CHAPTER 2: BROAD PERSPECTIVE OF THE WATER SITUATION IN THE ORANGE RIVER CATCHMENT AND RELATED STRATEGIES FOR RESOURCE MANAGEMENT

2.1 INTRODUCTION

In this chapter summarised information from the NWRS and the "Overview of Water Resources Availability and Utilisation" reports for the Upper and Lower Orange River WMA is included to provide the reader with the required background of the water situation in the Orange River catchment. This information will enable the reader to better understand the overarching strategies as obtained from the ISP process. When more detailed background information is required, the reader is referred to the NWRS document (**DWAF, 2003c**) chapter 2 and the appendices and secondly to the "Overview of Water Resources Availability and Utilisation" reports (**DWAF, 2003a & 2003b**) for each WMA, which was used as the basis for the NWRS document. These reports should in general provide sufficient detail for most readers. The reader is however strongly advised to read these two reports. Even more detail can be obtained from the "Water Resources Situation Assessment Study" prepared for each Water Management Area, as these reports were used as the base to compile the Overview reports. Inputs to the "Water Resources Situation Assessment Study" reports were mainly obtained from existing reports of previous detailed studies of which the Orange River Replanning Study (ORRS) is the most recent.

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

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

The development of the strategies has been formulated with the IWRM process in mind (see **Figure 1.4**) and the generic structure, according to which the strategies are presented, follows the broad framework of the National Water Act.

2.2 GENERAL CATCHMENT DESCRIPTION

The catchment description focuses on the Orange River. The Orange River was sub-divided into two WMAs, the Upper Orange WMA and the Lower Orange WMA. The location and borders of the two WMAs are shown in **Figure B-1 of Appendix B.** Although the Vaal River is a

tributary of the Orange River it has been described in the Vaal River Overarching document (DWAF, 2003g). The Riet River, which is in fact a tributary of the Vaal River will be included in this document as it is part of the Upper Orange WMA.

The Upper Orange water management area lies predominantly within the Free State, but also covers 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 is the main river in the water management area. 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 2.1** for the location and general layout of the Upper Orange Water Management Area.

Figure 2.1: Upper Orange WMA Base Map

The 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 1000 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 1500 mm per year. Potential evaporation is well in excess of the rainfall.

Extensive inter-catchment transfer schemes have also been developed for the transfer of water within the water management area as well as to other water management areas.

The most significant transfers being from Katse Dam via the Lesotho Highlands Water Project to the Upper Vaal water management area and from Gariep Dam via the Orange-Fish tunnel to the Fish to Tsitsikamma water management area. Transfer rate for the Lesotho Highlands

Water Project at year 2000 was 491 million m^3 per year and will be increased to about 835 million m^3 per year when Mohale Dam is commissioned in 2003. Water is transferred at a constant rate irrespective of the water levels or demand situation in the Vaal River System, based on the volume as agreed on by RSA & Lesotho. On route the water is used to generate hydropower for use in Lesotho before it is released into the Ash River in the Upper Vaal WMA.

Transfer from Gariep Dam located in the Gariep key area through the Orange Fish tunnel to the Fish to Tsitsikama WMA to supply the irrigation requirements in the Eastern Cape as well as to supply a part of the requirement for Port Elizabeth. The transfer varies slightly from year to year due to the irrigation requirements of the ±51 500ha listed under the Orange/Fish transfer scheme, which vary from year to year due to variations in rainfall and evaporation. Due to salinity problems within the irrigation scheme more water than the allocation has to be released from Gariep Dam to improve the water quality. This is mainly done during periods when Gariep Dam is spilling. This might however not be adequate especially during long dry periods. Future growth in this transfer will mainly be affected by the growing demand for Port Elizabeth, as well as the 4 000 ha allocated to resource poor farmers in the Fish to Tsitsikama WMA. Some trading has already taken place where farmers along the Orange River bought allocations from Fish River farmers. This will slightly reduce releases to the Fish River and correspondingly increase releases downstream of Vanderkloof Dam into the Orange River.

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 flows 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 quality of groundwater is naturally good in the eastern high rainfall parts of the water management area, becoming more mineralised and brackish in the drier areas and in the vicinity of salt pans.

Present land use in the water management area is mostly under natural vegetation with livestock farming (sheep, cattle and some game) as the main economic activity. Extensive areas under dry land cultivation, mostly for the production of grains, are found in the north-eastern parts of the water management area. Ficksburg is famous for the cherry orchards in the region. 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 this water management area. Mining activities have significantly declined and currently mainly relate to salt works and small diamond mining operations.

The Upper Orange water management area (see **Figure 2.1**) was divided into sub-areas comprising the following catchments:

- 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).

The geographic extent of **the Lower Orange water management area** largely corresponds with that of the Northern Cape Province, with very small components falling within the Western Cape and Free State Provinces on the southern and eastern boundaries respectively. It borders on Namibia in the north-west and on Botswana in the northern extreme. The Lower Orange water management area is the most downstream of five water management areas covering the Orange/Vaal River Basin, with most of it's water requirements being met from releases from major dams in the Upper Orange WMA. It also borders on three other water management areas. The Orange River is also the main river in this water management area.

The Lower Orange water management area is characterised by a harsh climate with minimal rainfall and prolonged droughts, sometimes to be terminated by severe flooding. Rainfall usually occurs during late summer to autumn. The area experiences the lowest mean annual rainfall in the country, which ranges between 20 mm at the coast and 400 mm on the eastern boundary. Potential evaporation can be as high as 3 000 mm per year and in general is several times more than the rainfall. South of the Orange River and westwards the geology is complex with a variety of rich mineral deposits and shallow, rocky soils.

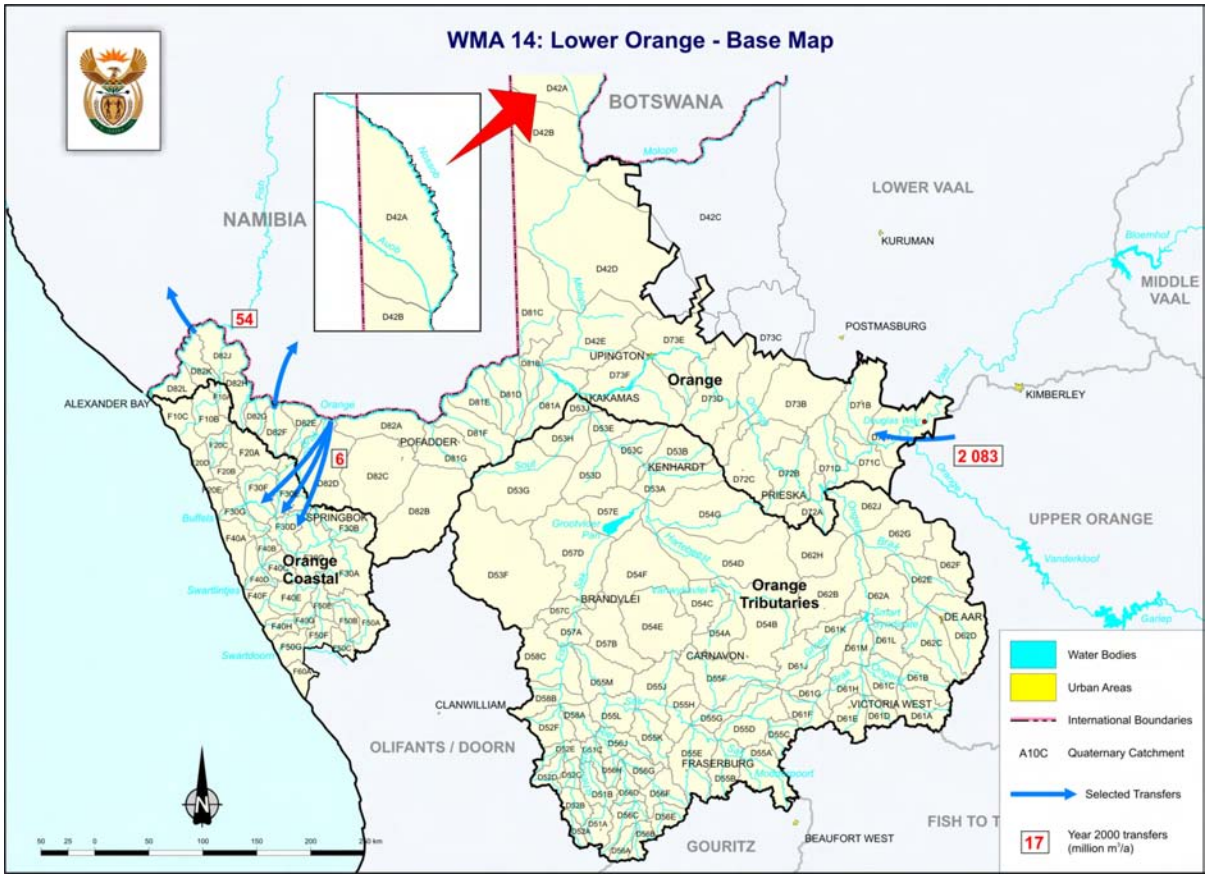

Figure 2.2: Lower Orange WMA Base Map

The Orange River, which forms a green strip in an otherwise arid but beautiful landscape, also forms the border between South Africa and Namibia over about 550 km to the west of the 20 degree longitude. The Vaal River, the main tributary to the Orange River, has its confluence with the Orange River about 13 km west of Douglas. Other tributaries are the Ongers and Hartebeest Rivers from the south, and the Molopo River and Fish River (Namibia) from the north. There are a number of highly intermittent watercourses along the coast, which drain directly to the ocean. Refer to **Figure 2.2** for the location and general layout of the water management area.

Minerals and water from the Orange River were the key elements for economic development in the region, and still remain so. Since the early explorations large mining operations were established, related to the diamonds and other minerals found in the water management area

From a land use perspective, the water management area almost totally still remain under natural vegetation. Sheep and goat farming is practised over most of the area, with large parts falling within conservation areas. Cultivation is restricted to isolated patches where somewhat higher rainfall occurs, and irrigation in the narrow ribbon of fertile alluvial soils along the Orange River. Large mining operations occur in various parts of the water management area (some of the diamond mining activities along the coast are not being reflected on the map). There are no large urban developments or power stations in the water management area. Due to the arid climate, no afforestation occurs. Invading alien vegetation is found along some tributary water courses and on the banks of the Orange River.

In the natural state the quality of water in the Orange River was good, although of high turbidity during flood flows. Water from the tributary streams tends to be of high salinity. Both the flow regime and water quality in the Orange River has, however, been severely impacted upon by extensive upstream developments. Salinity in the Orange River has increased due to the transfer of high quality water away from the Orange River (in Lesotho and the Upper Orange water management area) and as a result of high salinity irrigation return flows along the Orange River. Poor quality water from the Vaal River, which contains a high proportion of irrigation return flows as well as treated urban effluent, may also periodically enter the Orange River.

The Lower Orange was divided into three sub-areas as shown on **Figure 2.2**.

- The Orange sub-area includes the Orange River over the whole of its length through the water management area, together with minor tributary streams.
- The Orange Tributaries sub-area includes the catchments of the Ongers and Hartebeest Rivers.
- The Orange Coastal sub-area includes the mostly dry watercourses, which lead directly to the ocean.

Orange River General: The Orange River rises in the eastern highlands of Lesotho where it is known as the Senqu River and is the largest and longest river in South Africa. From the Upper Orange WMA, the river flows through the Lower Orange WMA where it discharges into the Atlantic Ocean some 2 300 km from its origin in Lesotho (See locality map in **Appendix B, Figure B-1**).

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 the usual diamond rush and lead to the establishment of the towns Koffiefontein and Jagersfontein. In the Upper Orange WMA Bloemfontein, the capital of one of the former boer republics, later developed into the only city in the Upper Orange WMA. Minerals and water from the Orange River were the key elements for economic development in the Lower Orange WMA. Copper was discovered near Springbok in 1850 and the first diamond in the county in 1866 when a young boy found a transparent stone on the south bank of the Orange River. The first irrigation scheme of note was built at Upington, which was originally established as a trading station for items such as copper, iron, assegais, ivory, skins and tobacco. Construction of the weir at Boegoeberg for irrigation purposes began in 1906. Irrigation development in the Upper Orange WMA was stimulated by the construction of several dams. Great expansions of irrigation was made possible along the Orange River in both WMAs by the construction of Gariep and Vanderkloof dams in the Upper Orange WMA during the 1970's. Two large hydropower stations were also constructed at Gariep and Vanderkloof Dams.

Approximately 6 % of the Gross Domestic Product (GDP) originates from this area (5% from Upper Orange WMA & 1% from Lower Orange WMA). The potential for economic growth can be found in the agriculture sector converting to higher value products. Agriculture, mining, trade and Government are the main sectors contributing to the GDP in the two WMAs.

The main storage dams in the Orange River WMAs (See in **Figure B-2 in Appendix B**).are:

- 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.

Katse and Mohale dams in Lesotho are not located in the two WMAs, but have a significant impact on the available water in the Orange River, as the bulk of the water flowing in the Orange River is generated in Lesotho. Katse Dam is located in the Senqu sub-area in Lesotho and is used for the transfer of water to the Upper Vaal WMA. Mohale Dam, which was recently completed are located in the same sub-area, and started to impound water in 2003. This dam is also used to support the transfer to the Upper Vaal WMA.

For more detailed information the reader is referred to the two reports, one for the Upper Orange WMA (**DWAF, 2003a**) and one for the Lower Orange WMA titled (DWAF, 2003b) "Upper/Lower Orange Water Management Area Overview of Water Resources Availability and Utilisation".

2.3 RESOURCE AVAILABILITY

Fifty seven percent of the natural runoff is generated in Lesotho and 33% in the Upper Orange WMA and the remaining 10% in the Lower Orange WMA. The bulk of the runoff generated in

the Lower Orange is coming from the Fish River in Namibia (approximately 60% of the Lower Orange runoff) and is only entering the main Orange River close to the river mouth. The bulk of the surface water in the Lower Orange Water Management Area is therefore found in the main stem of the Orange River, with virtually all flowing into the river from the Upper Orange Water Management Area.

Although the surface water resources of the Orange River is already heavily regulated through the many large dams in the system, potential has been identified for the re-regulation of releases from Vanderkloof Dam as well as the storage of more flood flows from the Upper Orange and Vaal Rivers. These options could contribute to the improved management of the Orange/Vaal River System, and facilitate more water being made available for use. No meaningful potential for surface water regulation exists in the Orange Coastal sub-area.

Groundwater is an extremely valuable source in both WMAs and in particular in the Lower Orange WMA where approximately 60% of the water in the tributary catchments is from groundwater. Although the total volume groundwater used is insignificant in comparison with the surface water resources, groundwater is the only source in large areas. Groundwater resources will have a small impact on issues of an overarching nature and are dealt with in detail in each of the WMA ISPs. More detail is therefore given in the Upper and Lower Orange ISP reports (**DWAF, 2003e & 2003f**).

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. The hydrology for the Lower Orange downstream of Vanderkloof Dam that was obtained from the WR90 (WRC Study) represents less than 3% of the total natural runoff and will also not affect the yield determined for Gariep and Vanderkloof dams as well as for most of the other major dams.

For effective Integrated Water Resources Management it is required to have a clear understanding of the current and future water resources available in the WMAs (Future development of the resource is discussed in **section 2.6**). This includes the quantities of usable water in terms of spatial distribution and any factors that may affect the yield of the system and requires an operational analysis on an annual basis. With regards to the resource availability it is required to attend to the following:

- Assess the need to update the hydrology on a continuous basis and in particular for areas with relative old hydrology and areas where a higher resolution hydrological data and system models is required for local water sources under stress. Detail of local water resource conditions will be given in the ISPs for individual WMAs.

- The hydrology should be updated after the occurrence of a severe drought event. By 2008 it will be possible to extend the shorter hydrology records by another 20 years which is quite a substantial extension and it recommended to at least re-evaluate the extension of the hydrology at that time if a severe drought event has not occurred before then.

- The main variables that impacts on the salinity loads in the system should be assessed on a continuous basis to establish the need to update the TDS model and to commission studies accordingly.

2.4 WATER REQUIREMENTS

Present land use in the area is mostly under natural vegetation with livestock farming (sheep, goats, cattle and some game) with large parts falling within conservation areas. Extensive areas under dry land cultivation, mostly for the production of grains, are found in the north-eastern parts of the water management areas. Large areas under irrigation for the growing of grain, fodder crops, grapes etc. have been developed along the main rivers, mostly downstream of dams.

Bloemfontein and Thaba 'Nchu represent the main urban and industrial development and is located in the Upper Orange water management area. Two large hydropower stations were constructed at Gariep and Vanderkloof Dams. Large mining operations occur in various parts of the Lower Orange WMA.

Irrigation is by far the dominant water use sector in the Orange River WMAs, representing 88% of the total gross water use of 1 996 million m^3/a estimated for the year 2000. This figure excludes the transfers out of the WMAs. Only 12% are used by the urban, industrial, mining and rural sectors.

Based on the scenarios for population and economic growth, initial estimates of possible future water requirements were made for the period until 2025 (DWAF, 2003a & 2003b). In addition, provision was made for known and probable future developments with respect to power generation, irrigation, mining and bulk users as described under the respective sub-areas where applicable. A total requirement of 60 million m^3/a and 63 million m^3/a was used for Namibia and Lesotho respectively with an assumption of zero growth from 2000 to 2025. Quantification of the projected future requirements for water includes the development of an additional 4 000 ha of irrigation as was approved for poverty relief and the settlement of emerging farmers in the Upper Orange WMA, and 4 000 ha of irrigation for the Lower Orange WMA. The 4 000 ha allocated to the Fish – Tsitsikama WMA as well as 28 million m^3 for urban requirements (mainly Port Elisabeth) are included in the growth in the transfer through the Orange – Fish tunnel. The relevant provincial governments are currently developing processes to manage these allocations and indications are that the first allocations will be made during 2003.

Within the spectrum of population and economic growth scenarios, a base scenario was selected for estimating the most likely future water requirements, built on the high scenario of population growth and more equitable distribution of wealth leading, in time, to higher average levels of water services. The projected base scenario requirement for 2025 is 2 134 million m^3/a and includes irrigation, urban, rural and mining requirements.

Large transfer schemes have also been developed for the transfer of water within the Upper Orange water management area as well as to other water management areas. There is one

major transfer out of the Upper Orange WMA (LHWP and (Orange Fish Tunnel) as well as the water use by Namibia along the common border, which is for the purpose of this description also listed as a transfer out of the Lower Orange WMA. Although the transfer from the LHWP to the Upper Vaal WMA is not a transfer from the Upper Orange WMA, it directly effects the flow in the Orange River.

Releases from Gariep and Vanderkloof dams to supply in the requirements of the downstream users are made through the hydropower turbines at both dams. These releases therefore represent a non-consumptive use by Eskom for the generation of hydropower. Eskom is also utilising the current surplus in the Orange River system (Gariep and Vanderkloof dams) to generate hydropower. The utilisation of this surplus does not only include the releasing of the available surplus through the hydropower turbines but also operating rules that benefit hydropower generation. These rules typically include the release pattern from Gariep Dam, the storage control curves in both Gariep and Vanderkloof dams etc. 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. As the surplus in the system reduces over time, it will therefore be required to gradually move away from the rules that benefit hydropower generation to ensure that the existing users are supplied at the required risk levels.

The information on water use in the system will be significantly improved by the recently completed registration process, which is followed up by the verification of existing lawfull use. Results from this exercise have to be compared with the water use figures used in the water balance. This may have a negative effect on the water balance of the system as it is possible that the finally accepted registered lawfull use may be in excess of the water requirements currently used in the water balance calculations. Although the regional offices have completed the main initiative regarding the registration of water use, the Department is still receiving registrations from users in the catchment. The verification process will therefore have to be continued to determine the validity of each subsequent registration.

It is important that during this process comparisons be made on a regular basis to establish if the water requirements used in the current water balances are being exceeded by the total of the registration database.

The available data on water requirements need to be on the same level of certainty for both WMAs, the Vaal and the Fish/Sundays systems, to be able to develop scenarios for reconciliation as the resource is shared by more than one WMA.

2.5 WATER BALANCE

For the purpose of this water balance the total yield at a 1 in 50 year assurance level is compared to the water requirements, also converted to represent the requirement at a 1 in 50 year assurance level. Although the two sub-areas located in Lesotho (Caledon & Senqu) is not part of the two Orange River WMAs, they were both included in the water balance as they fulfil a key role in the overall water balance. The supply situation in the Orange River System is such that there is a surplus in the system at the year 2000 development level, which will reduce significantly due to the completion of the Phase 1B of the Lesotho Highlands Project in 2003 and even further over the next fifteen to twenty years as result of the minor growth in the future projected water requirements in the system. Eskom is using the water that is released for

downstream use as well as the surplus water in the system to generate hydropower. This "surplus" available for hydropower generation is, however, small in relation to the releases for downstream use (333 versus 2 110 at year 2000) and will decrease as already indicated. Recent operating analysis indicated that the projected risk of curtailments in the water supply to the consumptive users is such that only relatively small allocations can be made for power generation purposes.

More than half the current (year 2000) surplus of 333 million m³/a in the Orange River will be taken up with the commissioning of Mohale Dam in 2003 and the associated transfer to the Vaal System (See **Tables 2.1 & 2.2**). Although **Tables 2.1 and 2.2** is prepared for the Upper Orange WMA, the releases from the Upper Orange to support the demands along the main stem of the Lower Orange is included in the transfers out of the Upper Orange, as indicated for the Vanderkloof sub-area. For the purpose of the Overarching ISP, these two tables will provide the required water balance results, as the water balance for Lower Orange Coastal and Tributaries sub-areas has no effect on the overarching water balance and will therefore be dealt with in the Lower Orange ISP document. **Table 2.1** represents the water balance as obtained from the Overview report, Upper Orange (**DWAF, 2003a**).

Table 2.1: Year 2000 water balance for the Upper Orange WMA (million m³/a)

Sub-area	Available water			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
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.

The effect of Mohale Dam is illustrated in **Table 2.2** and it can be seen that the surplus is reduced from 333 million m³/a to 158 million m³/a. As already mentioned, water has been reserved for 12 000 ha new irrigation development (net requirement of approximately 114 million m³/a) for poverty relief, which will reduce the surplus to 44 million m³/a once implemented.

Table 2.2: 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 (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
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

The water balance for the year 2025 as obtained from the Upper Orange WMA Overview report (**DWAF, 2003a**) is shown in **Table 2.3** and indicates a surplus of 90 million m³/a. At 2025 development level it is expected that the 12 000 ha allocated to 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 2.3: 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
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)
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 40 million m³/a to accommodate the 4 000ha allocated to the Fish-Tsitsikama WMA. This requirement was not included in the volume given for the transfer out of the Vanderkloof sub-area in **Table 2.3.**

- The local yield in the Caledon RSA sub-area was increased in **Table 2.3** 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 2.3**.

- The 4 000ha allocated to the Upper Orange WMA was included in the Kraai sub-area in **Table 2.3** and it was decided that it should rather be included under the Vanderkloof sub-area.

The adjustments as described above were included and the results are shown in **Table 2.4.** 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 2.4** is therefore also representative of a 1 in 50 year risk level.

Table 2.4: Year 2025 adjusted water balance for the Upper Orange WMA (million m³/a)

Sub-area	Available water			Water requirements			Balance
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)
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)

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)

The Orange River still has potential to transfer significant volumes to the Vaal System over and above that transferred through the existing Phase 1 (Katse and Mohale dams and Matsoku Weir) of the LHWP. To achieve this, additional infrastructure will however be required. Any future development of transfer schemes to support the Upper Vaal WMA will have to provide sufficient water resources to support the transfer and maintain the assurance of supply to all users in the Orange River System.

Factors that can have a significant impact on the water balance given above include:

- The indicated surplus was determined without taking into account the effect of water conservation and demand management (WCDM) on the projected water requirements. It is anticipated that the impact of certain WCDM measures will result in a reduction of the net requirements to be supplied from the system. (See the WCDM strategy for more detail).

- The environmental requirement used in the water balance was obtained from the ORRS and the figures may change when a comprehensive estimate is made.

- The ORRS indicated significant operational losses and a potential increase in yield if improvements can be made that will reduce these losses.

- The increase in releases from Katse and Mohale dams for the environment as recently implemented in Lesotho will increase the surplus available in the Orange.

- There are uncertainties with regards to the international requirements for Lesotho and Namibia. Indications of these requirements will be obtained from the LORMS and Lesotho Lowlands Study, which is currently in process.

The current Lower Orange Management Study (LORMS) commissioned jointly by the Namibian and South African governments has the purpose of investigating management measures for the Lower Orange River system (mainly along the river reach that coincide with the border between the two countries) and will during part of the process develop an updated water balance for the system. All of the above mentioned factors will be considered in the updating of the balance. The findings and water balances derived from this study will have to be incorporated into the ISP documentations at a later stage.

2.6 WATER BALANCE RECONCILIATION OPTIONS

From **Tables 2.1** to **2.4** it is clear that although there is a surplus available in the system at the 2000 development level, it is expected that the surplus will reduce over time and that there will be a small deficit in the system by the year 2025.

The resource is shared by more than one WMA and includes the Upper and Lower Orange WMAs, the Vaal system with transfers through the LHWP to the Upper Vaal WMA as well as the Fish/Sundays water supply system with transfers from Gariep Dam through the Orange Fish Tunnel. Reconciliation therefore needs to be done for both the Upper and Lower Orange WMAs at the same time, taking into account the future requirements of the Vaal and the Fish/Sundays water supply systems.

As mentioned in **Section 2.4**, it is important to remember that at the point when intervention is required, Eskom should already have moved away from the rules that benefit hydropower generation to ensure that the existing users are supplied at the required risk levels.

2.6.1 Intervention measures

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 Orange River

WMAs. The ORRS and LORMS are the two most recent studies in this regard, and possible intervention measures as obtained from these two studies are listed below.

Based on the given water balance information, which indicate that intervention measures may be required in the next 15 to 20 years, the management actions listed in **Table A1** in **Appendix A** should be implemented. Reconciliation can be obtained through any of or combinations of the following options:

- Reduction in operational losses in the Orange River System, which are currently estimated at 270 million m³/a. The operating losses can be reduced through improved release management and/or by constructing an operating dam in the Lower Orange at Boegoeberg or Vioolsdrift. The most feasible measures to reduce the operating losses should be assessed and implemented. This aspect is being assessed as part of the LORMS and indications are that up to 170 million m³/a can be saved by means of a re-regulating dam at Vioolsdrift. Although the possible re-regulating dams are located in the Lower Orange they will have a direct effect on the availability of water in the Upper Orange WMA.

- Water conservation and demand management measures. This would focus on irrigation as the largest water user sector in the system. It is perceived that water conservation and demand management measures in the irrigation sector will mainly improve the efficiency of water use and that any savings will be taken up by the users themselves to expand their irrigated areas. It is therefore anticipated that the overall Orange River System water balance will not be significantly influenced by WCDM in the irrigation sector. It could however be used to address inequities if required at a later stage, after the allocated 12 000 ha had been taken up.

- Utilise the storage volume below the current minimum operating level in Vanderkloof Dam. This option can increase the yield by as much as 231 million m³/a, but will have a direct impact on hydropower generation as hydropower cannot be generated below the current minimum operating level. The effect on hydropower as result of this possible option is currently being determined and discussed with Eskom.

- Construction of Boskraai Dam in the Orange River between Gariep Dam and the Lesotho border. This dam can be used to improve the water supply situation on the Orange River as well as to transfer water to the Vaal System. The Boskraai Dam was identified in the ORRS study as one of the best options for possible future transfers from the Orange to the Upper Vaal. This dam is located across the Orange and Kraai Rivers just upstream of the confluence of the Kraai and Orange Rivers.

- Proposed possible developments from Lesotho Lowlands study may be utilised by the RSA as a joint development by both countries. Although the Lesotho Lowlands study is aimed at the developing of local resources to meet the local water requirements in Lesotho it is possible for the RSA to contribute to the proposed development to also meet water requirements in the RSA. The existing Orange-Senqu Commission should be used to communicate RSA's requirements in terms of the study to the Government of Lesotho.

- Results from the current LORMS should be evaluated as further possible options to supply in the future requirements. The possible options that are investigated in the LORMS include the following of which some have already been discussed above:
    - Using the Lower Level Storage in Vanderkloof Dam.
    - Utilising spills from the Vaal River by means of real time modelling.
    - Decrease operational losses by means of re-regulating dams.
    - Large Storage dam at Boegoeberg or Vioolsdrift.
    - Making more water available through WCDM.

2.6.2 Compulsory licensing

Compulsory Licensing is a procedure defined in Section 43 of the National Water Act, which has the purpose of correcting imbalances in water allocations and can be used to address the following:

- Correct the imbalance if the current water balance is negative.
- Make additional water available for the Reserve.
- Meet reasonable equity demands.

Based on the current surplus supply situation and the fact that a positive water balance is projected for the following fifteen to twenty years, the implementation of Compulsory Licensing is not considered a priority in the Orange River System as a whole. It is possible that there are locally stressed catchments in the system which may require Compulsory Licensing, however, those were identified during the development of the detailed WMA ISPs and are included in the relevant documents (**DWAF, 2003e & 2003f**).

Environmental requirements for the main stem of the Orange River as obtained from the ORRS are currently supplied from the system and are included in the water balance above, together with the desktop estimates for the remaining areas as given in the NWRS. There is therefore no eminent need for allocation corrections to satisfy the existing environmental requirements. Estimations of the environmental requirements for the main stem of the Orange River as indicated by the current LORMS study is higher than that obtained from the ORRS. It is therefore possible that the Reserve, which still needs to be determined, might eventually put more strain on the water balance.

Allocations to address inequities in water allocation have already been made by means of the 12 000 ha allocated to resource poor farmers and the effect of the allocations was included in the water balance. These allocations must first be taken up, before more will be considered for which compulsory licensing might be an option to make it possible. There is therefore no immediate need to enter into compulsory licensing for this purpose.

2.7 STRATEGIES FOR WATER RESOURCE MANAGEMENT RELATED TO BOTH WMAs

2.7.1 Water Resource Protection

The two aspects that were dealt with under water resource protection are the ecological Reserve and water quality management.

Water Quality : Water quality of the surface water in the Upper Orange is generally good except for the high sediment load in the Caledon and the salinity problems in the Lower Riet. The water quality in the Lower Orange has, however, been severely impacted upon by extensive upstream developments. It is possible that the water quality problems in the Orange is coming from the Vaal as water quality in the Vaal becomes worse as one proceeds along the Vaal. Under normal operating conditions very little water from the Vaal reach the Orange River and it is mainly under flood conditions that large volumes will enter the Orange. Potentially toxic algae bloom events are also occurring in the central region of the Orange River. The water quality issues in the catchment at the over-arching level relate to the management of the water quality passed down between WMAs and can therefore not be solved on a WMA basis alone. The large urban, industrial and mining developments are located in the Upper Vaal WMA and to a lesser extent in the Middle Vaal WMA. This is the case of the poor water quality being passed down to the Lower Vaal and Orange WMAs. The water quality variables of concern at a system level are eutrophication and salinity. There are water quality variables of concern relating to specific WMA or sub-catchments within a WMA. These will be dealt with in the individual WMA ISPs. The water quality is currently being managed by releases of clean water used to dilute the water quality to meet salinity targets.

Water Quality Objectives (WQOs) are being put in place for the management of water quality. WQOs have been set in a number of the catchments. These are generally a result of a negotiation process through the Forums as part of a situation assessment or the development of water quality management plans. The setting of the WQOs may or may not have involved a process to determine the feasibility of implementation, the allocation of waste loads between dischargers, and the downstream effects of the WQOs set. The impact of the implementation of source directed strategies on the instream water quality in terms of improvement has in general not been investigated. The integration of all these factors needs to be investigated and an integrated water quality management tool developed for the Orange River Basin to allow for the rational assessment of the factors that impact on water quality. This is a complex system and water quality will have to be modelled in more detail.

In addition to the practice of blending, the Department of Water Affairs and Forestry is busy implementing the source control measures through the licencing, EIA and EMPR processes. These factors influence mining, industry and sanitation system discharges. These practices of source control and best practice should continue.

Ecological Reserve Determination: The instream and estuarine flow requirements were determined for the Orange River downstream of Vanderkloof Dam in the ORRS (more or less at intermediate level but methodology differ from that currently used and accepted). These ecological requirements (±280 million m^3/a) are currently being released from Vanderkloof Dam.

Lesotho has determined and implemented updated IFRs for the Senqu River in Lesotho. The updated releases are more than that specified in the Treaty between RSA and Lesotho and will most likely increase the Orange River System yield by about 30 to 60 million m^3/a.

As part of the LORMS, modified Desktop level estimates of the environmental requirements were made for the section of the Orange River from the Vanderkloof Dam to the Orange River mouth as well as for the estuary. These in-stream and estuarine flow requirements are used in the LORMS study to perform sensitivity analysis. Analysis from the LORMS showed a reduction in the system yield of approximately 100 million m^3/a when the modified desktop level environmental flow requirements are used in place of the ORRS environmental flow requirements. A comprehensive Reserve must however still be determined for the Orange River. In the mean time it is essential that proper monitoring must be set in place to monitor the ecological health of the river and the estuary and to collect sufficient data as required for a comprehensive Reserve determination. Indications from the LORMS are that the ecological requirements can be higher than that currently released and it is therefore important not to allocate the surplus in the system as result of the higher ecological releases from Lesotho. The water quality requirements for the environment have not been fully addressed in any of the current available environmental flow assessments. A draft management plan for the Orange River estuary has been produced.

The implementation of the IWRM process requires an ecological Reserve as a basic building block or input to the process. The preliminary determination from the ORRS will be used for the main stem of the Orange River until better estimates have been determined for the Orange River and the main tributaries. The Orange River Reserve will have to be determined in close co-operation with the Vaal River Reserve Determination.

2.7.2 Water Use Management

Operational Management: System management measures are implemented 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.

The operation of the Orange River System is linked to the operation of the Vaal River System and the Lesotho Highlands Project. The Vanderkloof and Gariep Dams in the Orange River System are operated to support all the downstream users and at the same time to generate hydropower with the releases for downstream users as well as with the surplus available in the system (see **Section 2.4** for more detail). Allowing maximum hydropower generation optimises the utilisation of the water resource, without adversely impacting on the long-term reliability of supply to the users in the system. There is an annual review of the operations of the dams to optimise power generation and water availability. The operation of this system requires continuous analysis of the projected water requirements and return flows, current state of the dams and requires communication and liaison with the major users. The system is also operated to manage water quality (TDS) by using blending or dilution. The system therefore requires continuous management of the existing and planned water resource systems to optimally manage the system from an operating cost, water quality and assurance of supply point of view.

The Orange River System is well regulated with releases being made from the system of dams and transfers to meet downstream water requirements. The water volume released can travel large distances to the users through arid and semi-arid areas. Water is also transferred into the system via pipelines and canal systems. There are losses associated with these conveyance

systems. These losses can affect the yield of the system and implementation dates of future augmentation schemes. These losses need to be quantified through measurement and the efficiency of the systems improved.

Hydropower generation at Gariep and Vanderkloof Dams forms an important component of Eskom's peak generation capability. Fluctuating releases from hydropower turbines impact negatively on some users between Vanderkloof Dam and Marksdrift. In turn, upstream transfers of water negatively impact on the water availability for power generation.

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

Essential to the operation and planning of the Orange River System is the record keeping and feedback of water use information and return flow volumes. The lack of accurate water use information for irrigation schemes has been cited as a cause of concern.

Groundwater: Groundwater resources play an important role in the supply of local water requirements in the Orange River system and are particularly important in the Lower Orange WMA. Details are however given in the individual WMA ISPs.

Licensing Strategy: The process of verification of the current registered water use has started but is not yet completed. Satellite imagery is used for verification purposes and the required tools for this process are already in place. The verification process started in the areas where the most problems were experienced.

The existing WARMS information management system are being used to manage water use licenses data and to capture data of the actual requirements / discharges of users.

The issuing of licences for water abstraction is and should be considered within the framework as given in **Appendix A Table A.3.4**.

Licensing is the mechanism defined in the NWA to control water use within a sustainable level given the current and future water availability estimates. The issuing of licences is important to protect the water resources and allow the use of the resource for economic benefit in a manner that is equitable among competing users.

Public Health and Safety: The Department's current commitments are associated with:

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

Flood management at Gariep and Vanderkloof Dams aims to not have the Orange River floods in phase with floods from the Vaal River as this is of major importance with respect to the protection of developments along the Lower Orange River. To achieve this, flood peaks are basically reduced and released over a longer period.

The annual hydropower operational analysis is used to determine the surplus or deficit in the system. During dry periods when there is a short-term deficit in the system, the required curtailments will be imposed on the system by taking into account the assurance of supply allocated to the various users.

Potentially toxic cyanobacterial bloom events are occurring in the central region of the Orange River and nutrient management strategies regarding this issue need to be addressed.

2.7.3 Water Conservation and demand Management

The efficient and optimal use of water is important in a water scarce country like South Africa. Water conservation and demand management (WCDM) is crucial in achieving the objective of efficient use of water. However, a cohesive and practical implementation of WCDM should be adopted. This implies that the effects on return flow volumes and economics should be considered. The results of the implementation of WCDM should be coupled to monitoring to assess the affects of the measures implemented on the projected water requirements.

2.7.4 Water Pricing and Financial Assistance

The pricing strategy will be conducted in accordance with the process specified in the NWRS. The application of the pricing policy is expected to curtail the use of water in particular the future use of the surplus where the full cost for the water will be charged.

The implementation of the waste discharge charge system (WDCS) will play an important role in the Orange River system. The WDCS will encourage the implementation of recycling, source control measures and effluent treatment. This will reduce water requirements and improve the water quality of the receiving water.

2.7.5 Iternational aspects and implications

Countries sharing the Orange Senqu river basin include the Republic of Botswana, Kingdom of Lesotho, the Republic of Namibia and the Republic of South Africa.

The National Department is responsible to draft and implement strategies and policies regarding international shared river basins. These strategies are guided by international protocols that define the basic framework for water management across international boarders.

The most important international connections that affects the Orange River System is the Lesotho Highlands Water Project (LHWP), which transfers water from Lesotho, the possible developments from the Lesotho Lowlands Study and thirdly the section of the Orange River along the RSA / Namibia border, where water is abstracted by RSA and Namibian users.

International water supply sharing therefore mainly includes Namibia in the Lower Orange WMA and Lesotho in the Upper Orange WMA. It is important to 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. To address this need a study was recently initiated by ORASECOM (Orange-Senqu River Commission) which an international organisation representing the Governments of the Republic of Botswana, Kingdom of Lesotho, The Republic of Namibia and the Republic of South Africa. The proposed study basically involves developing an Integrated Water Resource Management Plan for the Orange Senqu river basin.

Local water resource developments in Lesotho (excluding the LHWP) have historically been small, with little impact on the water resources of the Orange River System. This situation could change with the possible development of the water resources in the Lowlands of Lesotho. The Government of Lesotho has recently commissioned a study to investigate the feasibility of such schemes. The impacts of the possible water resource developments in Lesotho Lowlands on the water balance of the Orange River system must be assessed and the possibility of combined utilisation of future water resource developments can also be considered. The use of the same modelling systems as applied in RSA should be considered in the study for compatibility and consistency purposes.

Allocations to Namibia have been identified during previous studies and the current LORMS has been commissioned to investigate improved options for the joint management of the Lower Orange River. Current Namibian requirements are in line with the existing proposed 50 million m^3/a permanent allocation to Namibia and 60 million m^3/a temporary allocation until 31 December 2007. There are however uncertainties with regards to the growth in transfers to Namibia and an agreement with regards to the maximum abstraction and payment of water abstractions by Namibia from the Orange River, needs to be formalised. Results from the LORMS should be used for guidance in this regard.

2.7.6 Monitoring and Information Systems

There are a number of shortcomings that have been identified in the monitoring system. These include water quality, flow measurements to gauge power generation releases, river losses, flows at the Orange River mouth, low flows along the main stem of the Orange River mainly in the Lower Orange and biomonitoring. A comprehensive water monitoring system needs to be developed to address all the monitoring requirements in the Orange River System.

Note should be taken of existing National Monitoring Programmes (National Eutrophication Monitoring Programme; National Microbiological Monitoring Programme; National Chemical Monitoring Programme; etc). It is further important that all CMAs should be committed to the establishing of the database for the National Status Reporting.

2.8 ISP IMPLEMENTATION STRATEGY

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

The ISP is intended to act as DWAFs perspective on how the 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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