referred to the Orange River System Overarching ISP (DWAf, 2004).</p> <p>The available hydrology records for the Caledon, Gariiep and Vanderkloof sub-catchments are almost 10 years shorter than that of the remaining catchments. The hydrology for these sub-catchments can now be updated and extended by at least 15 years, as observed records are available. Detail of the various hydrological records is given in the Orange River System Overarching ISP (DWAf, 2004).</p> <p>There is a fairly high level of confidence in the in the yield estimates of the surface water in the system although some of the hydrology is relatively old. It is however expected that the extension of the hydrology by 15 years, will have a relative small impact on the system yield. (See Section 2.3.1). Observed river flow records, rainfall records and updated demand data are readily available. It is however a costly exercise to include the data into the models. Records need to be verified and patched through various processes before the rainfall runoff models can be calibrated to produce natural runoff records for all the selected sub-catchments. The generated stochastic sequences must be also verified and validated before use in the WRYM and WRPM. Updated environmental requirements are required. The WRYM can only then be updated with the new hydrology and water requirement data and used to determine the updated yield characteristics of the system. The updated short-term yield characteristics, hydrology and water requirements and projections are then used as input to the WRPM for planning purposes.</p> <p>It is therefore important that any hydrology update must be carefully planned and programmed to co-ordinate the various processes and to ensure that all the components affecting the yield figures are updated.</p> <p>The water resource models, as configured for the Orange River System, are not at a high enough resolution to define the availability of all local water resources at a sufficient level of confidence. The natural hydrology and set up in the system models were based on the larger sub-catchments as dictated by the larger dams and main flow gauges. To be able to model smaller areas, further work will be required to accurately split the hydrology and demands and to include the required detail in the system model. The current models and hydrological data are however sufficient for the larger sub-systems such as the Caledon/Modder transfer system, larger dams such as Rustfontein, Krugersdrift, Kalkfontein, Mockes and Tierpoort.</p>

<p>Situation Assessment (Continued):</p>	<p>Groundwater resources</p> <p>The groundwater availability (exploitable volume not contributing to surface base flow) estimated volume for this WMA is significant. The groundwater represents a large potential resource, particularly for local supply in areas that are distant from the main river system as only 10% of this resource was used in 1995.</p> <p>Groundwater is widely used in the area for domestic and agricultural purposes. Studies currently undertaken by DWAF in the Upper Orange area revealed that the Petrusburg region abstracts approximately $15 \times 10^6 \text{ m}^3/\text{year}$, while Bainsvlei region abstracts approximately $11 \times 10^6 \text{ m}^3/\text{year}$ for irrigation.</p> <p>There are uncertainties with regards to the areas irrigated from ground water resources. This problem is currently partly addressed by means of the DWAF study to develop a CMS for the Modder/Riet catchment.</p> <p>Groundwater plays a major role in the sustainability and economy of the Lower Modder River catchment. In this unit approximately 72% of the total groundwater abstraction for the Upper Orange WMA occurs. Therefore the uniqueness of the aquifers present in this catchment, the agriculture dependence thereof together with geohydrological unknowns and estimates, necessitates the management and protection of this unit.</p> <p>There is a gap in the understanding of the interaction of groundwater and surface water resources in some areas. The surface water tools also lack specific modules to simulate this interaction. This item has been identified in various WMA ISPs and will be taken up as a National Level ISP.</p> <p>Most of the municipalities said that they are in need of more groundwater to meet their sanitation needs. Some municipalities indicated that there is noticeable decrease in the yield of some of their production boreholes.</p> <p>Failure of boreholes in the Southern Free State is a common experience. Some towns have drilled many boreholes without much success. Groundwater monitoring and data on the availability of groundwater in general is insufficient.</p> <p>A mind shift with regards to the use of groundwater is required specifically in the Southern Free State area. Users need to be aware of the importance of proper groundwater management and the fact that groundwater is not private water anymore. Municipalities can now explore groundwater resources outside the town boundaries and should be looking to all sources within reach of distribution systems.</p> <p>Groundwater potential is significant in this WMA and seems to be currently under utilised in some areas. Use existing maps to obtain an indication of the possible potential.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 In areas where the development of surface resources for local use is inevitable, rigorous yield analysis assessment of the local water resources must be performed. This should be carried out only when and where the need exists and will be the responsibility of the specific towns or towns affected. DWAF will be involved from a controlling and advisory perspective. Users using groundwater sources need to put a monitoring strategy in place to obtain sufficient data. (At least one borehole and one rain gauge required)</p> <p>M2 Undertake analysis on a need basis to improve the confidence of the estimates of the unused groundwater resources. The data obtained from this analysis must be used as input to M1. The outcome of item M3 should be used as input to this activity. Also see groundwater related management actions as given in Appendix B (Potential use of the water is for local supply and poverty eradication purposes.)</p> <p>M3 Update the surface water resource balance if it is confirmed that the registered water use is significantly different from the current estimates. The important variables to consider are small dams and water use for irrigation purposes. (Any difference between the actual water use and the data currently used in the models is currently masked by the streamflow hydrology.)</p> <p>M4 The hydrology update – see Orange River System Overarching ISP (DWAF, 2004).</p>	<p>Dir: NWRP Region Towns (Priority 5)</p> <p>Who ever require the information. (Priority 5)</p> <p>Integrated WR Planning (Priority 5)</p>
References:	<p>a) Orange River System Analysis Phase 1 & 2 (Report no. P D000/00/1092)</p> <p>b) Orange Vaal River System Analysis Update - Summary Report (Report no. P C000/00/19496).</p> <p>c) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697).</p>	

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A.1.2 WATER USE REQUIREMENTS

<p>Management objective:</p>	<p>Ensure the knowledge base on the water requirement in the WMA is realistic and updated on a regular basis. Maintain and update water requirement projection scenarios for planning and management purposes.</p>
<p>Situation Assessment:</p>	<p>Water use data</p> <p>Water requirements within the water management area are dominated by irrigation water use, which represents 80% of the local requirements for water. As would be expected, most of the urban and industrial requirements for water are in the Riet/Modder sub-area, which includes Bloemfontein, Botshabelo and Thaba 'Nchu. Water requirements for rural domestic supplies and for stock watering are relatively small.</p> <p>The irrigation allocations for the Main Orange River System are collated on an annual basis using information from the different DWAF offices and larger users. This information is compared with the projected water requirements in order to make adjustments (over the short-term) for use in the annual operating analysis. It should be noted that data on actual water use for irrigation is not available. The irrigation water use for irrigation schemes on the Orange are calculated based on the scheduled areas and quotas. Water use on the tributaries (excluding government water schemes) is estimated as a function of crop water requirements determined by means of SAPWAT. Return flows are based on estimates. Farmers can through double cropping, use more water than allocated to them.</p> <p>Although detailed information is not available, the indications are that approximately 8% of irrigation water is abstracted from boreholes, 35% is delivered through canal systems and the remaining 57% is abstracted directly from the rivers.</p> <p>The verification of lawful water use has started in the areas where the most problems are experienced. With current funding and personnel the process is expected to be completed by June 2007.</p> <p>Table 2.2 in Section 2.4.1 of Chapter 2 in the text gives a breakdown of the water requirements between the indicated sectors and components for the year 2000. The total gross water use for the Upper Orange River System for the year 2000 was estimated at 905 million m³/a. Growth in the water requirements is as result of the 12 000 ha allocated to resource poor farmers and the relative small growth in urban/industrial/mining requirement. The local requirements increased from 998 million m³/a to 999 million m³/a in 2025. Due to the relative small surplus available in the system, the surplus is reserved for high priority users. (See Section 2.5 in the Orange River Overarching ISP (DWAF, 2004))</p> <p>All large industries are included in the municipal water supply systems. Water requirements for mining are insignificant. Although large quantities of water are passed through turbines at Gariep and Vanderkloof Dams for power generation, the water is primarily released to meet other downstream requirements, with hydropower as a secondary and non-consumptive use and is therefore not reflected in the tables. (Surplus water may at times be released for the express purpose of power generation, but does not constitute a basic requirement for water.)</p> <p>The water resource and water requirements of the majority smaller towns not supplied from the large water supply systems is mostly not available from existing reports. Details of the water supply to towns and the resources used are summarised in Appendix D. These water balances were discussed with the</p>

<p>Situation Assessment (Continued):</p>	<p>Regional Office.</p> <p>For effective Integrated Water Resources Management it is required to have a clear understanding of the current and future water resources available (surface and groundwater) in the WMA. This includes knowing the quantities of water in terms of spatial distribution and any factors that may affect the yield of the system. Annual updates of the main water users are required as input to the annual operational analysis.</p> <p>Although water use data for the city and larger towns is mostly available, it is necessary to plan for future requirements. Planning should show projection scenarios typically with different levels of growth and the likely impact of WCDM</p> <p>RELEVANT REQUIREMENT DATA FOR SUB AREAS</p> <p>Details of the water supply to towns located in the different sub areas are given in Appendix D. Details with regards to irrigation developments are included in Appendix F.</p> <p>Vanderkloof Sub-area includes the following sub-catchments, Gariep, Vanderkloof and Orange River d/s of Vanderkloof.</p> <ul style="list-style-type: none"> • The main Orange River System (Gariep and Vanderkloof dams as source) are located in these sub-catchments and are used to support the requirements of most of the users. • There is in total 16 towns of which 6 are supplied from groundwater. Indications are that water shortages can occur at 4 of the towns supplied from groundwater. • Irrigation is the main water user in this area and includes: <ul style="list-style-type: none"> <i>There is in total ±10 300 ha diffuse irrigation in this sub-area and is mainly supplied from small dams. Irrigation in this sub-area that is supplied from Gariep and Vanderkloof Dam amount to ±21 700 ha.</i> • Transfer from Gariep Dam to the Fish-Tsitsikamma WMA to mainly support irrigation (±51 500ha) and a small urban component (mainly support to Port Elisabeth). <p>Caledon RSA and Riet/Modder Sub-areas includes the sub-catchments as discussed below:</p> <p>Welbedacht RSA, Rustfontein & Krugersdrift sub-catchments</p> <ul style="list-style-type: none"> • The Caledon/ Modder transfer scheme is located within the above-mentioned sub-catchments and the main urban industrial demand centres are supplied from this scheme (Bloemfontein, Botshabelo, Thaba 'Nchu) • Possible water shortages were only indicated for 1 out of the 14 towns and are for the town of Vanstadensrus, which is supplied from groundwater. • Limited diffuse irrigation is found in these sub-catchments (±7 350ha) which is supported from small dams and from the main river. <p>Caledon RSA and Caledon d/s of Welbedacht sub-catchments</p> <ul style="list-style-type: none"> • There are in total 11 towns located in these areas and are mainly supplied from small dams and direct river abstractions and to a lesser extend from boreholes. Possible shortages in water supply were indicated for 7 of the towns. • Diffuse irrigation (±2 200 ha) is practised in this area as well as (±5 000 ha) supported by means of compensation releases from Welbedacht Dam.
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<p>Situation Assessment (Continued):</p>	<p>Kalkfontein, Riet and Riet/Modder sub-catchments</p> <ul style="list-style-type: none"> • There is a total of 13 towns located in these areas and most are supplied from the major dams and transfer schemes, with only 3 totally depended on groundwater of which 2 experience water shortages. • Several irrigation schemes amounting to a total of ±24 000 ha, which are supplied from large dams including transfers from Vanderkloof Dam, are located in these sub-catchments. Diffuse irrigation amounts to a total of ±5 240 ha. <p>Kraai Sub-area also referred to as the Orange River u/s of Gariiep sub-catchment</p> <ul style="list-style-type: none"> • Several towns (11) are located in this area and possible shortages were indicated for 8 of these towns (see Appendix F for more detail). These towns are mainly supplied from groundwater. • Approximately 4 000ha is irrigated with water abstracted directly from the Orange River. Diffuse irrigation from the tributaries and small dams are significant (±13 000ha) which is far in excess of that supplied directly from the Orange River.
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<p>MANAGEMENT ACTIONS</p>		
<p>Required actions, responsibilities and priorities:</p>	<p>M1 After the completion of the verification of existing lawful use, comparisons should be made between the lawful use and the water use data applied in the water resource system models. The models must then be adjusted accordingly.</p> <p>M2 Initiate studies and/or processes to obtain better information on the actual water use by irrigation. This study should indicate the levels of metering that are required for specific purposes. Information such as the total area/volume supplied from groundwater, canals, major dams, directly from the river, which is measured and which not, should be provided from the study. A strategy to obtain better information on water use must be recommended from the study. The study could also be used as input to the formulation of a national guideline with regards to the measuring requirements for irrigation water use.</p> <p>M3 Initiate studies and/or processes to obtain better information on the return flows from irrigation.</p> <p>M4 Initiate studies and/or processes to obtain the water requirements, projections and water resources used by smaller towns, which is not part of the large water supply schemes. This can typically be addressed in the WSDPs. To ensure that meaningful data are obtained, it is very important that DWAF should interact in the process and approval of the data be given by DWAF.</p>	<p>Region (Priority 1)</p> <p>Region (Priority 2)</p> <p>Region (Priority 2)</p> <p>Local Authority/ Region (Priority 2)</p>
<p>References</p>	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p> <p>c) Lower Orange River Management Study (LORMS)</p> <p>d) Orange River Water Balance – Orange River Continuous Study (Report no. P D000/00/4903)</p>	

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A.1.3 WATER BALANCE RECONCILIATION

<p>Management objective:</p>	<p>Manage the water resources to maintain a surplus or balance between the available water resources and the water requirements through progressive implementation of management measures. The aim is to schedule and implement low cost measures first, whereby the most costly measures (usually large capital intensive developments) are delayed for as long as possible</p>
<p>Situation Assessment:</p>	<p>Overall water balance situation (Integrated Orange River System)</p> <p>The Upper Orange WMA is a component of the extended Orange and Vaal River Systems and has been the subject of various studies in the past, which have the purpose of quantifying the water resources availability and/or evaluating measures to transfer water from the Upper Orange to other WMAs. Detail of the overall water balance is given in the Overarching ISP (DWAF, 2004). Results are for the purpose of this ISP summarised below.</p> <p>With the full Phase 1 of the LHWP in place and the 12 000ha allocated to resource poor farmers included, the surplus is about 44 million m³ in 2000 with a shortage of 47 million m³ in the year 2025, due to normal urban/industrial growth.</p> <p>It is important to note that the surplus given is not only for use in the Upper Orange WMA but also in the Lower Orange WMA and the Fish to Tsitsikamma WMA.</p> <p>The growth in demand on the Orange River is relatively low and is driven by two components:</p> <ul style="list-style-type: none"> • Irrigation – The only expected growth in irrigation is the 12 000 ha allocated to resource poor farmers. There are however currently limited plans for the development or phasing of the allocated ha, and the expected rate of growth for the 12 000ha is not known. • Urban/Industrial/Mining – The growth in this demand is mainly determined by the Bloemwater demand (Bloemfontein, Botshabelo, Thaba ‘Nchu) of 60 million m³ and Eastern Cape (Mainly Port Elizabeth) of 27 million m³ over the projection period. This provides a total increase of 90 million m³ for the base growth scenario and 145 million m³ for the high growth scenario. <p>Due to the relative small surplus available in the system, the surplus is reserved for high priority users. (See Section 2.5 in the Orange River Overarching ISP (DWAF, 2004))</p> <p>Water Balance Perspective and measures to improve water supply in the Upper Orange WMA:</p> <ul style="list-style-type: none"> • The Upper Orange WMA has a large commitment to support the local water requirements as well as transfers to the Upper Vaal WMA, Lower Orange WMA and the Fish to Tsitsikamma WMA. The annual operational analysis uses a fixed demand with a specific growth imposed on the demand with regards to the transfers through the Orange/Fish tunnel. Results will be improved if the Eastern Cape system is analysed in detail to obtain a better indication of the transfer requirement. • Adjust hydropower related operating rules to gradually move away from rules that only benefit hydropower generation so that it is in phase with the growth in demand. • Reduce Operating losses by means of improved release management and as next phase build a re-regulating dam in Lower Orange (Violsdrift or Boegoeberg). • Implement water conservation and demand management measures. • Utilise excess supply in the Vaal River System.

<p>Situation Assessment (Continued):</p>	<ul style="list-style-type: none"> • Utilise the lower level storage in Vanderkloof Dam. • Continue to release water to satisfy the existing EFR (ORRS). Re-evaluate the EFR when the final results from the LORMS are available. <p>RELEVANT DATA ON A SUB-CATCHMENT BASIS</p> <p>There is a fairly low level of confidence in the water availability data for most of the smaller water supply systems.</p> <p>Gariiep, Vanderkloof and Orange River d/s of Vanderkloof sub-catchments</p> <ul style="list-style-type: none"> • When focussing on the main Orange River System (Gariiep and Vanderkloof dams as source) the surplus and possible shortage are as described for the Integrated Orange River System. This includes the Gariiep, Vanderkloof and the Orange River d/s of Vanderkloof sub-catchments as well as the transfers to the Lower Orange WMA, the Fish to Tsitsikamma WMA transfer and the transfer from Vanderkloof to the Riet/Modder & Riet sub-catchments. <p>Welbedacht RSA, Welbedacht Lesotho, Rustfontein & Krugersdrift sub-catchments</p> <ul style="list-style-type: none"> • The Caledon/ Modder transfer scheme is located within the above-mentioned sub-catchments. This water supply system is used to supply Bloemfontein, Botshabelo, Thaba 'Nchu and smaller users. The water supply system includes Welbedacht and Knellpoort dams located in the Welbedacht RSA and Welbedacht Lesotho sub-catchments. Water is transferred from Welbedacht Dam to Bloemfontein through the Welbedacht Bloemfontein transfer pipe line (several of the small users are also connected to this pipe line) and from Knellpoort to Rustfontein Dam through the so-called Novo Transfer scheme. Rustfontein and Mockes dams located respectively in the Rustfontein and Krugersdrift sub-catchments are then used as part of the water supply system to supply water to Bloemfontein, Botshabelo, Thaba 'Nchu and the remaining small users. • Although the existing system, which includes the first phase of the Novo transfer scheme can provide sufficient water to the users to even beyond 2025, short term shortages are experienced due to severe siltation problems in the Caledon part of the system as well as due to limitations on the internal distribution system and insufficient internal balancing storage. <p>Caledon RSA sub-catchment</p> <ul style="list-style-type: none"> • Possible shortages in supply were indicated for the following towns located in this area, Fouriesburg, Clarens, Rosendal, Ficksburg, Clocolan and Ladybrand. <p>Caledon d/s of Welbedacht sub-catchment</p> <ul style="list-style-type: none"> • Possible shortages in supply were indicated for the towns Rouxville and Smithfield located in this area. <p>Orange River u/s of Gariiep sub-catchment</p> <ul style="list-style-type: none"> • Sterkspruit and Hershel experience water shortages. • Water supply from Kloof and Montagu dams to Zastron is sufficient. • Aliwal-North, water supply is sufficient as water is obtained from the Orange River. • Diffuse irrigation from the tributaries and small dams are significant (±13 000ha) and is in excess of that supplied directly from the Orange River. The assurance of supply to the diffuse irrigation is however significantly less than that from the Orange River.
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<p>Situation Assessment (Continued):</p>	<p>Kalkfontein sub-catchment</p> <ul style="list-style-type: none"> • Only the towns Jagersfontein and Fauresmith is supplied from boreholes. The assurance of supply is not known. • A fair amount of diffuse irrigation (±3 740ha) is located in this area and is mainly supplied from small dams. The assurance of supply is expected to be low. • Tierpoort Irrigation Board (708ha) is located in this area and is supplied with water from Tierpoort Dam. Assurance of supply expected to be low. <p>Riet sub-catchment</p> <ul style="list-style-type: none"> • Oppermansgronde is mainly supplied from boreholes. Assurance of supply is not known. • Assurance of supply from the Kalkfontein Canal Scheme (±3 000ha) is not known but it is expected to be lower than that for the schemes supplied from Vanderkloof Dam via the Orange Riet canal. • A proposal is currently being investigated to supply De Beers with water from Kalkfontein Dam for a development that entails the reworking of old mine dumps. This requires that De Beers will utilise some of the irrigation water (± 7 million m³/a) in Kalkfontein Dam for industrial purposes. Farmers at the lower end of the Kalkfontein Irrigation scheme will then in turn receive water from the Orange River through the Orange Riet Canal. This is economically a more viable option for De Beers than pumping the water directly to the mining development near Jagersfontein and Fauresmith. This proposal is still in the investigation stage and final decisions have not yet been made. There are therefore some uncertainties on how to deal with the request for water supply for De Beers Mine. <p>Riet/Modder sub-catchment</p> <ul style="list-style-type: none"> • The assurance of supply for the towns Dealsville and Petrusburg is not known. Dealsville and Petrusburg are supplied from groundwater. • Bloemspruit/Bainsvlei is supplied from the Caledon/Modder system by Bloemwater. • Assurance of supply from the Krugersdrift Dam to the Modder River Government Water Scheme (±3 500ha) is not known but is expected to be lower than that for the schemes supplied from Vanderkloof Dam via the Orange Riet canal. • The possibility of the raising of Krugersdrift Dam was investigated by DWAF in the early eighties. The IB has requested a copy of this report. It is however expected that this option will not be economically viable. The IB must still make a final decision in this regard. DWAF will support this only when the water can be made available and it is an economically viable option.
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MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Water Conservation Demand Management should be promoted in all the areas supplied from the Upper Orange WMA. Indications of possible savings will be given for some of the areas in the LORMS. (Details are provided in Strategy 4)</p>	Region (Priority 1)
	<p>M2 System analysis is required for the smaller water supply systems mainly in the Riet/Modder and Caledon catchments to determine the water availability and to identify shortages and surplus within these smaller sub-systems. Results from the study “Development of a Catchment Management Strategy for the Modder and Riet Rivers in the Upper Orange Catchment Management area” that is currently underway, will address some of the needs in this regard. The updated data will lead to more detailed and improved strategies. Investigate existing operating rules and determine if these can be improved.</p>	Region (Priority 2)
	<p>M3 Update data (water requirements, initial dam and water quality) from the Integrated Orange River Water Resource Model and undertake operating analysis on an annual basis. Monitor the supply situation through the analysis to ensure that the required management measures are implemented on time. This should include projections of the supply situation for a twenty-year planning window. (Also see M3 of Strategy A.1.2)</p>	WRPS (Priority 2)
	<p>M4 Complete the LORMS that is currently underway and implement the recommendations. Cost benefit and URV calculations from the LORMS will give guidance with regards to the most appropriate measures and or development options as well as the required sequence of implementation, to overcome future water shortages in the ORS.</p>	OA (Priority 2)
	<p>M5 The impacts of possible water resource developments in Lesotho Lowlands on the water balance of local sub-systems as well as on the overall system should be assessed.</p>	NWRP (Priority 2)
	<p>M6 Assess the impact of revised EFR from the LHWP on the water balance of the Orange River System. This is currently in process to be determined as part of a Lesotho Highlands Continuous Study.</p>	OA (Priority 1)
	<p>M7 The transfer to the Fish / Tsitsikamma WMA should be modelled in detail, including water quality requirements, as part of the annual operating analysis, as this is one of the major users from the Orange River System, which is currently only represented as a fixed demand in the annual operating analysis. This should receive attention particularly in dry periods when restrictions are to be imposed.</p>	WRPS (Priority 1)
	<p>M8 The main principle to follow with regards to the request from De Beers Mine, is that anyone wanting water from the Orange should be paying the full cost for the water. A groundwater expert should also investigate the possibility of pumping water from the old mine.</p>	WRPS Priority 1

	<p>M9 Initiate studies and/or processes to obtain the water availability of smaller towns, which is not part of the large water supply schemes. The focus should be on the towns that are frequently experiencing water shortages. This can typically be addressed through the WSDPs. (Also see management actions from Strategy A.1.7)</p>	<p>Local Authority/ Region (Priority 2)</p>
<p>References</p>	<p>a) National Water Resource Strategy DWAF RSA, First Edition b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697) c) Lower Orange River Management Study (LORMS) d) Orange River Water Balance – Orange River Continuous Study (Report no. P D000/00/4903) e) Orange River System: 2002 Hydropower Operating Analysis (Report no. 8350/06)</p>	

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A.1.4 TRANSFER AND RESERVATION OF WATER

<p>Management objective:</p>	<p>Reserve adequate water resources to support the transfers out of the WMA and secure internal transfers as well as the water supply to existing users within the borders of the WMA.</p>
<p>Situation Assessment:</p>	<p>General</p> <p>There are mainly two types of transfers that occur in this WMA. The first type is the transfers out of the WMA to other neighbouring WMAs and secondly the transfers within the Upper Orange WMA. The first type of transfer represents by far the largest volume of transferred. Transfers out of the Upper Orange are discussed in detail in the Overarching ISP (DWAF, 2004) and only a summary of these transfers are included in this ISP with detail of the other transfers as well as possible future transfers given below. There is however a small transfer of 2 million m³/a into the WMA from the Sand-Vet GWS (Middle Vaal WMA) to supply the town Brandfort/Majwemasweu with water.</p> <p>Existing transfers out of the Upper Orange WMA</p> <p>There are one transfer out of the Upper Orange WMA as well as a large release obligation to the Lower Orange, as listed below. Details are provided in the Orange River Overarching ISP:</p> <ol style="list-style-type: none"> 1. Transfers from Gariep Dam located in the Gariep sub-catchment through the Orange Fish tunnel to the Fish to Tsitsikamma WMA (± 600 million m³/a). 2. A release obligation (transfer) from the Upper Orange WMA to the Lower Orange River WMA. <p>Growth in this release obligation is expected to be low, driven primarily by the development of the 4 000 ha earmarked for resource poor farmers in the Lower Orange WMA as well as the urban requirements which is a very small component of the total water demand. The system is currently managed not to allow further irrigation development with the exception of the 4 000ha as no additional water can be allocated from the existing infrastructure. Namibia is currently investigating the possibility of substantial increase in irrigation on the Namibian side of the border. This will however require additional infrastructure or water conservation and demand management actions. These are currently being investigated as part of the LORMS. When the Reserve for the Lower Orange has been determined, the release obligation to the Lower Orange will be adjusted accordingly.</p> <p>Existing transfers within the Upper Orange WMA</p> <p>There are two major transfers within the WMA as listed below:</p> <ol style="list-style-type: none"> 1. Water is transferred from the Caledon (Welbedacht RSA sub-catchment) to the Modder River Catchment (Rustfontein & Krugerdrift Sub-catchments) to support Bloemfontein, Botshabelo, Thaba 'Nchu and other smaller users with water. These transfers take place through the Welbedacht Bloemfontein pipeline from Welbedacht Dam and via the Novo transfer pumping line from Knellpoort Dam to Rustfontein Dam. The transfer and water supply system is operated and maintained by Bloem Water although the storage dams belong to DWAF. The transfer is expected to grow in future as result of the growing urban/industrial requirement from approximately 47 million m³/a in the year 2000 to 85 million m³/a in 2025). This growth will be allowed in the system as it is considered part of the high priority users. 2. Transfers from Vanderkloof Dam (Vanderkloof sub-catchment) via the Orange Riet canal to supply mainly irrigation in the Riet/Modder catchment (Riet and Riet/Modder sub-catchments). Irrigation schemes supplied by means of this transfer includes Orange-Riet canal irrigation, Riet River Settlement, Scholtzburg IB,

Situation Assessment (Continued):	<p>Richie IB and the Lower Riet River IB. Towns supplied with water from this scheme are Ritchie, Koffiefontein and Jacobsdal. Minimal growth is expected in future transfers to satisfy urban water requirements.</p> <p>Future transfers from the Upper Orange WMA: (See detail in the Orange River Overarching Report (DWAF, 2004)) New transfer schemes from the Upper Orange WMA is most unlikely to occur in the near future.</p>
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MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	M1 Include recommendations of the LORMS with regards to the transfer/support from the Upper Orange WMA to the Lower Orange WMA.	IWRP (Priority 1)
References	a) National Water Resource Strategy DWAF RSA, First Edition b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697) c) Orange River Water Balance – Orange River Continuous Study (Report no. P D000/00/4903)	

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A.1.5 INTERNATIONAL OBLIGATIONS

Management objective:	Comply with all International Obligations that may indirectly be assigned to the Upper Orange WMA.
Situation Assessment:	This strategy is described in the Orange River Overarching ISP(DWAF, 2004).

MANAGEMENT ACTIONS

Required actions, responsibilities and priorities:	
References	a) National Water Resource Strategy DWAF RSA, First Edition

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A.1.6 COMPULSORY LICENSING

Management objective:	Ensure the sharing of the available water resources for both Equity and the Reserve (as priority users) and for activities to maintain the economic and social structures that rely on the water resources of the Upper Orange WMA.
Situation Assessment:	<p>Considering the three variables (Reserve, water for equity, and a negative water balance) that could drive the need for Compulsory licensing, the status is as follows:</p> <ul style="list-style-type: none"> • Due to the current excess supply situation as indicated in the Reconciliation Strategy, there is no need to implement compulsory licensing on the grounds of water supply constraints. • Currently the Reserve has not been determined for the WMAs and no urgent Reserve issues were identified during the Overarching Workshops that pointed to the need for Compulsory Licensing on the basis of pressures brought upon by the Reserve. Releases are however currently made to supply the environmental requirements at the estuary based on the work done in the ORRS. • Allocations to address inequities in water allocation have already been made by means of the 12 000ha of irrigation land earmarked for emerging and resource poor farmers. These allocations must first be taken up before more will be considered. Only at that stage will compulsory licensing be considered as a possible option for re-allocation if water cannot be made available otherwise. • Although the above status indicates that Compulsory Licensing is not a priority in the whole Orange River System, it may be required in selected tributaries. Localised areas that were listed at the workshops include the Petrusburg and Bainsvlei area and portions of the Riet/Modder sub-catchment. The main problem at Petrusburg and Bainsvlei seems to be over abstraction of the local groundwater source. There are however other methods to address the problem that should be implemented before compulsory licensing is carried out.

MANAGEMENT ACTIONS

Required actions, responsibilities and priorities:	<p>M1 Evaluate the priority of compulsory licensing for localised stressed catchments. The Petrusburg/Bainsvlei area was identified as one of the areas, specifically with regards to groundwater. It should be possible to do the compulsory licensing separate from the surface water due to the low interaction between the two sources. Other ways to manage the situation should be found first, before we get down to compulsory licensing. This should typically include the verification of law full use, eliminating of illegal users, checking on the availability, imposing of curtailments, educating people and make them aware of the problem, improve the management of the groundwater system, etc. (See groundwater related management actions in Appendix B)</p>	Region (Priority 1)
References	a) National Water Resource Strategy DWAF RSA, First Edition	

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A.1.7 SUPPLY TO DISTRICT AND LOCAL MUNICIPALITIES

Management objective:	<p>Ensure that local authorities have sufficient water resources to supply their requirements and implement measures for efficient utilisation of the available resources. The objective with water supply to local authorities should be to implement economical feasible supply options with acceptable environmental impacts.</p>
Situation Assessment:	<p>A significant number of towns in the WMA are supplied by Bloem Water or have allocations from nearby large inter-basin transfer schemes (some examples include Bloemfontein, Botshabelo, Koffiefontein and Jacobsdal).</p> <p>In other cases towns are located close to the main river or have access to water from an upstream storage dam (Aliwal-North, Hopetown, Maseru and Bethulie).</p> <p>The water requirements in the above two situations are considered as part of the water balance of the Integrated Orange River River System.</p> <p>However, a third supply situation exists where a town relies partially or fully on local water resources such as groundwater and small dams. In order to obtain an indication of the supply situation in these cases, information were obtained from the Regional Office. These results are given in Appendix D.</p> <p>Significant groundwater resources do exist in the WMA and some are already utilised. Groundwater should be considered as one of the first options for local water supply, as it can potentially still be a valuable resource to supply local water needs, which may be more cost efficient, compared to surface water supply options. The Water Act also allows a town to search for groundwater outside its boundaries. Towns should investigate these possibilities. There is however limited hydrological data available on the groundwater resources. Data is available, but it needs to be pulled together, reviewed and synthesised.</p> <p>Water Conservation & Demand Management must be adopted to reduce the demand and recover as much water as possible, before the development of any future resource is considered.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Implement WC & DM first to reduce current water usage, before developing alternative water resources</p> <p>M2 Promote and encourage the utilisation of groundwater resources for local water resource development. Water Service Development Plans and feasibility studies (business plans) should indicate the groundwater supply options in all resource planning.</p> <p>M3 Assess local groundwater yield capabilities in support of the local authorities that require additional water resources.</p>	<p>Local Authority (Priority 1)</p> <p>Region (Priority 1)</p> <p>Local Authority (Priority 1)</p>

<p>Required actions, responsibilities and priorities:</p>	<p>M4 Provide water resource availability assessments for areas where extensions to the water resources are required. The need for this information should be identified in the WSDP development process and the outcomes should be included in the WSDP reports</p> <p>M5 Source the data available from Local Authorities, Municipalities etc. and store it in a single database. Use the GRIP (Groundwater Resources Information Programme) as an example for this process.</p> <p>M6 Provide and support groundwater utilization and management protocols for all the required groundwater actions. (See groundwater related management actions in Appendix B)</p>	<p>Local Authority (Priority 1)</p> <p>Region (Priority 2)</p> <p>Region (Priority 1)</p>
<p>References</p>	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p> <p>c) Lower Orange River Management Study (LORMS)</p> <p>d) Orange River Water Balance – Orange River Continuous Study (Report no. P D000/00/4903)</p>	

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	<p>Author:</p>	<p>ISP Study</p>

A.2 WATER RESOURCES PROTECTION STRATEGY

A.2.1 RESERVE AND RESOURCE QUALITY OBJECTIVES

<p>Management objective:</p>	<p>The main stem of the Orange River and all major tributaries needs to be classified in terms of the new classification system to ensure a balance between environmental health and the optimal use of the resource. Ultimately a Comprehensive Reserve determination needs to be undertaken for the Orange River catchment, with the Reserve being implemented and enforced.</p>
<p>Situation Assessment:</p>	<p>General</p> <p>The Upper Orange WMA includes the main stem of the Orange River but also several other large tributaries such as the Caledon, Kraai, Seekoei, Riet and Modder Rivers. The Upper Orange is a well-regulated system with the Vanderkloof and Gariep Dams on the Orange River main stem. Several large dams are also located in the Riet, Modder and Caledon rivers from where releases are made to support downstream users or dams. There are also a number of farms dams on some of the tributaries of the Orange River. The Vanderkloof and Gariep Dams are used for hydropower generation and the natural flow patterns of the Orange River are impacted by the hydropower release pattern. To increase hydropower generation in winter the release pattern from Gariep Dam is the inverse of that used for Vanderkloof Dam. This means that high flows are released in winter and lower flows in the summer. This has a possible negative effect on the ± 40km river reach between Gariep and Vanderkloof dams. To date the ecological responses with regard to these releases have not been quantified and accounted for, and need to be taken into consideration and assessed. Furthermore, the ecological consequences of specific drought operating rules that may be applied (see Strategy A.7.4) need to be assessed.</p> <p>Environmental requirements have been determined for the following rivers:</p> <p><u>Orange River main stream downstream of Vanderkloof Dam.</u></p> <p>The environmental requirements for the Orange River downstream of Vanderkloof Dam as well as for the River Mouth have been determined as part of the ORRS. Currently these requirements are being released from Vanderkloof Dam. These environmental requirements were determined by using methods, which have since been improved upon. As part of the LORMS study new estimates of the environmental requirements are made. These are still not based on detail assessments and are preliminary estimates to be used in the evaluation and comparisons of various possible future development and management options identified in the LORMS. They nevertheless indicate that significantly higher releases are required than originally estimated by the ORRS.</p> <p><u>Tributaries of the Senqu River that form part of the LHWP</u></p> <p>The Upper Orange WMA shares a border with Lesotho. A Reserve has been determined for Lesotho and is in the process of being implemented and tested in the water resources models. The first indications are that the increase in releases from Katse and Mohale Dams as result of the new Reserve will increase the yield of the ORS in the RSA by approximately 30 to 60 million m³/a.</p> <p><u>The Modder/Riet river system</u></p> <p>A CMS is being developed for the Modder-Riet system of the Upper Orange WMA. The surface water ecological Reserve at the intermediate level of confidence is being determined for the Modder-Riet River system as part of this process. The preliminary groundwater reserves have been determined for Petrusburg and Bainsvlei.</p> <p>Bio monitoring is already in place in the Riet and Modder river catchments as well as one site in the Caledon River. DWAF is planning to have further bio monitoring sites</p>

Situation Assessment (Continued):	<p>in place in the Caledon, Kraai and Orange River by not later than March 2004.</p> <p>A comprehensive Reserve determination for the Upper Orange WMA and its main tributaries needs to be determined. The timing for the Comprehensive Reserve determination is not known and will be triggered mainly by the following two activities:</p> <p>The development of large infrastructure (with the key interest being in the area downstream of the development.) or when the Orange River appears on the National List for Reserve Determination.</p> <p>There is a need to develop guidelines to prioritise the need for a reserve determination for the different rivers in the WMA. This is also required on a National level. The Reserve determination should be done at a level of detail, which is on par with the other water resource information.</p>
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MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 When a Reserve determination becomes necessary the RDM and Regional office should assess whether the Reserve for the entire catchment needs to be determined or only sections of the catchment and when this determination should take place. The Reserve Determination for the Orange River Main Stem should be coordinated with the Reserve determination for the Vaal River System.</p>	WRPS (Priority 1)
References	<p>a) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p> <p>b) Lower Orange River Management Study (LORMS)</p>	

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A.2.2 WATER QUALITY MANAGEMENT

Management objective:	<p>The Department has a mandate to manage water resources in a sustainable manner. In other words, it realises that in its pursuit to stimulate development and socio-economic growth, that there will be a negative impact on water quality impact. The main objective is therefore to ensure a sound and reasonable balance between development impacts and the protection of the resource. Fitness for use for all users and protection of the natural ecosystems must be used as the basis for strategy development</p>
Situation Assessment:	<p>General Overview (Also see Section 1.7 in chapter 1 of this ISP)</p> <p>The water quality in the Upper Orange WMA varies from poor in the highly developed areas to good in those that are less developed. The land use in the catchment includes agriculture, some mining and industrial activities and urban developments. Groundwater is well used for urban water supply and irrigation. The urban developments consist of towns and dense settlements particularly in the Bloemfontein, Thaba 'Nchu and Botshabelo areas. All these activities impact on the surface water and groundwater quality in the catchment.</p> <p>The Upper Orange WMA contributes to the flows in the Lower Orange WMA and so too with water quality. The Upper Orange WMA also receives water from Lesotho and any further development of the Lesotho Highlands Scheme as well as possible developments from the Lesotho Lowlands Study, could influence the water quality in Upper and Lower Orange WMAs as result of the reduction in the inflow of good quality water.</p> <p>The approach adopted for the management of the water quality in the WMA is on a sub-catchment basis. A Catchment Management Strategy (CMS) is presently being developed for the Modder-Riet. These plans involve the setting of water quality objectives (WQO), identification of pollution sources, and the modelling and the development of management actions. These plans for the individual areas need to be linked to an assessment of the overall water quality management of the Orange River. (See the Orange River Overarching ISP (DWAF, 2004)).</p> <p>A number of the sewage works are not functioning adequately and are in a poor state. The reasons for this are both bad management and the overloading of the plants due to the replacement of pit latrines with water borne sewerage systems. Systems are audited on a two yearly basis and feedback is given to local government.</p> <p>Due to the interdependencies of the water quality in the different WMAs, an integrated water quality management tool modelling nutrients and salinity is needed to allow for the development of an integrated water quality management plan for the Orange and Vaal River catchments. (See the Orange River Overarching ISP(DWAF, 2004)).</p> <p>Some problems do exist with regards to the licensing processes such as the need to streamline the licensing process for small mining operations, and municipalities that tend to go ahead with the development of sewerage works before a formal license was issued.</p> <p>The study undertaken by the Council of Geosciences giving guidance on the placement of solid waste sites at the villages in the catchment, needs to be sourced and made available to all Local Authorities.</p> <p>The water quality situation in each of the sub-catchments of the WMA is briefly discussed hereafter.</p>

<p>Situation Assessment (Continued):</p>	<p>The upper part of the Caledon RSA Sub-area (This includes the Caledon RSA and the Welbedacht RSA sub-catchments (See Figure C-3))</p> <p>The water quality and the water infrastructure in these sub-catchments are impacted on by sedimentation. The soils have a moderate to high erosivity index, which coupled with poor land use practises particularly in the Lesotho Lowlands area, has resulted in high erosion rates. This is reflected in the sedimentation of Welbedacht Dam and the operating rules that have to be adopted for the water supply infrastructure in the sub-catchments.</p> <p>Significant soil conservation structures and measurements were previously implemented by Department of Agriculture in these areas. The larger soil conservation actions, which were carried out on a national basis have been completed in these areas and no further work is currently undertaken. Some smaller works are being undertaken at a provincial level. The development plans in the Lesotho Lowlands with regards to land and water resource development are not presently available. The effect of these on the erosion and sedimentation rates in the Caledon River are not known at present.</p> <p>Sewerage return flows from Lesotho and RSA as well as return flows from textile industries in Lesotho currently result in a deterioration of the water quality in the Caledon River. There are also a significant number of small mining and sand digging operations taking place in these sub-catchments.</p> <p>Kraai Sub-area and the lower part of the Caledon RSA Sub-area (This includes the following sub-catchments, Orange upstream of Gariep Dam and Orange downstream of Welbedacht Dam (See Figure C-3))</p> <p>The water quality in these sub-catchments is generally good. Some local water quality problems have been reported in the Kraai River.</p> <p>Vanderkloof Sub-area (Includes Gariep, Vanderkloof and Orange River downstream of Vanderkloof sub-catchments (See Figure C-3))</p> <p><i>Gariep Sub-catchment</i></p> <p>Silt is being deposited in the Orange River at Bethulie in the upper reaches of the Gariep Dam basin. This could influence the local flood levels in the area. The area has been bought out as part of the Gariep Dam basin expropriation. There is some pressure to allow people back into the purchased area.</p> <p><i>Vanderkloof and Orange downstream of Vanderkloof sub-catchments</i></p> <p>Nothing specific noted except that the water quality in the Seekoei River is affected by the irrigation taking place from weirs constructed on this tributary.</p> <p>Riet Modder Sub-area (This includes the Rustfontein, Krugersdrift, Kalkfontein, Riet/Modder and Riet sub-catchments (See Figure C-3))</p> <p>In the Riet Modder system the extent of the pollution of the groundwater system and the behaviour of the system needs to be understood. This is being addressed as part of phase 2 of the Riet- Modder (CMS) study.</p>
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Situation Assessment (Continued):	<p><i>Rustfontein and Krugersdrift sub-catchments</i></p> <p>The water quality in this area is impacted by the extensive urbanisation (Bloemfontein, Botshabelo and Thaba 'Nchu) of the sub-catchments. The surface water quality is influenced by sewage treatment plant return flows and urban runoff. The groundwater is also polluted with the use of pit latrines cited as a source of pollution. Some of the boreholes in the Thaba 'Nchu area cannot be used because of poor quality due to nutrients and microbiological quality.</p> <p><i>Kalkfontein, Riet/Modder and Riet sub-catchments</i></p> <p>These areas are characterised by extensive irrigation. The irrigation water supply is from groundwater, surface water and water transferred from the Orange River. The surface water quality shows elevated salinity levels and nutrients.</p> <p>The irrigation has also resulted in the pollution of the groundwater resources. The water quality problems are mainly salinity and nutrient enrichment. Elevated salinity levels in the Jacobsdal area have been reported. The elevated salinity levels in the Jacobsdal area are due to the closed nature of the groundwater system, which does not allow for the flushing out of the accumulating salts.</p> <p>Portions of these sub-catchments are urbanised and the water quality is impacted on by sewage treatment plants return flows and urban storm water runoff.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 The existing Departmental and international communication systems should be used to keep track of the proposed water resource developments and land use planning as they affect water quality and erosion sedimentation.</p> <p>M2 The silt surveys of the impacted dams should be reviewed to monitor the extent of the silt problem. Further siltation must be monitored closely. The existence of a programme run by the Department of Agriculture to revitalise and repair soil erosion should be confirmed.</p> <p>M3 The water quality problems in the Modder-Riet are being addressed during the phase 2 study to develop a CMS for the Modder-Riet River system. Incorporate the results in ISP as soon as it is available.</p> <p>M4 The water quality and land use changes in the remaining sub-catchments should be monitored and CMSs developed when required</p> <p>M5 The study by the Council of Geosciences giving guidance on the placement of solid waste sites needs to be sourced, evaluated and the results communicated to the Local Authorities and within the Department.</p>	<p style="text-align: right;">Region (Priority 1)</p> <p style="text-align: right;">Region (Priority 1)</p> <p style="text-align: right;">Region (Priority 1)</p> <p style="text-align: right;">Region (Priority 1)</p> <p style="text-align: right;">Region (Priority 2)</p>

References	<p>a) Vaal River System Analysis Update-Summary Report (Report no. P C000/00/19496)</p> <p>b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p>
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A.3 WATER USE MANAGEMENT STRATEGY

A.3.1 INTERNATIONAL USE

Management objective:	Ensure that international water use is based on sound agreements among shared basin states and that current and future water use data are exchanged to facilitate efficient planning and management.
Situation Assessment:	This strategy is described in the Orange River Overarching ISP document (DWAF, 2004). The Upper Orange CMA will only be responsible for operational arrangements with Lesotho if delegated to them from the Overarching ISP.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:		
References	a) National Water Resource Strategy DWAF RSA, First Edition	

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A.3.2 GENERAL AUTHORISATIONS STRATEGY

Management objective:	To ensure that General Authorisation are used sensibly and effectively without detriment to the resource, but reducing administrative bureaucracy.
Situation Assessment:	<p>The NWA makes provision for certain basic water uses (i.e. small in volume and which have a minimal impact on quality) to be conducted without formal authorisation, using general authorisations. The Orange River main stem is part of a GWCA since 1977 and general authorisations were therefore not applicable to the main stem Orange.</p> <p>Small diamond diggers are commonly found in the area and guidance is required with regards to the authorisation for water use to these diggers to ease the current licensing process.</p> <p>The onus lies with the Regional Office to review the general authorisations on an annual basis and to ensure that the needs of the Upper Orange WMA are adequately covered.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	M1 Carry out a survey to determine the extent of small mining operations and their cumulative impact. Try and use General Authorisations to deal with this.	Region (Priority 1)
References	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Notice number 1911 promulgated in Government Gazette No. 20526 dated 8 October 1999, providing the current General Authorisation Schedule.</p>	

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A.3.3 LICENSING STRATEGY

Management objective:	Licensing of water use (as defined in the National Water Act) should be considered on a continuous basis when applications are received. The licences should be considered in accordance with the framework as presented below:
Situation Assessment:	<p>From Strategy A.1.4 a small surplus of 44 million m³/a was indicated to be available in the Main Orange River System. This takes into account the water requirement for the 12 000 ha earmarked for resource poor farmers was taken into account. The surplus of 44 million m³/a is under National control as it can be allocated to high priority users in the Upper Orange WMA, Lower Orange WMA and the Fish to Tsitsikama Wma. The 44 million m³/a surplus is reserved for urban, industrial and mining developments. Mechanisms need to be put in place to keep track of the licences issued from the 44-million m³/a surplus. (See the strategy as described in the Orange River Overarching ISP document (DWAF, 2004)).</p> <p>Within the Upper Orange WMA licences can be issued for 4 000ha of the 12 000ha of irrigation, earmarked for resource poor farmers.</p> <p>Water for the above-mentioned licences will mainly be accessible from Gariep and Vanderkloof dams as well as from the Orange River main stem upstream of Gariep Dam and to a certain extent also from the Caledon River.</p> <p>Licences for water use may also be considered when storage is created and yield is added to the system. It is however unlikely that this would be cost effective for irrigation purposes.</p> <p>Trading of water allocations will always be an option for new users to obtain water.</p> <p>There is currently no surplus available in the Modder/Riet sub-area. New users will therefore have to obtain water mainly through the trading of water allocations. The existing trading policy need some guidelines and mechanism for inter sectoral and across WMA trading. Another option will be to add yield to the system by creating additional storage. This is however unlikely as the Modder/Riet system is almost fully developed.</p> <p>Irrigation farmers tend to switch from surface water to groundwater during times when water shortages are experienced. The problem is however, that the farmers tend to register only for the surface water use and not for the groundwater use. An assessment of the ground water resources in certain areas should first be completed to determine the water availability, before licenses can be granted.</p> <p>The existing WARMS information management system will be used to manage water use license data and to capture data of the actual requirements / discharges of users.</p> <p>The issuing of licences for water abstraction should be according to the guidelines as given in this ISP as well as in the Overarching ISP (DWAF, 2004).</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Issue licences according to the given structure.</p> <p>M2 Carry out an assessment of the ground water resources in selected areas to determine the water available from this source.</p> <p>M3 In cases where irrigation farmers are using surface and ground water resources, the use from both sources should be registered. The WUA should implement the necessary control to eliminate the current problem of farmers only registering for one source while more than one source is used.</p>	<p>National level (Priority 1)</p> <p>Region (Priority 1)</p> <p>Region (Priority 1)</p>
References	a) National Water Resource Strategy DWAF RSA, First Edition	

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A.4 WATER CONSERVATION & WATER DEMAND MANAGEMENT

A.4.1 WATER CONSERVATION & WATER DEMAND STRATEGY

<p>Management objective:</p>	<p>To improve efficiency of water use by developing and implementing targeted measures to monitor and control water use efficiency.</p> <p>To make more effective and efficient use of the existing available water resources in all water user sectors. This will enable the Catchment Management Agency (and DWAF) to conserve this scarce resource and avoid expensive schemes for transfers and storage when these may not be necessary if demand is properly managed.</p>
<p>Situation Assessment:</p>	<p>General</p> <p>Evidence of inefficient water usage can be found in all water use sectors throughout the country and the value of water seems largely unrecognised by many water users. South Africa is a developing country that is water stressed and requires improved management of its limited water resources.</p> <p>The implementation of water conservation and water demand management principles is essential in meeting the national goals of basic water supply for all South Africans and the sustainable use of water resources.</p> <p>Although urban/industrial use is a relative small component in this WMA, Water Conservation and Demand Management Programmes or strategies for urban centres need to be reviewed and if not available, designed as it has a significant impact in some of the sub-catchments. These programmes need to resolve issues related to conveyance losses, to unaccounted for losses (over 20 % in Bloemfontein), to re-use and to return flows. These programmes must include surface water and groundwater pollution mitigation strategies that will require monitoring by the CMA. The programmes should set best practice norms and minimum requirements. There is a need to make small towns aware of WCDM as a source and not to first develop other new sources.</p> <p>Bloemfontein, Botshabelo and Thaba ‘Nchu supply area</p> <p>Although the infrastructure is large enough to supply the projected requirement to even beyond 2025, savings can still be achieved. Based on experience elsewhere in South Africa an overall sustainable reduction in water use of up to 25% can be expected without having a detrimental effect on users. Bloem Water has already started with WCDM and is busy installing meters in Botshabelo. Further work with regards to WCDM should be promoted in this supply area.</p> <p>Small towns</p> <p>Prioritise towns currently experiencing water shortages and assist them with WCDM as a first option to address the water shortages.</p> <p>There are currently several initiatives by Local Authorities and Service Providers to implement Water Conservation and Demand Management (WCDM) measures and it is perceived that large savings could be achieved in the gross demand of the urban sector. These initiatives should be supported and used as building blocks for further work.</p> <p>Irrigation</p>

<p>Situation Assessment (Continued):</p>	<p>Irrigation is the main water user in this WMA and water conservation and demand management should be focussed on this user group to obtain maximum savings. Promote WCDM in this sector as a benefit to the irrigators. This will allow them to expand irrigation or increase their production with the available water.</p> <p>Comprehensive irrigation water demand management, or water conservation strategies and actions were prepared for the Orange River Replanning Study (ORRS) in 1998 based on the conceptual framework and principle of water demand management detailed by Johnson (Johnson, 1995). Significant savings can be obtained by reducing conveyance losses in canals, proper irrigation scheduling, metering and pricing of irrigation water and the improvement of irrigation systems. This work can be used as guidance for the implementation of WCDM in the irrigation sector.</p> <p>A further factor to be considered when implementing WCDM measures is to achieve a balance between savings in costs and maintaining an income stream that covers the cost of water supply without exorbitant increases in the water tariffs.</p> <p>The operational losses of 270 million m³/a with regards to releases from Vanderkloof Dam, can be regarded as a conveyance loss. This offers a major opportunity for savings. (See Orange River Overarching ISP for more detail (DWAF,2004))</p> <p>Scope for savings:</p> <p>Substantial scope exists for saving water through the implementation of strategies to improve efficiency of water use. E.g.</p> <ul style="list-style-type: none"> - Losses in Bloemfontein are in excess of 20%. - Irrigation scheduling 10% savings. - Metering and pricing of irrigation water 10% savings. - Improvement of irrigation systems up to 27% - Operational losses possible saving of up to 170 million m³/a. <p>The LORMS is also considering WCDM with the focus mainly on the Lower Orange. Results from the LORMS will however provide valuable indications of possible savings, listing of practical issues around implementation of WCDM and principles that can also be used in the Upper Orange.</p> <p>There are currently various WCDM initiatives undertaken in the areas supplied from the water resources in the WMA, however, what is lacking is a clear picture of what the impact will be on the water requirement in future. This information is essential to ensure that intervention and operations planning is based on realistic water requirement projections. It is also perceived that the interdependency between WCDM measures and price of water (more specifically on discharge tariffs) is not well understood.</p>
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MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Allow irrigators to use the water saved to expand their irrigated area or to trade or sell the water. The saver therefore gets the benefit and the country also benefit, as overall more are produced with the same volume of water.</p> <p>M2 Promote WCDM for all urban/industrial and mining users. Further work with regards to WCDM should be promoted in the Bloemfontein, Botshabelo and Thaba 'Nchu supply area, as the people in the area will directly benefit from the savings.</p> <p>M3 Small towns must utilize WCDM as a first source of water before the development of other new sources.</p>	<p>Region (Priority 1)</p> <p>Region (Priority 1)</p> <p>Region (Priority 1)</p>
References	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Orange River System: 2002 Hydropower Operating Analysis (Report no. 8350/06)</p> <p>c) DWAF & Eskom operational contract.</p>	

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A.5 INSTITUTIONAL DEVELOPMENT & SUPPORT MAIN STRATEGY

A.5.1 CO-OPERATIVE GOVERNANCE STRATEGY

<p>Management objective:</p>	<p>Co-operative governance (i.e. liaison and integration of planning between government departments, district and local authorities) needs to be factored into the overall integrated water resources management arena to ensure a compounded benefit to all users in the catchment.</p>
<p>Situation Assessment:</p>	<p>The Upper Orange WMA is an extremely significant catchment in the context of South Africa's economy as the impacts of water resource management within the basin directly extend to other WMAs and to neighbouring countries. Consequently the integrated management of this catchment is important and it is very important that all the role players are fully informed and aware of their responsibilities.</p> <p>Even with the establishment of WMAs and devolution of water management to CMAs, certain water resource management functions remain with the Minister. Co-ordination at a national level will always remain necessary, especially at policy and regulation level.</p> <p>Institutions at District and Local Municipal level are relatively new on the scene and water resource and water service capacity is slowly being built in these institutions. Liaison between the various institutions needs to be encouraged in the interest of integrated water resources management in the Upper Orange Catchment. The Department must encourage co-operative governance by interfacing actively with the local authorities and provide input into the WSDP and IDPs. A structure should be in place to assess WSDPs and IDPs, especially in the Eastern Cape Province part of the WMA.</p> <p>Typical elements of management that show a need for co-operative governance are:</p> <ul style="list-style-type: none"> • Erosion problem in the Caledon. Set up a discussion or work group on erosion with the Department of Agriculture (Free State) (see Strategy A.2.2) • Poverty eradication and resource poor farmers. Interact with the CCAW for poverty eradication in terms of irrigation development. (see Strategy A.5.3) • Irrigation licensing (see Strategy A.3.3) • Water Quality Management. Interact with Local Authorities and also through WSDPs. (see Strategy A.2.2) • Monitoring & Data Capture (see Strategy A.8)

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 There is a need to co-ordinate and encourage communications between the various government and regional and local authorities. A communication strategy and innovative means of communicating current and planned activities must be developed and implemented.</p> <p>M2 A formal liaison strategy is specifically required to assess WSDPs and improve liaison in the Eastern Cape Province part of the Upper Orange WMA.</p>	<p>Region (Priority 1)</p> <p>Region (Priority 1)</p>
References :	a) National Water Resource Strategy DWAF RSA, First Edition	

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	<p>M3 The involvement and responsibilities of DWAF with regards to the MIG should be in line with the document “ Principles and Methods for the implementation of the MIG”. Funds for the management of groundwater resources for the installation of physical systems such as telemetry for the operation of boreholes should be considered from the MIG.</p> <p>M4 A formal liaison strategy is specifically required between the Upper Orange and Fish to Tsitsikamma WMAs.</p>	<p>Region (Priority 1)</p> <p>Region (Priority 1)</p>
<p>References:</p>	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Suggested Principles and methods for the implementation of the MIG</p>	

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A.5.3 POVERTY ERADICATION

Management objective:	<p>The main objective is to contribute to the eradication of poverty through:</p> <ul style="list-style-type: none"> • The provision of basic community water supply and creation of employment in developing community water supply and sanitation infrastructure. • Making water available for irrigation by Resource Poor Farmers (RPF) • Ensuring that water is available and does not limit economically productive activities associated with urban centres, major industry and mining.
Situation Assessment:	<p>Water supply and sanitation</p> <p>Capital expenditure on water supply and sanitation projects in the financial year ending March 2002 was R28.5 million for the Upper Orange (assuming that the expenditure can be split evenly across each of the provinces). R26.5 million for water supply and R2.0 million for sanitation.</p> <p>In addition DWAF's Free Basic Water programme covers the provision of free basic amounts of water to alleviate the plight of the poorest people.</p> <p>There is a general depopulation of the rural areas and people tend to settle in informal settlements around existing towns.</p> <p>Irrigation Water Allocations</p> <p>Surplus water available within the Orange River System (Gariep & Vanderkloof dams) was allocated for use by resource poor farmers for the development of 12 000 ha of irrigation. 4 000ha of the total allocation is located in the Upper Orange WMA, 4000ha in the Fish to Tsitsikamma WMA and 4000ha in the Lower Orange WMA. The aim of this allocation is for poverty relief and rural development. None or very little of these developments have yet taken place although some are in process. Potential irrigation areas were identified in the ORRS for possible future development and in the LORMS investigations for potential irrigation areas and crops are focussed on the area along the RSA-Namibian border.</p> <p>The current strategy is that the development of the irrigation for resource poor farmers should be co-ordinated by the CCAW and should take place through the WUAs, which means that the subsidies will also be paid to the WUA. The drive for these developments is therefore expected to be from the WUAs. The Orange Riet WUA is currently looking at a development of ± 200 ha at Oppermansgronde. It is envisaged that one or two existing commercial farmers will assist each emerging farmer with the benefit being a partial and temporary use of this allocation.</p> <p>The 1000 ha located in the Kraai River catchment and allocated to the Eastern Cape is located upstream of Gariep Dam but close to the Orange River main stream. Water will therefore be abstracted directly from the Orange River main stream for this development.</p> <p>Constructive, well structured, and viable development plans and developments are required for the 12 000 ha allocated to resource poor farmers. The Upper Orange WMA should draw from the 4 000 ha allocated to them. Any new proposed developments should be routed through the appropriate CCAW of the Province under consideration.</p> <p>Other</p> <p>The establishment of community nurseries to provide trees for various purposes has already started in the WMA (One located in Thaba 'Nchu).</p>

Situation Assessment (Continued):	<p>Although poverty is an overall problem in most areas, the sub-catchment, Orange River upstream of Gariep was mentioned by DWAF, specifically with reference to the Kraai River Catchment.</p> <p>Poverty alleviation should be included, as far as possible, in any new developments, funded by DWAF. Poverty eradication must be sustainable (Rather spend more and be effective) and should address the actual needs of the people such as community gardens in squatter camps.</p> <p>Groundwater in selected areas should also be considered as a possible resource for resource poor farmers. Implement the standard poverty eradication principles in the managing and administrating of water supply schemes funded by DWAF.</p> <p>Other possibilities that could be investigated for poverty eradication is the bottling of pristine groundwater, community gardens in squatter camps and working for soil protection as a parallel to working for water. Soil erosion is in particular a problem in the Caledon River catchment where soils have a moderate to high erosivity index, which coupled with poor land use practises (See Strategy A.2.2).</p>
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MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Support the Department of Agriculture through existing forums to undertake judicious planning of irrigation developments of the 4 000ha allocated to resource poor farmers in the Upper Orange WMA.</p> <p>M2 Similar to Working for Water promote an initiative “Working for soil protection” as a poverty eradication action which at the same time will replenish groundwater, base flow in rivers and reduce sedimentation in storage (See Strategy A.2.2).</p> <p>M3 Promote other possible poverty eradication actions such as the bottling of pristine groundwater, community gardens in squatter camps, etc.</p>	<p>Region & Agriculture (Priority 1)</p> <p>Region & Agriculture (Priority 2)</p> <p>Region (Priority 2)</p>
References	<p>a) National Water Resource Strategy DWAF RSA, First Edition</p> <p>b) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p>	

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A.6 ENVIRONMENTAL STRATEGY

Management objective:	Ensuring that there is a balance between the need for development (i.e. including all activities undertaken by DWAF) and the need to protect the natural and social environment for the benefit of all.
Situation Assessment:	No specific issues were identified for the overarching ISP. The reader is referred to Chapter 1 Paragraph 1.5 of this report with regards to DWAF's responsibility.

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A.7 INFRASTRUCTURE DEVELOPMENT & MANAGEMENT MAIN STRATEGY

A.7.1 INFRASTRUCTURE DEVELOPMENT & SUPPORT STRATEGY

<p>Management objective:</p>	<p>Provision of adequate water resource development infrastructure (storage) and bulk water supply infrastructure to sustain and encourage social and economic growth.</p>
<p>Situation Assessment:</p>	<p>General</p> <p>With the introduction of the Municipal Systems Act and the emphasis on sustainable development in the municipal IDP planning process, the development of undeveloped towns will start to gain momentum. This growth of development of towns will have a significant impact on water resources management in South Africa.</p> <p>There are a number of towns, particularly in the southern Free State area, that, require improvement of services, including water and sanitation. This will result in further demands on the water resources in these areas.</p> <p>New mining activities such as the proposed diamond mine at Jagersfontein will result in additional demands imposed on the existing infrastructure.</p> <p>Planning approach</p> <p>A holistic planning effort will be required to identify the optimum bulk water storage and supply infrastructure layout that will make optimal use of the local water resources in the Upper Orange River WMA. Most of the possible future development options are of an overarching nature and are discussed in the Orange River Overarching ISP document.</p> <p>The Lesotho Government has commissioned a study to investigate the water resource development potential in the Lesotho Lowlands. The impacts of such a scheme on the water resources of the Orange River need to be assessed and should be illustrated clearly in results from the study. (See Strategy A.1.3) The existing Orange-Senqu Commission should be used to communicate RSA's requirements in terms of the study to the Government of Lesotho. The use of the same modelling systems as applied in RSA should be considered in the study for compatibility and consistency purposes.</p> <p>Situation Assessment</p> <p>Sedimentation appears to be a real problem in terms of effectively operating dams in the Upper Orange River (mainly Caledon River) catchment. Sedimentation results in wear and tear on plant & equipment with the result that downtime increases and the reliability of supply is decreased in areas that have inadequate storage facilities, e.g. Bloemfontein.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	M1 Evaluate results from the Lesotho Lowlands Study and take the required actions to follow up.	NWRP (Priority 1)
References	a) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697) b) Lower Orange River Management Study (LORMS)	

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A.7.2 SYSTEM MANAGEMENT STRATEGY

<p>Management objective:</p>	<p>Implement system management measures to optimally utilise the available water resources, in terms of short-term benefits and to maintain the reliability of supply over the long-term. The aim is to postpone the need for the development of new costly infrastructure for as long as possible into the future while saving operating costs over the short-term.</p> <p>Optimise the utilisation of the water resource by allowing maximum hydropower generation without adversely impacting on the long-term reliability of supply to the users in the system.</p>
<p>Situation Assessment:</p>	<p>General trends in the Upper Orange WMA are the continued concentration of economic development and population in the Bloemfontein region, and a decline in rural population. A growth in urban/industrial water requirements can therefore be expected in the Riet/Modder sub-area.</p> <p>Operating analyses are undertaken on an annual basis to determine the surplus available in the Orange River System, which can be used for the generation of hydro-power over and above that released for normal downstream requirements. Detail description is given in the Orange River System Overarching ISP (DWAF, 2004).</p> <p>Operating rules with regards to water restrictions exist for all the major dams in the WMA. The system models are however only used to determine the extent of restrictions that will be required for Gariep and Vanderkloof dams in times of drought. When restrictions are imposed on the users from Gariep and Vanderkloof dams, water abstractions upstream of Gariep Dam from the Orange River main stem and Caledon River will also be restricted. This means that the abstraction from the Caledon to Knellpoort Dam will also be restricted. If Knellpoort Dam is full at that time, it is however possible that Bloem Water will not necessarily impose restrictions on the Bloemfontein, Botshabelo and Thaba 'Nchu supply area. Although Knellpoort, Welbedacht and Rustfontein dams belong to the DWAF, the operation and maintenance are the responsibility of Bloem Water.</p> <p>The Caledon/Modder transfer system as well as other sub-systems within the Riet/Modder catchment are not analysed on an annual basis. Models and the required data already exist for this purpose and it should seriously be considered to include these systems as part of the annual analysis or as a separate analysis.</p> <p>Operating rules for the major dams needs to be verified by means of system analysis and should be implemented in practice.</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	<p>M1 Undertake annual operating analysis to determine the operating rules to apply as defined in the Situation Assessment Above, including analyses to determine availability of excess yield for power generation. Include updated/reviewed hydropower operating rules as referred to in Strategy A.7.1.</p> <p>M2 Include the Caledon/Modder water supply system (and other sub-systems) as part of the annual operating analysis.</p> <p>M3 Record existing operating rules and monitor if these rules are implemented. These rules as well as possible new rules must be verified by means of a system analysis.</p> <p>See ISP Orange River Over Arching document for management actions relating to the main system (DWAF, 2004).</p>	<p>WRPS (Priority 1)</p> <p>Region (Priority 2)</p> <p>WRPs (Priority 1)</p>
References:	<p>a) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p> <p>b) Lower Orange River Management Study (LORMS)</p> <p>c) Orange River System: 2002 Hydropower Operating Analysis (Report no. 8350/06)</p> <p>d) DWAF & Eskom operating contract</p>	

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A.7.3 PUBLIC HEALTH & SAFETY STRATEGY

<p>Management objective:</p>	<p>The water resource needs to be protected, and it must be ensured that users in the Orange River Catchment area are safe from the effects of poor water quality that can create health problems (e.g. cholera). Strategies are required to deal with floods and droughts as these impacts on the socio-economic environment.</p>
<p>Situation Assessment:</p>	<p>The Department's current commitments are associated with:</p> <ul style="list-style-type: none"> • Managing floods and drought disasters by direct intervention on the ground. • Reducing pollution and preventing serious or hazardous pollution events. • Promoting dam safety. <p>DWAF's (and the CMAs in some cases) future commitments under National Disaster Management Act which is to be promulgated in 2003 will be:</p> <ul style="list-style-type: none"> - DWAF/CMA will be required to become involved in supporting and enforcing disaster management planning by all relevant authorities. - Drafting a National Flood Management Policy (DWAF). - Dam safety policy (DWAF). - Co-operating with the Department of Agriculture on drought relief strategies and policy formulation. - Pollution control of water resources (i.e. limiting health hazards such as cholera). <p>Flood management at Gariep and Vanderkloof Dams is discussed in the Orange River System Overarching ISP (DWAF, 2004).</p> <p>Significant variation in the releases from Gariep and Vanderkloof dams occur as result of hydropower releases. There is an existing communication strategy in place, which notifies DWAF as well as the affected downstream users of the releases.</p> <p>There are several large dams in this WMA, which must all apply to the dam safety policy (DWAF). Operation manuals and dam safety aspects of these dams need to be reviewed periodically.</p> <p>Based on the results from the annual hydropower analysis curtailments will be imposed on the Orange River System during drought periods when required and to the extent indicated by the analysis. (See Orange River Overarching ISP document (DWAF, 2004))</p>

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	M1 Compliance with the above-mentioned requirements. Continue with the existing public health and safety actions	Region (Priority 1)
References	a) National Water Resource Strategy DWAF RSA, First Edition NWRS	

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A.8 MONITORING AND INFORMATION MANAGEMENT STRATEGY

<p>Management objective:</p>	<p>The design and implementing of effective monitoring networks and repository databases to ensure adequate quantification of the balance between sustainable water use and protection for surface freshwater bodies and groundwater.</p>
<p>Situation Assessment:</p>	<p>Water use control</p> <p>Irrigation is by far the main water user in this WMA and very little data is available on the actual water use by and return flow from irrigation, as irrigation abstractions are not gauged. On the larger irrigation schemes the releases into the main canals is often available but no measurements of the outflow at the canal end is available.</p> <p>Monitoring networks and data capturing</p> <p>Monitoring is required for all aspects of water resource management from local, to catchment, to WMA to National level. Other institutions than DWAF such as Local Authorities, Industries, Universities etc. also do monitoring work. The data collection is therefore largely uncoordinated and results in unnecessary duplication and gaps in data. It is important that proper coordination should take place.</p> <p>Resources currently available for monitoring are generally inadequate throughout all existing systems. Some notable issues in the ISP-area are briefly discussed below:</p> <p>Groundwater quality monitoring is inadequate although groundwater potential is significant in this WMA and it seems that there is scope for further development. Regional groundwater monitoring is non-existing and needs priority above other regional monitoring. Feedback received from municipalities also indicated that little or no groundwater monitoring is taking place. Ambient groundwater quality monitoring however, is adequate. To ensure sustainable utilization from groundwater resources it is essential to get early warning systems managed at local level, in place. Groundwater resources are to be managed on three levels. A national and regional level of monitoring would monitor ambient and regional resource trends whilst the user of the resource must monitor abstraction from a resource at local level.</p> <p>The rain-gauging network in Lesotho needs to be improved by the addition of new gauges at selected sites.</p> <p>At several key points in the Modder/Riet river catchment streamflow gauging or significant improvement on the accuracy of existing gauging are required. This for example includes the inflow to Mockes and several key points in the Riet River Catchment upstream of the Kalkfontein Dam.</p> <p>The calibration of the salinity model for the Orange River was very difficult due to problems with the available water quality data and specific recommendations were given with regards to a water quality monitoring programme in the WQ reports.</p> <p>The combined water balance for Gariep and Vanderkloof dams was often found to be unsatisfactory as recorded outflows from Gariep contradict the calculated inflows to Vanderkloof Dam. Recorded inflows to Gariep Dam are often unreliable particularly at low flows and recorded flows through the turbines at Vanderkloof Dam were found to be unreliable and appear to be under estimated by approximately 10% in many instances. These were findings from the Orange River System Analysis study “Upper Orange River Hydrology “ report of 1991 and it might be possible that the situation has since improved.</p>

<p>Situation Assessment (Continued):</p>	<p>Most of the stream flow gauges in the Orange River downstream of Vanderkloof Dam are inaccurate at low flows. The accurate recording of low flows at and downstream of Vanderkloof Dam is a major problem contributing to the current operational losses of 270 million m³/a and difficulty in obtaining the correct flow for environmental purposes at the Orange River mouth. Low flow conditions occur most of the time under normal operating conditions where the river flow is mainly dependent on releases from Vanderkloof Dam. This makes it extremely difficult to operate the system and to release the correct volume from Vanderkloof without resulting in excessive losses or some times in shortages. Obtaining the required flow to meet the river mouth environmental requirement, particularly at low flows is hardly possible. Based on feedback at the workshop it seems that the problem was addressed and that the accuracy of the flow gaugings should have improved. A detail evaluation of the improved flow readings must however still be done along with any further improvements.</p> <p>Details of the various data related problems and shortcomings are given in the recommendations of the relevant study reports and should be consulted to evaluate and prioritise the monitoring needs.</p> <p>Information Management</p> <p>To be considered at National Level. At local level the Regional office / CMA should co-ordinate all the monitoring needs in the WMA. Some of these needs will be required at a National level while others will be related to requirements at local level.</p>
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MANAGEMENT ACTIONS		
<p>Required actions, responsibilities and priorities:</p>	<p>M1 Establish a WMA level monitoring & information management committee to co-ordinate the monitoring requirements in the WMA.</p> <p>M2 As part of the Overarching ISPs a need was identified to undertake an assessment of all the monitoring needs to support Integrated Water Resource Management in the Vaal and Orange river catchments. The most important needs are given in the situation assessment of this strategy. Details of the monitoring needs must be obtained from the recommendations given in the relevant study reports as well as inputs from the Regional Office. As part of the audit function of the WMA it is also required to know how much water is flowing into and out of the WMA. (See groundwater related management actions in Appendix B)</p> <p>M3 Evaluate the accuracy of the current flow gaugings at Gariep and Vanderkloof dams for the period after the gauging equipment has been improved.</p>	<p>Region (Priority 1)</p> <p>Region (Priority 1)</p> <p>WRPS (Priority 1)</p>
<p>References</p>	<p>a) Orange River Development Project Replanning Study Main Report. (Report no. P D000/00/6697)</p> <p>b) Orange River System Analysis Phase 1 & 2 (Report no. P D000/00/1092)</p> <p>c) Vaal River System Analysis Update-Summary Report (Report no. P C000/00/19496)</p>	

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A.9 IMPLEMENTATION MAIN STRATEGY

<p>Management objective:</p>	<p>To ensure that the approaches put forward by the Department through this ISP are adopted and implemented in the Upper Orange River WMA. This will require willpower, funding and capacity.</p>
<p>Situation Assessment:</p>	<p>The ISP is an internal document, developed by the Department of Water Affairs and Forestry. The ISP sets out the approaches, which the Department is taking towards water management in the Upper Orange River WMA and list, suggested actions towards achieving good management of the water resource.</p> <p>The wider public has had no direct input into this ISP – yet it is recognised that the approaches adopted have a significant impact on the populace of the Upper Orange River WMA. Whilst the approach to date in developing this ISP may seem non-participatory, it must be remembered that this is not a Catchment Management Strategy – but DWAF setting out how it sees the situation, and the steps which it views as most appropriate in dealing with the situation.</p> <p>The ISP is not a closed document but is to be made available to the wider public for comment and input. This makes the ISP an inherently transparent document – exposing the thinking and planning of the Department in a way that has never been done before. Although DWAF makes no commitment to adopt every comment made, these will be taken seriously and the ISP will be updated and improved as newer and better perspectives are formed. Once the CMA has been established it will be required to develop a CMS, and this will require full public participation. It is to be hoped that the ISP will be taken as useful baseline information and, indeed, that the approaches adopted here are found to be acceptable to, and adaptable by, the new dispensation.</p> <p>The ISP is guided by the approach set out in the NWRS – and details this approach for the Upper Orange River WMA. The ISP carries significant weight in expressing how water resource planning and management will be carried out in the WMA. It is not, however, an inflexible document. As such the ISP may be adjusted and adapted when new and better ideas are presented. Despite this the approaches and requirements of this ISP may not be ignored.</p> <p>The Implementation of the ISP is an enormous task and will have to be tackled in a stepwise fashion. Much of what is in this document describes the day-to-day functions of the Department – but there are many new tasks, functions, and actions set out in response to DWAF’s visions for the future.</p> <p>It is recognised that it is quite impossible to immediately launch into, and achieve, all that is required by this ISP. Funds and capacity are, blocks that must be climbed over. The approach is to take the ISP and to use it as instruction, guidance, and motivation in the development of yet clearer management and action plans. These must be built into Departmental Business Plans, and budgeted for as part of Departmental operating costs. This will necessarily be in a phased manner as dictated by available resources, but it is important that the ISP be used to leverage maximum funds, maximum capacity, and to bring optimum management to the WMA.</p> <p>The position with regard to the Authority of Information contained in the ISP is set out in Paragraph 1.3.4 of Chapter 1 of this ISP document.</p>

MANAGEMENT ACTIONS			
Required actions, responsibilities and priorities:	M1	Publish the ISP to be accessible for public input and comment (Consider hardcopy and web-based options). Copies will be presented to key stakeholders on request. It is not the intention to have a major drive for public input, but merely to create accessibility for input.	Regional Offices (Priority 1)
	M2	All Regional staff, Working for Water, Eskom, and other major stakeholders should have access to, or copies of, the ISP.	Regional Offices (Priority 1)
	M3	There are many actions in the ISP, which do require public involvement – and it is important that the thinking with regard to, for example, the use of groundwater, and the importance of WCDM, is taken out forcefully both to local authorities, other direct water users such as agriculture, and the wider public.	Regional Offices (Priority 1)
	M4	Collate comment and consider this in revising and improving the ISP.	Regional Offices (Priority 1)
	M5	There is a need to develop materials – suitable for the provincial cabinet, the various management committees, the mayor’s forum, etc. Also to support the Water Services Development Plan, Organised Agriculture, Emerging Farmers, etc. Materials should be suited to the preparation of the Provincial Growth and Development Strategy, and other regional and provincial planning activities.	Regional Offices (Priority 1)
	M6	The ISP should, in any event, be open to continuous improvement, with possible updating on a bi-annual basis.	Regional Offices (Priority 1)
	M7	Approaches set out in the ISP need to be accepted and adopted by both national and regional staff. Where there is resistance to ideas then this needs to be resolved in an open climate of debate and understanding. Modification of the ISP is not ruled out!	Regional Offices (Priority 1)
	M8	The practicalities of implementation demands must always be considered.	Regional Offices (Priority 1)
	M9	Most actions in this ISP have been assigned to the Region. It is critically important that the tasks outlined are prioritised, budgeted for, and built into regional and national business plans and budgets	Regional Offices (Priority 1)
Implementation	The implementation is to be ongoing until the Upper Orange River WMA is established and the ISP is superseded by a CMS		

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Appendix B
Groundwater Overview

INTERNAL STRATEGIC PERSPECTIVE FOR THE UPPER ORANGE WATER MANAGEMENT AREA

A GROUNDWATER OVERVIEW

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Introduction

The following topics give a brief description of the current groundwater situation in the Upper Orange WMA.

Availability of Information

Information with regard to the Upper Orange WMA is available at:

- The Department of Water Affairs & Forestry Head Office, in the form of raw data (NGDB & WMS), hydrogeological maps and reports. Reports vary from GH (Geohydrology) to consultants' reports.
- The Department of Water Affairs & Forestry Free State Regional Office, in the form of raw data (WARMS & data not on the National Databases) and reports. Reports are mainly consultant reports, of various site-specific assessments, for the sections Geohydrology and Water Services.
- Consultants, in the form of raw data and reports for assessments done for institutions such as Local Government.

Geology

Sedimentary rocks of the Karoo Supergroup underlie the main area and have been intruded by dolerite dykes and sills, with the maximum occurrence in the Beaufort Group. The Supergroup can be described lithologically as follows (Meyer, 2003) and shown in **Figure 1**:

- The Dwyka Group comprises of bluish-grey, unbedded, unsorted tillite with a thickness that varies from a few meters up to 120m.
- The Ecca Group comprises of carbonaceous shale, dark bluish-green to grey massive shale, olive-green micaceous shale/mudstone, light green to greenish-grey shale, mudstone, siltstone and fine-grained sandstone, with a thickness that varies between 340– 360m.
- The Beaufort Group comprises of the Adelaide Subgroup (sandstone, siltstone, grey to reddish mudstone, blue-green-grey shales and red to purple mudstone) and the Tarkastad Subgroup (light coloured, feldspathic sandstone, red, purple and green mudstone). The Adelaide Subgroup can be up to 400m in thickness while the Tarkastad has been reported as up to 900m thick.
- The Molteno formation comprises of grey-green and red-purple mudstone with bands of fine to coarse-grained sandstone. A maximum thickness of 250m has been recorded.
- The Elliot Formation comprises of maroon or green mudstone and medium grained feldspathic sandstone.
- The Clarens Formation comprises of cream-coloured, fine-grained, massive aeolian sandstone with a maximum thickness of 200m.
- The Drakensberg Group overlies the Clarens Formation with sharp contacts and comprises of basaltic lava with a maximum thickness of 900m.

In the north-western part of the area patchy occurrences of the Ventersdorp Supergroup is observed. The Supergroup is characterised as porphyritic lava, quartzite, tuff and volcanic breccia. (Meyer, 2003)

Alluvium occurs in broad valleys along streams and rivers. It is made up of various materials typically including clayey sand, sandy silt, limestone, sand pebbles and small boulders. Thickness can vary from 1- 15m. (Meyer, 2003)

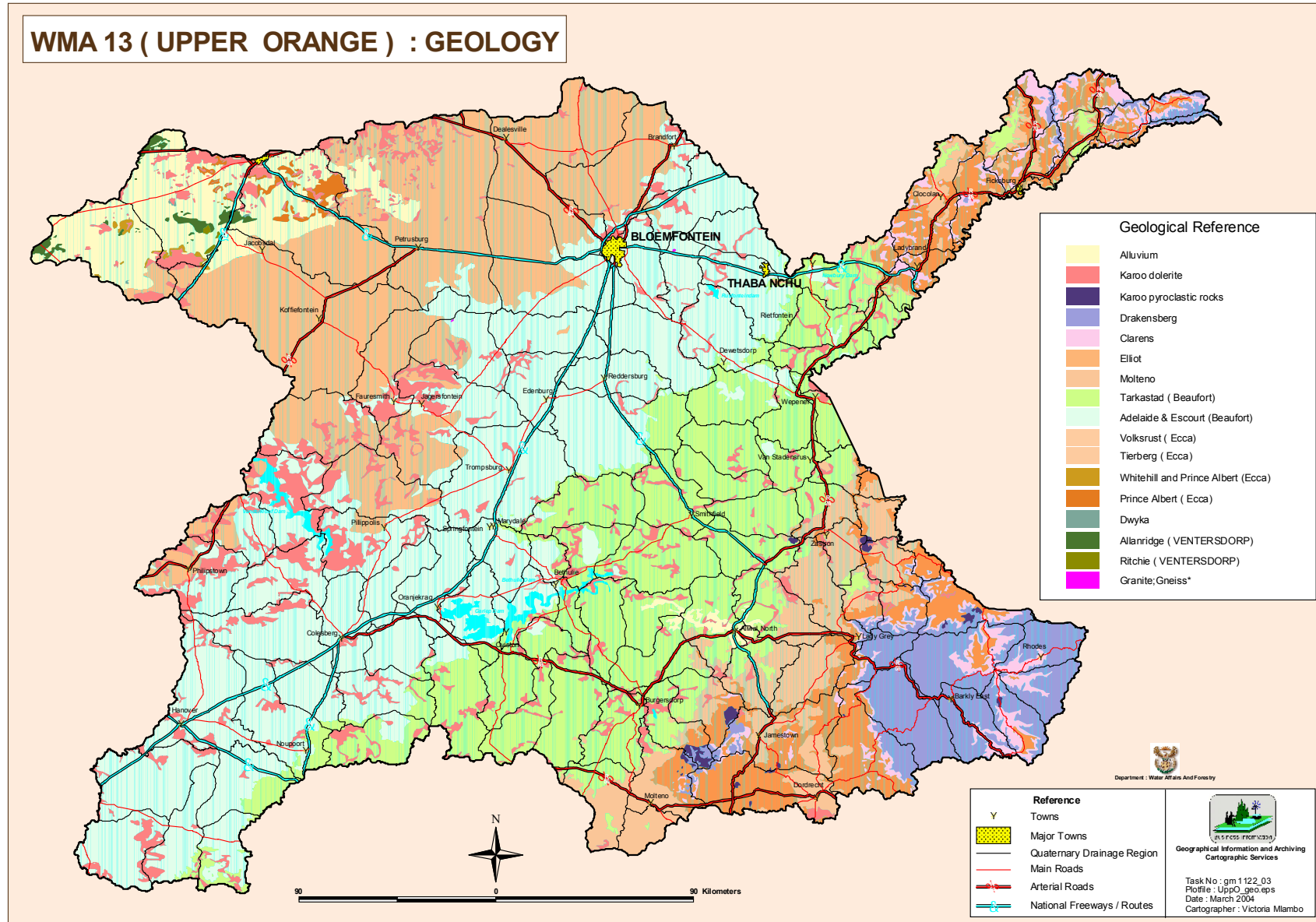


Figure 1: Geology of the Upper Orange WMA

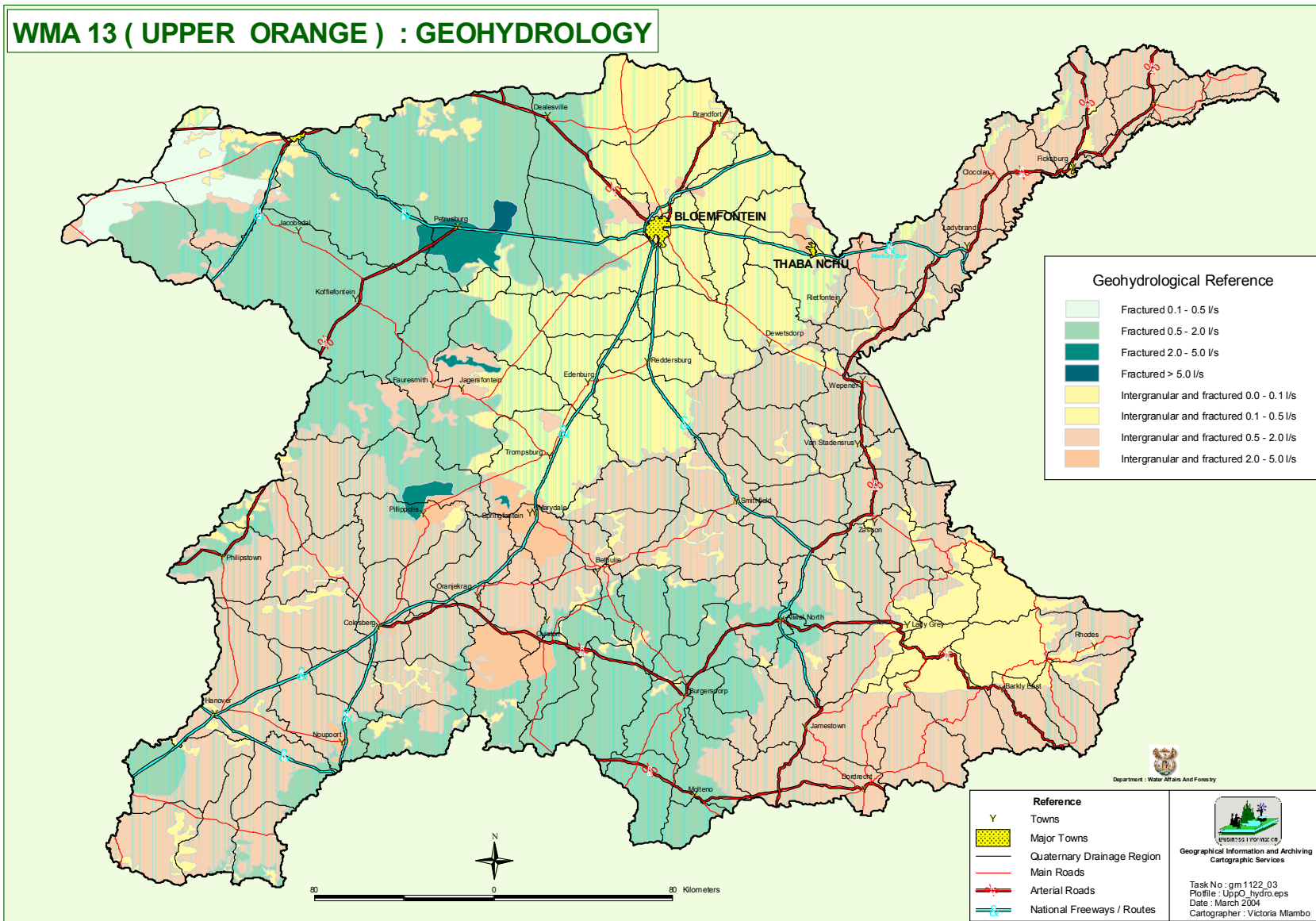


Figure 2: Geohydrology of the Upper Orange WMA

Geohydrology

The Upper Orange WMA lies mainly on the Bloemfontein 2924 1:500 000 hydrogeological map with small portions of the area on the Kimberley 2722, Kroonstad 2726, Prieska 2920, Beaufort West 3122 and Queenstown 3126 hydrogeological maps and is shown in **Figure 2**.

Two aquifer types occur in the area namely fractured (Dwyka, Ecca Group and portions of the Tarkastad Subgroup) and fractured and intergranular (Ventersdorp Supergroup, Beaufort Group, Molteno, Elliot and Clarens Formations) aquifers. The geohydrology of the Karoo Supergroup is briefly described as the following (Meyer, 2003):

- In total the Dwyka Group rocks offer poor groundwater potential (0.1 – 0.5 l/s), but yields are associated with jointing, fracturing and weathering of the rocks.
- Groundwater occurrence in the Ecca Group is mainly associated with dolerite contact zones, joints and bedding planes. Thick calcrete layers with a high porosity can enhance recharge to the aquifer, but are not found as a blanket covering the Group. Borehole yields averages between 0.5-2.0 l/s but more than 10% of recorded boreholes yield more than 5 l/s.
- The Adelaide Subgroup of the Beaufort Group has been extensively intruded by dolerite sills and to a lesser extent by dolerite dykes. Groundwater occurs in joints and fractures on the contact zones, in weathered dolerite zones, weathered and jointed sedimentary rocks and on bedding planes. Borehole yields vary from 0.5-2.0 l/s.
- Groundwater occurs in dolerite contact zones, joints and fractures and on bedding planes in the Tarkastad Subgroup of the Beaufort Group. Weathering promotes the groundwater potential although this unit is less prone to weathering. Borehole yields varies from 0.5-2.0 l/s but 17% of the recorded borehole yields are more than 5 l/s.
- The Molteno, Elliot and Clarens Formations cover the eastern portion of the area along the Lesotho border and have been intruded by a variety of dolerite dykes and sills. Groundwater can be developed on contact zones, joints and fractures in the sedimentary rocks and in weathered zones, but occurrence is restricted because of various factors. High runoff and little infiltration and relative scarcity of dolerite intrusions limit possible borehole sites. Little chemistry data is available as a result and no conclusions were made with regard to the water quality in these Formations.
- Groundwater do occur in the dolerite dykes and sills, especially where these have been weathered or jointed and fractured.
- Groundwater in the Drakensberg Group is associated with weathered lava and contact zones between lava and dolerite intrusions. Numerous low-yielding springs emerge on contacts between weathered and solid rocks. Borehole yields are expected to be very low, with ranges between 0.1-0.5 l/s but a large proportion of boreholes with less than 0.1 l/s.

Groundwater occurrence in the Allanridge Formation of the Ventersdorp Supergroup is associated with jointed diabase dykes and their contact zones, fractures in the occasional fault zones and weathered basins with associated joints. Borehole yields vary from 0.5-2.0 l/s. (Meyer, 2003)

No meaningful intergranular (alluvial) aquifers have been reported, although one can accept that alluvium can act as a groundwater recharge mechanism. (Meyer, 2003)

Groundwater Quality

Groundwater quality in the area is generally unpolluted, because of the rural nature and lack of heavy industry and mining. Saltwater intrusions do occur in the vicinity of salt pans and elevated nitrate levels, exceeding the maximum drinkwater limit of 10 mg/l, are mainly attributed to agricultural practices, e.g. use of fertiliser. (Meyer, 2003)

Mean EC values in the Dwyka Group is expected at 200 mS/m, in the Ecca Group at 118 mS/m (ranging from 10-12000 mS/m with the high salt loads in the vicinity of salt pans), < 100 mS/m in the Beaufort Group and in the dolerite intrusions. The Ventersdorp Supergroup EC values ranges between 70-300 mS/m. (Meyer, 2003)

The groundwater in the Bainsvlei area can be classified as a CaMg (HCO₃)₂ type water. The relative low Cl values of the groundwater indicate that the groundwater was recently recharged. The nitrate in some boreholes are relative high due to ground organic enrichment, from cultivated land processes (Van Tonder & Rudolph, 2003). Water samples from the Petrusburg area is classified as recent, old and stagnant groundwater (Ninham Shand & Geo-Hydro Technologies, 2003).

Groundwater Quantity

Precipitation is usually the most important source of recharge, but due to the nature of the rocks and topography, recharge generally increases from east to west in contrast with precipitation that reduces from east to west. (Meyer, 2003)

Borehole yields in the Bainsvlei area vary between 0.2-20 l/s with an average of about 1 l/s. Water levels in an area in Bainsvlei have dropped with at least 10 m during the past 50 years (personnel comm. Fourie and Du Plooy). (Van Tonder & Rudolph, 2003)

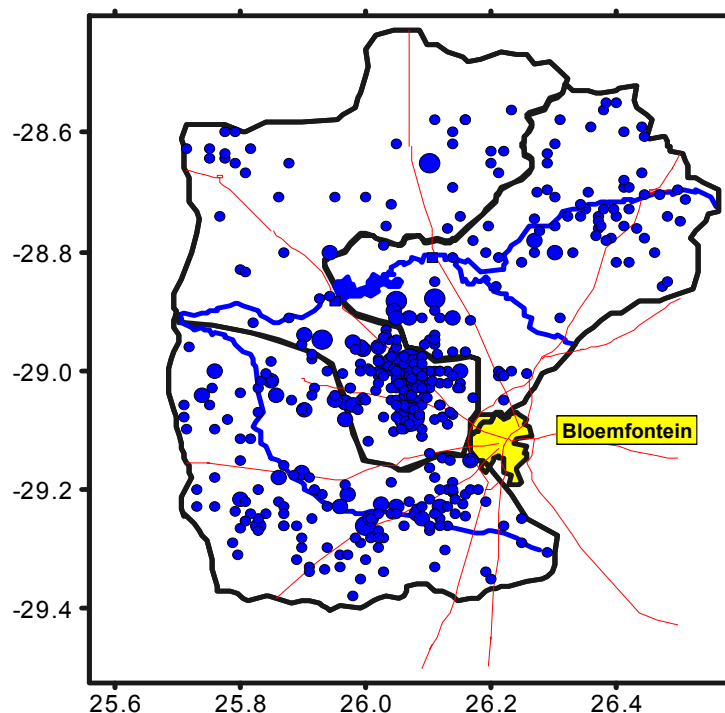


Figure 3: Position and relative volume of abstractions in the Bainsvlei area (Van Tonder & Rudolph, 2003)

Human dependency on groundwater amounts to about 1 million m³/a. Approximately 7 000 ha is irrigated in the area and the annual total abstraction from boreholes is in the order of 33 million m³/a. **Figure 3** shows the positions of abstraction boreholes with their relative volume abstracted. An area of fairly high intensity of abstraction is clearly visible in the centre of the area. (Van Tonder & Rudolph, 2003)

Recharge to the 3 quaternary catchments of Bainsvlei has been calculated to be 60 million m³/a (using 2% of the average annual rainfall of 500 mm, as estimated with the CI-method). Using a total ground water usage of 33 million m³/a, an aquifer stress percentage of 60% has been calculated. It can therefore be stated that the aquifer is under stress. (Van Tonder & Rudolph, 2003)

Recharge to the aquifer of Petrusburg was determined as 8.65% of annual average rainfall (22.1 million m³/a). Recharge to the aquifer will not always be the same since it is directly dependent on rainfall, e.g. years with annual rainfall below the average will experience less recharge, as years with annual rainfall above the average will experience higher recharge. The last six years experienced annual rainfall figures below the average annual rainfall. (Ninham Shand & Geo-Hydro Technologies, 2003)

According to a survey done in Petrusburg, during 94/95, the total area under irrigation for the Helderwater, Immigrant and Tafelkop isotopes, was approximately 1 332 ha, 16 % of the catchment area, therefore approximately 61% of the annual recharge was used for irrigation purposes in the main catchment (Ninham Shand & Geo-Hydro Technologies, 2003). However, irrigation from groundwater occurs outside these isotopes in the quaternary catchment C52K and the groundwater abstraction in C52K is estimated at 14.6 million m³/a (Darcy, 2004).

It is evident that recharge estimates is site-specific and one recharge value cannot be assigned to the whole area. As a rule of thumb, between 2-5% recharge is used for determining volumes of water available in Karoo aquifers. The variance of this value depending on different factors influencing recharge to the aquifer. The Harvest Potential Map (Seymour & Seward, 1995) can be used to determine the maximum volume of water available per surface area for sustained abstraction from groundwater and is estimated for the WMA as 10 000 m³/km²/a. The total catchment area for the Upper Orange WMA (Lesotho excluded) amounts to 101 977 km². The harvest potential for the WMA as a whole is then estimated at 1 020 million m³/a.

Aquifer Characteristics

The following site-specific studies gives an indication of the aquifer characteristics one can expect in this WMA. However, specific values cannot be integrated over the WMA, as aquifer characteristic will always be site specific.

A typical rock transmissivity, for the Bainsvlei area, is between 5-10 m²/d with a storativity of 0.005. Porosity values vary between 1 and 7%. (Van Tonder & Rudolph, 2003)

From the 72 hour pump test analysis done for 5 boreholes in the Petrusburg area, the following conclusions were made (Veltman, 2003):

- The aquifer is defined as a double porosity fractured hard-rock system.
- Radial flow in this system cannot be attributed to flow from the porous matrix, but rather a network of fractures that function as a matrix.
- Depths of the fractures are also site specific, but most fractures observed appear in the range of 20-30 m below ground level.
- The boreholes' yields depend on the availability of fractures.

- As soon as the main fractures in the borehole are dewatered, the confined nature of the aquifer is changed to a semi-confined or leaky aquifer.
- Boundary conditions do exist, but are site specific.

Water Use

The main agricultural activity in the WMA is mixed farming, although various crops are irrigated with the use of groundwater. Small scale irrigation in the Koffiefontein and Luckhoff districts (Meyer, 2003). The main areas of concern related to irrigation from groundwater are the Bainsvlei and Petrusburg areas.

Mining is limited to diamond mining at Koffiefontein and Jagersfontein and salt mining at Herbert, Fauresmith, Jacobsdal and Hopetown. The De Beers mining company supplies Jagersfontein and water is pumped from a depth of 220m below surface. (Meyer, 2003)

In the past various boreholes (60-70) have been drilled in the Thaba Nchu area, at the time being its only supply of fresh water. At present Bloemwater is supplying it through a pipe system. (Meyer, 2003)

Table 1 gives an indication of groundwater use by the various towns for water supply in the WMA (personnel comm. Free State Regional Office personnel).

Table 1: Status of groundwater use for water supply

Town Name	Sole Supply	Supplementing Surface Water
Barkly East		x (extreme droughts)
Burgersdorp	x	
Colesberg		x
Dealesville	x	
Edenburg		x
Fauresmith	x	
Hanover	x	
Jacobsdal		x
Jagersfontein	x	
Jamestown		x
Koffiefontein		x
Lady Grey		x (extreme droughts)
Norvalspont		x
Noupoort	x	
Petrusburg	x	
Petrusville		x
Phillipolis		x
Rouxville	x	
Smithfield		x
Trompsburg		x
Zastron		x

Ninham Shand & Geo-Hydro Technologies, 2003, did a study to determine the feasibility of establishing a Water User Association for the Petrusburg area and four different scenarios of various types of Associations were presented. The groundwater users decided to establish a WUA with the Bainsvlei area. The Kalkveld WUA has been proposed to the Minister for establishment and includes both the areas of

Bainsvlei and Petrusburg in the proposed constitution. To date this constitution has not been approved.

Groundwater / Surface Water Interaction

Springs do exist in the WMA e.g. the Trompsburg spring which has been channelled to serve as supplement to the town water supply, **Figure 4& Figure 5.**



Figure 4: Spring near Trompsburg



Figure 5: Flow from the Trompsburg spring

The groundwater component of baseflow to rivers; therefore the groundwater / surface water interaction in the WMA, is very small. The following case studies illustrate this point.

Case Study Bainsvlei:

The Modder River drains the area (C52H and C52G) and flows into the Kurgersdrift Dam 40 km north of Bloemfontein, while the Kaal Spruit drains the water in quaternary catchment C52J. (Van Tonder & Rudolph, 2003)

At the Farm Uitvlug-West a spring originates 30 m from the river. It flows 1.5 l/s in the winter and 0.7 l/s in the summer. This clearly illustrates that there is some groundwater flow towards the Modder River. (Van Tonder & Rudolph, 2003)

Water level information is known at a number of boreholes in the quaternary catchments and the correlation between the surface elevation and the water levels in these boreholes is 97%. This implies that Bayesian interpolation can be used to simulate groundwater level contours and groundwater flow is towards the Modder River. The water level gradient from a borehole towards the River was 0.001. It was also estimated that the annual groundwater flux of groundwater to the Modder River is 0.26 million m³/a. It is interesting to note that in about 50% of all months the flow in the Modder River is zero (naturalised conditions). It is thus clear that the Aquatic Reserve is very small compared to the annual recharge. (Van Tonder & Rudolph, 2003)

At the farm "Touch of Africa, owned by Mr G Dicks", a water sample was taken during Dec 2002 in the River and a borehole situated 80 m from the river. The EC of the River was 31 mS/m and that of the borehole 307 mS/m, which clearly indicates that, the flux towards the river is very, very small. (Van Tonder & Rudolph, 2003)

It was decided to give all the baseflow that originated from groundwater to the Ecological Reserve, i.e. 0.26 million m³/a, 0.4% of annual recharge. (Van Tonder & Rudolph, 2003)

Case Study Petrusburg:

Current data available (static water levels) suggest that water is leaving the northern part of the Petrusburg area. From the static water level contours a definite groundwater gradient towards the Modder River was determined, with base flow calculated as 294 336 m³/a, 1.3% of annual recharge. (Ninham Shand & Geo-Hydro Technologies, 2003)

Monitoring

Monitoring of groundwater data can be done on four different levels: Basic/reference (ambient), Regulatory (linked to (1) aquifer functions & uses or (2) local compliance), Specific Purpose (e.g. radioactivity) and Early Warning & Surveillance (site specific impact on resource - short term). Currently in the Upper Orange WMA only Basic/reference and Regulatory (aquifer functions & use) monitoring networks exist. A form of Regulatory (local compliance) is being done by the Bloemfontein branch of the CSIR, A v Vuuren, with monthly sampling of drinking water supply to towns.

Figure 6 shows the current groundwater monitoring points in the WMA, monitored by the Free State Regional Office of the DWAF. The ZQM monitoring network is a Basic/reference groundwater quality network and is driven by E v Wyk at the Head Office of the DWAF. The Orphimedes and Thalimedes points are part of the

Petrusburg Regulatory (aquifer function & use) network and are driven through the Regional Office of the DWAF.

No Regulatory monitoring is done on a catchment base for the areas where municipalities are using groundwater for bulk supply.

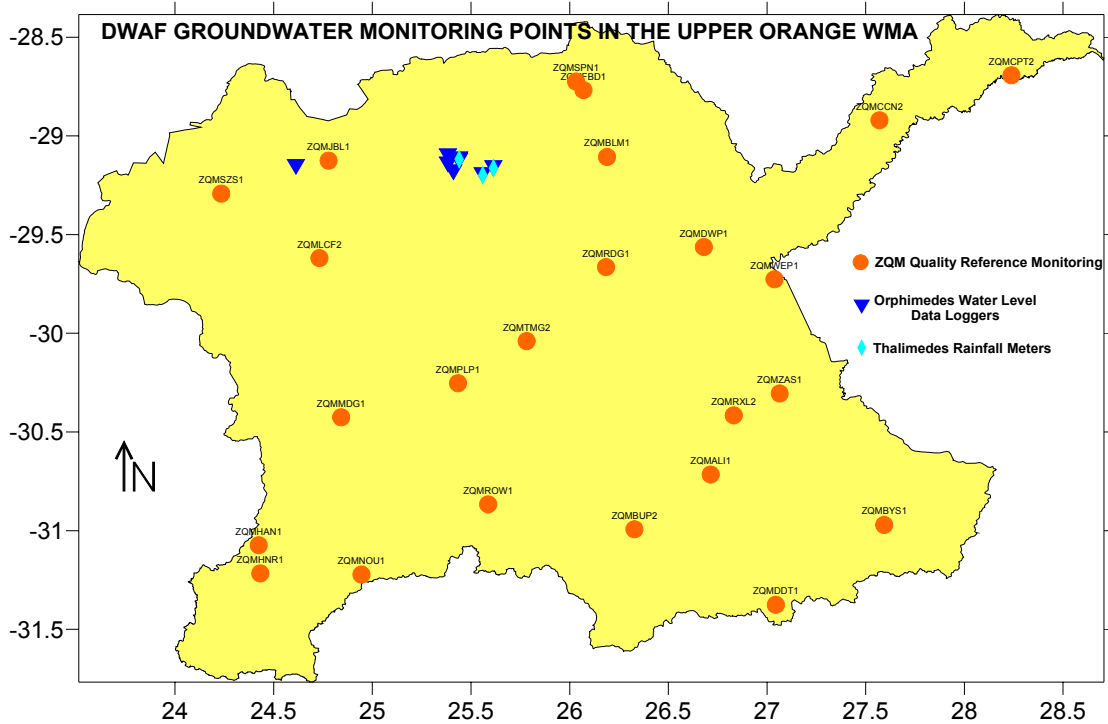


Figure 6: Groundwater monitoring points in the Upper Orange WMA

The Bainsvlei and Petrusburg areas have been identified as high intensity groundwater use areas and site-specific studies have highlighted the following recommendations regarding monitoring.

The following recommendations were made with regard to the Bainsvlei Area (Van Tonder & Rudolph, 2003):

- Groundwater levels must not decrease more than 5 m per year, but in the high intensity abstraction area the current water level must be maintained and no more licenses must be issued.
- Boreholes must be monitored on a 3-monthly basis.
- Abstraction must be monitored on a 3-monthly basis.

The following recommendations were made with regard to the Petrusburg Area: (Ninham Shand & Geo-Hydro Technologies, 2003)

- Surveying of all existing and new boreholes.
- The measurement of abstraction volumes from boreholes.
- The measurement of pumping and rest water levels in 30 selected boreholes. The monitoring network boreholes should be monitored once a week for the first year to establish a trend of water levels to the abstraction rates, thereafter the monitoring can be done once a month.
- Measurement of weather data (precipitation, evaporation, transpiration).

- A groundwater quality-sampling network is required with the following boreholes recommended for monitoring the chloride content: ABH057, ABH048, and ABH024 together with all the production boreholes supplying water to the municipality. For the first year of the management programme a full spectrum test should be done every three months, thereafter only annually with selected parameters done every 4 months. The chemicals tested for in the minor tests will be identified after the first year.

The main purpose of the monitoring programme and compilation of the database is to ensure on time corrective actions, in other words an early warning system. Water levels are plotted once a month. The water levels must be recorded before pumping (rest water level) and just before pumping stops (pumped water level). If the median of the graph shows declining water levels a problem exists with the system and immediate attention is required such as limiting the abstraction. Similar trends can be plotted for quality criteria. The critical acceptable water quality standards must be determined by the water users and be included in the Resource Quality Objectives (RQO). (Ninham Shand & Geo-Hydro Technologies, 2003)

Management Actions

The following site-specific management actions needs to be taken as soon as possible:

- Implement the groundwater resource class and allocation strategy that has been compiled for the Petrusburg area, based on variability in rainfall and all the different users, with assurance of supply built into the allocation tables. Resource protection and a possible tariff structure have also been taken into account. (Ninham Shand & Geo-Hydro Technologies, 2003)
- Control measures and limitations proposed to ensure the reliability of the aquifer system and that the integrity of the Reserve remain in tact, includes (Ninham Shand & Geo-Hydro Technologies, 2003):
 - The static water level outside the high volume abstraction geohydrological region may not decline over the long term.
 - Pumped groundwater levels may not drop by more than a set depth below the ambient static groundwater level over the long term.
 - Water levels in the region of salt pans may not drop more than 5m, which will result in recharge of salt water into the aquifer.
 - Water quality may not deteriorate below an agreed level.
- Integrate above-mentioned for the whole Kalkveld WUA area, specifically taking into account the Bainsvlei groundwater situation.
- Update, establish and integrate the monitoring network of the Kalkveld WUA area, to capacitate them for groundwater management.
- Evaluate monitoring data constantly and make recommendations towards groundwater management actions and implement them.

The following WMA management actions needs to be taken as soon as possible:

- Evaluate the ZQM monitoring data for the Upper Orange WMA and therefore evaluating the usefulness of the network in order to take corrective action.
- Establish and implement a catchment based Regulatory monitoring network for the areas where municipalities use groundwater for bulk supply, including groundwater level and rainfall monitoring in the bigger aquifer.

- Ensure the establishment and rollout of the Kalkveld WUA as soon as possible, in order to promote good groundwater management practices.
- Delineate and map calcrete occurrence in the WMA. (Darcy, 2004)
- Study the influence of cultivated land on the recharge of the aquifer systems. (Darcy, 2004)

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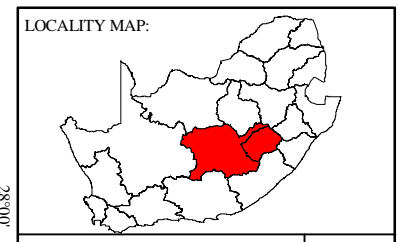
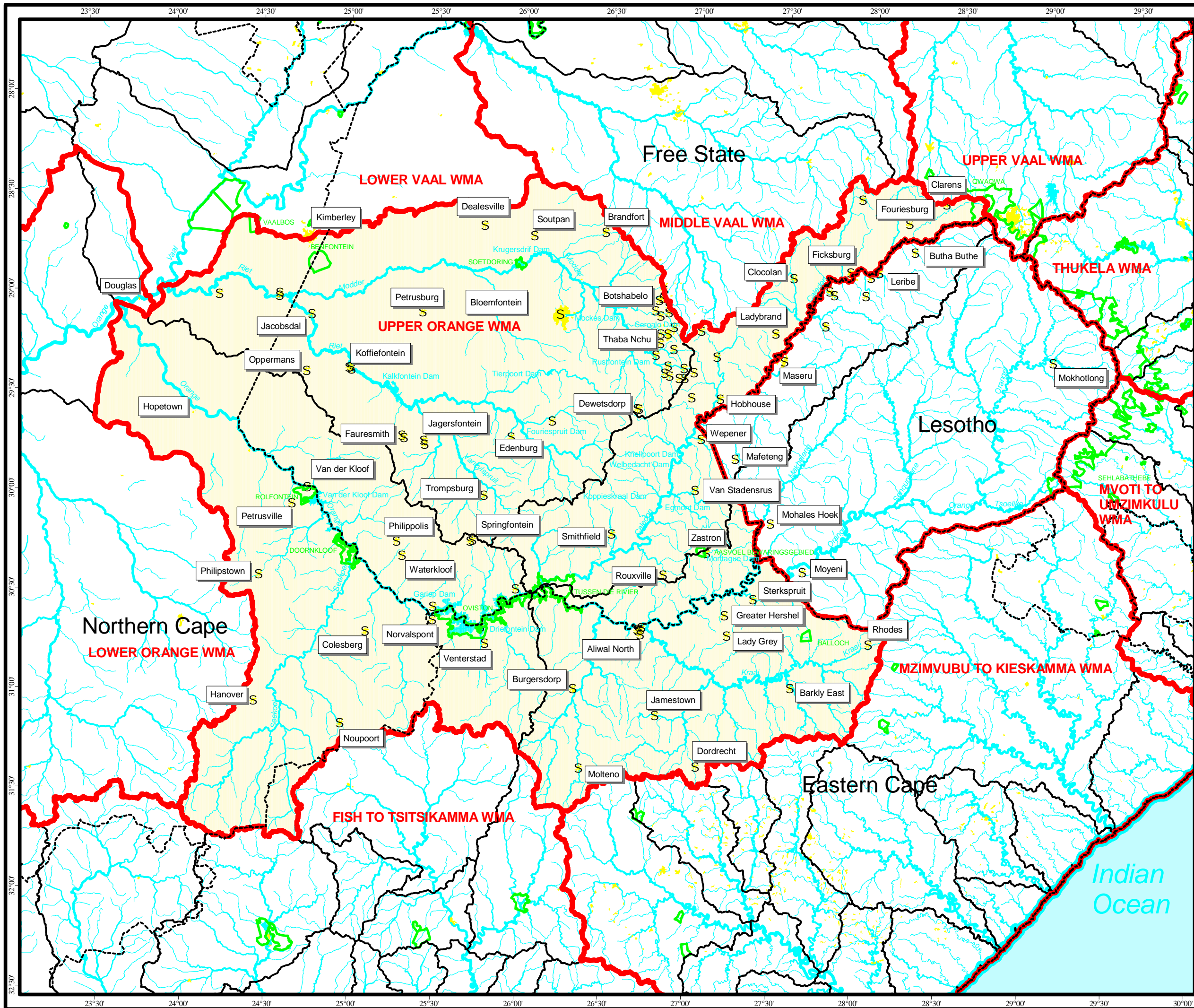
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Appendix C
Figures



LEGEND:	GIS COV:
Water Management Area	Waterman
International Boundary	Interbnd
Provincial Boundary	Prov0897
Towns	Newtown
Towns	Town
Rivers	Wri500
Dams	Ndams
Secondary Catchment	Drgnsnd
Nature Reserve	Consgco

PREPARED BY:
 STEWART SCOTT

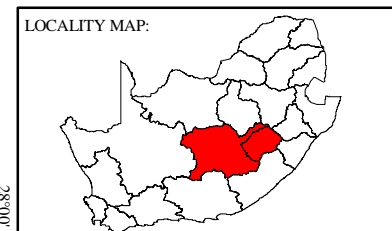
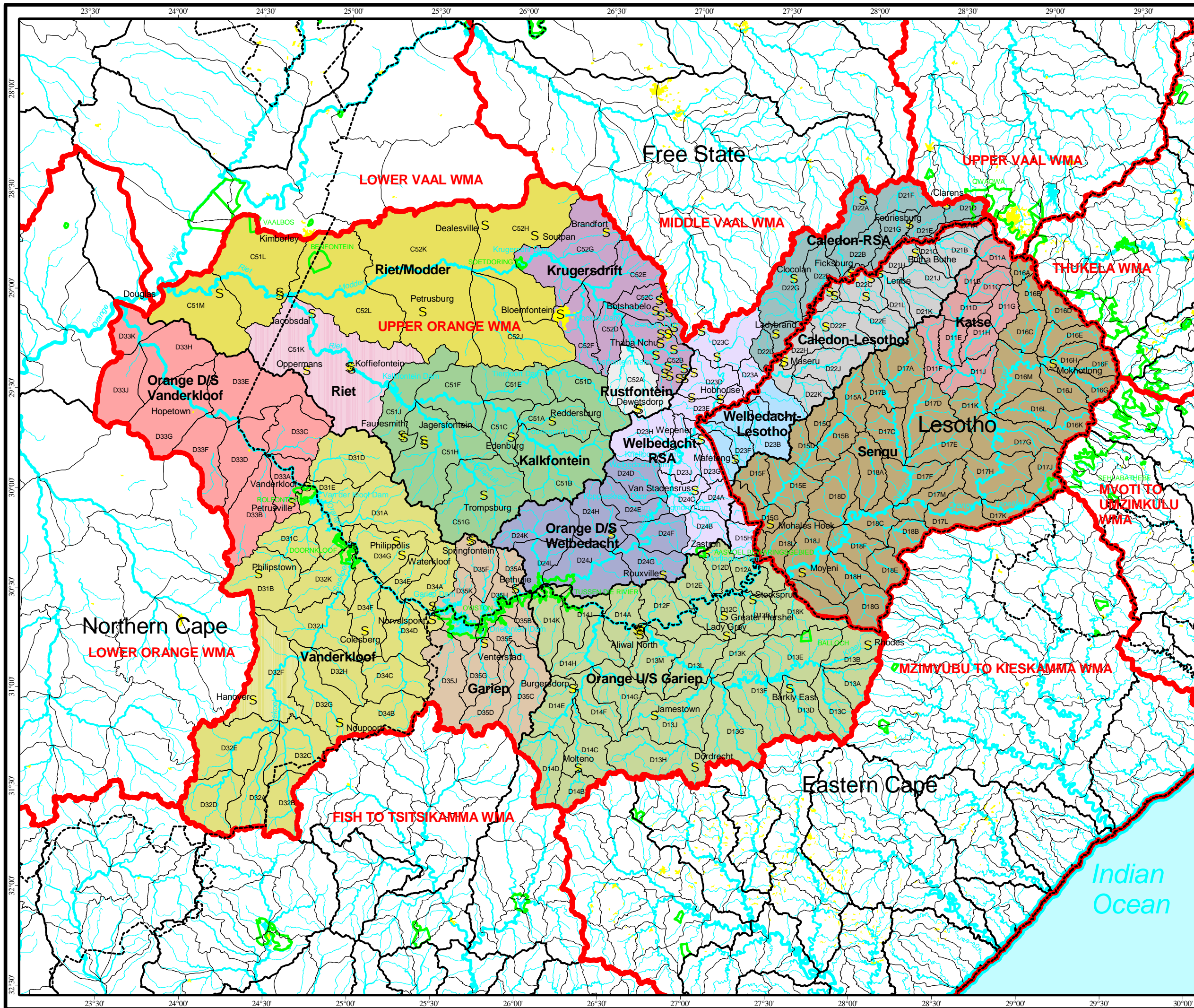
CLIENT:
 Department: Water Affairs and Forestry
 Directorate: Water Resources Planning

PROJECTION:
 ALBERS EQUAL AREA
 1:2000000
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TITLE:
UPPER ORANGE WMA
 THE STUDY AREA

Prepared by:	Petrus Blom	Figure C-1
Date:	12/2002	
Data Type:	StudyA3.apr	





LEGEND:	GIS COV:
Water Management Area	Waterman
International Boundary	Interbnd
Provincial Boundary	Prov0897
Towns	Newtown
Towns	Town
Rivers	Wri500
Dams	Ndams
Quaternary Catchment	Drnquat
Secondary Catchment	Drnqsnd
Nature Reserve	Consgeo
Nature Reserve	WSAM
Sub-catchments	
Caledon - Lesotho (Part D21A, D21B, Part D21C, Part D21H, D21J, D21K, D21L, Part D21C, Part D21D, D22E, D22F, Part D22H, D22J, D22K, Part D22L)	
Caledon - RSA (Part D21A, Part D21C, D21D, D21E, D21F, D21G, Part D21H, D22A, D22B, Part D22C, Part D22D, D22G, D22H, Part D22L)	
Caledon - Lesotho	
Caledon-RSA	
Katse (D11A-K)	
Krugersdrift (C52B-G)	
Orange d/s Vanderkloof (D33A-K)	
Caledon d/s Welbedacht (D24D-L)	
Orange U/S Gariep (D12A-F, D13A-M, D14A-K)	
Riet (C51K)	
Riet/Modder (C51L-M, C52H-L)	
Rustfontein (C52A)	
Senqu (D15A-H, D16A-L, D17A-M, D18A-L)	
Vanderkloof (D31A-E, D32A-K, D34A-G)	
Welbedacht - Lesotho (Part D23A, D23B, Part D23E, Part D23F, Part D23G)	
Welbedacht - RSA (Part D23A, Part D23C, D23D, Part D23E, Part D23F, Part D23G, D23H, D23I, D24A-C)	

PREPARED BY:
 STEWART SCOTT

CLIENT:
 Department: Water Affairs and Forestry
 Directorate: Water Resources Planning

PROJECTION:
ALBERS EQUAL AREA
 1:2000000

TITLE:
UPPER ORANGE WMA
 HYDROLOGICAL
 SUBCATCHMENTS

Prepared by:	Petrus Blom	Figure C-3
Date:	12/2002	
Data Type:	HydroA3.apr	

Appendix D

Water Supply to Urban/Industrial Centres

Table 1-1: Summary of sub-catchments and towns with adequate water resources

Name of town	Quaternary catchment	Key notes
Kalkfontein Sub-catchment		
Reddersburg / Matoporong	C51A	Caledon/Modder system Bloemwater also supplemented from boreholes.
Edenburg / Ha-rasebei	C51C	Caledon/Modder system Bloemwater & supplemented from groundwater.
Trompsburg / Madikgetla	C51G	Pipeline from Gariep Dam operated by Bloemwater & supplemented from groundwater.
Riet Sub-catchment		
Koffiefontein / Dithake	C51K	Vanderkloof Dam via Orange Riet Canal & supplemented from groundwater.
Jacobsdal / Ratanang	C51K	Vanderkloof Dam via Orange Riet Canal & Kalkfontein Dam & Boreholes
Oppermansgronde	C51K	Boreholes, bulk supply from Orange-Riet canal.
Riet/Modder Sub-catchment		
Ritchie / Motswedimosa	C51L	Vanderkloof Dam via Orange Riet Canal
Bloemspruit / Bainsvlei	C52H	Caledon/Modder system Bloemwater
Soutpan / Ikgomotseng	C52H	Located ± 15km North of Krugersdrift Dam no major tributary or river closer. Bulk supply from Krugersdrift Dam. Sufficient supply.
Rustfontein Sub-catchment		
Dewetsdorp / Morojaneng	C52A	Caledon/Modder system Bloemwater
Krugersdrift Sub-catchment		
Botshabelo	C52B	Caledon/Modder system Bloemwater
Thaba Nchu	C52B	Caledon/Modder system Bloemwater & Groothoek Dam
Bloemfontein / Mangaung	C52F	Caledon/Modder system Bloemwater
Brandfort / Majwemasweu	C52G	Sand-Vet GWS
Orange u/s Gariep Sub-catchment		
Aliwal-North / Dukathole	D14A	Located next to Orange River just below its confluence with the Kraai River
Caledon RSA Sub-catchment		
Clarens / Kgubetswana	D21D	Townlands Dam and TCTO purification works. Sufficient supply and storage.
Fouriesburg / Masjaing	D21G	Located next to a tributary in upper reaches of Caledon River. Bulk supply from Caledon River built with CMIP funding. Sufficient supply. Also supplemented from groundwater.
Ladybrand / Manyatseng	D22H	Caledon River Cathcartdrift Dam. Sufficient supply from

Name of town	Quaternary catchment	Key notes
		Caledon River. Also supplemented from groundwater.
Welbedacht RSA Sub-catchment		
Wepener / Thapelang / Qibing	D23G	Caledon/Modder system Bloemwater
Tweespruit / Borwa	D23C	Lovedale Dam. Sufficient supply from Lovedale Dam and Groundwater. CMIP funding.
Thaba Patchoa	D23D	Armenia Dam & Boreholes. Sufficient supply from Armenia Dam
Hobhouse / Dipelaneng	D23E	Armenia Dam. Sufficient supply from Armenia Dam
Caledon d/s Welbedacht Sub-catchment		
Smithfield / Mofulatshepe	D24H	Smithfield Dam & Boreholes. Sufficient supply from Caledon River and off-channel storage. More a maintenance problem.
Gariiep Sub-catchment		
Bethulie / Lephoi	D35H	Pipeline from Gariiep Dam operated by Bloemwater & Boreholes
Springfontein	D35F	Surface water & supplemented from groundwater.
Verwoerddam	D35K	Gariiep Dam Bloemwater
Venterstad / Nozizwe	D35G	Located next to a tributary close to Gariiep Dam. Sufficient supply from Oviston directly from Gariiep Dam.
Vanderkloof Sub-catchment		
Norvalspont	D34A	Abstraction directly from Orange River. Sufficient supply
Philippolis / Phoding-Tse-Rolo	D34G	Pipeline from Orange River down stream of Gariiep Dam operated by Bloemwater & supplemented from groundwater.
Colesberg / Kuyasa	D34F	Located close to a small tributary of the Orange between Gariiep & Vanderkloof dams. Pump water from the Orange River and groundwater
Orange d/s Vanderkloof Sub-catchment		
Petrusville / Thembinkosi	D33A	Groundwater and supply from Vanderkloof Dam via Vanderkloof Municipality
Vanderkloof	D33A	From Vanderkloof Dam
Luckhoff	D33C	Vanderkloof via Orange Riet Canal.
Hopetown	D33G	Located next to main Orange River & utilize Orange River Water.
Petrusville / Thembinkosi	D33A	Located ± 13 km south of Vanderkloof Dam. Sufficient supply from Vanderkloof Dam via the Vanderkloof Municipality and their groundwater resources.
Vanderkloof	D33A	Next to Orange River at Vanderkloof Dam. Sufficient supply from Vanderkloof Dam.

Note: CMIP – Consolidated Municipal Infrastructure Programme.

Table 1-2: Summary of sub-catchments and towns with inadequate water resources

Name of town	Quaternary catchment	Key notes
Kalkfontein Sub-catchment		
Jagersfontein / Itumeleng	C51H	Boreholes and mine shaft of decommissioned mine. Problem with quality and quantity.
Fauresmith / Ipopeng	C51J	Jagersfontein Boreholes and mine shaft. Problem with quality and quantity.
Riet Sub-catchment		
Riet/Modder Sub-catchment		
Dealsville / Tswaraganang	C52H	Located almost on watershed between Modder & Lower Vaal. Use boreholes.
Petrusburg / Bolokanang	C52K	Located almost on watershed between Modder & Riet rivers. Use boreholes.
Rustfontein Sub-catchment		
Krugersdrift Sub-catchment		
Orange u/s Gariep Sub-catchment		
Greater Hershel	D12C	Located on watershed between Orange & Kraai rivers. Using mainly boreholes, also Jozhanashoek Dam in the Sterkspruit area. The groundwater supply is fairly stable and shortage in the water supply are not a serious problem.
Zastron / Matlakeng	D12D	Kloof & Montagu dam & supplemented from groundwater.
Lady Grey / Khwezinaledi	D12E	Located on watershed between Orange & Kraai rivers & supplemented from groundwater.
Rhodes / Zakhele	D13B	Located in upper reaches of Kraai just south of the southern tip of Lesotho
Barkly-East / Nkululeko	D13D	Located next to a tributary of upper Kraai. Storage problem. Applied for CMIP funding to build off-channel storage dam. Supplemented from groundwater in dry periods.
Dordrecht / Sinakho	D13H	Located next to a tributary of middle Kraai
Jamestown / Masakhane	D13J	Located next to a tributary of middle Kraai. Storage problem. Applied for license to abstract water from Skulpspruit and to upgrade old railway storage dam as an off-channel storage dam & supplement from groundwater.
Molteno / Nomonde	D14C	Located next to a tributary in upper reaches of Stormberg River. Currently using boreholes. Currently investigating a

Name of town	Quaternary catchment	Key notes
		possible scheme to supply water from Teebus to Molteno and Burgersdorp.
Burgersdorp / Mzamomhle	D14E	Located next to Stormberg River middle of catchment. Currently using boreholes. See note for Molteno future supply.
Caledon RSA Sub-catchment		
Rosendal / Mautse	D22A	Rosendal Dam & supplemented from groundwater.
Ficksburg / Meqheleng	D22C	Meulspruit Dam also use water from Caledon river
Clocolan / Hlohlolwane	D22G	Moperri Dam although the bulk supply is from Meulspruit Dam to Clocolan, Marquard and Sparta Beef to augment groundwater supply with CMIP funding.
Welbedacht RSA Sub-catchment		
Vanstadensrus	D24C	Boreholes
Caledon d/s Welbedacht Sub-catchment		
Rouxville / Rweleleyathunya	D24G	Kalkoenkrans Dam & Boreholes
Gariiep Sub-catchment		
Vanderkloof Sub-catchment		
Philipstown / Lukhanyiswei	D31B	Located almost on the Watershed between the Orange & Brak rivers. Currently using boreholes.
Hanover / Nompumelelo	D32F	Located almost on the Watershed between the Seekoei (Orange) & Brak rivers. Currently using boreholes.
Noupoort / Kwazamuxolo	D32G	Located almost on the Watershed between the Seekoei (Orange) & Fish rivers. Currently using boreholes.
Waterkloof	D34G	Located just south of Philippolis next to a small tributary of Orange River. Currently using boreholes.
Orange d/s Vanderkloof Sub-catchment		

Note: CMIP – Consolidated Municipal Infrastructure Programme.

Appendix E
Principles and methods for the
Implementing
of the MIG

DRAFT VERSION 1

Suggested principles and methods for the implementation of the MIG (Municipality Infrastructure Grant) and proposing the future role of the DWAF.

BACKGROUND

Cabinet has approved the MIG on 5 March 2003 with the following conditions:

- a) approves the establishment of the Municipality Infrastructure Grant (MIG) in the 2003/04 financial year:
- b) approves that the following current conditions infrastructure grants should be phased out and consolidated into the MIG over the next three years.
 1. The Consolidated Municipal Infrastructure Programme (CMIP) and Local Economic Development (LED) provisions, administered by the Department of Provincial and Local Government;
 2. The Water Capital Grant, administered by the Department of Water Affairs and Forestry;
 3. The Community Based Public Works Programme (CBPWP), administered by the Department of Public Works;
 4. The National Electrification Programme (NEP), administered by the Department of Minerals and Energy; and
 5. The Building for Sports and Recreation Programme, administered by the Department of Sports and Recreation;
- c) agrees that the incorporation of poverty relief programmes into the MIG once there is greater clarity in respect of the distribution industry restructuring process;
- d) agrees that the electricity grant would be incorporated into the MIG once there is greater clarity in respect of distribution industry restructuring process;
- e) notes that the existing commitments of national departments administering current grants would be honoured;
- f) approves that at least 92% of the grant be a formula-drive-three-year allocation process and that a maximum of eight percent be a separate window for a special Municipality Infrastructure Fund for regional investments and innovation;
- g) notes that a formula and key policy proposals would be reviewed by the Cabinet through annual budget process, but that the Ministers of Finance and Provincial and Local Government may, if necessary, approve formula or policy changes;
- h) notes that the Department of Provincial and Local Government will administer the MIG, subject to the oversight of the Municipal Infrastructure Task Team (MITT);

- i) notes that national departments would be expected to exercise their normal responsibilities with regard to policy, strategic planning, regulation, monitoring and capacity building, while financial accountability (restricted to administering the transfer of grants) rests with the department of Provincial and Local Government;
- j) requests the Director General of the department of Provincial and Local Government to constitute (and chair) the MITT, and request the Director General of the Departments of Water Affairs and Forestry, Minerals and Energy, Public Works, Sports and Recreation, Transport, Housing and the National Treasury to nominate their representatives to the MITT; and
- k) requests the National Treasury and the Department of Provincial and Local to develop general monitoring systems for national oversight over municipalities. The system should address financial and non-financial performance elements and clarify the roles and responsibilities of all stakeholder national and provincial line-function departments.

PROBLEM STATEMENT

Now that the MIG is given, DWAF must ensure that all the “ normal responsibilities with regard to policy, regulation, strategic planning, monitoring and capacity building” of a national department (as set out in sub-par (i) of the Cabinet decision) is still to be achieved through the MIG. It should be done in such a way as to minimise the concerns raised by DWAF in our meetings with NT as summarised by the DG in his memo reference 6/11/2003 of 21 February 2003 to the Minister.

SUGGESTED PRINCIPLES

1. That DWAF engage with municipalities at different stages of the project cycle. Although this would now essentially be a municipal process cycle, DWAF must engage in this process through what can be described as “entry points” or “gates”. Some engagement can be described as “soft entry” points where we would support, interact and co-operate. Other points could be better described as “gates” or “hard entry points” where the conditions of the MIG must be met or else intervention or stoppage of funds should occur.
2. DWAF staff will not be transferred to DPLG or provinces but that DWAF staff engages in this monitoring and support role as a national department
3. The following soft entry points are proposed (see attached diagram):
 - Throughout the planning and WSDP process
 - During construction if resources allow
4. The following “hard entry points” or “check gates” are proposed:
 - Finalisation of the project priority list of council
 - Business Plan approval stage
 - Design stage
 - Completion of projects i.e. commissioning.
5. DPLG should do the general monitoring of the capital programme as per Cabinet decision (see (k) DWAF should provide a list of KPI's (Cabinet's “financial and non-financial

- performance elements”) to DPLG and National Treasury. This report must be presented on a monthly basis to DWAF and must enable DWAF to make an assessment at “ check gates”.
6. DWAF should as soon as possible review the conditions it want to impose on water supply and sanitation projects as these must be fed into the annual budget review process to ensure that it is printed in DoRA.
7. DWAF should at least achieve the following main goals through the above check gates, conditions and KPI's:
- Ensure that planning is done (WSDP as a legislative requirement)
 - Basic needs are addressed. (engagement in WSDP and priority lists)
 - Sanitation projects are prioritised (engagement in WSDP and priority lists.)
 - Community involvement during all phase (e.g. concerns expresses by chair of portfolio committee on CMIP sanitation projects)
 - Funding and provision for operation and maintenance. (and designs and construction can promote that)
 - Soft issues such as awareness, health and hygiene are all included. (in BP as well as during implementation)
 - Construction is labour based. (determined at BP and design stages)
 - Sustainability in all its many elements is achieved. (such as institutional arrangements with a WSP)
 - Projects are not merely consultant driven but bases on real needs within communities.

GOVERNANCE PRINCIPLES

As agreed between DG's there would be two levels of the MITT (Municipal Infrastructure Task Team), the first at DG or DDG level and the second at operational level.

The DG/DDG committee should deal with

- Strategic issues such as refinement of policy and implementation strategy.
- Formula issues and oversight over allocation to municipalities
- Review regular reports from operational committee and can request independent audits.
- Deal with those cases where conditions of the MIG will result in funds being withhold or withdrawn.
- Deal with appeal cases from local government.

The operational committee should do the following:

- Ensure implementation.

- Review and correct blockages in process.
- Review regular reports from municipalities and PMU's.
- Recommend policy changes to the DG/Higher Committee.

Helgard Muller

CD: WS

Appendix F
Irrigation Development
Detail description

Table F-1: Summary of irrigation development on sub area basis**VANDERKLOOF SUB-AREA**

Includes the following sub-catchments Gariep, Vanderkloof and Orange River d/s of Vanderkloof

Irrigation is the main water user in this sub-area and includes:

Gariep sub-catchment ($\pm 2\ 200$ ha) diffuse irrigation from small dams. Transfer from Gariep Dam to the Fish-Tsitsikama WMA to mainly support irrigation ($\pm 51\ 500$ ha) and a small urban component (mainly support to Port Elisabeth).

Vanderkloof sub-catchment ($\pm 8\ 100$ ha) diffuse irrigation from small dams mainly in the Seekoei River catchment and ($\pm 2\ 000$ ha) of irrigation directly from the Orange River and is supported from Gariep Dam. Releases of at least $16\text{m}^3/\text{s}$ are required from Gariep Dam to enable the users to abstract water from the Orange River.

Orange d/s of Vanderkloof sub-catchment ($\pm 14\ 000$ ha) directly from the Orange River by means of releases from Vanderkloof Dam as well as an additional ($\pm 5\ 700$ ha) supplied from the Vanderkloof right bank canal. Significant variations in river flow due to bulk releases for hydropower generation purposes create problems for the irrigation users along the Orange River in this sub-catchment. These bulk releases are partly used by the irrigators in this sub-catchment and the remaining volume flows to the Lower Orange to be used by the users along the Orange River below the Vanderkloof sub-catchment. Water is also transferred from Vanderkloof to the Riet sub-catchment mainly to support irrigation. See the notes under the Riet sub-catchment.

CALEDON RSA, CALEDON LESOTHO AND RIET/MODDER SUB-AREAS

Includes the following sub-catchments: Welbedacht RSA, Welbedacht Lesotho, Rustfontein & Krugersdrift

Limited irrigation is found in these sub-catchments:

Welbedacht RSA sub-catchment, ($\pm 3\ 900$ ha)

Welbedacht Lesotho sub-catchment, (± 500 ha)

Rustfontein sub-catchment, (± 450 ha) diffuse irrigation from small dams and from the main river.

Krugersdrift sub-catchment, ($\pm 2\ 500$ ha) diffuse irrigation from small dams and from the main river.

Caledon Lesotho sub-catchment

Limited irrigation (± 800 ha) is practised in this area.

Caledon RSA sub-catchment

Limited irrigation ($\pm 1\ 400$ ha) is practised in this area.

Caledon d/s of Welbedacht sub-catchment

Significant irrigation developments ($\pm 5\ 000$ ha) exist in this area, which is supported from compensation releases from Welbedacht Dam but also utilises water from small dams in the area.

Kalkfontein sub-catchment

A fair amount of diffuse irrigation ($\pm 3\ 740$ ha) is located in this area and are mainly supplied from small dams.

Tierpoort Irrigation Board (708ha) is located in this area and is supplied with water from Tierpoort Dam.

Riet sub-catchment

Irrigation is the main water user in this area and includes the Kalkfontein Canal Scheme ($\pm 3\ 000$ ha), which is supplied from the Kalkfontein Dam, Riet River Settlement ($\pm 8\ 000$ ha) and part of the Orange Riet Canal irrigation ($\pm 4\ 000$ ha). The latter two irrigation schemes are supplied with water from Vanderkloof Dam via the Orange Riet canal.

Limited diffuse irrigation exists in this area.

Riet/Modder sub-catchment

Irrigation is a major water user in this area and includes:

Modder River Government Water Scheme (±3 500ha) supplied from Krugersdrift Dam.

Scholtzburg IB (±650ha) supplied from Vanderkloof Dam via Orange Riet canal.

Richie IB (±100ha) supplied from Vanderkloof Dam via Orange Riet canal.

Lower Riet IB (±4 000ha) supplied from Vanderkloof Dam via Orange Riet canal

Diffuse irrigation (±1 500ha) mainly from small dams.

KRAAI SUB-AREA

This area is also referred to as the Orange River u/s of Gariiep sub-catchment

Significant abstractions from the Orange for irrigation occur in this area (±4 000ha).

Diffuse irrigation from the tributaries and small dams are significant (±13 000ha) and is in excess of that supplied directly from the Orange River.