REPORT No:PWMA 15/000/00/0405

DEPARTMENT OF WATER AFFAIRS
AND FORESTRY

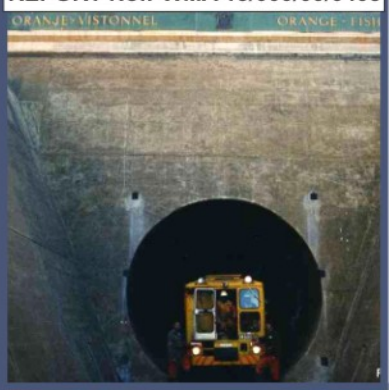
FISH TO TSITSIKAMMA WATER MANAGEMENT AREA

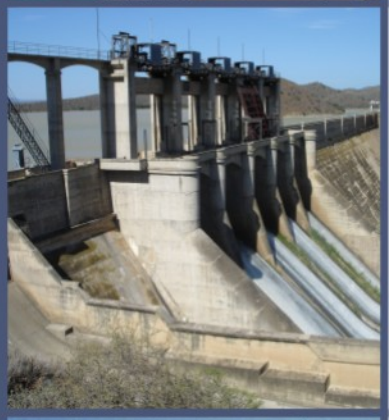
FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE

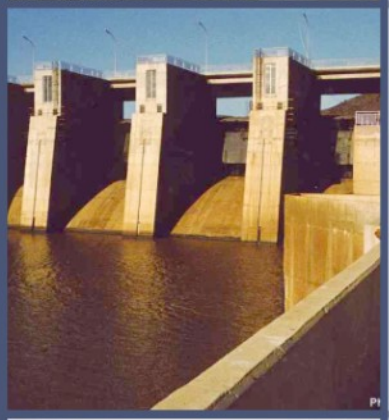
VERSION 1
February 2005

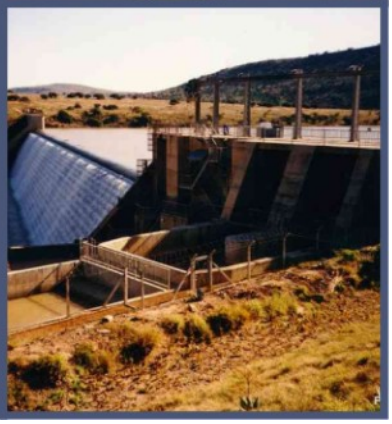
NINHAM SHAND
CONSULTING SERVICES

UMVOTO









P WMA 15/000/00/0405

Department of Water Affairs and Forestry
Directorate National Water Resource Planning

INTERNAL STRATEGIC PERSPECTIVE

for the

FISH TO SUNDAYS

portion of the

FISH TO TSITSIKAMMA WATER MANAGEMENT AREA
(WMA 15)

Version 1: February 2005

Prepared by: Ninham Shand

In association with:
FST
Jakoet & Associates
Tlou & Matji
Umvoto Africa

Department of Water Affairs and Forestry
Directorate National Water Resource Planning

DEVELOPMENT OF INTERNAL STRATEGIC PERSPECTIVE
for the
FISH TO TSITSIKAMMA WATER MANAGEMENT AREA (WMA No 15)

Fish to Sundays Internal Strategic Perspective

APPROVAL

Title	:	**Fish to Tsitsikamma Water Management Area: Fish to Sundays Internal Strategic Perspective**
DWAF Report no.	:	P WMA 15/000/00/0405
Consultants	:	Ninham Shand in association with Umvoto Africa, Jakoet & Associates, and Tlou & Matji
Report status	:	Version 1, February 2005
Version Controller	:	TJ Geldenhuys (CE: WRM, DWAF Southern Cluster, Cradock)
Date	:	February 2005

STUDY TEAM: Approved for Ninham Shand, Umvoto Africa, FST, Jakoet & Associates, Tlou & Matji

.....
E. VAN DER BERG

.....
M J SHAND (Director)

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
Directorate National Water Resource Planning
Approved for Department of Water Affairs and Forestry:

.....
F A STOFFBERG
Project Manager

.....
J A VAN ROOYEN
Manager: NWRP

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water Affairs and Forestry, South Africa. 2005. *Fish to Tsitsikamma Water Management Area: Fish to Sundays Internal Strategic Perspective*. Prepared by Ninham Shand in association with Umvoto Africa, on behalf of the Directorate National Water Resource Planning. DWAF Report no. P WMA 15/000/00/0405.

INVITATION TO COMMENT

This report will be updated on a regular basis, until the Catchment Management Strategy eventually supersedes it. Water users and other stakeholders in the Fish to Tsitsikamma 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).

ELECTRONIC VERSION

This report is also available in electronic format as follows:

- DWAF website:
  - Internet: http://www.dwaf.gov.za/documents/
- On CD which can be obtained from the DWAF Map Office at:
  157 Schoeman Street, Pretoria (Emanzini Building)
  ☎ (012) 336 7813
  E-mail: apm@dwaf.gov.za

or from the Version Controller (see box overleaf)

The CD contains the following reports (all available on the DWAF website):

- Fish to Sundays Internal Strategic Perspective (this Report)
  (Report No: P WMA 15/000/00/0405)
- National Water Resource Strategy, First Edition, 2004
- The Fish to Tsitsikamma WMA - Overview of Water Resources Availability and Utilisation
  (Report No: P WMA 15/000/00/0203)
- The Fish to Tsitsikamma WMA – Water Resources Situation Assessment
  (Report No: P WMA 15/000/00/0101)

LATEST VERSION

This report is a living document and will be updated on a regular basis. If the version of this report is older than 12 months, please check whether a later version is not available.

This can be done on the DWAF website: http://www.dwaf.gov.za/documents/

or by contacting the Version Controller (see box overleaf)

VERSION CONTROL

FISH TO TSITSIKAMMA WMA
FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE

Version 1:	February 2005
(List of Previous Versions):	(Dates)
Current Version Controller:	T Geldenhuys DWAF Cradock Office 50 Sprigg Street Cradock 5880 ☎ (048) 881 3005 geldent@dwaf.gov.za

(The most significant amendments included in the latest version will be indicated here).

EXECUTIVE SUMMARY

Introduction

The Fish to Sundays ISP area forms the eastern part of the Fish to Tsitsikamma Water Management Area (WMA 15), and falls almost totally within the Eastern Cape Province. It derives its name from its two largest rivers, the Great Fish and the Sundays rivers. The remainder of the WMA was separately addressed in the Tsitsikamma to Coega ISP Report.

This document presents the Department of Water Affairs and Forestry's (DWAF's) internal strategic perspective (ISP) or view on how it currently manages and intends managing the water resources within the ISP area, during the period leading up to the establishment of a fully operational Fish to Tsitsikamma Catchment Management Agency, and the development of a catchment management strategy. One of the major goals of the ISP is to obtain a common understanding within DWAF about management objectives and strategies.

After internal approval, the Department will invite comment on the ISP from local authorities, water user associations, other water-related organisations and the public. Formal updates of the document will periodically be done until the catchment management agency is technically functional and financially sustainable, and assumes its functions. The knowledge of DWAF's regional and head office water management staff about this ISP area is documented in the ISP. The knowledge and strategies in this document will *inter alia* be used as reference material and as a comprehensive background document for new entrants involved in regional water management. The ISP presents a common and consistent approach that can be adopted when addressing water management related issues, problems and queries, and when evaluating water licence applications.

The ISP has been compiled by referring to policy documentation, legislation, regional planning, departmental guidelines, and relevant water-related studies and documents, and from interviews and communications with DWAF regional managers and head office staff.

The key driver of the ISP area

The Orange-Fish-Sundays Water Supply System (OFSWSS), which primarily supports irrigation in the Fish and Sundays catchments, but with water going as far as Port Elizabeth, is the major economic driver in the ISP area. Ensuring a continuous sustainable water supply for economic activity associated with the system is essential for community well-being and the socio-economic prosperity of the area. The rest of the ISP area has very little water of its own and the underlying geology also results in this local water being of very poor quality. The economy of this ISP area is therefore totally dominated by water transferred from the Orange River.

Water law and water management

The National Water Act (NWA) [40] is the principal legal instrument governing water resource management in South Africa, and is being incrementally implemented. The NWA is supported by other legislation such as the National Environmental Management Act and other Acts. The NWA does away with some far-reaching concepts but introduces others, which have both economic and social features.

The National Water Resource Strategy (NWRS) [25] 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 National Water Resource Strategy. 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 country has been divided into nineteen water management areas. The delegation of water resource management from central government to catchment level will be achieved by establishing catchment management agencies at water management area level. Each catchment management agency will progressively develop a catchment management strategy. Until such time as the catchment management agencies are established and are fully operational, the regional offices of DWAF will continue managing the water resources in their areas of jurisdiction.

As part of the implementation of integrated water resource management, in line with the requirements of the NWA, DWAF is following a process that includes:

- Determination of existing lawful use;
- Determination of water availability at acceptable confidence levels;
- Determination of ecological water requirements at high confidence levels and
- Development of the regional management strategies, the ISPs.

An iterative and interactive process will then follow where public participation (preferably through the catchment management agencies) will play a role in determining water resource and water use reconciliation options.

Physical features

The ISP area was divided into three sub-areas, namely the Fish, Sundays and Albany Coast sub-areas. The map following this executive summary shows the demarcation of the ISP area. Main rivers are the Great Fish, Sundays, Bushmans, Kowie and Kariega rivers.

The topography is relatively flat, bounded by mountain ranges to the north. The climate over the ISP area is strongly influenced by warm coastal currents and the topography. Most of the inland has typical dry Karoo climate. Rainfall generally occurs throughout the year in the coastal region and very late in summer in the inland areas. Rainfall varies from 300 mm/a to small areas of up to 900 mm/a. Evaporation is considerably greater than rainfall, ranging from 1 450 mm/a in the south-east to as high as 2 050 mm/a in the north-west.

The Addo Elephant National Park, Mountain Zebra National Park and the Alexandria Dune Field are important conservation areas. Several other game parks and conservation areas are located in the ISP area. The permanently open estuary of the Great Fish River is ecologically important.

Demography

Approximately half a million people live in the ISP area, with more than half of these living in the Great Fish River basin. Approximately 70% of the population lives within urban areas. The population of the Fish and Sundays sub-areas is expected to decline after 2005 [(19)]. This is attributable to the lack of economic stimulus, together with the impacts of HIV/AIDS. A small growth in the urban population is forecast in the Albany Coast sub-area.

Land use

Most cultivated land in the interior is irrigated, because the rainfall is too low and erratic to be relied upon. Significant irrigation takes place in the catchments of the Great Fish and Sundays rivers using Orange River water, with lucerne, vegetables and citrus being the main crops. Irrigation from local sources is also practised along the Kat and Tarka rivers. Farming with sheep, mohair and cattle is common in the ISP area. Natural and stocked wildlife are found in this area and seems to be increasing in popularity. Pineapples and chicory are grown in the Albany Coast area. Some indigenous forests are found in the Kat River catchment.

International links and links with other WMAs

The ISP area does not border on any neighbouring country and is not directly linked to any other country through the transfer of water. Large quantities of water are transferred into the ISP area from the Orange River catchment, which is an international river shared by four countries. Some Orange River water is transferred further to the Tsitsikamma to Coega ISP area, for urban use by the Nelson Mandela Metropolitan Municipality (NMMM). An amount of 38 million m^3/a has been reserved for future transfers from the Orange River to this ISP area, for new resource-poor farmer irrigation [(26)]. Allowance has also been made for a future additional transfer of 10 million m^3/a to NMMM, in accordance with the recommendations made in the Algoa Pre-Feasibility study. Additional transfers could be made in future, but this would require further infrastructure development in the Orange River catchment. The transfer is a national issue which also forms part of South Africa's normal and ongoing liaison with basin states.

Economic development

Agriculture and supporting industries dominate the economy of the ISP area, which is heavily dependent on irrigation. About 51 000 ha of irrigated lands in the Fish and Sundays catchments rely largely on water transferred from the Orange River. A total of 4 000 ha of identified future Orange River allocations have been reserved for new irrigation by resource-poor farmers in this ISP area, for uses where it will provide the most benefit and be most effective in eradicating poverty. Agriculture has linkages to several other economic sectors. Citrus, vegetables as well as cash and fodder crops are grown under irrigation, while the area is also known for its production of pineapples, chicory and dairy

products near the coast. Dryland crop farming is a significant contributor to the agricultural sector. Almost 60% of the world's mohair and much of the country's wool is produced in the water management area and surrounding areas.

The larger regional industries of the WMA consist of manufacturing, construction, trade, transport and finance. These sectors account for the employment of about a quarter of the workforce. Manufacturing in the ISP area is centred on agro-processing. Food and dairy processing are present in the larger towns. There are no significant mining activities and mining operations are limited to quarrying for building materials. Commercial forestry is practised mainly in the Kat River catchment. Tourism is well established, with a network of tourism routes, and is on the increase, with large potential for growth.

Water institutions

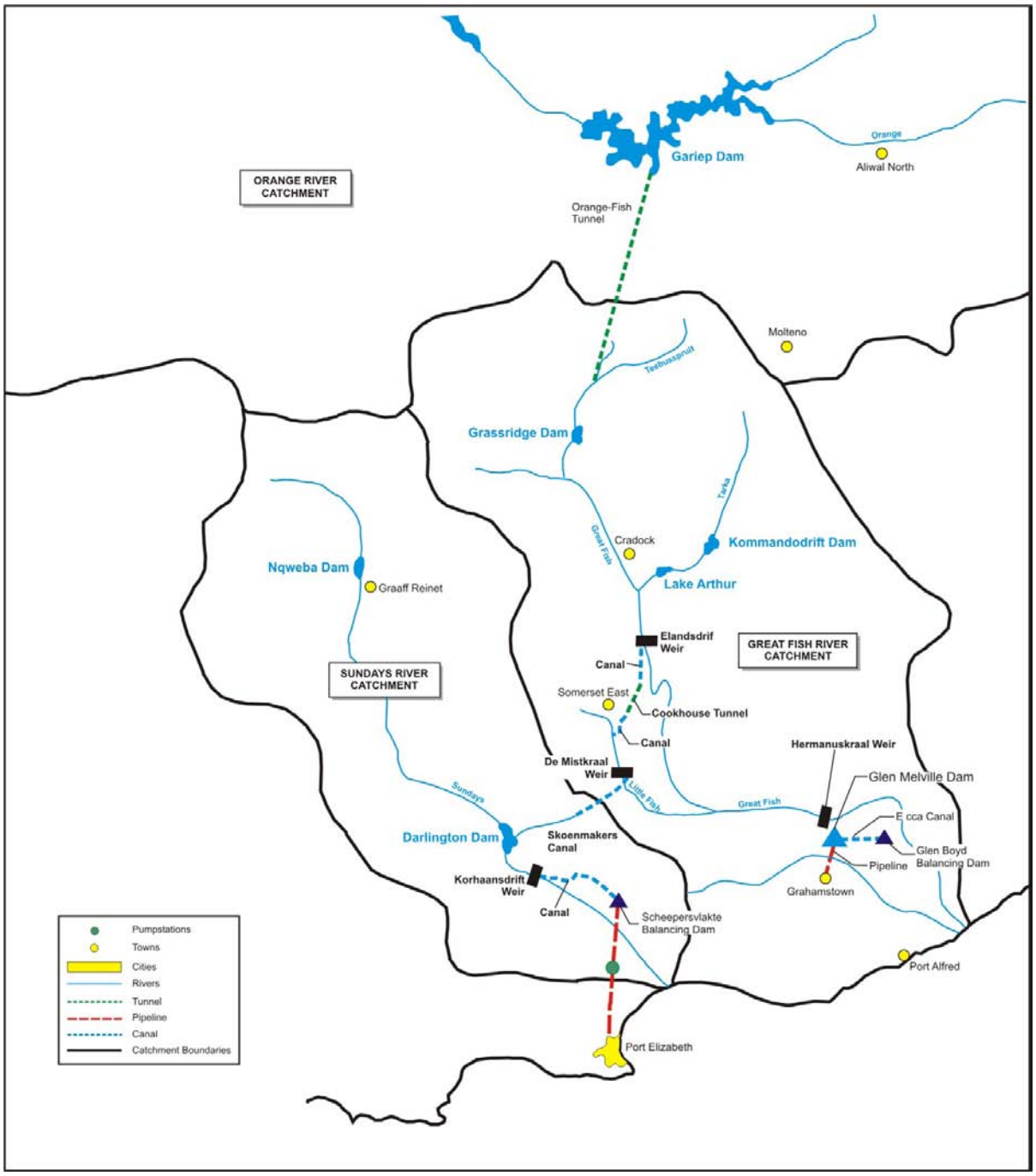
Water Services Authorities, which are all the local municipalities in the Cacadu, Chris Hani and Amatole district municipalities, are responsible for ensuring access to water services. The district municipalities of Cacadu, Chris Hani and Amatole manage most of the ISP area, whilst the Ukhahlamba District Municipalities manages a much smaller area. A water services authority is any municipality responsible for ensuring access to water services, while a water services provider provides water services to consumers or to another water services institution. The water services authorities are responsible for drafting water services development plans. The five local municipalities within the Cacadu District Municipality are all water services authorities/water services providers. For the remainder of the ISP area, the district municipalities act as the water service authorities and the local authorities as the water service providers.

The Albany Coast Water Board is the only water board in the ISP area. The Great Fish River Water User Association, including its Sub-Areas, Kat River Water User Association and the Sundays River Water User Association have been established. The Kat River Catchment Forum is the only catchment forum to have been established in the ISP area [(23)].

Waterworks

The Orange-Fish-Sundays water transfer scheme transfers Orange River water from Gariep Dam to the Great Fish River valley and thence to the Sundays River valley, to supplement local water supply for irrigation and some urban use by local towns. Some water is also transferred to the Nelson Mandela Metropolitan Municipality via this system. A schematic diagram of the system is shown on the following page. The scheme consists of Grassridge and Darlington dams and various balancing dams, weirs, canals and tunnels. The Lower Fish River Scheme transfers Orange River water to Grahamstown and to irrigators along the lower Great Fish River. Separate irrigation schemes exist on the Tarka and Kat Rivers, with irrigation taking place from the Commandodrift Dam, Lake Arthur and the Kat River Dam. Nqweba Dam supplies water to Graaff Reinet.

Potential future schemes have been identified in the Kat and the Koonap rivers. The proposed Foxwood Dam in the Koonap River has a potential yield of 25 million m^3/a, although this water would be expensive. The water source for the proposed Tamboekiesvlei Scheme will likely be from the proposed Baddaford Dam in a small tributary in the Kat River catchment, and from fountains [(27)].



Schematic diagram of the Orange-Fish-Sundays Transfer Scheme

Groundwater is widely used to supply towns and for rural water supply, with localised over-exploitation occurring. The urban and rural domestic water supplies are generally adequate, with some localised shortfalls occurring, mainly because of inadequate management of supply systems. Groundwater holds significant potential.

Water resources availability

The total available yield of the ISP area is estimated to be 757 million m^3/a.

Surface water availability

The water resources are not evenly distributed across the catchment. The natural mean annual runoff of 972 million m^3/a has been reduced by abstractions and other consumptive usages, but has been substantially augmented through transfers from the Orange River for irrigation, urban use and freshening releases. The available yield of local surface water resources is estimated to be 160 million m^3/a. The impact of water transferred into the ISP area from the Upper Orange WMA is 575 million m^3/a [(26)]. There are no natural lakes or large wetlands in the ISP area, although there are many small wetlands. There is uncertainty about the estimates of the Reserve and how these may change in future. The available yield in the ISP area is a combination of surface water, groundwater, usable return flows and transfers into the ISP area. Very limited potential for development of new dams and other water resources remain.

Surface water quality

The relatively flat topography, low mean annual runoff, high evaporation and underlying mudstones generally give rise to saline groundwater and resulting saline base flows in the Fish and Sundays rivers, irrespective of water transferred in from the Orange or irrigation return flows. Water quality in the Fish River deteriorates significantly in a downstream direction from good to very poor and from poor to very poor in the Sundays River. These rivers are significantly impacted on by saline irrigation return flows. High salinity is also the main concern in the Bushmans, Kariega and Kowie River catchments. The Bushmans River water quality is mostly unacceptable. Water quality in the Kowie River is poor and in the Kariega River the water quality is completely unacceptable.

Groundwater availability

Groundwater is often the only source of water for rural domestic use and stock watering, whilst several towns also obtain a large proportion or all of their water from underground sources. Groundwater is also used for urban supply by coastal towns, but cannot always support growing demands and peak seasonal uses. Exploited aquifers are not necessarily well managed. Actual groundwater use, especially for irrigation, is likely to be significantly higher than has been reflected in the National Water Resource Strategy and these numbers require verification. The potential for groundwater use is under-developed. It is suggested that improved borehole siting and wellfield management would significantly increase both the yield and the reliability of the groundwater resource.

Groundwater quality

In the Albany Coastal Range groundwater of poor quality is associated with outcrops of the Bokkeveld Group and the Dwyka-basal Ecca formations. Areas of low slope in the Ecca Group and lower Beaufort Group (Adelaide Sub-group) between the coastal ranges and the Middle Veld escarpment also have a higher salinity. In the south, the best quality groundwater is associated with the limited areas of the Witpoort aquifer in the Albany Coastal Range. In the north, good quality groundwater is generally associated with the Katberg sandstone aquifer in the Winterberg Range between Seymour and Cradock, and along the Great Fish and Sundays headwater divides near Nieu Bethesda, Middelburg and Steynsburg.

Available yield

Calculations of the available water per river sections, rivers and the ISP area were carefully studied, revisited and, where necessary, refined for this ISP, following the publication of the NWRS. This required limited changes to the NWRS yields. The major difference is in the presentation of results and in the way river losses have been included. Significant river losses due to the large volumes of transferred water have been taken into account in the calculations of total available yields. These river losses have not been included as part of the surface water resource as in the NWRS, because it can almost entirely be ascribed to losses from transferred Orange River water. This change however has no impact on the final calculated values of available yield. Transferred water from the Orange River accounts for the majority of all available yield in the ISP area. The following table shows the yields per ISP sub-area as revisited during the ISP process.

Available yield in the year 2000 (million m^3/a) at 1:50 year assurance

ISP Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers in (2)	River losses (3)	Grand Total (1)+(2)+(3)
	Surface water	Ground-water	Irriga-tion	Urban	Mining and bulk				
Fish	91	6	77	5	0	179	575	-94	660
Albany Coast	15	2	0	4	0	21	1	0	22
Sundays	54	16	22	2	0	94	123	-18	199
Total for ISP area	**160**	**24**	**99**	**11**	**0**	**294**	**575**	**-112**	**757**

1) After allowance for the impacts on the yield of the ecological component of the Reserve, river losses, invasive alien plants, dry land agriculture and urban runoff.
2) Transfers into and out of hydrological sub-divisions or sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) River losses as calculated for the Orange River Replanning Study (ORRS) and used in the NWRS.

The *major* differences between the available yields as determined in the ISP and the NWRS yields are the following:

- Available yield in the ISP area was determined as 757 million m^3/a compared to 786 million m^3/a in the NWRS;
- Sub-area available yields (according to the NWRS sub-areas) were determined as:
  - 660 million m^3/a in the Fish sub-area which is virtually the same as the 659 million m^3/a of the NWRS;
  - 22 million m^3/a in the Albany Coast sub-area which is the same as the 22 million m^3/a of the NWRS;
  - 199 million m^3/a in the Sundays sub-area compared to the 217 million m^3/a of the NWRS;
- The yields of Grassridge and Darlington dams, which is reflected in the surface water yields, have been adjusted, because under 1:50 year drought conditions, these dams operate purely as balancing dams for transferred water, and their yields become negligible. The reduction in yield

due to the Reserve, for the hydrological sub-divisions in which these dams fall, were consequently also adjusted;

- The impact on yield of the transfer from the Fish to the Sundays sub-area was increased from the 116 million m^3/a in the NWRS to 123 million m^3/a, to reflect a situation where just enough water is transferred to ensure a balanced situation.

Water use

Total water use of the ISP area is estimated at 759 million m^3/a. At 94%, irrigation currently constitutes by far the largest user of water in the ISP area. The water is mainly used to grow vegetables, deciduous fruit, citrus, lucerne and maize, and for the irrigation of pastures [17]. There is believed to be significant scope for more efficient use. Other uses are small in comparison.

Calculations of the water requirements of the ISP area were refined for this ISP, following the publication of the NWRS. The later calculations and updates of requirements show that there is significant uncertainty associated with irrigation water use. There is enough confidence in these revisited values that they have been shown in tables in this report. It is, however, essential that the apparent discrepancies be addressed as a matter of priority.

The following table shows the water requirements per ISP sub-area as revisited during the ISP process.

Water requirements for the year 2000 (million m^3/a)

ISP Sub-area	Average	1:50 year assurance								
	Average irrigation use [1]	Irrigation [2]	Urban [3]	Rural [3]	Mining and bulk industrial [4]	Power generation [5]	Afforestation [5]	Total local requirements	Transfers out	Grand Total
Fish	513	447	12	6	0	0	2	467	193 [6]	660
Albany Coast	13	11	9	2	0	0	0	22	0	22
Sundays	217	174	5	3	0	0	0	182	18 [6]	200
Total for ISP area	**743**	**632**	**26**	**11**	**0**	**0**	**2**	**671**	**88** [6]	**759**

1) Actual average irrigation use has only been included here to show the comparison with the 1:50 year requirement, and has not been included in the total requirement.
2) Irrigation requirements allows for canal losses.
3) Includes component of Reserve for basic human needs at 25 l/c/d.
4) Mining and bulk industrial water uses, which are not part of urban systems.
5) Quantities given refer to impact on yield only.
6) 70 Million m^3/a water flows to sea from the Fish River and 7 million m^3/a from the Sundays River, while 11 million m^3/a is transferred on to NMMM from the Sundays sub-area.

The *major* differences between the water requirements as determined in the ISP from the NWRS water requirements are the following:

- The irrigation requirement in the Fish sub-area was corrected to 447 million m^3/a, compared to 453 million m^3/a for the NWRS. This as a result of:

  - the Kat River use that was changed to 17 million m^3/a, in line with allocations, compared to 14 million m^3/a shown in the NWRS;
  - a reduction in the irrigation water requirement from the Commando Drift Dam, which should not include the irrigation below Lake Arthur in the Tarka River catchment (as it does in the NWRS), as this (except for 180 ha) receives transferred Orange River water via the Fish River;
- The transfer into the Tsitsikamma to Coega ISP area from this ISP area, for use by the NMMM, was corrected to 11 million m^3/a, compared to the 31 million m^3/a of the NWRS.
- A major difference between the ISP and NWRS is the presentation of flows to sea, which have been included in the ISP as downstream transfers out of the lowest sub-divisions, sub-areas and the ISP area. This was done to be able to show more realistic water balances, as this water is not used because of its very poor water quality. These changes then lead to the following differences:
  - Total requirements in the Fish sub-area is 660 million m^3/a, compared to 590 million m^3/a of the NWRS;
  - Water requirements in the Sundays sub-area is 200 million m^3/a, compared to 213 million m^3/a of the NWRS;
  - Local requirements of the ISP area were determined as 671 million m^3/a, compared to 677 million m^3/a for the NWRS;
  - Total requirements in the ISP area, is 759 million m^3/a, which includes transfers out of the area of 88 million m^3/a (most of which is due to freshening releases that flows to the sea), compared to 825 million m^3/a of the NWRS.

Potential maximum water use

A calculation of the potential maximum use of Orange River water requirements of the ISP area, according to current water allocations, indicates a maximum allocated quantity of 658 million m^3/a, compared to the annual 1:50 year transfer of 575 million m^3/a. The implications of this difference of 83 million m^3/a at 1:50 year assurance of supply, is that farmers could potentially use more water than have been allocated for transfer from the Upper Orange WMA. It is necessary to urgently address this difference.

Current yield balance

The following table shows the yield balance per ISP sub-area as revisited during the ISP process. The *yield balance* is: the *total available water* (the sum of the available local resources and the transfers into the area) compared or reconciled with *the total requirements* (the sum of the various water requirements and losses and the transfers out of the area).

ISP reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

ISP sub-area	Available yield				Water requirements			Balance
	Local yield	Transfers in (1)	River Losses (2)	Total	Local require-ments	Transfers out (1)	Total	
Fish	179	575	-94	660	467	193 (3)	660	0
Albany Coast	21	1	0	22	22	0	22	0
Sundays	94	123	-18	199	182	18 (3)	200	-1
Total for ISP area	**294**	**575**	**-112**	**757**	**671**	**88 (3)**	**759**	**-2**

1) 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.
2) The river losses resulting from evaporation and seepage for the transferred volumes have been included here. This was a best estimate from the ORRS modelling.
3) 70 Million m^3/a flows to sea from the Fish River and 7 million m^3/a from the Sundays River and 11 million m^3/a is transferred on from the Sundays sub-area to NMMM.

The reconciliation of available water and requirements for the year 2000, including transfers of Orange River water, indicates that the ISP area is approximately in balance, mainly because transfers are sufficient to satisfy the demand. The Tarka River catchment (Great Fish River tributary) is stressed. There are unused and under-utilised water allocations in the Kat River catchment (Great Fish River tributary). These unused allocations must be addressed, as well as the unlawful use of these current unused allocations.

The NWRS shows a balance of 38 million m³/a, which is substantially more than the balance determined in the ISP. The major difference is in the NWRS Fish sub-area, where the NWRS shows a balance of 37 million m³/a, compared to the ISP balance of zero million m³/a.

The surplus flows at the bottom end of the Fish and Sundays rivers include freshening releases made, unused irrigation releases, and return flows downstream of the last point of abstraction. The salinity of such flows may be too high for direct beneficial use without blending or treatment. This water is therefore generally not available for use.

Meeting future water requirements

Water for significant new envisaged resource-poor farmer developments (4 000 ha), involving a total estimated water requirement of about 38 million m^3/a of Orange River water to alleviate poverty, have been reserved for future transfers to this ISP area from the Upper Orange WMA. About two-thirds is expected to be used in the lower Sundays River catchment (27). Significant growth in urban water use is expected in the Albany Coast sub-area, due to the large projected growth of especially coastal towns. Some growth is also expected in urban use of towns in the Fish and Sundays rivers catchments.

In addition to the 38 million m^3/a reserved for future use by resource-poor farmers, 2 million m^3/a could be transferred to meet urban growth in small towns using Orange River water, totalling 40 million m^3/a that has been reserved for future transfer of Orange River water to this ISP area. Provision has also been made for a limited additional transfer of 10 million m^3/a to NMMM to meet the growth in urban demand. Local resources, mostly through an increase in the use of groundwater, will need to be developed to meet the urban water needs of growing towns. In a 1:50 year drought situation in the ISP area, additional transfers for freshening of the Orange-Fish-Sundays Water Supply System will depend on the availability of "surplus" water in the Upper Orange WMA, which is only available when Gariep and Van der Kloof dams are spilling.

Management of the Orange-Fish-Sundays Water Supply System

An integrated management approach to the OFSWSS is required, to address overall system management, development planning, monitoring, releases and other operational aspects, freshening releases and other water quality aspects, control of black fly and routine maintenance. Improved system operation and the cutting of losses or spillages from the system should be addressed as key priorities.

In the longer term, the water supply system is to be kept operational and the condition of its ageing infrastructure needs to be improved, through continued revitalisation of components in disrepair, fixing of infratructural damage, addressing erosion problems caused by transfers as well as some expansion of irrigation (4 000 ha). A long-term plan should be put in place, with the necessary financing. Areas of potential irrigation, or problem irrigation areas which should be closed down, should be identified and included in the plan.

At the moment there is still temporary operational latitude with the water supply system due to allocations not being fully utilised. Eventually, when all allocations have been taken up, the Orange System will be in balance and the Eastern Cape will have to make do with its allocation for long periods of time. Actual irrigation water use will need to be more accurately determined, to prepare an updated water balance that provides a more reliable picture of actual use versus scheduled water use.

A more user-friendly and understandable planning and operational model needs to be developed. The model will *inter alia* be used to operate the system more efficiently to limit operational losses. A Water Quality Operational Plan component, which will form part of the overall OFSWSS Management Plan, will be drafted. Management of salinity in the OFSWSS will determine when and how freshening releases should be made and could influence where new development would be allowed. The focus of the model will be to show what transfers are necessary, when and of what quality, and distinction will be made between releases for use and freshening releases. In addition, control of black fly will be addressed in co-operation with catchment forums. Improved real-time monitoring of the system is required. Resolving the infrastructural and operational problems with Grassridge and Darlington Dam must receive attention, along with other operational and management scenarios, once the new operational model is available.

The future focus on water use in the ISP area will be to ensure optimal utilisation of the irrigation water allocation, improving efficiency of urban water use, and ensuring that water is made available to uplift the poor.

Management of areas outside the OFSWSS

Due to the dryness of the area, irrigation outside the OFSWSS is limited. Information on irrigation use outside government water schemes are not readily available and needs to be improved. Information sources from allocations registered on the WARMS database will need to be verified and additional water use surveys may be required. Improved estimates of actual irrigation water requirements should be obtained so that allocations can be better matched to requirements. Reconciliation of urban, rural and irrigation water requirements will be addressed through co-operative governance. Groundwater development will be promoted, along with the implementation of other intervention measures to meet requirements. The need to implement Management Plans, for especially coastal aquifers, will be promoted.

Intervention measures

With the entire ISP area as well as all the sub-areas approximately in balance, any further demands for commercial water use should preferably be addressed either through the trading of unused or under-utilised water use authorisations, water conservation and demand management, more effective use of existing infrastructure and further groundwater development, to alleviate water shortages and meet future needs. Sustainable management must be implemented for stressed aquifers.

Unused or underdeveloped allocations, notably in the Kat River catchment, which is close to fully allocated, but where there is a big demand from irrigators without allocations, needs to be resolved through trading, delisting or possibly reallocation, or implementation of a pricing system.

Water saved through water conservation and demand management measures (especially in towns and irrigation schemes), such as e.g. the lining of earth canals, could make water available for development, although it would also mean that there would be less return flows. Many existing irrigators may also be in a position to use such “freed” water. The large conveyance losses experienced at some schemes must be tackled through demand management studies and the implementation of identified conservation measures.

Water for the use of resource-poor farmers will be given a very high priority.

Development options

Opportunities for new surface water developments are extremely limited and will generally be very costly. Sustainable development of groundwater holds the best potential. New irrigation development would be too expensive in most cases. Water for expansion of irrigation, where land is still available, should preferably be acquired through increased water use efficiency and water trading.

The proposed Foxwood Dam in the Koonap River will be costly. The proposed Baddaford off-channel dam in a Kat River tributary is being evaluated to supply a potential resource-poor farmer scheme. The

potential Wapadsberg Scheme for Graaff-Reinet would be very costly and would likely be unaffordable for local irrigation use, even if additional Orange River water were available, which it is not.

Introduction to the ISP strategies

The many issues and concerns identified in the ISP area will be addressed through the implementation of appropriate regional water management strategies (of which many are existing). DWAF staff has identified the essential management strategies to manage the Fish to Sundays ISP area. Additional strategies may be developed in future.

Ten broad strategy groups, called main strategies, which cover all necessary current and required future water management activities, were identified from current DWAF Regional Office activities, and the requirements of the NWA and the NWRS. These main strategies are the following:

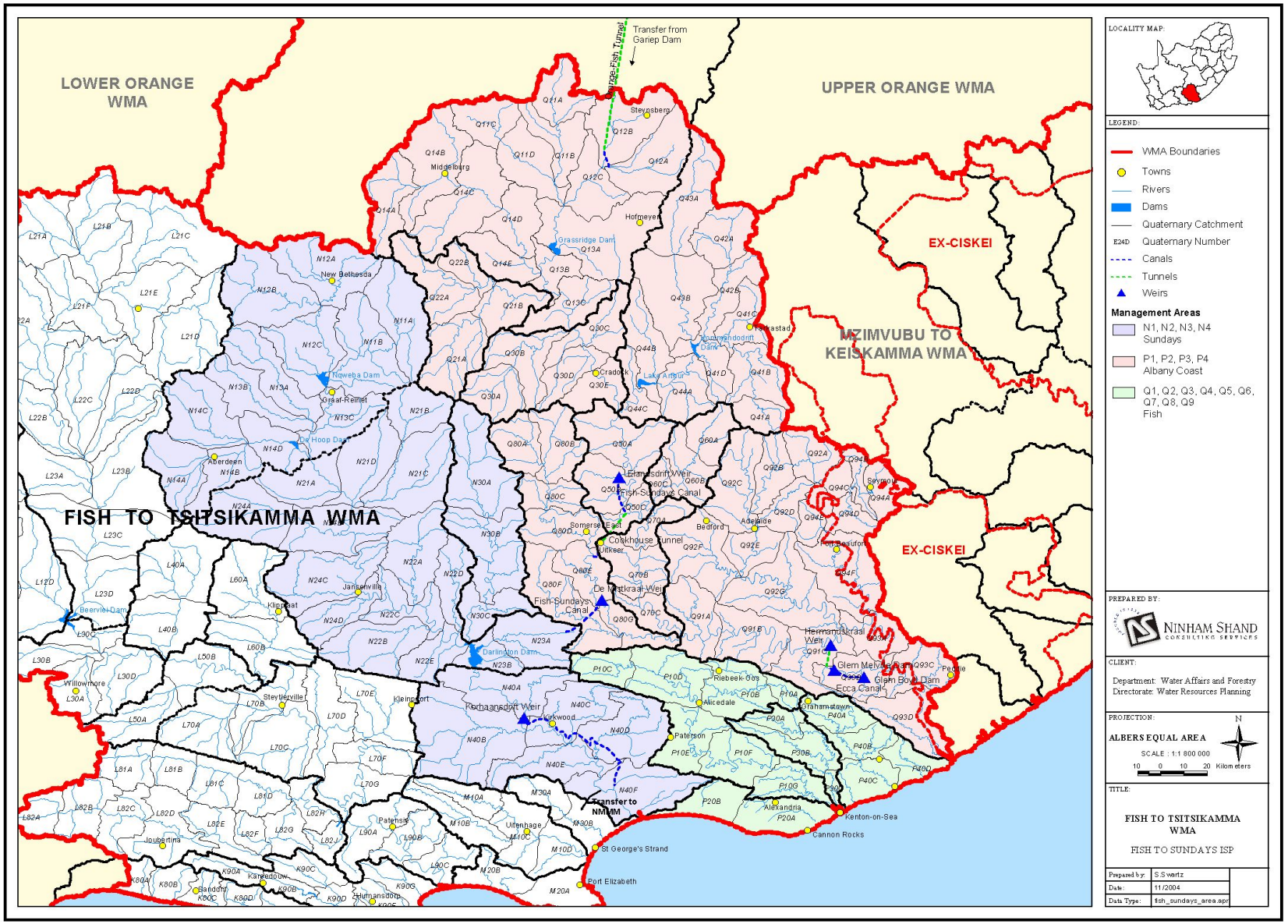
- ⇨ Yield balance and reconciliation;
- ⇨ Water resources protection;
- ⇨ Water use management;
- ⇨ Water conservation and demand management;
- ⇨ Institutional development and support;
- ⇨ Social and environmental considerations;
- ⇨ Integration and co-operative governance;
- ⇨ Waterworks development and management;
- ⇨ Monitoring and information management; and
- ⇨ Implementation.

Under each of these main strategy groups, specific strategies particular to the Fish to Sundays ISP area were developed.

For each strategy, the following aspects are addressed:

- ***Management objectives*** in terms of the envisaged outcomes for the strategy;
- ***Situation assessment;*** providing a synopsis of the current situation with a focus on the issues;
- ***Strategic approach;*** stating the approach or plan that DWAF will follow to reach its objectives for the strategy;
- ***Management actions;*** states the required actions to implement the strategy;
- ***Responsibility;*** the responsible offices or Directorates are named;
- ***Priority*** in terms of the ISP rating system (1 – 5, where 1 indicates the highest priority);

Responsibilities for main strategies and for individual strategies were assigned to responsible DWAF Directorates or Sections within the Eastern Cape Regional Office. DWAF head office champions were identified where appropriate.



Locality Map of the Fish to Sundays ISP area

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
Directorate National Water Resource Planning

FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE
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ABBREVIATIONS AND ACRONYMS

AWSS	Algoa Water Supply System
AIDS	Acquired immunity deficiency syndrome
CEIMP	Consolidated Environmental Implementation and Management Plan
CMA	Catchment management agency
CMS	Catchment management strategy
CCAW	Co-ordinating Committee for Agricultural Water
DLA	Department of Land Affairs
DEAET	Eastern Cape Department of Economic Affairs, Environment and Tourism
DEAT	National Department of Environmental Affairs and Tourism
DM	District Municipality
DWAF	National Department of Water Affairs and Forestry
ECA	Environmental Conservation Act (Act 73 of 1989)
EFR	Ecological flow requirement
EIA	Environmental impact assessment
EMF	Environmental management framework
EPP	Emergency preparedness plans
EWR	Ecological water requirements
GA	General authorization
GFRWUA	Great Fish River Water User Association
GIS	Geographical information system
GIWRM	Groundwater integrated water resources management
GRP	Gross regional product
GWS	Government water scheme
IAP	Invasive alien plants
IDP	Integrated development plan
ISP	Internal strategic perspective
IWRM	Integrated water resource management
IWRP	Integrated water resource planning
GRIP	Groundwater Resources Information Project
MAR	Mean annual runoff
NEMA	National Environmental Management Act (Act 107 of 1998)
NGDB	National Groundwater Database
NMMM	Nelson Mandela Metropolitan Municipality
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resource Strategy
OFSWSS	Orange-Fish-Sundays Water Supply System
ORP	Orange River Project
ORRS	Orange River Replanning Study
PDI	Previously disadvantaged individual
RAMSAR	The Convention on Wetlands of International Importance, signed in Ramsar, Iran, in 1971
RO	Regional office (DWAF)
RDM	Resource directed measures
RQO	Resource quality objectives
SFRA LAAC	Licence assessment advisory committee for stream flow reduction activities
SUP	Sustainable utilisation plan
TDS	Total dissolved solids

UAW	Unaccounted for water
WARMS	Water use authorisation and registration management system
WC&DM	Water conservation and demand management
WDM	Water demand management
WfW	Working-for-Water
WfWetlands	Working-for-Wetlands
WMA	Water management area
WMI	Water Management Institutions
WQM	Water quality management
WRC	Water Research Commission
WRSA	Water resources situation assessment
WSA	Water service authorities
WSDP	Water service development plan
WSM	Water management system
WSP	Water service providers
WTW	Water treatment works
WUA	Water user association
WUE	Water use efficiency
WWTW	Wastewater treatment works

GLOSSARY OF TERMS

AQUIFER	A saturated permeable geological unit that can transmit significant (economically useful) quantities of water under ordinary hydraulic gradients. Specific geologic materials are not innately defined as aquifers and aquitards, but within the context of the stratigraphic sequence in the subsurface area of interest.
ASSURANCE OF SUPPLY	The reliability at which a specified quantity of water can be provided, usually expressed either as a percentage or as a risk. For example "98% reliability" means that, over a long period of time, the specified quantity of water can be supplied for 98% of the time, and less for the remaining 2%. Alternatively, this situation may be described as a "1 in 50 year risk of failure" meaning that, on average, the specified quantity of water will fail to be provided in 1 year in 50 years, or 2% of the time.
AVAILABLE YIELD	This is the amount of water that can be expected to be "available" for commercial use (for 98% of the time in this case), either from dams, directly from rivers, or from groundwater - during any one year.
CONDENSED AREA	The equivalent area of alien plants with a maximum concentration/density that represents the more sparsely distributed alien plants that occur over a large area.
CATCHMENT	The area of land drained by a river. The term can be applied to a stream, a tributary of a larger river or a whole river system.
COMMERCIAL FARMING	Large scale farming, the products of which are normally sold for profit.
COMMERCIAL FORESTS	Forests that are cultivated for the commercial production of wood or paper products.
CONFINED AQUIFER	An aquifer that is physically located between two aquicludes, where the piezometric water level is above the upper boundary of the aquifer. The water level in a well tapping a confined aquifer usually rises above the level of the aquifer. If the water rises above ground level, the aquifer is called artesian.
DEFICIT	Describes the situation where the availability of water at a particular assurance of supply is less than the unrestricted water requirement.
DISCHARGE AREA	The area or zone where ground water emerges from the aquifer naturally or artificially. Natural outflow may be into a stream, lake, spring, wetland, etc. Artificial outflow may occur via pump wells.

ECOSYSTEM	A unit made up of all the living and non-living components of a particular area that interact and exchange materials with each other.
ENVIRONMENTALLY SENSITIVE AREA	A fragile ecosystem, which will be maintained only by conscious attempts to protect it.
GROUNDWATER	Water in the subsurface, which is beneath the water table, and thus present within the saturated zone. In contrast, to water present in the unsaturated or vadose zone which is referred to as soil moisture.
IRRIGATION QUOTA	The quantity of water, usually expressed as m^3/ha/a, or mm/a, allocated to land scheduled under the scheme. This is the quantity to which the owner of the land is entitled at the point at which he or she takes delivery of the water and does not include conveyance losses to that point.
MEAN ANNUAL RUNOFF	Frequently abbreviated to MAR, this is the long-term mean annual flow calculated for a specified period of time, at a particular point along a river and for a particular catchment and catchment development condition.
OPPORTUNISTIC IRRIGATION	Irrigation from run-of-river flow, farm dams, or compensation flows released from major dams. As storage is not provided to compensate for reduced water availability in dry years, the areas irrigated generally have to be reduced in dry years.
PRIMARY AQUIFER	Aquifers in which the water moves through the spaces that were formed at the same time as when the geological formation was formed, for instance intergranular porosity in sand (for example alluvial deposits).
RECHARGE AREA	Areas of land that allow groundwater to be replenished through infiltration or seepage from precipitation or surface runoff.
RELIABILITY OF SUPPLY	Synonymous with assurance of supply.
RESERVE	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997) for people, who are now or who will, in the reasonably near future, be (i) relying upon; (ii) taking water from; or (iii) being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource as indicated in the National Water Act (Act No. 36 of 1998).
RESOURCE DIRECTED MEASURES	Measures that focus on the quality and overall health of water resources.

RESERVOIR	The lake formed behind a dam wall. In this report the colloquial term dam is generally used for reservoir.
RESOURCE QUALITY	The quality of all the aspects of a water resource including: (a) the quantity, pattern, timing, water level and assurance of instream flow; (b) the water quality, including the physical, chemical and biological characteristics of the water; (c) the character and condition of the instream and riparian habitat; and (d) the characteristics, condition and distribution of the aquatic biota.
RESOURCE QUALITY OBJECTIVE	Quantitative and verifiable statements about water quantity, water quality, habitat integrity and biotic integrity that specify the requirements (goals) needed to ensure a particular level of resource protection.
RIVER SYSTEM	A network of rivers ranging from streams to major rivers and, in some cases, including rivers draining naturally separate basins that have been inter-connected by man-made transfer schemes.
SALINITY	The concentration of dissolved salts in water. The most desirable drinking water contains 500 parts per million or less of dissolved minerals.
SECONDARY AQUIFER	Aquifers in which the water moves through spaces that were formed after the geological formation was formed, such as fractures in hard rock.
SOURCE-DIRECTED CONTROL	Measures primarily designed to control water use activities at the source of impact, through tools such as standards, and conditions in water use authorisations.
SUBAREA	The sub-divisions used as management regions for this document.
SUB-CATCHMENT	A sub-division of a catchment.
SURPLUS	Describes the situation where the availability of water at a particular assurance of supply is more than the unrestricted water requirement.
WATER TABLE	The top of an unconfined aquifer where water pressure is equal to atmospheric pressure. The water table depth fluctuates with climate conditions on the land surface above and is usually gently curved and follows a subdued version of the land surface topography.
WATER TRANSFERS	Water transferred from one drainage basin or secondary sub-catchment to another.

YIELD	The maximum quantity of water obtainable on a sustainable basis from a dam or river in any hydrological year, in a sequence of years, and under specified conditions of catchment development and dam operation.
WARMS	Water Use Authorisation and Registration Management System.

FISH TO TSITSIKAMMA WATER MANAGEMENT AREA
Fish to Sundays Internal Strategic Perspective

CHAPTER 1 - BACKGROUND TO THE FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE FISH TO TSITSIKAMMA WMA

Figure 1.1 shows the position of the Fish to Tsitsikamma WMA, which falls almost totally in the Eastern Cape Province. The position of the Fish to Sundays ISP area within the Fish to Tsitsikamma WMA is shown.

The Fish to Sundays ISP area forms the eastern part of the Fish to Tsitsikamma WMA. It is bordered by the Indian Ocean to the south, the Gamtoos (Groot River tributary), Swartkops and Coega Rivers to the west, the Upper-Orange WMA to the north and the Mzimvubu to Keiskamma WMA to the east. The remainder of the WMA was separately addressed in the Tsitsikamma to Coega ISP Report.

Figure 1.1: Location of the Fish to Tsitsikamma WMA

To put the importance of the Fish to Tsitsikamma Water Management Area (WMA) in perspective, the following observations are made in comparison to the eighteen other WMAs:

- The WMA is one of the largest in terms of size, has the seventh largest population and the seventh highest gross regional product (GRP) of the WMAs;
- It has the eighth highest mean annual runoff but the fifth highest water requirement;
- It has been accorded the top priority, in the NWRS, together with some other WMAs for Reserve determinations, third highest together with some other WMAs for compulsory licensing, a low priority for CMA establishment and a low priority for transfer of government-owned infrastructure to Water Management Institutions.

The Fish to Sundays ISP area has the smaller share of the GRP, population and water requirements when compared to the remainder of the 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 - geographically, seasonally, and 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 [25] 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 [40] 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) [49] 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; and
- 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.

1.3 INTERNAL STRATEGIC PERSPECTIVES (ISPs)

1.3.1 The Objectives of the ISP Process

The objective of the ISP is 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 ISP for the Fish to Sundays ISP 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 ISP area. The current status, as well as issues and concerns relating to water resource management in the Fish to Sundays ISP area, were identified through individual interviews held with the relevant personnel of the Eastern Cape Regional Office in Port Elizabeth, Cradock and King Williams Town and by collating information from the NWRS, WMA reports, Water Resources Situation Assessment (WRSA) report, water services development plans (WSDPs) and other catchment study reports. Issues and concerns relating to the individuals' areas of expertise were identified. 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 Southern Cluster, and the Integrated Water Resources Planning (IWRP) Chief Directorate of the Department as well as the consulting team. The workshop focussed on the general issues in the ISP area as well as the area-specific issues. These issues were clarified and refined during the workshop.

iii) The third stage involved the preparation of the *starter document for the second workshop*, which contained draft strategies to address the identified issues and concerns.

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 of carrying out the strategies were identified. Attendees of the first workshop 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 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 incorporated into later versions of the ISP. Adopting this

procedure means that 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 (as noted in section 1.5. Also see the *Implementing the ISP Strategy*, Strategy 14.1).

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. Relevant and readily available details have however been included where possible. The responsible authority for the further development of each strategy is indicated. For the most part this is the Regional Office, which remains responsible for involving the relevant DWAF directorates. References for this ISP can be found in **Appendix 1.**

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. The introduction of new strategies also 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

Changes to this ISP will depend on need, and will be managed by DWAF until the CMA is in place to develop its own catchment management strategy. Revisions may be required as frequently as annually, or only once in five years, with frequency based the degree to which conditions change and knowledge advances. New information affecting this ISP, and the need for new for additional strategies must be brought to the attention of the Catchment Manager responsible for this ISP. There is no current incumbent but **Mr. Theo Geldenhuys** 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 NWRS contains the best information and knowledge available at the time of its preparation. 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 of the NWRS 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' [(19)]. The WMA reports were also finalised with the February 2003 information.

Still deeper in the background lies another set of reports (one per WMA). These are the Water Resource Situation Assessment Reports [(17)]. These reports contain a wealth of information on each WMA, but the figures on requirements, availability and reconciliation have been superseded 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, in some cases, emerged. The level of study has been very detailed and intense for the ISP. This has 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 differing from that in the NWRS, these discrepancies are carefully explained, as are all other instances of divergence. 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 with the ISP reports published on the Internet and in hardcopy, and presented and discussed at WMA forums. Comments received will be considered and worked into subsequent versions of the ISP on a regular (annual) 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 in poverty eradication and the redressing of inequities.

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 1.2.**

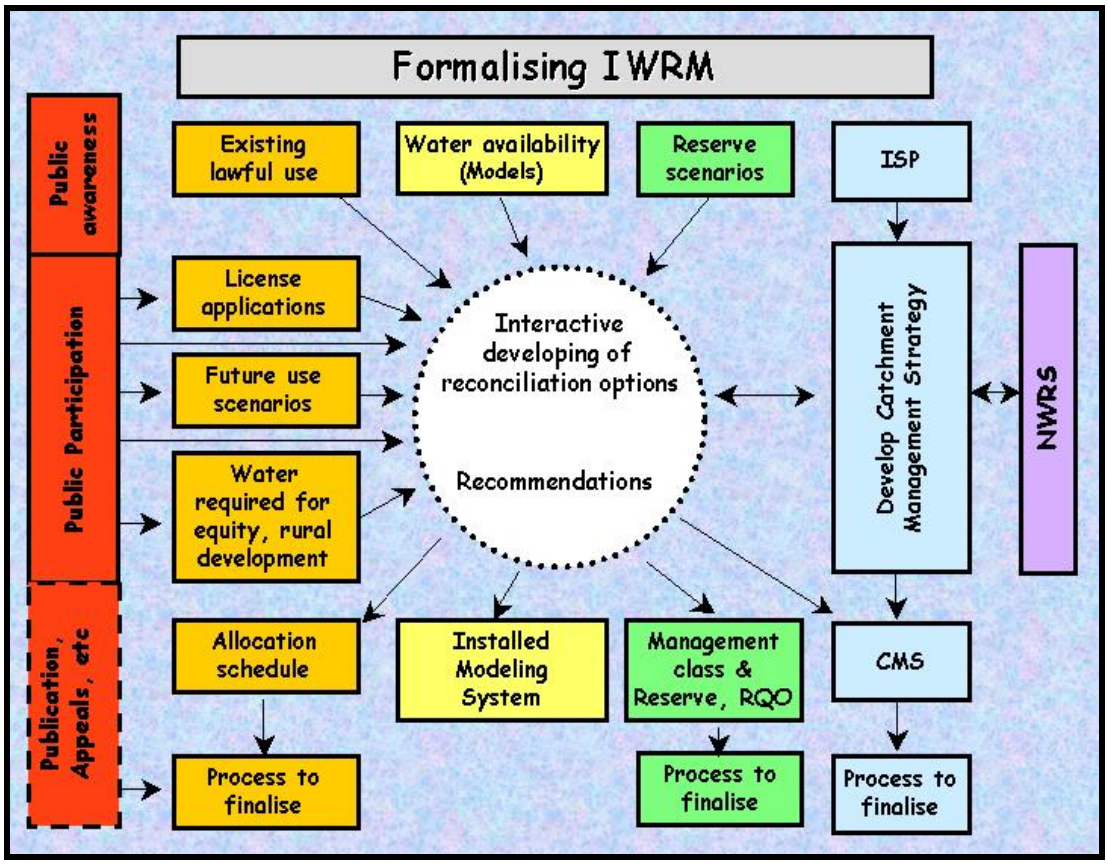

Figure 1.2: Diagram showing DWAF Integrated Water Resources Management approach

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 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.

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 needs 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 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 emphasizes 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 Strategies. 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 (Strategy 14.1) 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 Brandvlei Dam for freshening the saline water in the lower reaches of the Breede River, 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 license 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 license 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 (50-100 m 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 6.1 and 6.2** 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 the case of endoreic areas there is no interaction at all. Where interactions are weak, groundwater can very significantly add to the availability of water to users, much in the way the construction of a dam would do, but without all the negative impacts which a dam can have on the environment and on flow in rivers. Groundwater often 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 licences 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 the *Groundwater strategy*, Strategy 5.2.

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 Berg, 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 - OVERVIEW OF THE ISP AREA

2.1 INTRODUCTION

This ISP area has very little water of its own and the underlying geology also results in much of this being of very poor quality. The Kat and Koonap rivers, and to a lesser extent the Tarka River, are the only tributaries with significant own resources. The Orange-Fish-Sundays scheme, implemented in the 1970s, moves over 600 million m^3 of water each year out of the Orange River Basin, primarily for irrigation in the Fish and Sundays catchments but with water going as far as Port Elizabeth. The hydrology, water balance and economy of the Fish-Sundays system are completely dominated by this imported water. A further allocation of 38 million m^3 of water for the irrigation of an additional 4 000 ha of land by resource-poor farmers has been added to the region, but this allocation must still be implemented [(26)]. There are very significant losses through the transfer of water through the system, and saline return flows pose a serious problem for downstream users. Our knowledge of these losses, and the necessary releases and compensations that must be made, is poor, and is further complicated by the variable natural yield of the Fish and Sundays systems. Very significant work is required to improve our knowledge if this system is to be efficiently managed. Areas removed from the main rivers are mainly supplied from groundwater.

2.2 PHYSICAL FEATURES

2.2.1 Locality

For practical reasons the Fish to Tsitsikamma WMA was divided into two ISP areas, the Fish to Sundays area, which is the subject of this report, and the Tsitsikamma to Coega area which is covered in DWAF report P WMA 15/000/00/0304.

The *Fish to Sundays ISP area* forms the eastern part of the Fish to Tsitsikamma Water Management Area (WMA 15), as shown in **Figure 2.1** on the following page.

The main rivers of this ISP area are the Great Fish, Sundays, Bushmans, Kowie and Kariega Rivers, as shown in **Figure 2.2**. All these rivers drain to the Indian Ocean. Except for a small area that falls in the Northern Cape Province, the entire ISP area falls in the Eastern Cape Province.

2.2.2 Sub-areas

The Fish to Sundays ISP area was further sub-divided into three key areas as shown in **Figure 2.2**. These sub-areas are groupings of the 123 quaternary catchments of the P, Q and N primary drainage regions in the ISP area. The three key areas were demarcated in accordance with the National Water Resource Strategy (NWRS) as follows:

Figure 2.1: Locality map of the Fish to Tsitsikamma WMA and its ISP areas

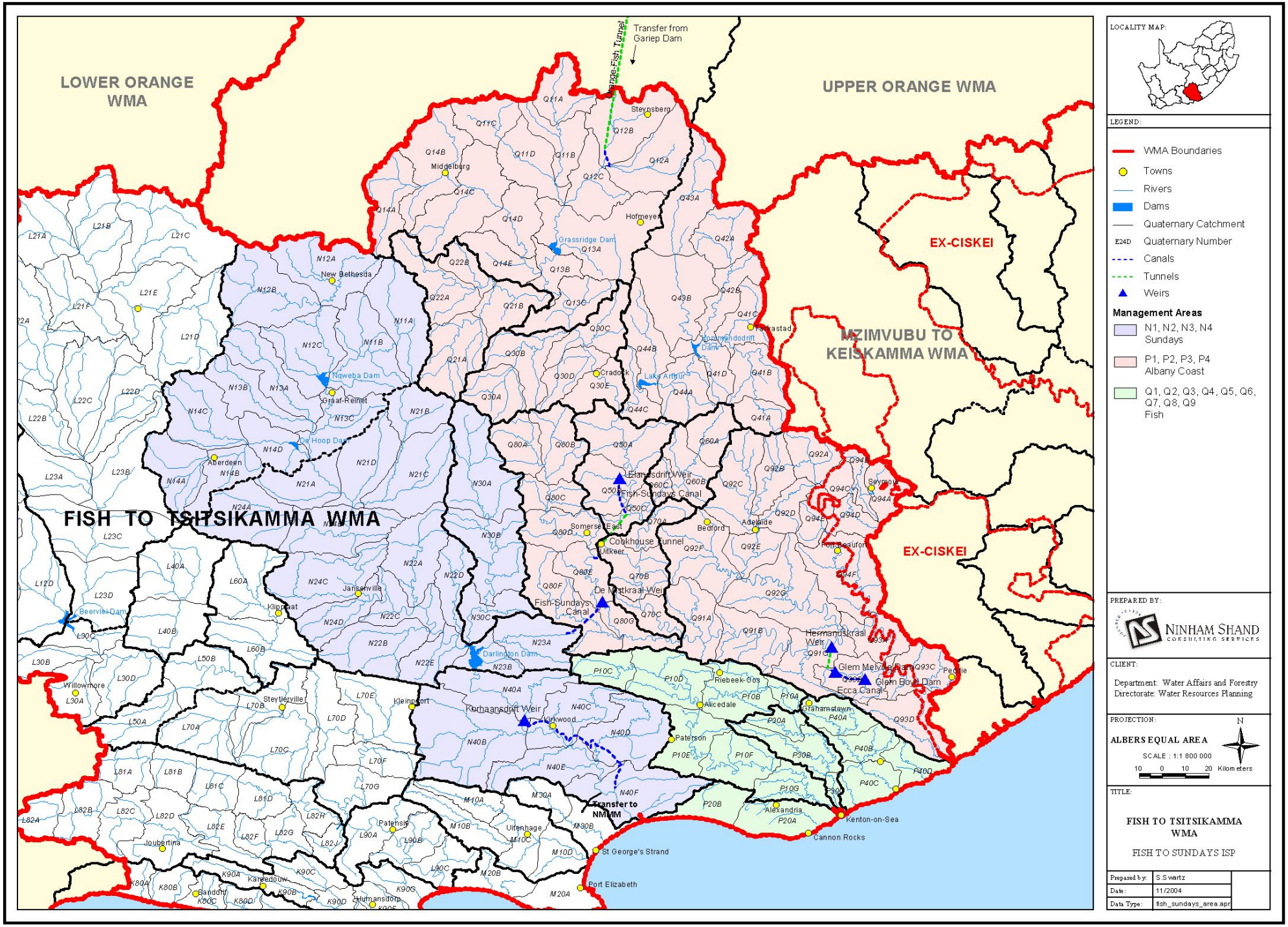

Figure 2.2: Locality map of the Fish to Sundays ISP area

- The *Fish* sub-area, which corresponds to the catchment of the Fish River (Drainage Region Q) with 71 quaternary catchments;
- The catchment of the Sundays River, as the *Sundays* sub-area (Drainage Region N) with 36 quaternary catchments; and
- The *Albany Coast* sub-area, comprising the coastal catchments between the Fish and Sundays rivers (Drainage Region P) with 16 quaternary catchments.

Most of the Fish and Sundays sub-areas, particularly the upper basins, are situated in the arid Great Karoo. The Albany Coast sub-area consists of steep, bush covered hills with deeply incised river valleys. The drainage basins of the Great Fish and Sundays rivers comprise 85% of the quaternary catchments within this ISP area. These two sub-areas are supplied with water from the Orange River Development Project.

Only the Kat River, the Koonap River and the coastal catchments have significant natural runoff. In the rest of the catchments, the annual runoff is much lower than the mean annual runoff (MAR). In a small percentage of years higher runoff occurs, mainly in the form of floods.

2.2.3 Topography

The ISP area is dominated by the arid Great Karoo interior. This area is bounded in the north by the mountain ranges of the interior plateau and in the south by the higher rainfall coastal catchments. The topography is relatively flat and the basin soils are naturally highly erodible.

The upper parts of the Great Fish catchment, with a total area of about 30 000 km^2, have numerous small, and usually dry, tributaries that originate along the edge of the interior plateau. The Tarka River tributary rises in the northern slopes of the Winterberg Mountains, while the Little Fish River tributary drains the arid area to the southwest of Cradock. The Koonap River rises on the southern slopes of the Winterberg and flows through mountainous terrain to join the lower reaches of the Fish River. The Kat River catchment, with its headwaters in the vicinity of Seymour, has a fairly wide main valley. Only minor tributaries join the Great Fish River downstream of its confluence with the Kat River. The Great Fish River then flows for a further 100 km through deeply incised meanders in hilly terrain to its estuary 25 km east of Port Alfred. See **Figure 2.3** on the following page.

The Sundays River has its headwaters in the catchment of the Nqweba Dam [27] (formally the Van Rynevelds Pass Dam) at Graaff-Reinet. Most of the Sundays basin is situated in the Great Karoo, where the topography consists of arid plains interspersed with steep rocky hills. The Sundays River basin covers an area of some 21 250 km^2 and discharges into Algoa Bay in the vicinity of Cannonvale.

The coastal catchments of the Albany Coast sub-area are situated in an area of approximately 5 300 km^2 between the basins of the Sundays and Great Fish rivers and the sea. This is an area of steep, bush covered hills with deeply incised river valleys. The main rivers are the Kariega, the Bushmans and the Kowie.

Figure 2.3: Topography

Figure 2.4 Great Fish River in the Grahamstown vicinity

Figure 2.5: Horseshoe bend in the Kowie River

2.2.4 Geology, hydrogeology and soils

A detailed review of the groundwater situation is contained in **Appendix 2**. Groundwater is also addressed from a resource perspective in Chapter 3. This section provides the background information to the presence, availability and utilisation of groundwater in the Fish to Sundays ISP area.

a. Geology and hydrogeology

i. Groundwater integrated resource management (GIWRM) domains

The ISP area has been categorised into two hydrogeological or 'hydrogeotectonic' provinces or domains, namely the Algoa-Albany Basin-and-Range province and the Sundays-Great Fish Uplands province. Integrated water resource management needs to take note of these distinctive domains when reconciling surface and groundwater availability and use.

These hydrogeological provinces are summarised in **Table 2, Appendix 2**. The ***Algoa-Albany Basin-and-Range*** province incorporates the Algoa Basin and Albany Coastal Range, but has also been extended to include the "Southern Karoo Foreland" subprovince, where topography and drainage is structurally controlled by fold and fracture structures in lower Karoo strata.

The ***Sundays-Great Fish Uplands*** province is divided into generally an E/W-trending escarpment zone and an upland area consisting of the Great Fish headwaters. The sub-provinces are the Camdeboo-Winterberg Escarpment and the Upper Great Fish Basin. The base of the Katberg Formation sandstone is the main geological factor controlling this subdivision (see to the red lines in **Figure 2.6, Aquifer Types**).

ii. Physiography and hydrostratigraphy

The topography, drainage characteristics and groundwater quality of the area are closely related to the underlying geology (see **Appendix 2**).

In the **southern coastal belt** folded sedimentary rocks of the *Cape Supergroup* (Table Mountain, Bokkeveld and Witteberg Groups) and *lower Karoo Supergroup* (Dwyka and Ecca Groups) are the dominant bedrock units. This area constitutes the eastern part of "*Groundwater Region No. 52*" (Grootrivier-Klein Winterhoek-Suur-Katrivier Ranges) as defined by J.R. Vegter. There is also a minute portion of the adjacent *Groundwater Region No. 50* (Southern Cape Ranges) appearing along the crest of the divide at the southern boundary of the N40B and N40E quaternary sub catchments**.** The northern boundary of Groundwater Region No. 52 is drawn along the Witteberg-Dwyka (Cape-Karoo) stratigraphic contact.

Volcanics and volcaniclastic sediments of the Suurberg Group, overlain by generally shaley sediments of the Uitenhage Group, occupy a major fault-bounded basin (**Algoa Basin**) on the Sundays River coastal plain (N4 & P1 / P2 secondary catchments). This constitutes *Groundwater Region No. 64.* Coarse conglomerate and grit of the Enon Formation occurs in

the hanging wall of the major east-west border fault stretching from Paterson in the east to south of Wolwefontein in the west. Unconsolidated to semi-consolidated, palaeo-coastal calcareous sand and conglomerate deposits of the younger *Algoa Group* occur within the eastern portion of the Algoa Basin and the **Bushman's coastal plain**, overlain by Quaternary alluvium in much of the Sundays River valley south of Kirkwood. Recent and reworked coastal sands occur within a narrow dune zone between Cannonvale and Port Alfred.

The northern interior uplands are underlain by sedimentary rocks of the *middle Karoo Supergroup* (Beaufort Group, consisting of Adelaide [lower] and Tarkastad [upper] subgroups) and abundant intrusive dolerite sills and dykes of the Drakensberg Formation underlie the northern interior uplands. This region covers the eastern part of *Groundwater Region No. 42* (Eastern Great Karoo) and the western part of *Groundwater Region No. 43* (Ciskeian Coastal Foreland and Middle Veld), the common boundary of which is the Sundays/Great Fish drainage divide.

b. Soils

Moderately deep to deep clayey loams are found in the undulating terrain of the coast in the south-east and in the upper portion of the Fish River basin. Moderately deep to deep clayey loams are also found on the flat floor of the lower Sundays River. Predominantly moderately deep to deep sandy soils in undulating and steep terrain make up the rest of the Fish to Sundays ISP area. Refer to **Figure 2.4.1** of the *Fish to Tsitsikamma WMA WRSA Report P 15/000/00/0101* for a map of soils.

c. Aquifer classification

The greater part of the WMA is underlain by a shallow regolith aquifer (intergranular/weathered-and-fractured - yellow area in **Figure 2.6**). The true secondary fractured rock aquifers in this ISP area (green areas in **Figure 2.6**) occur in the southern coastal zone and include the quartz arenites of the Table Mountain Group (Peninsula Formation and Nardouw Sub-group) and the Witteberg Group. The Karoo dolerites occurring in the northern interior upland (principally to the north of the Fort Beaufort-Somerset East-Aberdeen line) represent another fractured rock system (black area in **Figure 2.6**). Primary/intergranular (porous sandy) aquifers are best developed within tertiary/quaternary sediments of the southernmost coastal belt of the WMA (purple area in **Figure 2.6**), including alluvium along the Sundays River, semi-consolidated calcareous sands and conglomerates of the palaeo-coastal Algoa Group, and the coastal sand dunes developed between Cannonvale and Port Alfred. Surface silcrete aquifers are limited to the African relict land-surface in an area north and east of Grahamstown.

d. Springs

The mapped distributions of boreholes and springs in the WMA (**Figure 5 in Appendix 2**) illustrate somewhat sporadic occurrences of springs, the main cluster of which is related to the interior escarpment east of the Great Fish River. In this northern part of the Q9 secondary catchment, springs cannot be directly correlated with structural geological controls, rather with

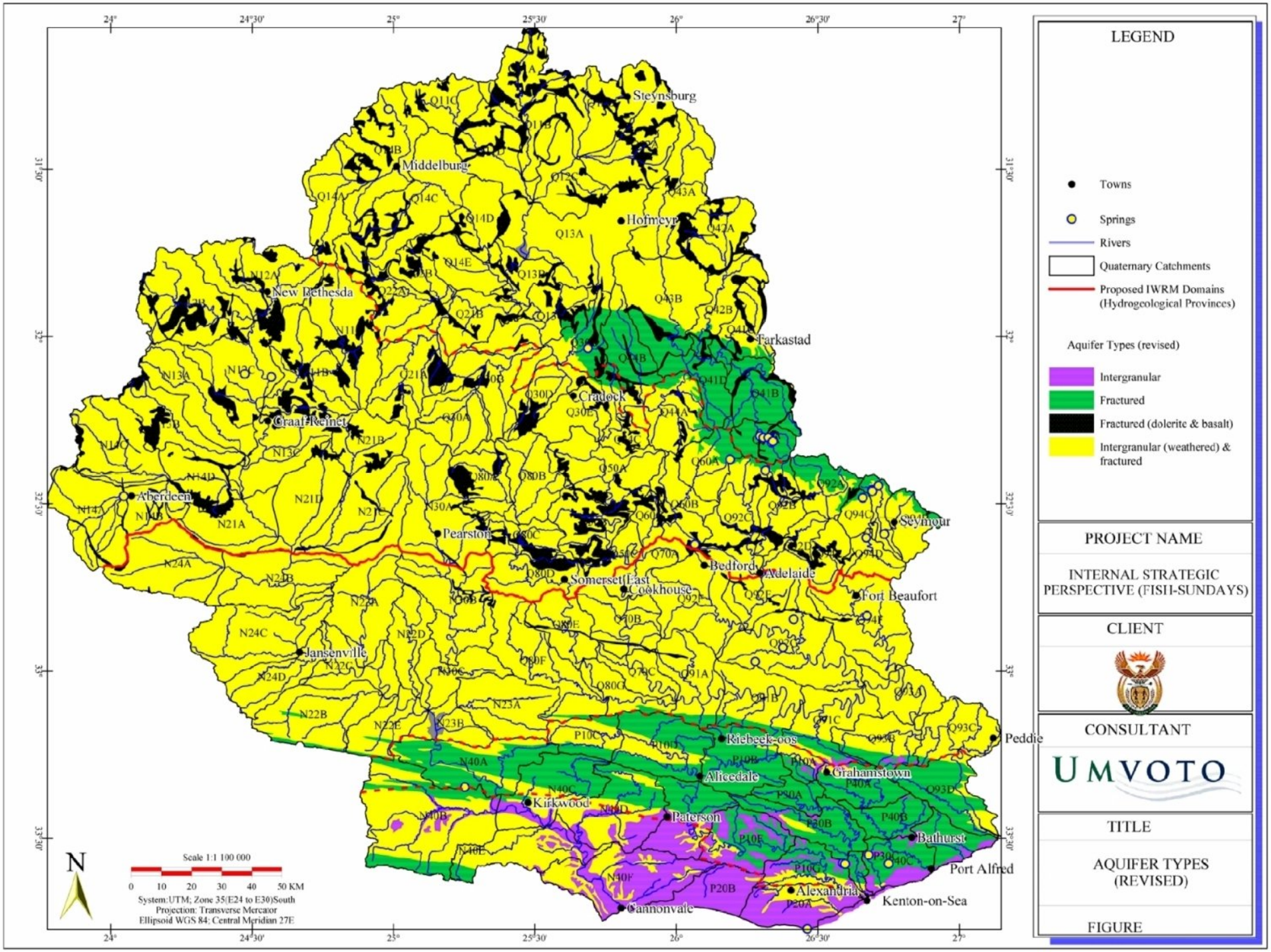

Figure 2.6: Aquifer types

topographic controls (**Figure 2 in Appendix 2**) and lithological changes. Springs in the Fort Beaufort and Seymour areas are associated with dolerite dykes and those in the Bedford area with dolerite sill intrusions. Springs north of Seymour lie along the escarpment edge and around the basal contact of the Katberg Formation. The NGDB appears incomplete and lacks site-specific detail, which is a general problem in the area. Notwithstanding this, the concentration of springs in the east-central part of the ISP area correlates with the relatively higher rates of recharge (25 to 50 mm/a; **Figure 4 in Appendix 2**) to groundwater, which supports the topographic/ orographic control interpretation. Additionally, the springs in the Albany Coast sub-area are expected to reflect baseflow from the Cenozoic Alexandria Formation conglomerate and equivalent palaeo-coastal deposits of the Algoa Group.

e. Boreholes

The borehole distributions documented in the NGDB and in the DWAF Eastern Cape records (**Figure 5 in Appendix 2**) show dense localised concentrations of boreholes around the larger population centres (e.g. Graaff-Reinet and Middelburg) in the northern interior upland of the WMA, which demonstrates the dominance of groundwater usage in the Eastern Great Karoo (derived from shallow primary intergranular-weathered and secondary fractured-dolerite aquifers). Similar borehole concentrations are centred about the smaller agricultural centres of Somerset East, Cookhouse, Bedford, Adelaide, Fort Beaufort and Seymour, situated along the foot of the Middleveld escarpment. North of the divide, in the east-central part of the Fish-Sundays ISP area, a more evenly dispersed pattern of (agricultural) boreholes prevails, disrupted only by axial concentrations along the Middle to Upper Fish (Q3, Q5 and Q7) and Tarka catchments. Except in these instances of boreholes associated with alluvium along the principal distributaries, there appears to be little or no correlation between the borehole distribution pattern and expected geological controls, e.g. the outcrop and subcrop distribution of dolerite sills and dykes, although this may reflect the inadequate representation and/or outcrop expression of dolerites at this map scale.

South of the Middleveld/Eastern Karoo escarpment, boreholes are more uniformly distributed although borehole concentration apparently increases closer to the coast (see **Figures 3.5 and 3.6**). The Albany Coast south and east of Grahamstown has an elevated borehole concentration, consistent with high groundwater use in this arid coastal belt. In this area there is a relatively strong correlation between the borehole distribution and the aquifer type, with most boreholes situated in the fractured Witteberg Aquifer, and to a lesser degree, within the primary intergranular Algoa Aquifer and coastal dune belt.

2.2.5 Climate and Rainfall

The distribution of rainfall and evaporation is shown in **Figure 2.7**. The climate of the southern part of the ISP area is strongly influenced by warm coastal currents of the Indian Ocean. The coastal band of this area also forms the southern boundary of South Africa's subtropical coast with wet, humid summers. The climate inland is typically Karoo with cool, dry winters and hot summers with some rain, with frost occurring during the winter months. Rainfall in the ISP area generally occurs very late in summer over the inland region. The coastal region receives rainfall throughout the year, with most during the summer months.

Figure 2.7: Average annual rainfall and evaporation

There is a great variation of rainfall throughout the ISP area. The mean annual precipitation (MAP) along the coastal band ranges from 400 mm at the Sundays River mouth to 700 mm at the Fish River mouth. The area around the Bushmans River mouth receives a MAP of 700 mm to 800 mm. Rainfall varies between 300 mm and 400 mm in the northern escarpment region and between 150 mm and 400 mm in the interior. The highest rainfall of about 900 mm occurs in the upper Kat River catchment.

Mean annual evaporation in the ISP area ranges from 1 450 mm in the south-east to 2 050 mm in the north-west.

2.2.6 Vegetation

a. Natural vegetation

Systematic Conservation Planning is now being widely implemented in the Eastern Cape. The Succulent Karoo Ecosystem (SKEP) and the Thicket Biome (STEP) C-plans are particularly relevant to the Fish Sundays ISP area. These plans, housed with the Eastern Cape Department of Economic Affairs, Environment and Tourism, reflect the conservation value of landscape in terms of biodiversity and other features, and are a very useful tool in identifying areas in need of protection and in understanding the potential impacts of any planned development.

A simplified description of the vegetation types and a natural vegetation map has been included as ***Figure 2.5.2*** *of the Fish to Tsitsikamma WMA WRSA Report P 15/000/00/0101*. In brief, five types of vegetation have been recorded, according to the Acocks classification system, as follows:

- *Coastal Tropical Forest Types* include lush rain forests, thornveld and bushveld. This veld type is typically confined to the coastal area or immediate vicinity between the Sundays to Fish River estuaries.

- *Karoo and Karroid Types* are found mostly in the western interior of the ISP area. The flora is characteristically low, typically less than one meter high, and includes scrub, bushes, dwarf trees and a few grasses.

- *False Grassland Types* close to the coastal areas and the nearby inland areas occur on either sandy or stoney soils. Farming activities have impacted on much of this veld type.

False Karoo Types and *Pure Grassveld Types* occur in the upper eastern part of the Sundays and Fish River catchments. *False Karoo* vegetation is typically low vegetation, but contains numerous grassy elements. *Pure Grassveld* represents the true grassveld, and occurs on the upper plateau and the mountain tops which are too dry or experience frost too regularly for the development of any kind of forest. Farming activities have impacted on much of this veld type.

b. Invasive alien plants (IAPs)

Substantial infestation by alien plants occurs in the Albany Coast sub-area, especially in the Kowie and Kariega River catchments. Lower levels of infestation are experienced in the upper and lower parts of the Great Fish River, the Kat River and in the middle Sundays River. In the rest of the ISP area, infestation is generally low. More detailed information on IAPs and their water use has been included under the *Managing invasive alien plants Strategy*, Strategy 7.4.

c. Aquatic weeds

Waterweeds are problematic in the Grahamstown supply dams and in the New Years Dam in a tributary of the Bushmans River, although this problem tends to be cyclic [23]. No other problems are reported.

2.2.7 Environmental protection and sensitive areas

A vital requirement for ensuring sustainable conservation practices is the identification of conservation worthy habitats or sensitive ecosystems. The Greater Addo National Park, incorporating the Addo Elephant National Park [51] and Zuurberg Reserve, Shamwari Game Reserve (private) Mountain Zebra National Park [53], Alexandria State Forest, Thomas Baines Nature Reserve and the Mananga Cycad Colony are some of the protected sites that fall within the ISP area. A coastal strip is planned to become part of the Greater Addo National Park.

A southern coastal strip that incorporates the Alexandria Dune Field, making up the largest coastal dune field in the world is set to become part of the Addo Elephant National Park. Groundwater seeps to sea in this area, resulting in a unique form of plankton blooms that should be monitored and protected. This proposed extension of the nature reserve to the coast may have an impact on the current abstraction of water from the Colchester dunes.

All the rivers and tributaries should be properly managed to protect indigenous species. The permanently open estuary of the Fish River is ecologically significant [19]. Little is known about wetlands in this ISP area.

Land-use practices in the former Ciskei area have caused land degradation and soil wash-off. A lack of post-farming rehabilitation leads to increased erosion.

The Archeology Department of the Albany Museum in Grahamstown serves as the Archaeological Data Recording Centre and official repository for archaeological collections from the Eastern Cape Province of South Africa. This department has also published the "*Southern African Field Archaeology*" journal which has provided a forum for publishing archaeological site reports.

Table 2.6.1 *in the Fish to Tsitsikamma WMA WRSA Report P 15/000/00/0101* contains a list of the protected areas within the Fish to Tsitsikamma WMA.

Figure 2.8: Addo Elephant National Park

Figure 2.9: Mountain zebra

2.3 DEMOGRAPHY, LAND USE AND DEVELOPMENT

There is little communal land in the ISP area, with land outside urban areas and nature reserves mainly owned by commercial farmers.

2.3.1 Population

The population, divided between urban and rural areas, is shown in **Table 2.1**. Approximately half a million people reside in the Fish-Sundays ISP area, with more than half of these living in the Great Fish River basin. Approximately 70% of the population resides within the urban areas. The population of the Fish and Sundays sub-areas is expected to decline after 2005. This is attributable to the lack of economic stimulants together with the impacts of HIV/AIDS [(19)]. A small growth in urban population is foreseen in the Albany Coast sub-area.

Table 2.1: Population

Sub-area	**Population** (1000s)		
	Urban	**Rural**	**Total**
Sundays	67	30	96
Albany Coast	109	27	136
Fish	147	88	234
Total in ISP area	**323**	**145**	**466**

2.3.2 Land use

Figure 2.10 shows land use in the ISP area.

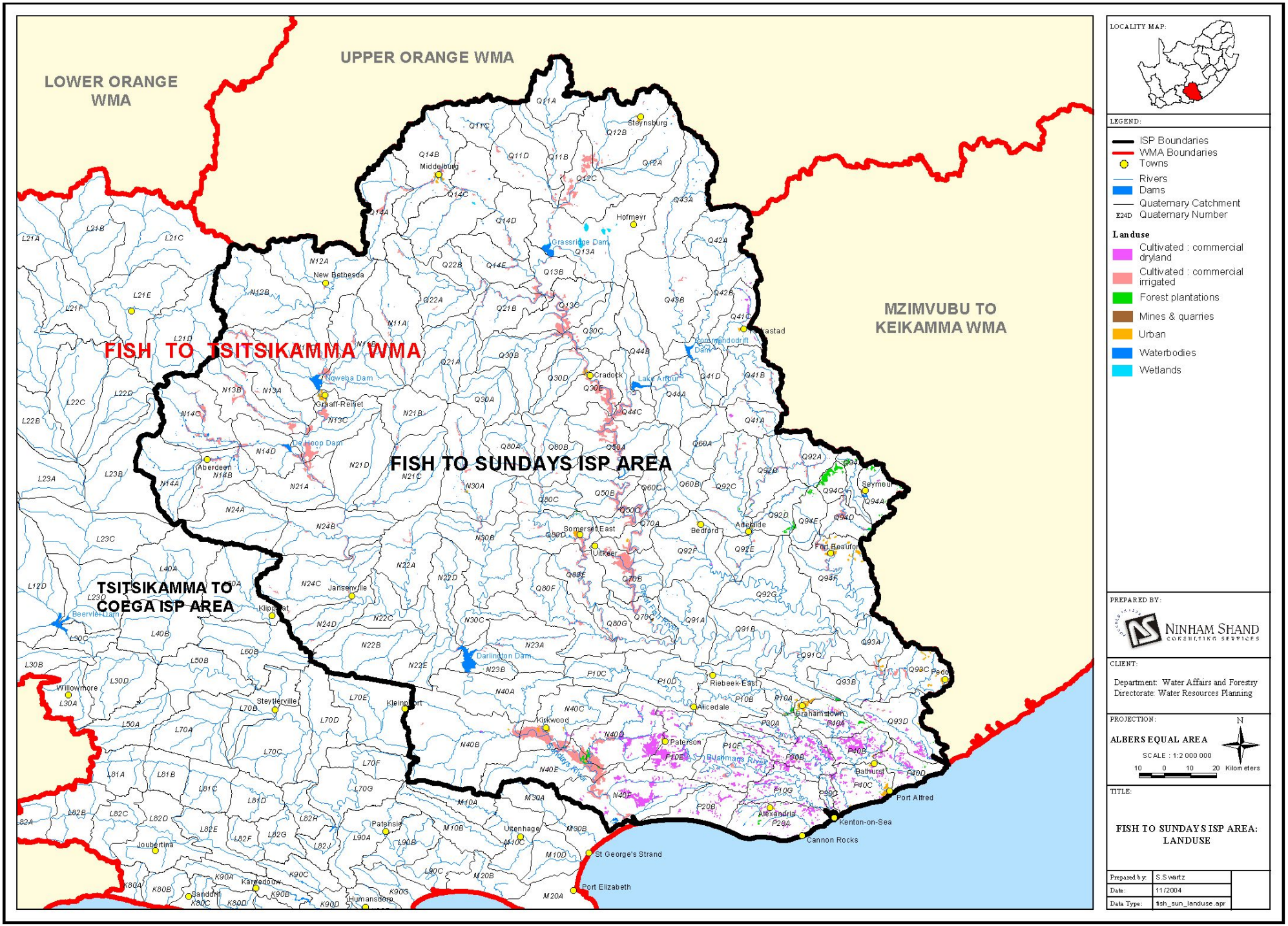

Figure 2.10: Land use map

Within the Fish River basin, land use is predominantly grazing for livestock (94%), particularly sheep [17]. Cattle ranching is the main land use in the Lower Fish catchment. As a result of the transfer of Orange River water, there is intensive cultivation and irrigation of land in the valleys of the Teebus and Groot Brak tributary rivers and along the main stem of the Great Fish River. Prior to the implementation of the ORP the latter area relied on the Grassridge Dam and Lake Arthur. Orange River water is transferred to the Sundays River from the Fish River via the Fish-Sundays Canals Transfer Scheme. There is intensive irrigation along the route of the transfer canals as well as along the Little Fish River. Lucerne is the dominant crop. Crops cultivated to a lesser degree are wheat, oats, vegetables and maize.

Irrigated citrus farming is also practised in the Kat River catchment, using local resources. There are some indigenous forests in the Kat River catchment. There is also significant irrigation from local resources along the Tarka River, below the Commando Drift Dam, and along the Koonap River.

Most of the Sundays River catchment is situated in the arid Great Karoo. The land-use is mainly sheep, mohair and game farming. Natural and stocked wildlife are found in this area and seems to be increasing in popularity. In the lower Sundays River there are mainly citrus orchards, with lucerne and vegetables making up the balance, mainly based on the use of transferred Orange River water. There is also irrigation in the upper and middle Sundays River catchments from natural river flows. Irrigated agriculture occupies 1.3% of the Sundays River catchment. Agricultural practices however lead to increased salinity due to the leaching of salts out of the profile and the use of fertilisers.

Land-use in the Albany coastal catchment is predominantly grazing for cattle and dairy farming, mohair goats and sheep, but pineapples are grown on a large scale without irrigation along the coast. Chicory is also extensively grown as a dryland crop, especially around Alexandria.

Figure 2.11: Grahamstown

The main urban and industrial centre in the ISP area is Grahamstown. Kaolin is mined close to the town. As there are not many large urban centres, pollution and other impacts due to urbanisation tend to be fairly limited in the ISP area. In Grahamstown there are some informal settlements without adequate services.

Effluent from the smaller towns in the ISP area typically evaporates from maturation ponds, or may be absorbed by irrigation and infiltration [23].

Only a very small portion of the ex-Ciskei area falls within this ISP area. Land degradation and soil wash-off is a problem in these former Ciskei areas due to poor land-use practices.

Refer to **Figure 2.14**, the map of Municipalities in the ISP area, which shows the former Ciskei homeland area.

Siltation is naturally high in many parts of the ISP area and has already impacted heavily on many dams. ***Figure 6.5.1*** *in the Fish to Tsitsikamma WMA WRSA Report P 15/000/00/0101* shows the potential for sediment accumulation in reservoirs.

2.3.3 International links and links with other WMAs

The ISP area has no international borders and is not directly linked to any other country through the transfer of water. The large quantities of water transferred into the Fish to Sundays ISP area from the Upper Orange WMA increase the 1:50 year yield of the ISP area by 575 million m^3/a. The Orange River is an international river shared by four countries (South Africa, Lesotho, Botswana and Namibia). The transfer is a national issue which also forms part of South Africa's normal and ongoing liaison with basin states.

Quaternary Q93C (Peddie), in the Fish to Tsitsikamma WMA, has access to water from the Keiskamma to Mzimvubu WMA through a regional water supply scheme for dense rural settlements [(23)].

Limited amounts of water that have been earmarked for resource-poor farmer schemes will in future be transferred, as well as small amounts that have been reserved for urban growth.

2.3.4 Economic Development

The Fish-Sundays ISP area contributes slightly less than 20% of the gross geographic product (GGP) of R21.8 billion (1997) generated by the Fish to Tsitsikamma WMA. The Orange-Fish-Sundays Scheme however provides growth and job opportunities. Despite this, unemployment in the area is high. Of the potential workforce of 680 000 in the Fish to Tsitsikamma WMA in 1994, 39% were unemployed. The Government, agriculture and manufacturing sectors dominate the regional economy. Government services play a significant role in the economy, providing 28% of formal employment. Unemployment is higher in the small Karoo towns where many farm workers have lost their jobs during the past decade, attributable to a shift to less labour-intensive farming, typically the shift from sheep to game farming. The economy of this ISP area is heavily dependent on irrigation.

a. Strategic water use

There is no large-scale power generation in the ISP area and no pumped storage schemes. A small 600 kVA hydropower station is situated at the Orange-Fish tunnel outlet at Teebus. Provision has also been made to extend its capacity to 1 200 kVA. This was originally intended to feed power into the national power grid, but apart from periodic testing until 1990 (when it was damaged) has been unused since it was installed. Power from the national grid is being used instead.

Some irrigators have permits for small hydropower plants, which they use for their own power needs.

b. Mining

The area is not mineral rich. There are no significant mining activities and mining operations are limited to quarrying for building materials. The main quarrying operations are for kaolin for brick making from weathered shales of the Witteberg Group in the vicinity of Grahamstown.

c. Industry

The larger regional industries of the WMA consist of manufacturing, construction, trade, transport and finance. These sectors account for the employment of about a quarter of the workforce. Manufacturing in the ISP area is centred on agro-processing. Food and dairy processing are present in the larger towns, while small businesses and craft co-operatives in the small towns of the Karoo produce mohair products, mostly hand-knitted. Leather and leather goods are a small local industry, with its base in Grahamstown. There is opportunity to expand this industry with respect to automotive seat leather, especially with the automotive industry being so well established both in East London (Daimler-Chrysler), Uitenhage (Volkswagen) and Port Elizabeth (Delta/General Motors).

The basis for the fishing industry is squid, with some recreational and commercial fishing for line fish.

d. Agriculture and irrigation

Agriculture is of major importance to the region and has linkages to several other economic sectors. Almost 60% of the world's mohair and much of the country's wool is produced in the water management area and surrounding areas. Citrus, vegetables as well as cash and fodder crops are grown under irrigation, while the area is also known for its production of pineapples, chicory and dairy products near the coast. Agriculture and supporting industries dominate the economy of the ISP area. Small-stock farming predominates in the dry Karoo interior.

Cattle and dairy farming are strongly represented in the areas around Grahamstown, Cookhouse and Alexandria. The areas around Peddie are also excellent cattle farming areas. Deciduous fruit and citrus are exported through Port Elizabeth. The main challenge of this area is to both expand agricultural production and to diversify the economy and add value to agricultural production by building agro-processing industries. Agriculture has been in relative decline for the past decade, primarily due to falling small-stock production. Many farmers have converted to game farming, which is now a major industry.

Dryland crop farming is a significant contributor to the agricultural sector, especially around the higher rainfall regions of the Albany Coastal catchment areas, where chicory and pineapples are farmed.

Some 51 000 ha of irrigated lands in the Fish and Sundays basins rely largely on water transferred from the Orange River. The main crops irrigated in the Fish River Basin are lucerne, maize and pastures, while citrus, lucerne and vegetables are the main crops cultivated in the Sundays River.

The allocated 4 000 ha for resource-poor farmer irrigation schemes creates limited opportunities for new development. Potential exists for irrigation to be expanded in the Fish and Sundays River catchments, where there are opportunities for further citrus production and high value horticultural production (vegetables, flowers, etc.). The potential for new large-scale schemes, involving *inter alia* the irrigated growing of cotton and sugar beet and their associated industries, have been identified in the central Fish River basin.

An important feature of irrigation outside of the GWSs is that most areas are only irrigated when water is available from natural runoff, which is very variable. In many years therefore, only parts of the total developed areas for irrigation will actually be irrigated. As a consequence, much water use by irrigation is highly variable from year to year, with much of it very opportunistic and at a low assurance of supply.

Irrigation efficiencies are low at some schemes and potential exists for a move towards more efficient irrigation methods. Flood irrigation is for example still widely used for lucerne and pastures. Exceptionally large conveyance losses are experienced from unlined canals in the Fish and Sundays sub-areas. Refer to the *Agricultural water conservation and demand management Strategy*, Strategy 8.2 for a more detailed description.

The water supply infrastructure of some irrigation schemes needs to be rehabilitated, especially in the former Ciskei areas. Typical problems are badly designed schemes, illegal connections, high non-payment and inadequate metering.

e. Forestry

Commercial forests cover approximately 83 km^2 in the ISP area, of which the largest part (73 km^2) is in the northern Kat River catchment and some 6 km^2 is in the Albany Coast sub-area, south of Grahamstown [(17)]. There is biophysical potential for some limited expansion of forestry, but the impact that expansion would have on other existing users precludes the likelihood of any further forestry water use licences being issued. The potential in this sector therefore lies primarily in the processing of wood products (crafts and furniture) using existing resources. The Kat River also has 32 km^2 of indigenous forest [(17)]. The Albany Coast area has coastal tropical forests, but they do not provide marketable timber beyond the craft market.

f. Tourism

Tourism is well established, with a network of tourism routes, and is on the increase. Tourism attractions include the well-known Addo Elephant National Park, Mountain Zebra National Park near Cradock and the Mohair Route. Coastal towns such as Port Alfred also draw tourists. Farm tourism is beginning to develop in the Karoo, and Graaff-Reinet and

Grahamstown are visited for their history and architecture. Annual events are the Grahamstown Arts Festival and the Fish River canoe marathon. Game farming is becoming a major tourism activity, with top game farms such as Shamwari being located in the ISP area.

Tourism has large potential for growth. It is expected that the Addo Elephant National Park and the Fish River Reserve will be expanded, and will increase the attraction of other game reserves in the district. A strong base in beach, marina and sports tourism, including surfing, can be developed further. A number of major arterial routes traverse the area with the potential to develop rest stops and "stop-overs" combined with eco-tourism for motorists passing through.

Figure 2.12: Valley of Desolation near Graaff-Reinet

g. Identified poor areas

Poverty is seen as the denial of opportunities and choices most basic to human development, to lead a long, healthy, creative life and to enjoy a decent standard of living with dignity. In terms of a basic needs analysis, priorities for rural poor and urban poor differ significantly, with poverty usually the highest in both the more populated metropolitan areas (highly urbanised and relatively well serviced) and former homelands areas (rural with minimal services).

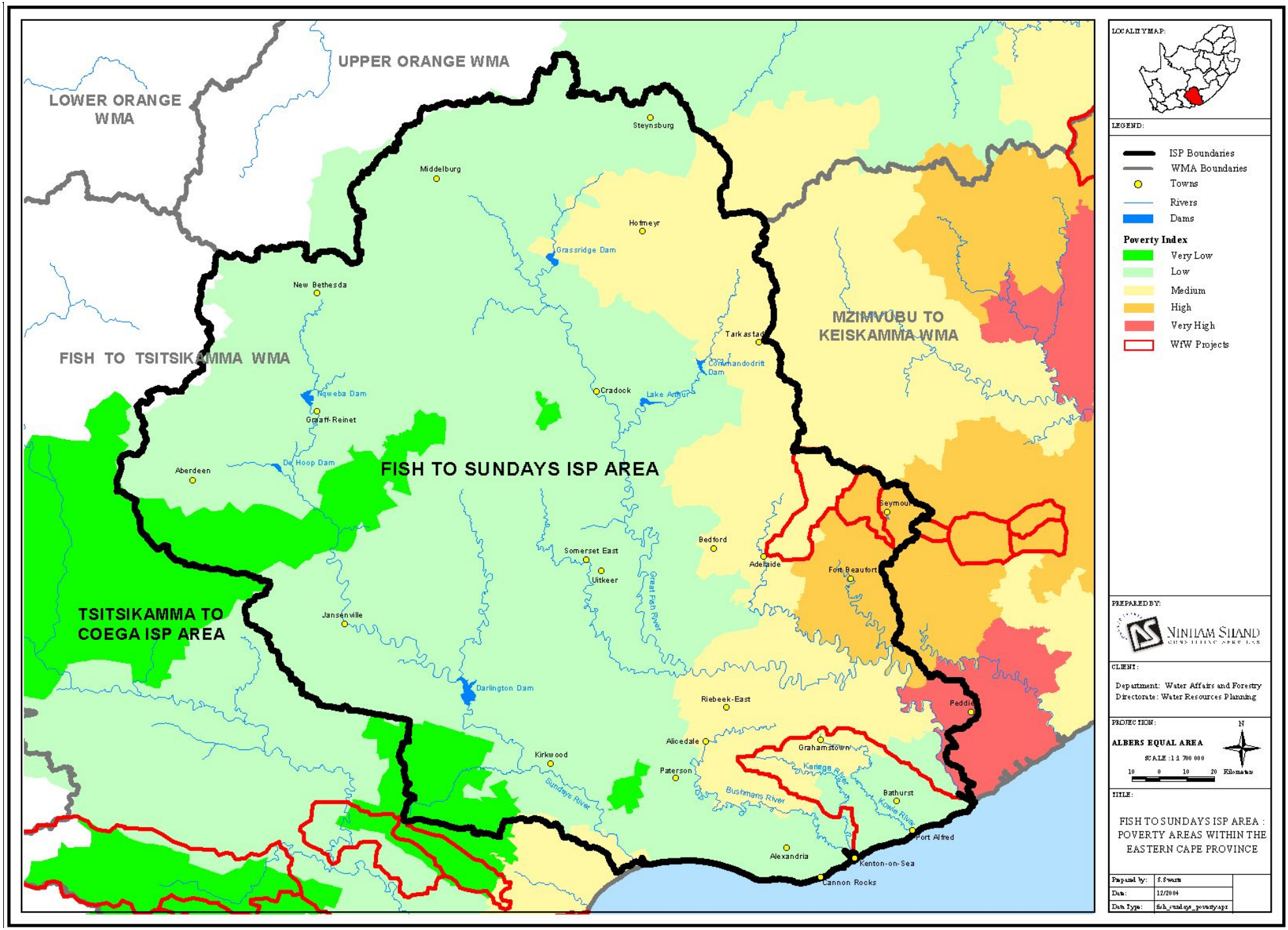

Figure 2.13: Eastern Cape Poverty Areas

Based on an overall poverty analysis conducted as part of the provincial economic analysis (DEAET, 2002), the Eastern Cape came out as the province with the highest poverty levels in the country, the measures being highest unemployment and lowest standards of living, as shown in **Figure 2.13** [(42)]. Certain areas, particularly in the eastern part of the province, display higher unemployment rates relative to the rest of the province. In this ISP area the eastern part of the Amatole District Municipality within the Fish River basin has high to very high poverty levels, this to a great extent being in the ex-Ciskei areas, falling within Ngqushwa (very high) and Nkonkobe (high) Local Municipality areas. The assessment for the rest of the ISP area varies from relatively low poverty levels in the west and north to medium in the central parts of the area.

h. Resource-poor farmers

A total of 5 000 ha of identified future Orange River allocations have been reserved for new irrigation by resource-poor farmers in the Eastern Cape, 4 000 ha through the Orange-Fish transfer tunnel (38 million m^3/a) and 1 000 ha in the Upper Orange WMA respectively [(26)]. The Eastern Cape Province can however influence where this development will take place, if well motivated. The general approach would be that this water should be beneficially used where it will provide the most benefit and be most effective in eradicating poverty. Such decisions, to be recommended by the Co-ordinating Committee for Agricultural Water (CCAW), should also preferably be in line with the Eastern Cape Growth and Development Plan. An area of 180 ha has already been approved near Addo for resource-poor farmers in the Sundays River Municipal area. The proposed Tamboekiesvlei Scheme in the Kat River catchment, of which the feasibility study is under way, initially aims to develop 35 ha under drip irrigation for the benefit of successful land claim recipients [(27)].

2.3.5 Water institutions

Water Services Authorities, which are all the local municipalities in the Cacadu, Chris Hani and Amatole district municipalities (DMs), are responsible for ensuring access to water services. The map of municipalities (**Figure 2.14**) shows the DMs, local municipalities (LMs) and metropolitan municipalities in the ISP area.

Three DMs manage most of the ISP area. They are the Cacadu DM (6 LMs), Chris Hani DM (2 LMs) and the Amatole DM (3 LMs). The Ukhahlamba DM manages a much smaller area, whilst the Central Karoo DM and Nelson Mandela Metropolitan Municipality (NMMM) boundaries just extend into this ISP area. Some other municipalities cover small portions of the ISP area.

The water services authorities are responsible for drafting water services development plans. A water services authority is any municipality responsible for ensuring access to water services, while a water services provider provides water services to consumers or to another water services institution. The five LMs within the Cacadu DM are all water services authorities. For the remainder of the ISP area, the DMs act as the water service authorities.

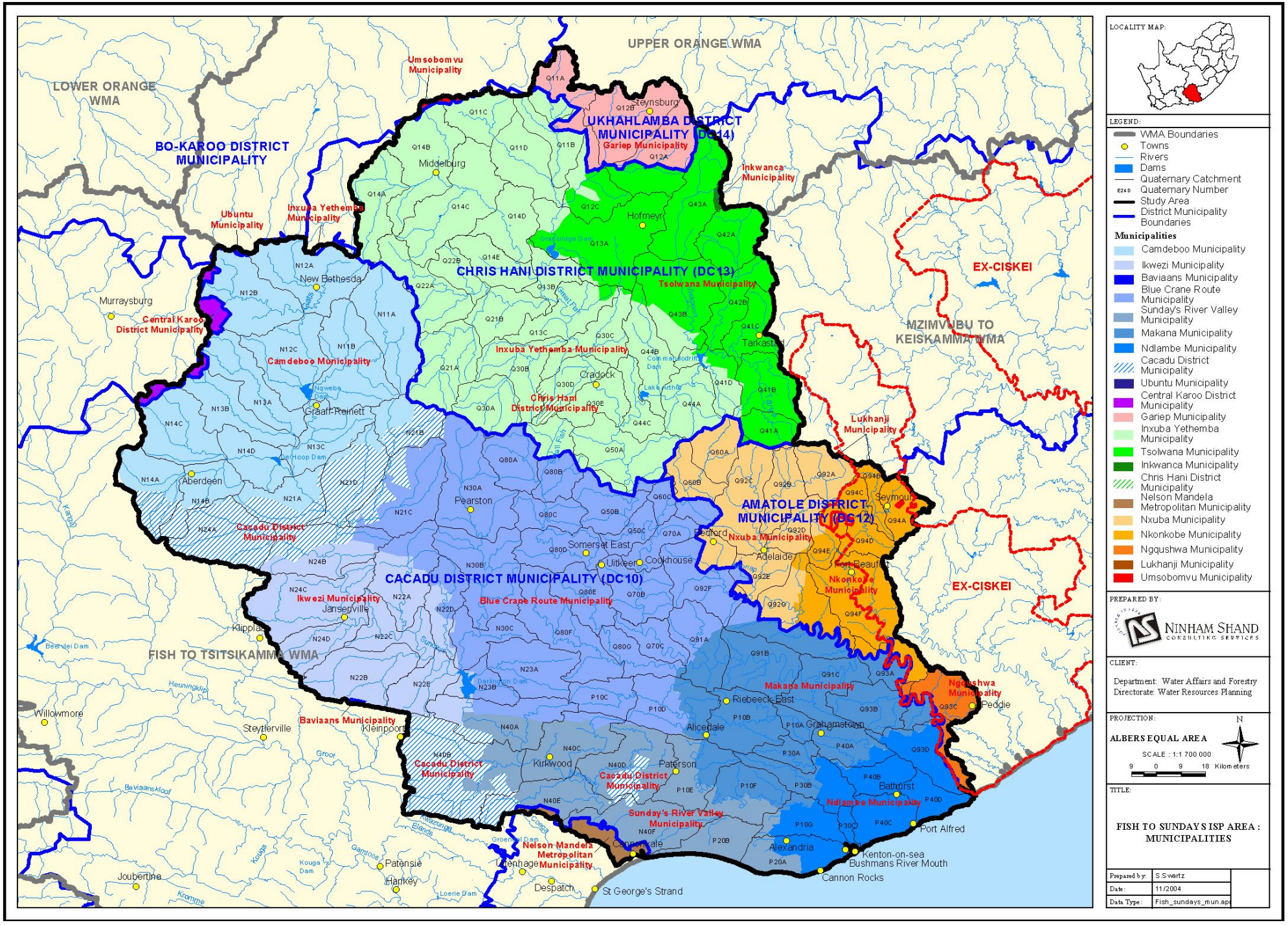

Figure 2.14: Municipalities in the ISP area

The Albany Coast Water Board, the only water board in the ISP area, supplies water to Bushmans River Mouth and Kenton-on-Sea.

The Great Fish River WUA (including Sub-Boards), Kat River WUA and the Sundays River WUA have been established by transforming the respective irrigation boards. Establishment of the Tyhefu WUA has not progressed satisfactorily due to inadequate support to the community. The Kat River Catchment Forum is the only catchment forum to have been established in the ISP area.

2.4 WATERWORKS

2.4.1 Major infrastructure and transfer schemes

a. The Orange-Fish-Sundays Transfer Scheme

Figure 2.15 on the following page shows a schematic diagram of the transfer scheme, which shows the main infrastructure components. Detailed information relating to other water infrastructure is also contained in the Appendices.

Irrigation along the Fish, Sundays and Tarka rivers started in the 1920s, with the construction of a number of dams and canal schemes. Dams included Grassridge, Commando Drift, van Ryneveld's Pass, Lake Arthur and Lake Mentz. Some of these schemes were developed on private initiative, while others were Government assisted. Extensive areas were put under irrigation from these dams. However, water shortages occurred regularly and the available water became saline due to salts in the catchment formations and irrigation return flows. The reliable yields of the dams further diminished over time, due to reduced catchment run-off to the dams as well as loss of dam storage capacity because of siltation. It is interesting to note that the catchment rehabilitation/ soil conservation measures, implemented by the Department of Agriculture during the 1950s, played an important role in the reduction of catchment run-off.

Because of the progressive decrease in water volumes and increase in salinity, irrigated agriculture became a high-risk activity and many farmers went out of business. Good examples are Golden Valley in the upper Fish River catchment and the Kendrew area in the upper Sundays River catchment. This strongly influenced the Government's decision in the early 1960s to build the Orange-Fish-Sundays transfer scheme, although this has not saved all the original irrigation regions. For example the more than 3 000 ha of irrigation previously supplied from the van Ryneveld's Pass Dam (now Nqweba Dam) no longer exists because the area is not supplied with Orange River water. So too, the large-scale irrigation that previously existed along the Tarka River has dwindled drastically. These days all the significant irrigation (about 51 000 ha) in the region is totally dependent on Orange River water.

This system supplies Orange River water to the Great Fish River valley and thence to the Sundays River valley, to supplement local water supply. Some water is also transferred to the NMMM via this system. From the Orange-Fish Tunnel outlet at Teebus, down to the NMMM is a distance of approximately 500 km. The impact of the transferred water on the yields of the

Great Fish and Sundays river catchments is 575 million m^3/a (in accordance with the Upper Orange WMA ISP Report), although larger volumes are transferred on average, including freshening transfers. Actual water use is on average less than allocated use, notably so in the lower Sundays River.

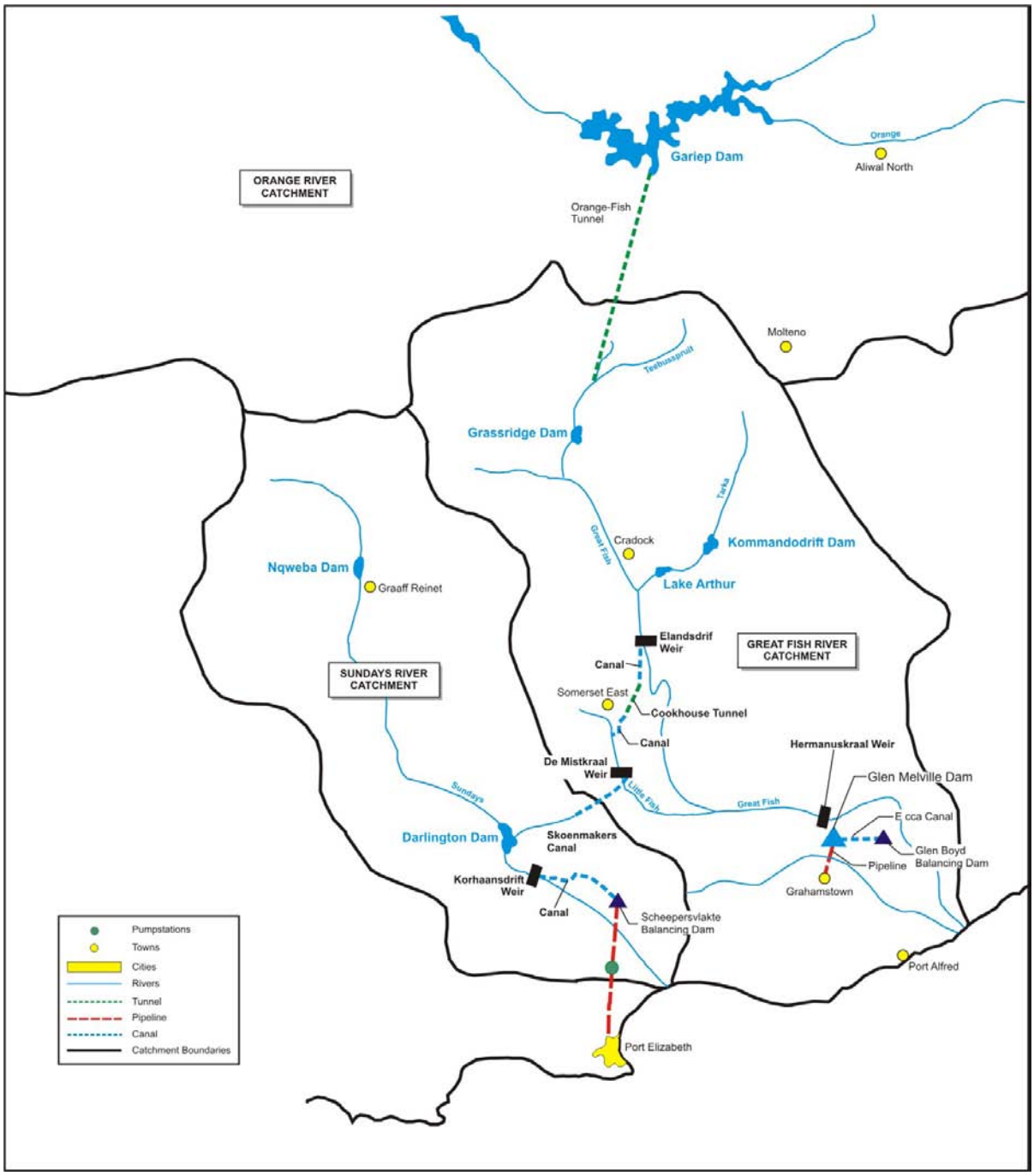

Figure 2.15: Schematic diagram of the Orange-Fish-Sundays Transfer Scheme

Any farmer is only entitled to his/her allocation. The amount transferred is however determined by (*allocated quantity + allowed canal distribution losses + river losses + freshening releases (if any) – expected return flows*). Irrigation water distribution from the

main canals to field edge in all the small schemes and most of the large schemes along the Great Fish River is via earth canals. Canal losses are very significant and DWAF allows for a loss of 25% in the Fish River basin and 15% in the lower Sundays at no cost to the irrigator [17, 23]. The historic situation has put no incentives on irrigators to be more effective, and there is a need to especially curtail operating losses.

The natural quality of water in the Fish Sundays system deteriorates downstream through natural salinity. The water transferred from the Orange River System is of high quality but overall the quality gets progressively worse, as is common for irrigation schemes in relatively arid areas, through the leaching of salts and consequent saline return flows. A significant volume of additional water is required each year from the Orange River, purely to provide for freshening releases to keep the rivers within an acceptable quality.

It is the task of the water managers to see that downstream quality is suitable for irrigators and others users, although this would also be defined by natural quality. The Reserve requires that a sufficient quantity of water, of a quality which reasonably mimics the natural situation, remains in the river at all times. This also guides management.

i. Orange-Fish infrastructure

The small power plant at the Teebus tunnel outlet has never been used for the production of electricity and the DWAF is at present evaluating the possibility of implementing a public/private partnership for its future operation. Any potential future operation must not influence the operation of the tunnel system.

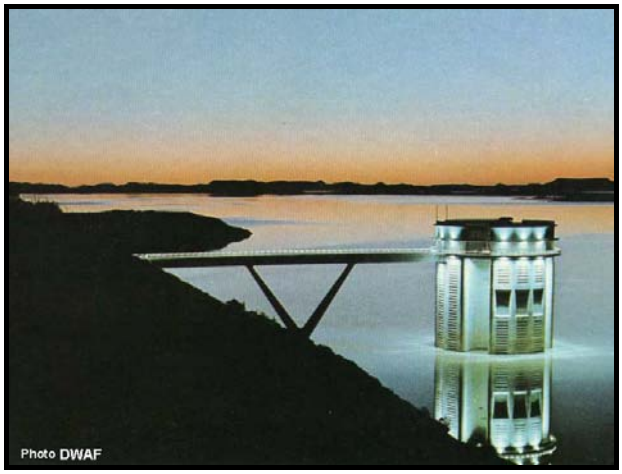

Figure 2.16: Intake tower at Gariep Dam

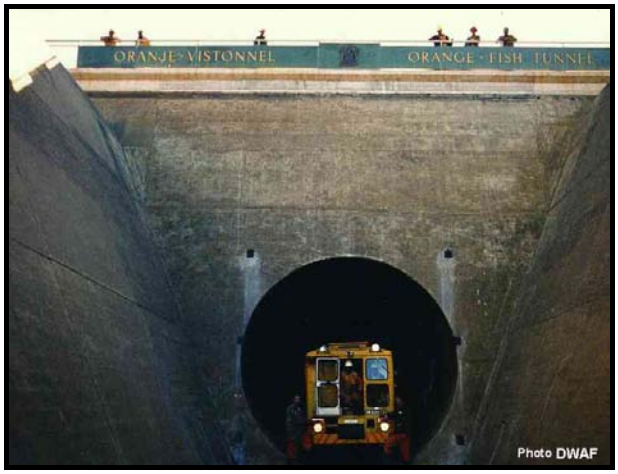

Figure 2.17: Orange-Fish tunnel outlet

Orange River water is transferred from the Gariep Dam through the 83 km long Orange-Fish Tunnel to be discharged into the Teebus Spruit, a tributary of the Great Fish River, and runs down into the Grassridge balancing dam. The tunnel is one of the largest water supply tunnels in the world. The maximum original capacity of the tunnel was 54 m^3/s at full supply level in the Gariep Dam, and has since decreased by approximately 10%. Most of the water supplied

through the tunnel is used for irrigation purposes, although transferred water is also used for evapo-river losses, transport of salts, urban supply, groundwater recharge and distribution (canal) losses. The volume of water transferred fluctuates on an annual basis according to local catchment yield and crop mix, areas irrigated, requirements for freshening and availability of Orange River water to be transferred.

Transferred water (see **Table 3.6** and **Figure 3.7** for annual transfer volumes) released from the Grassridge Dam is used by the various sub-areas of the Great Fish River WUA for irrigation along the Great Fish River, down to the confluence with the Little Fish River. Irrigation along part of the lower Tarka River also falls under this scheme. Due to natural catchment salinity and especially irrigation return flows, water in the river becomes progressively more saline downstream. Elandsdrift Weir is another balancing dam upstream of the confluence with the Little Fish tributary. At the confluence with the Little Fish River the water quality reaches the point where it is, on average, no longer suitable for irrigation use.

Riparian owners downstream of the confluence with the Little Fish River abstract water on an opportunistic basis. Grahamstown and the Tyhefu Irrigation Scheme along the lower Fish River are however supplied with water of suitable quality through pulse releases from the Elandsdrift Weir, diverted from the Hermanuskraal Weir through a tunnel to the Glen Melville off-channel storage dam. From there irrigation water is supplied by means of canals and pipelines. Water is also purified at the dam and pumped to Grahamstown.

Water is also released from Elandsdrift Weir into the Great Fish River to supply users of the Lower Fish River Scheme (which consists of the Hermanuskraal diversion weir in the Great Fish River and a tunnel to divert water into the Glen Melville Dam on the Ecca River), and to serve users in the Grahamstown area. The distribution system for irrigation consists of a weir in the Ecca River below the Glen Melville Dam, which diverts water into a canal leading to the Glen Boyd balancing dam. From there, pipelines divert the water to the irrigable land on both sides of the river. A municipal pumping scheme conveys water from a treatment works at the Glen Melville Dam to Grahamstown (1 million m^3/a is currently transferred for their use).

ii. Fish-Sundays infrastructure

At the Elandsdrift Weir about 163 million m^3/a is diverted for eventual use in the lower Sundays River valley. The Elandsdrift Weir is the start of the Fish-Sundays transfer scheme. The scheme consists of a 19 km canal to the 13 km Cookhouse tunnel through the Bosberg mountain chain and a further 14 km canal to the stepped chute near Somerset East which discharges into the Little Fish River. About 40 km further down the Little Fish the water is picked up at De Mistkraal Weir into the 26 km Schoenmakers Canal which discharges 123 million m^3/a into the Schoenmakers River, a tributary of the Sundays River, which feeds into the Darlington Dam. All along the way water is used for irrigation.

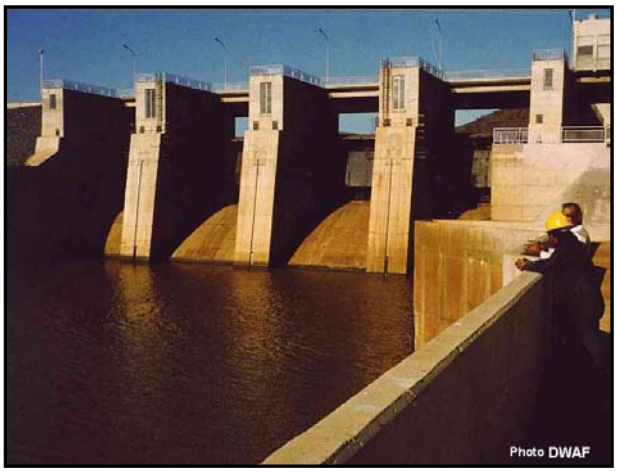

Figure 2.18: Elandsdrift Weir

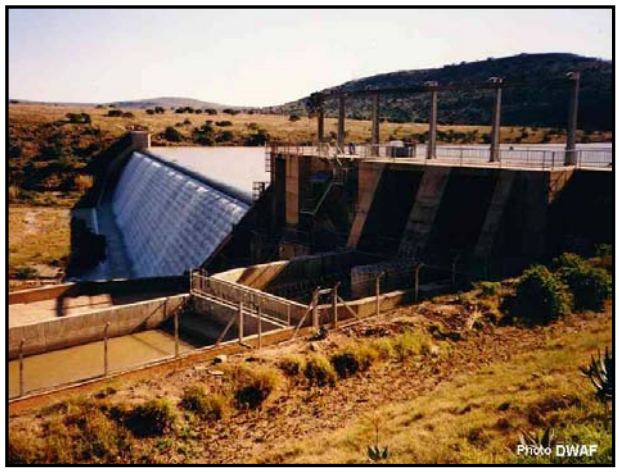

Figure 2.19: De Mistkraal Weir

Figure 2.20 on the following page is a simplified schematic diagram of the Orange-Fish-Sundays Water Supply System, which also shows the deterioration of water quality as it flows through the system.

Before the construction of the Orange River Project, natural water quality in Darlington Dam was often poor in the past, because the base flow in the Sundays River is heavily mineralised. Water from Darlington Dam is released down the river to the Korhaansdrift Weir, which diverts water into the Lower Sundays main irrigation canal. Most of the water is used for irrigation and some flows to the Scheepersvlakte Dam from where the remainder is transported to the Nooitgedacht purification works on the right bank of the Sundays River by gravity pipeline. From there it is conveyed to Motherwell Reservoir by a pumping main and gravity pipeline to serve users in the urban areas of Port Elizabeth (the final remainder of 11 million m^3/a of the transferred water).

The Tsitsikamma to Coega ISP addresses the water requirements of the NMMM through the *NMMM future augmentation Strategy* and the operation of the relevant portion of the Orange-Fish-Sundays Water Supply System (OFSWSS) infrastructure through the *Algoa System Management Strategy*. The current 25.6 million m^3/a capacity of supply of Orange River water to the NMMM, via the Sundays River, is limited by the treatment capacity and could, if necessary, be substantially increased in the future by extending the treatment works and increasing the capacity of the delivery pipelines and some sections of the raw water conveyance system. At present, water treatment capacity of approximately 20 million m^3/a has been constructed, the intention being to increase both the treatment and conveyance capacity as dictated by future water requirements.

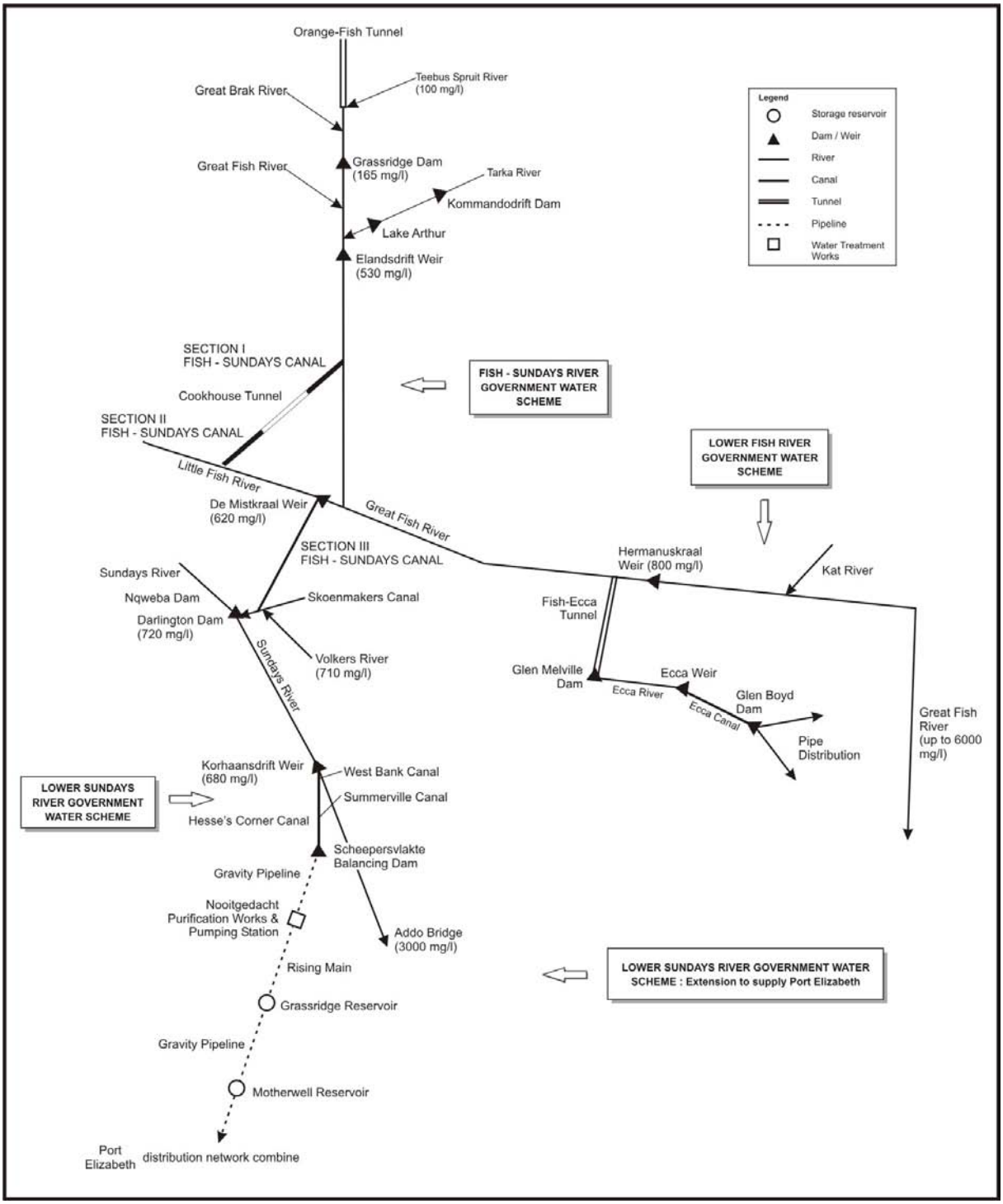

Figure 2.20: Simplified schematic diagram of the O-F-S Transfer Scheme

Figure 2.21: Darlington Dam wall

b. Other significant infrastructure

Separate irrigation schemes exist on the Tarka and Kat Rivers.

The Kat River Dam Water Supply Scheme supplies raw water to the towns of Seymour and Fort Beaufort, as well as for the irrigation of 1 130 ha of land (1 600 ha is scheduled), with citrus being the predominant crop.

The Tarka River Government Water Scheme obtains water from the Commando Drift Dam. Some Orange River water is also supplied, by means of a pump and canal, to the lower reaches of the scheme below Lake Arthur. Only about 180 ha are still irrigated from Lake Arthur itself. Owing to loss of storage capacity as a result of siltation, together with the building of farm dams, abstraction works and anti-erosion structures in its catchment, the yield of Lake Arthur is now negligible and it is essentially operated as a weir.

c. Potential future schemes

Potential future schemes have been identified in the Kat and the Koonap rivers. The proposed Foxwood Dam in the Koonap River has a potential yield of 25 million m^3/a, although this water would be expensive. Groundwater holds significant potential, as is explained in Section 3.1.2. The water source for the proposed Tamboekiesvlei Scheme will likely be from a small tributary in the Kat River catchment, and from fountains.

2.4.2 Local water supply schemes

Figure 2.22: Graaff-Reinet

Several towns use transferred Orange River water. These include Grahamstown, Enon, Kirkwood, Cookhouse, Bedford and Cradock. A scheme to supply water to Steynsburg from the Orange-Fish tunnel was recently initiated.

The towns of Nieu Bethesda, Aberdeen, Jansenville, Riebeeck East, Alexandria, Boknes, Cannon Rocks, Paterson, Kenton-on-Sea, Tarkastad, Hofmeyr, Steynsburg and Middelburg all rely solely on borehole supplies. Borehole development is prominent not only in these towns but also around them (**Figure 5** in **Appendix 2**).

Towns supplied by local dams are Graaff-Reinet (Nqweba Dam, previously known as Van Rynevelds Pass Dam), Alicedale (New Years Dam), Port Alfred and in Bathurst (Mansfield and Sarel Hayward dams), Seymour and Fort Beaufort (Kat River Dam), Adelaide (off-channel storage on the Koonap River) and Peddie (Khewekazi Dam). Peddie forms part of a regional water supply system that receives Keiskamma River water from the Peddie Regional Scheme, along with many dense rural settlements. Grahamstown also receives water from a number of local dams.

The water supply status, need for augmentation, and possible and expected future sources of towns are discussed in the table that form part of the *Supply to local authorities strategy*, Strategy 5.4.

CHAPTER 3 – WATER RESOURCES PERSPECTIVE OF THE ISP AREA

This chapter presents a perspective of the water availability in the ISP area, water requirements of the various water use sectors and the yield balance and reconciliation options. Supplies and demands in the ISP area are currently practically in balance. Only enough water is transferred from the Orange River into the Fish River to meet the requirements for abstraction and to provide freshening flows.

Surplus flows observed or recorded in the lower Fish and Sundays Rivers are as a result of freshening releases, unused releases for irrigation use, or return flows downstream of the last point of abstraction. Salinity may be too high in these river stretches for direct beneficial use without further blending or treatment. This water is therefore not readily available for use, but for a large part of the year provides flows that are beneficial for the functioning of the estuary.

As will become clear in this Chapter, only limited additional amounts (over and above current transfer volumes) of Orange River water will in future be transferred to this ISP area via the Orange-Fish-Sundays Water Supply System. Water for future allocation and transfers has only been reserved for the establishment of 4 000 ha of resource-poor farmer irrigation schemes in the Fish and Sundays catchments and for full use of its allocation by the NMMM. Further transfer to meet the growing urban demand in the Port Elizabeth/Uitenhage/Despatch urban areas, now unified under the Nelson Mandela Metropolitan Municipality (NMMM), and the Coega Industrial Development Zone, which is currently under development, is however a possibility.

Although only three sub-areas have been demarcated for this ISP area, twelve hydrological sub-divisions (river stretches, rivers or grouped rivers) have been identified for hydrological calculations, so as to present a more detailed picture of the water balance in the ISP area. These hydrological sub-divisions are shown in **Table 3.1** and are graphically depicted in **Figure 3.1**.

3.1 WATER RESOURCES AVAILABILITY

The transfer of Orange River water dominates the availability of water. Local catchment yields (Fish and Sundays) are relatively small and highly variable. Information on water resources availability has been drawn from the NWRS, and approximately the same format of presentation has been followed.

3.1.1 Surface water availability

The water resources are not evenly distributed across the catchment, with natural runoff greater towards the coast and in a small area along the western boundary, where higher rainfalls occur. The natural mean annual runoff (MAR) of 972 million m^3/a has been reduced by changes in land use, soil conservation measures, abstractions and other consumptive uses,

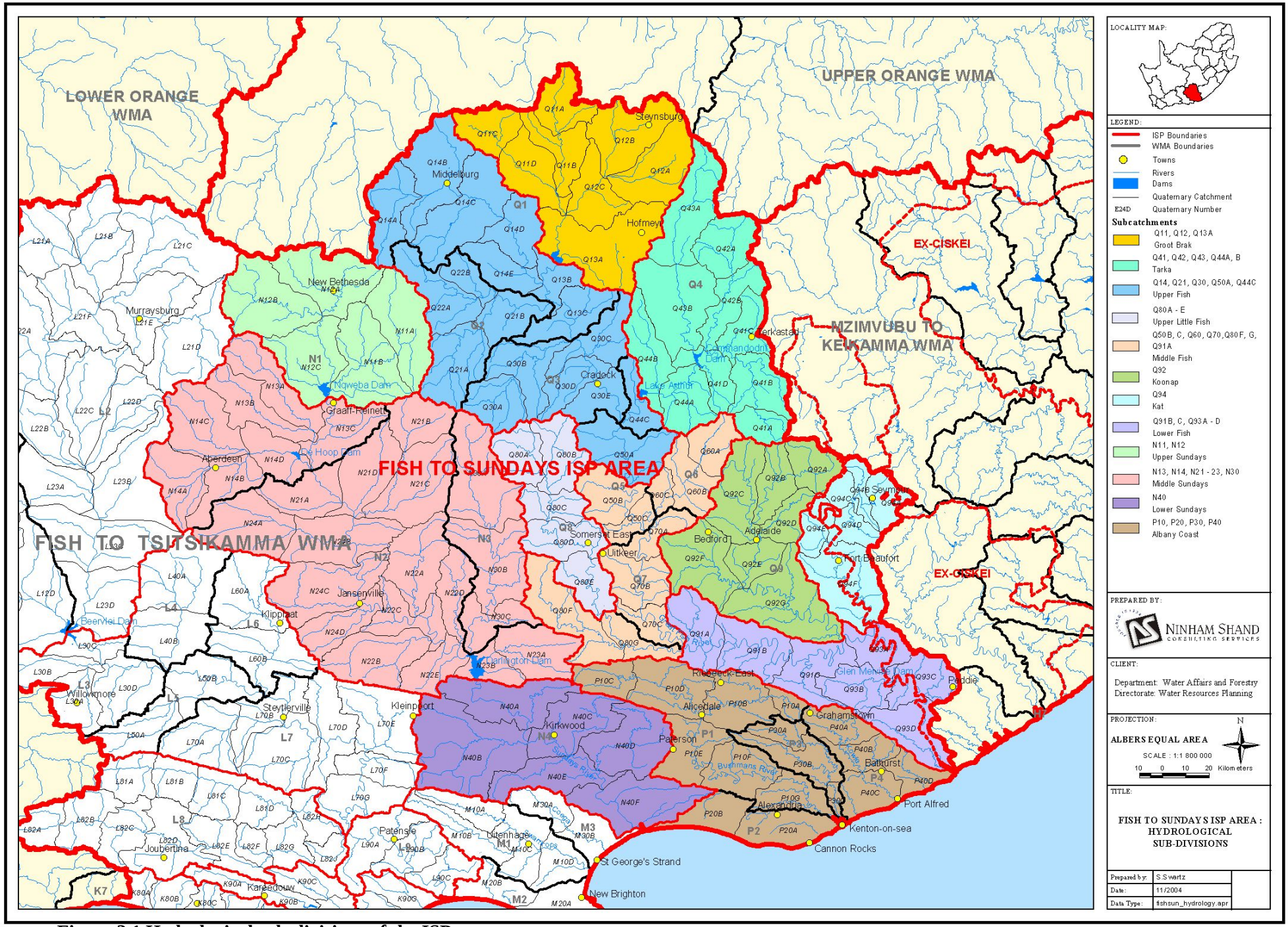

Figure 3.1 Hydrological sub-divisions of the ISP area

but has been substantially augmented through transfers from the Orange River for irrigation, urban use and freshening releases. There are no natural lakes or large wetlands in the ISP area, although there are many small wetlands. There is uncertainty about the estimates of the Reserve and how these may change in future. The Great Fish estuary is ranked among the top fifteen estuaries in South Africa in terms of conservation importance [19].

Table 3.1: ISP sub-areas and hydrological sub-divisions

ISP Sub-area	Hydrological sub-division / River	Reason for selection	Secondary catchment	Tertiary / quaternary catchment
Fish	Groot Brak	Catchment of Grassridge Dam	Q1 (part)	Q11, Q12, Q13A
	Tarka	Catchment of Lake Arthur	Q4	Q41, Q42 Q43 Q44A, B
	Upper Fish	Incremental catchment of Elandsdrift Weir	Q1 (part) Q2 to 4 Q5 (part)	Q13B, C Q14, Q21 Q22, Q30 Q50A Q44C
	Upper Little Fish	Catchment of De Mistkraal Weir	Q8 (part)	Q80A to E
	Middle Fish	Part of Fish River Irrigation Scheme area	Q5 - Q9 (part)	Q50B, C, Q60, Q70 Q80F, G
	Koonap	Koonap River Catchment	Q9 (part)	Q92
	Kat	Kat River Catchment	Q9 (part)	Q94
	Lower Fish	Main stem of lower Fish River	Q9 (part)	Q91 A, B, C Q93A to D
Albany Coast	Bushmans	Catchment of Bushmans River	P1, P2	P10, P20
	Kowie/Kariega	Catchments of Kowie and Kariega Rivers	P3, P4	P30, P40
Sundays	Upper Sundays	Catchment of Nqweba Dam	N1 (part)	N11, N12
	Middle Sundays	Incremental catchment of Darlington Dam	N1 (part), N2, N3	N13, N14 N21 - 23 N30
	Lower Sundays	Lower Sundays Irrigation Scheme area	N4	N40

More detail on the estimation of the Reserve is discussed in **Addendum 3 of the NWRS First Edition, 2004**. Only estimates of the Reserve for the ecological water requirements of the rivers were available. Estimates of the requirements of the estuaries still need to be made and incorporated into the figures.

A summary of the natural runoff, together with the estimated ecological flow requirements (EFR), is given in **Table 3.2**. An *incremental value* refers to the flow in the main stem river at the outlet of an individual hydrological sub-division, relating only to that area, while a cumulative value (MAR or EFR) indicates the cumulative flow in the main stem of a river at

the outlet of the hydrological sub-division, and includes the flows originating from upstream river reaches and tributary rivers.

Table 3.2: Natural MAR and estimated EFR (million m³/a)

Hydrological sub-division	Natural MAR	Incremental natural MAR (1)	EFR	Incremental EFR (1)
Groot Brak	60.5	60.5	4.5	4.5
Tarka	65.9	65.9	4.6	4.6
Upper Fish	215.6 (2)	89.2	15.5 (2)	6.4
Upper Little Fish	38.8	38.8	4.2	4.2
Middle Fish	310.0 (2)	55.6	23.2 (2)	3.5
Koonap	76.4	76.4	9.6	9.6
Kat	70.0	70.0	7.1	7.1
Lower Fish	518.5 (2)	62.1	46.8 (2)	6.9
Fish Total	**518.5**	**518.5**	**46.8**	**46.8**
Bushmans, Kowie/Kariega	173.6	173.6	15.3	15.3
Albany Coast Total	**173.6**	**173.6**	**15.3**	**15.3**
Upper Sundays	43.7	43.7	3.0	3.0
Middle Sundays	217.6 (2)	173.9	13.1 (2)	10.1
Lower Sundays	279.9 (2)	62.3	19.8 (2)	6.7
Sundays Total	**279.9**	**279.9**	**19.8**	**19.8**
Total for ISP area	**972**	**972**	**81.9**	**81.9**

1) Quantities given are incremental, and refer to the sub-area under consideration only. This is the total volume, based on preliminary estimates. Impact on yield will be a portion of this.
2) The value indicates the cumulative flow in the main stem of the river, at the outlet of the hydrological sub-division, and includes the flows from upstream river reaches and of rivers flowing into the hydrological sub-division's main stem river.

The **available yield** is the amount of water that can be expected to be "available" for commercial use (for 98% of the time in this case), either from dams, directly from rivers, or from groundwater - during any one year. The available yield in the ISP area is a combination of the yields obtainable from local catchments through existing infrastructure supplying surface water, groundwater and usable return flows, as well as transfers into the ISP area.

Figure 3.2: Sundays River Estuary

Figure 3.3: Great Fish River Estuary

Table 3.3 shows the calculation for the determination of the surface water yields for the various hydrological sub-divisions, the sub-area totals and the ISP area totals. It is important to note that under 1:50 year drought conditions, the Grassridge and Darlington dams operate purely as balancing dams for transferred water, and their yields are negligible. In the case of Darlington Dam, this is because the dam is not operated anywhere near its full capacity, because of problems with the gates [27]. The yield of the dam when operated to its full capacity was determined to be 28 million m³/a.

Owing to the aridity of the area, the estimated impacts of the ecological flows on the available surface water yields are very small. Invasive alien plants have an even lesser impact. Concern have been expressed that the yields from minor dams and run-of-river abstraction seem too high, but the values from the NWRS, determined through modelling, have been retained because information at an improved confidence is not available.

Table 3.3: Surface water yield in the year 2000 (million m³/a) at 1:50 year assurance

Hydrological sub-division	Yields from major dams (a)	Yields from minor dams & run-of-river (b)	Surface water yield before reductions (c = a+b)	Reduction in yield: Reserve (d)	Reduction in yield: Alien plants (e)	Surface water yield (c-d-e)
Groot Brak	0.0 (1)	2.0	**2.0**	0.0	0.0	2.0
Tarka	7.0	2.0	**9.0**	1.3	0.0	7.7
Upper Fish	0.0	2.0	**2.0**	0.0	0.0	2.0
Upper Little Fish	0.0	20.0	**20.0**	0.0	0.0	20.0
Middle Fish	0.0	5.7	**5.7**	0.0	0.0	5.7
Koonap	0.0	20.0	**20.0**	0.0	0.0	20.0
Kat	12.7	10.3	**23.0**	1.3	1.2	20.5
Lower Fish	0.0	13.0	**13.0**	0.0	0.0	13.0
Fish Total	**19.7**	**75.0**	**94.7**	**2.6**	**1.2**	**90.9**
Bushmans, Kowie/Kariega	6.8	10.3	17.1	0.0	2.3	14.8
Albany Coast Total	**6.8**	**10.3**	**17.1**	**0.0**	**2.3**	**14.8**
Upper Sundays	4.5	10.0	**14.5**	1.1	0.0	13.4
Middle Sundays	0 (1)	27.7	**27.7**	0.0	0.3	27.4
Lower Sundays	0.0	14.0	**14.0**	0.0	0.0	14.0
Sundays Total	**4.5**	**51.7**	**56.2**	**1.1**	**0.3**	**54.8**
Total for ISP area	**31.0**	**137.0**	**168.0**	**3.7**	**3.8**	**160.5**

1) At 1:50 year assurance, the yields of both Grassridge and Darlington dams are negligible, and these dams act only as balancing dams.

The reduction in yield due to the Reserve was set to zero for both the Groot Brak and Lower Sundays hydrological sub-divisions, whereas in the NWRS the reduction in yield due to the Reserve for the Groot Brak was 1.2 million m^3/a and for the Lower Sundays 3.7 million m^3/a. These changes were made because the yields from large dams in these hydrological sub-divisions for the 1:50 year situation are negligible. The reduction in yield due to the Reserve would therefore also be negligible in such circumstances.

3.1.2 Water availability

Table 3.4 shows the yields per ISP sub-area and per hydrological sub-divisions. Return flows resulting from irrigation with Orange River water is strictly speaking not part of the local yield, but has been included here, in a similar fashion as in the NWRS. Values under the "*Transfer in*" column refer to impacts that transferred flows have on the yields of the receiving catchments under 1:50 year drought conditions, determined through modelling.

Table 3.4: Available yield in the year 2000 (million m^3/a) at 1:50 year assurance

Hydrological sub-division	Natural resource		Usable return flow			Total local yield	Transfers in	River losses	Grand Total
	Surface water	Ground-water	Irriga-tion	Urban	Mining and bulk	(1)	(2)	(3)	(1)+(2)+(3)
Groot Brak	2	0	0	0	0	2	575	-6	**571**
Tarka	8	2	0	0	0	10	0	0	**10**
Upper Fish	2	2	39	3	0	46	512	-20	**538**
Upper Little Fish	20	1	11	0	0	32	163	0	**195**
Middle Fish	6	1	25	0	0	32	220	-33	**219**
Koonap	20	0	1	1	0	22	0	0	**22**
Kat	20	0	1	1	0	22	0	0	**22**
Lower Fish	13	0	0	0	0	13	110	-35	**88**
Fish Total	**91**	**6**	**77**	**5**	**0**	**179**	**575**	**-94**	**660**
Bushmans, Kowie/Kariega	15	2	0	4	0	21	1	0	**22**
Albany Coast Total	**15**	**2**	**0**	**4**	**0**	**21**	**1**	**0**	**22**
Upper Sundays	13	1	0	0	0	14	0	0	**14**
Middle Sundays	27	13	12	1	0	53	128	0	**181**
Lower Sundays	14	2	10	1	0	27	115	-18	**124**
Sundays Total	**54**	**16**	**22**	**2**	**0**	**94**	**123**	**-18**	**199**
Total for ISP area	**160**	**24**	**99**	**11**	**0**	**294**	**575**	**-112**	**757**

1) After allowance for the impacts on the yield of the ecological component of the Reserve, river losses, invasive alien plants, dry land agriculture and urban runoff.
2) Transfers into and out of hydrological sub-divisions or sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) River losses as calculated for the Orange River Replanning Study (ORRS) and used in the NWRS.

Transferred water from the Orange River accounts for the majority of all available yield in the ISP area. Significant river losses (as calculated in the ORRS study) due to the large volumes of transferred water have also been taken into account in the calculations of total available yields. The total year 2000 *available surface water yield* from the ISP area at a 1:50 year assurance is 160 million m^3/a. Groundwater yield, which reflects the year 2000 use, is 24 million m^3/a.

Return flows along those parts of the Fish and Sundays Rivers that receive water transferred from the Orange River are high because the substantial seepage losses from distribution canals, as well as the seepage from irrigated lands, which contribute to the totals. Elsewhere they are low to negligible because much of the irrigation occurs in areas in which there is little or no flowing surface water during the summer months. Irrigation return flow of 99 million m^3/a has been included as part of the local area yield, although it must be borne in mind that such return flows only exist because of irrigation with Orange River water.

There is some uncertainty about the 4.5 million m^3/a 1:50 year yield of Nqweba Dam on the Upper Sundays River (which supplies Graaff-Reinet) as previously determined. This must be verified.

The *major* differences between the available yields as determined in the ISP and the NWRS yields are the following:

- Available yield in the ISP area was determined as 757 million m^3/a compared to 786 million m^3/a in the NWRS;
- Sub-area available yields (according to the NWRS sub-areas) were determined as:
    - 660 million m^3/a in the Fish sub-area which is virtually the same as the 659 million m^3/a of the NWRS;
    - 22 million m^3/a in the Albany Coast sub-area which is the same as the 22 million m^3/a of the NWRS;
    - 199 million m^3/a in the Sundays sub-area compared to the 217 million m^3/a of the NWRS;
- The yields of Grassridge and Darlington dams, which is reflected in the surface water yields, have been adjusted, because under 1:50 year drought conditions, these dams operate purely as balancing dams for transferred water, and their yields become negligible. The reduction in yield due to the Reserve, for the hydrological sub-divisions in which these dams fall, were consequently also adjusted;
- The impact on yield of the transfer from the Fish to the Sundays sub-area was increased from 116 million m^3/a in the NWRS to 123 million m^3/a, to reflect a situation where just enough water is transferred to ensure a balanced situation.

3.1.3 Groundwater

Refer to **Appendix 2,** *Groundwater overview* for a more detailed groundwater resources perspective.

Groundwater use is shown by catchment in **Table 3.4,** and by sector in **Table 3.5**. These are

the values given in the NWRS and this use is considered to be equivalent to the current available yield from groundwater sources. Groundwater is often the only source of water for rural domestic use and stock watering, whilst several towns also obtain a large proportion or all of their water from underground sources. Groundwater is also used for urban supply by coastal towns, but cannot always support growing demands and peak seasonal uses.

Actual groundwater use, especially for irrigation, is likely to be significantly higher than has been reflected in the NWRS and these numbers require verification. In general over the ISP area the potential for groundwater use is under-developed.

Table 3.5: Groundwater use in the ISP area

Use	Annual volume (million m^3/yr)	% of total use
Irrigation	17	70
Agricultural /livestock	4	17
Rural domestic	0 (1)	0 (1)
Municipal (bulk water)	3	13
Industrial /mining	0	0
Total	**24** (1)	**100**

1) The zero usage of groundwater for rural supply is questionable. It is possible that this sector has been included under municipal use, but this is not clear – also see **Appendix 2**.

Groundwater is considered to be under-utilised in the Albany Coast sub-area, heavily to over-utilised in many parts of the Upper and Middle Fish areas of the Great Fish sub-area, and moderately to heavily utilised in the middle parts of the Sundays sub-area. This too requires verification.

The under-developed groundwater potential in the ISP area is contained in the fractured rock aquifers of the Katberg and Witteberg Formations (middle to lower reaches of the Great Fish sub-area and the Albany Coast sub-area). It is suggested that improved borehole siting and wellfield management would significantly increase both the yield and the reliability of the groundwater resource in the upper and middle reaches of the Great Fish sub-area.

A purposeful exploration strategy is required to quantify and realise the groundwater usage and resource in this ISP area. In areas where the groundwater yield is low and/or the aquifers are vulnerable to mismanagement and are generally recharged in the extreme precipitation events, it is imperative that the groundwater usage values are correct and up to date. If not, planning is impacted upon and areas in which there appears to be available resources could in fact be stressed and *vice versa*.

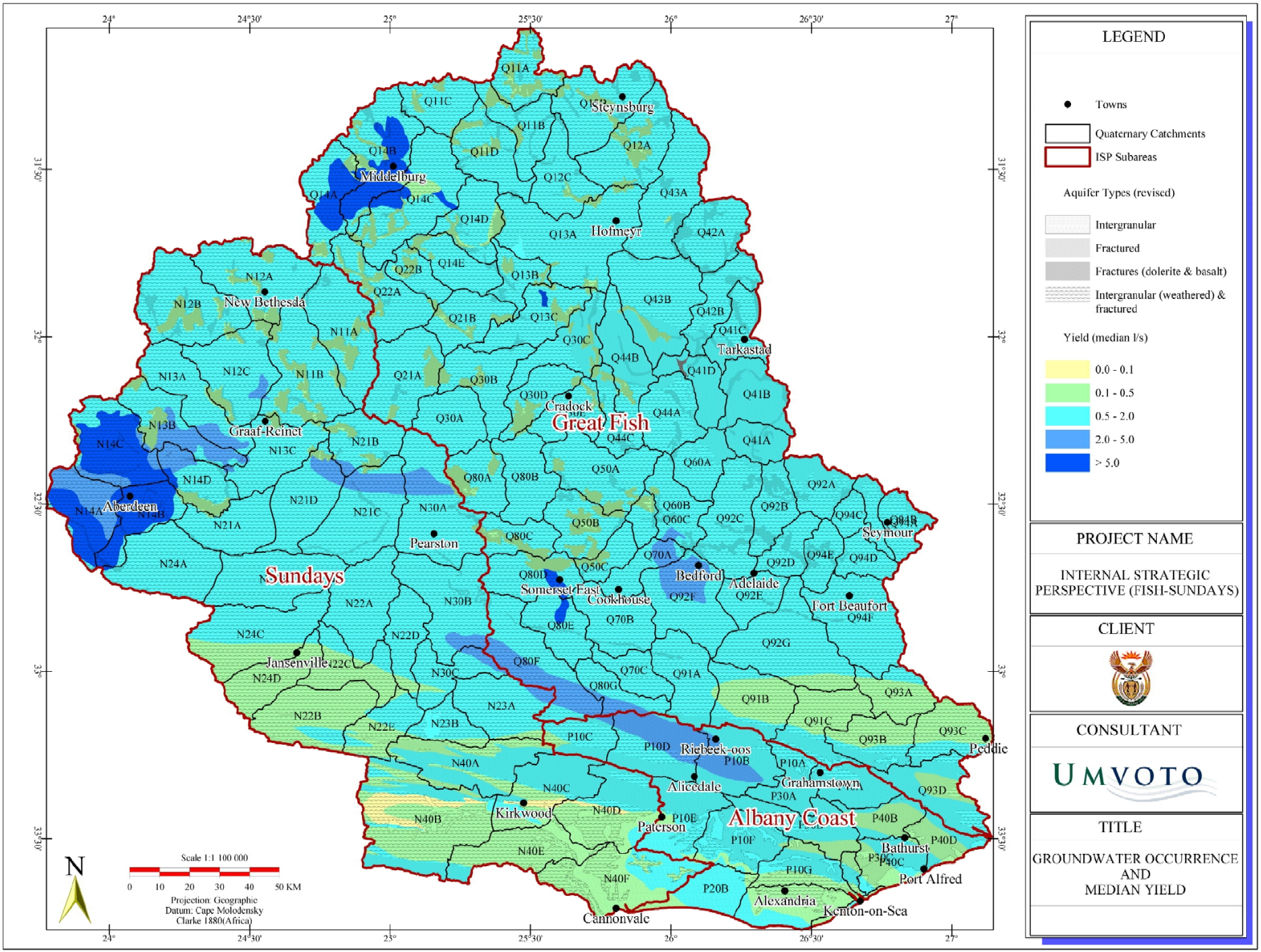

Figure 3.4: Groundwater occurrence and median yield

There are four main aquifer systems in this ISP area (see **Figure 1** in **Appendix 2**). These are:

- the Katberg Sandstones - a fractured rock aquifer;
- the Witteberg Quartzites - a fractured rock aquifer;
- the Intergranular Coastal Aquifers - primary aquifers of marine, fluvial and Aeolian origin; and
- the Dolerite Dyke system - a fractured rock aquifer. This can be considered as a strategic resource since it delivers reliable yields and acceptable water quality in the sub-areas, which are otherwise dominated by regolith aquifers of very poor water quality and yield.

The Katberg and Witteberg aquifers are relatively unexploited and yield good quality groundwater, being fractured sandstone aquifers. Borehole yields from these aquifers are expected to be in the moderate to good range (5 – 20 l/s) and, being in the highest rainfall areas and receiving good recharge. These aquifers would be best exploited if they were explored and developed on a regional scale and if production boreholes were drilled to depths of no less than 300 m.

The coastal aquifers are currently exploited for use in coastal towns but are not necessarily well managed. The groundwater quality varies from good to very poor, depending upon the position and recharge patterns. Boreholes are generally shallow (less than 100 m) or the groundwater is extracted using well points.

The dolerite dyke and sill system extends throughout the Fish and Sundays sub-areas. Small and large Karoo towns use groundwater from this aquifer system. Understanding of the aquifer is improving and significantly increased yields have been realised with improved siting techniques. Monitoring on a regional and a wellfield scale is required to upgrade the management of the wellfields and to improve assurance of supply. The aquifer system could strategically be further developed if location boreholes depths vary between 100 to 300 m.

a. Aquifer recharge and borehole yields

The shallow "regolith" (intergranular/weathered-and-fractured) Karoo Aquifer centred on the towns of Aberdeen, Middelburg and Somerset East (**Figure 4** in **Appendix 2**) provides the highest median borehole yields (>5 l/s) within the Fish-Sundays ISP area. Intermediate to high median yields (2 to 5 l/s) are obtained from the same aquifer within a discontinuous axis stretching from Aberdeen/ Graaff-Reinet in the west through to Bedford in the east. This axis coincides with the transition from the Ciskeian Coastal Foreland to the Middleveld/Eastern Karoo Escarpment and marks the southern limit of the extensive dolerite sheets.

Rates of recharge to groundwater are also somewhat higher along this axis (**Figure 4 in Appendix 2**), but in contrast the area of highest recharge around Seymour produces only low to moderate (0.5 to 2 l/s) median borehole yields from the same aquifer type. Further south, intermediate to high yields are obtained within an elongated WNW-ESE trending zone with its eastward termination in the area between Alicedale, Riebeeck East and Grahamstown. This linear belt of relatively high median yields shows no apparent correlation with aquifer type (fractured Witteberg vs. Intergranular/weathered-and-fractured Adelaide Sub-group) or documented recharge-to-groundwater rate, but appears to coincide closely with an orographically induced zone of higher (400 to 800 mm) mean annual rainfall.

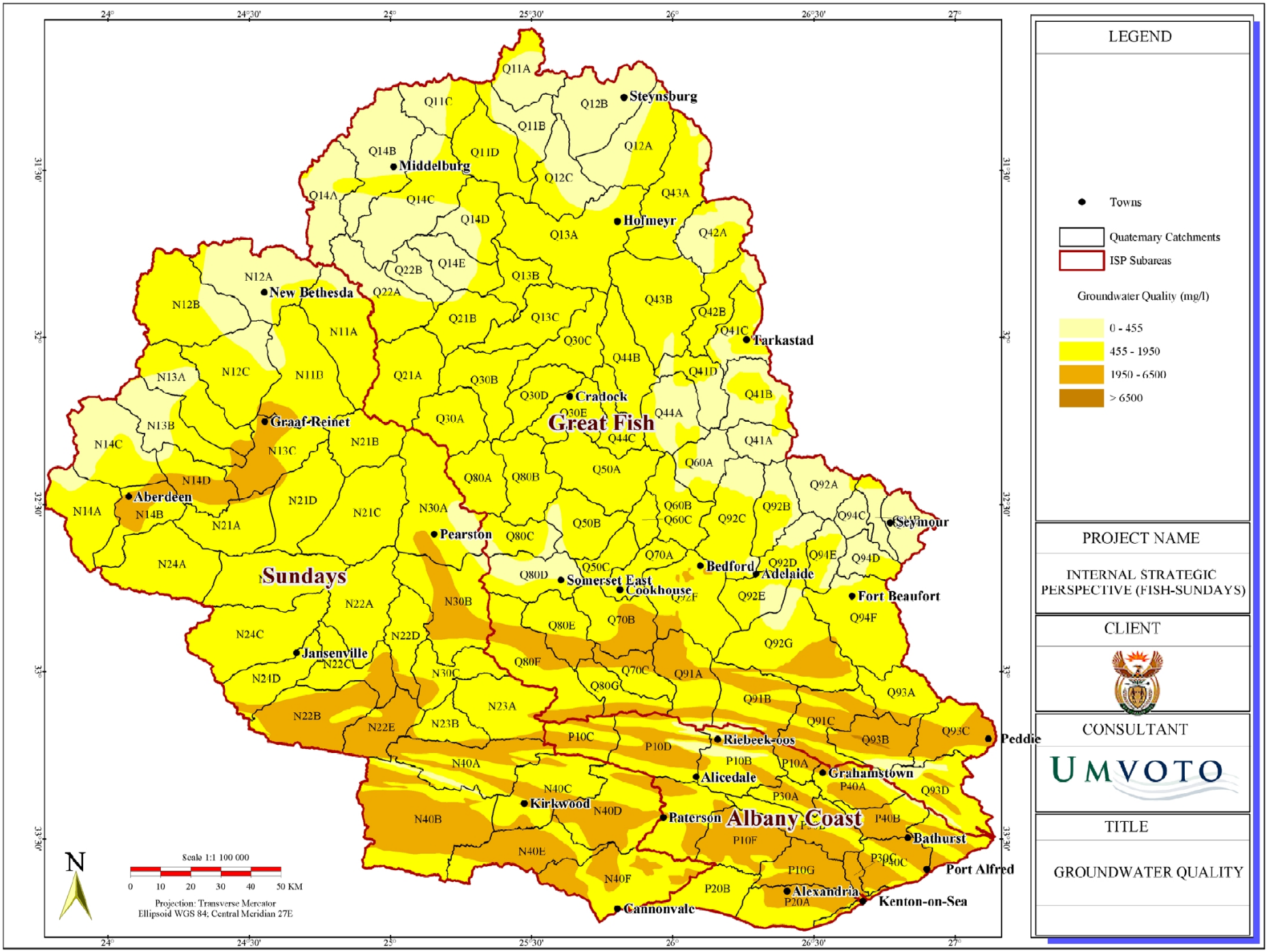

Figure 3.5: Groundwater quality

Low to moderate (0.5 to 2 l/s) median borehole yields are characteristic of the WMA as a whole, with low median yields (0.1 to 0.5 l/s) being obtained in the low lying, middle and lower Sundays (secondary catchments N2 and N4), Lower Fish and Kariega-Kowie/Kariega catchments. In general, the median yield in the southern half of the WMA may be broadly correlated with orographically induced rainfall patterns and to a lesser degree with the aquifer type, with the fractured Peninsula and Witteberg Aquifers and primary Algoa Aquifer showing the highest groundwater potential in the coastal belt.
Rain-shadow areas on the northern side of the Groot Winterhoek Mountains, Klein Winterhoek Mountains and Grootrivier mountains are characterised by mean annual rainfall of 100 to 300 mm and typically have low median borehole yields (0.1 to 0.5 l/s).

b. Vulnerability to pollution

Mapping of aquifer vulnerability (**Figure 6** in **Appendix 2**) indicates that most of the aquifers are in the "least vulnerable" category. There are small areas in the east-central, southern, and north-western parts that are mapped as moderately vulnerable. These areas cannot be correlated with either geology or the nature of the aquifer. The primary and fractured rock aquifers (purple and green areas, respectively, on **Figure 2.5**) may perhaps be considered as more vulnerable units, while the shallow regolith aquifers are in general only moderately vulnerable.

3.1.4 Water quality

The relatively flat topography, low MAR, high evaporation and underlying mudstones generally give rise to saline groundwater and resulting saline base flows in the Fish and Sundays rivers, irrespective of water transferred in from the Orange or irrigation return flows. It is not known what natural water quality without development would be, but it is likely that natural surface water would often be unusable if not diluted with transferred water. The 'natural quality' in an undisturbed system would be an important quantity in assessing quality requirements from a Reserve perspective

a. Groundwater quality

Groundwater quality, shown in **Figure 3.5**, is controlled by the aquifer lithology and geochemistry. In the Albany Coastal Range groundwater of poor quality (TDS > 2 000 mg/l) is associated with outcrops of the Bokkeveld Group and the Dwyka-basal Ecca formations. Areas of low slope (see **Figure 2.2**) in the Ecca and lower Beaufort (Adelaide Sub-group) between the coastal ranges and the Middle Veld escarpment also show a higher electrical conductivity, probably reflecting higher residence times of groundwater under conditions of low hydraulic gradient and low transmissivity of the shallow regolith aquifer.

In the south, the best quality groundwater (TDS < 500 mg/l) is associated with the limited areas of the Witpoort aquifer in the Albany Coastal Range. In the north, good quality groundwater is generally associated with the Katberg sandstone aquifer in the Winterberg Range between Seymour and Cradock, and along the Great Fish and Sundays headwater divides near Nieu Bethesda, Middelburg and Steynsburg.

b. Surface water quality

Water quality in the upper reaches of the Fish River is generally good at 50-100 mg/l [17]. TDS where the Orange River water enters the system. The quality however decreases in a downstream direction, and in the middle reaches of the Fish it is marginal to poor. Sources of salinity in the middle and lower reaches are the geology of the river valley as well as irrigation return flows. Above Elandsdrift Weir water quality is generally of an acceptable standard. Below Elandsdrift Weir the water quality deteriorates downstream and is often not usable, but not much is needed. At Middleton/Sheldon on the Fish River water quality is approximately 800 mg/l and at Committees Drift in the lower Fish River the quality is approximately 2 000 to 3 000 mg/l. Water quality in the lower Fish River can at times be in excess of 6 000 mg/l [25].

Sources of salinity in the middle and lower reaches are the geology of the river valley as well as irrigation return flows. Water quality in the Fish River is controlled to the point where the Middleton WUA abstracts, approximately at the confluence with the Little Fish River. Riparian irrigation below that point are not scheduled to receive Orange River water and no water will be let down for freshening purposes.

The lower Fish River operates as a drain for discharging highly saline irrigation return flows and catchment runoff to the sea. Salinity impacts due to irrigation return flows are the main concern in these catchments. There is however a commitment to supply relatively good quality water to the Lower Fish River Scheme at points of use, i.e. at less than 650 mg/l TDS. Releases to the lower Fish River is therefore made with the aim of achieving a water quality of between 300 to 400 mg/l at Hermanuskraal Weir, where water is diverted to Glenn Mellville Dam, for eventual use by Grahamstown and all scheduled irrigation along the Lower Fish River (Lower Fish River GWS irrigators). Releases of slugs of good quality water is discharged from Elandsdrift Weir and/or De Mistkraal Weir, in the Little Fish River, two or three times a year to fill the Glen Melville Dam. Releases of slugs of such good quality water show "slug flow" behaviour with intermittent periods of good quality (transfer water) and poor quality (natural base flows).

Water quality in the Sundays River is poor in the upper reaches. Darlington Dam has somewhat better water quality because of the introduction of Orange River water. Quality deteriorates to very poor again in the lower reaches of the Sundays River, primarily as a result of irrigation return flows, where the river acts as a collector drain for such flows.

When the Gariep and Van der Kloof dams spill, significant additional volumes can be transferred to the Fish/Sundays rivers to freshen the system.

A gradual increase in salinity in the Fish/Sundays Rivers over the medium term has been observed. **Figure 3.6**, as measured in 1999, and possibly still valid, provides a picture of how water quality decreases as it flows or is transferred through the Orange-Fish-Sundays Water Supply System. The lower Fish River would show a similar (even more pronounced) worsening of quality.

In the Scheepersvlakte Dam from which Port Elizabeth draws some of its raw water, problems have been experienced with corrosion of pumping equipment, taste and odours in treated water and trihalomethane compounds which have formed during the treatment process. Some of the problems are related to elevated levels of dissolved oxygen content [18].

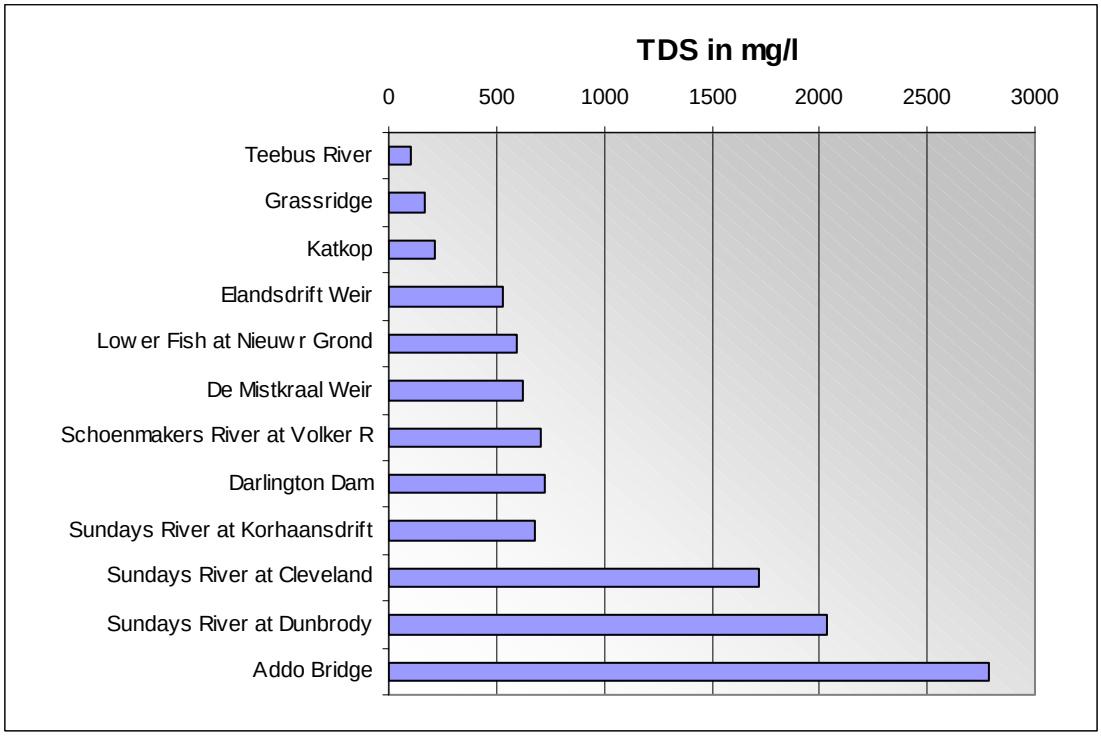

Figure 3.6: Median TDS values of transferred Orange/Fish water (from Herold 1999)

High salinity is the main concern in the Bushmans, Kariega and Kowie River catchments. The Bushmans River water quality is mostly unacceptable. Water quality in the Kowie River is poor and in the Kariega River the water quality is completely unacceptable. The geology of the Bushmans, Kariega and Kowie River catchments results in highly saline base flow which explains the poor water quality in the area.

3.2 WATER TRANSFERS

Table 3.6 and **Figure 3.7** show the various transfers taking place. Large volumes are annually transferred into the ISP area, mainly for irrigation use but also for some use by small towns and further transfer on to the NMMM. Large volumes of freshening flows are also currently transferred in (apparently up to 200 million m^3/a in some years). These transfers also allow for river losses and canal transportation losses. The total impact of transferred Orange River water from the Upper Orange WMA into the Fish to Sundays ISP area on the yield of the ISP area is 575 million m^3/a, of which freshening flows contribute 32 million m^3/a, by making poor quality water usable. A total of 11 million m^3/a of this is transferred further to the Tsitsikamma to Coega ISP area for use in the NMMM. See the Upper Orange ISP [31], Report P WMA 13/000/00/0304 for the corresponding description of transfers to this ISP area. Significant volumes flow to the sea through the estuaries of the Great Fish and Sundays Rivers.

Table 3.6: Transfers within the ISP area (million m^3/a) at 1:50 year assurance

Hydrological sub-division	Transfer from upstream	Freshening transfer from upstream	Other transfers in	Total transfer in	Notes on transfer in	Transfer out d'nstream	Freshening transfer out d'nstream	Other transfer out	Total transfer out	Notes on transfers out
Groot Brak	0	32	543	**575**	Transfer in from Upper Orange WMA	478	32	0	**510**	To Upper Fish, including freshening release flows
Tarka	0	0	0	**0**	No transfer in	2	0	0	**2**	To irrigators below Lake Arthur (in Upper Fish)
Upper Fish	478	32	2	**512**	From Groot Brak and Tarka	150	45	163	**358**	Transfer to Upper Little Fish and d/s to Middle Fish, including freshening releases
Upper Little Fish	0	0	163	**163**	From Upper Fish	0	25	123	**148**	Transfer to Middle Sundays and freshening release to Lower Fish
Middle Fish	150	70	0	**220**	From Upper Fish and Upper Little Fish, including freshening releases	40	70	0	**110**	To Lower Fish
Koonap	0	0	0	**0**	No transfer in	0	0	0	**0**	No flows under 1:50 year conditions
Kat	0	0	0	**0**	No transfer in	0	0	0	**0**	No flows under 1:50 year conditions
Lower Fish	40	70	0	**110**	From Middle Fish	0	70	1	**71** (1)	To Albany Coast and flows to sea
Fish Total	0	**32**	**543**	**575**	From Upper Orange WMA	0	**70** (1,2)	**123**	**193** (1)	To Sundays River and flows to sea
Bushmans, Kowie/Kariega	0	0	1	**1**	From Lower Fish	0	0	0	**0**	No transfer out
Albany Coast Total	0	**0**	**1**	**1**	From Lower Fish	0	**0**	**0**	**0**	No transfer out
Upper Sundays	0	0	0	**0**	No transfer in	5	0	0	**5**	To middle Sundays
Middle Sundays	5	0	123	**128**	From Upper Little Fish	115	0	0	**115**	To Lower Sundays
Lower Sundays	115	0	0	**115**	From Middle Sundays	0	7 (3)	11	**18**	To NMMM and flows to sea
Sundays Total	0	**0**	**123**	**123**	From Upper Little Fish	0	**7** (3)	**11**	**18**	To NMMM and flows to sea
Total for ISP area	0	**32**	**543**	**575**	From Upper Orange WMA	0	**77** (1,2)	**11**	**88** (1)	To NMMM and flows to sea

1) Includes freshening flows/ return flows of 70 million m^3/a to sea from the Fish River.

2) Irrigation return flows of 7 million m^3/a to sea from the Sundays River.

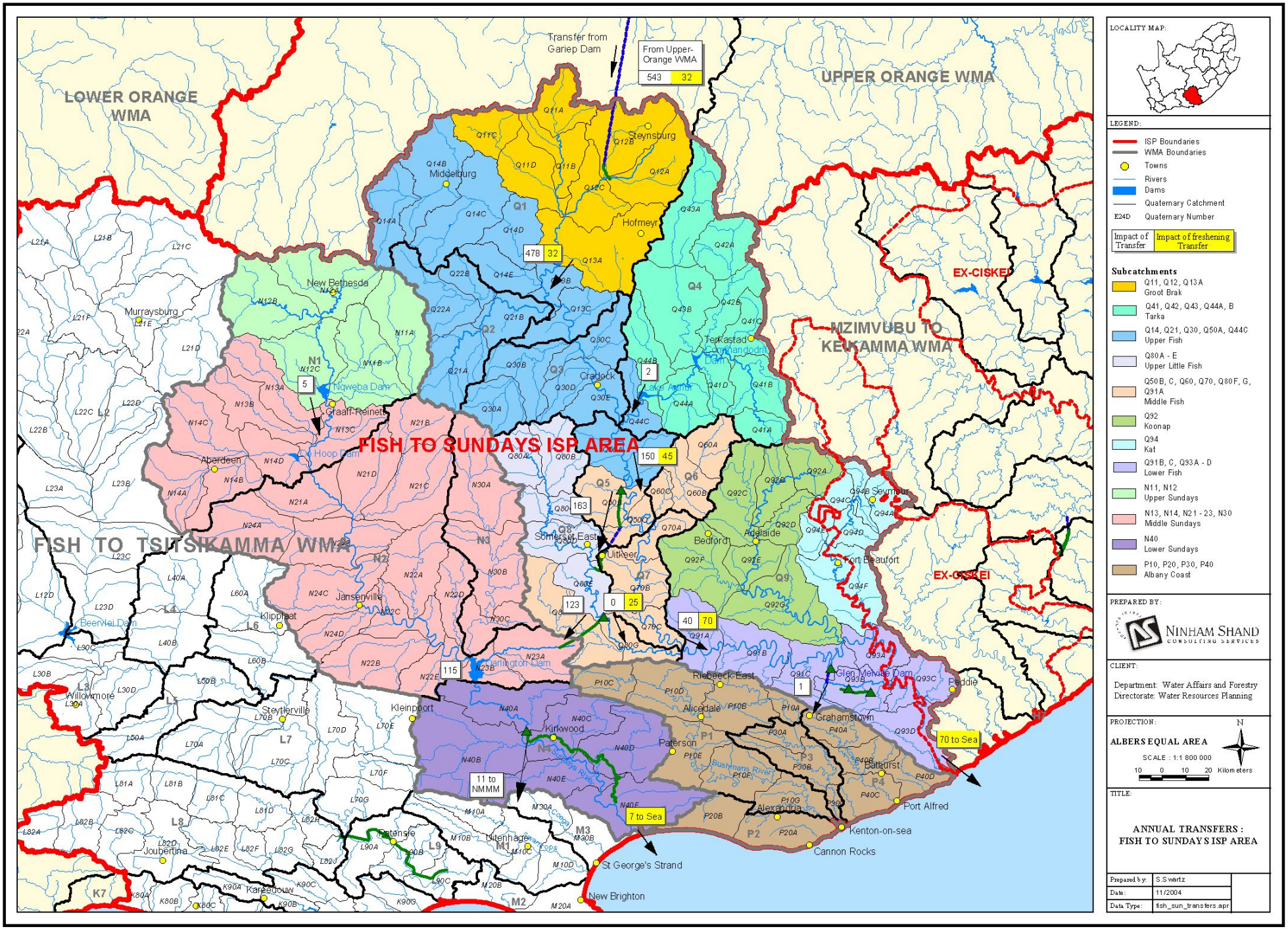

Figure 3.7: Annual transfers

Distinction is made between flows to river reaches of downstream hydrological sub-divisions, transfers to other sub-divisions and freshening releases, which are shown separately as downstream transfers in **Table 3.6**. Freshening flows are specifically released into the Great Fish River, in addition to irrigation requirements, to control the salinity of the water abstracted for irrigation. In addition, freshening releases from Elandsdrift Weir, at the outlet of the Upper Fish sub-division, account for 1:50 year yields of 45 million m^3/a, and 25 million m^3/a from De Mistkraal Weir, at the outlet of the Upper Little Fish sub-division. Part of this water released for freshening originates from return flows.

It has been assumed that areas receiving Orange River water transfer just enough water (including freshening flow requirements) to satisfy the demands, i.e., they are in balance. Transfer amounts from the NWRS were used to determine the water balance, as a starting point. Because of the assumption that all the hydrological sub-divisions are practically in balance, such transfers were then slightly modified, so that areas receiving Orange River water were in balance. The impact on yield (116 million m^3/a) of the transfer from the Fish to the Sundays sub-area in the NWRS was subsequently increased to 123 million m^3/a.

3.3 WATER USE

Figure 3.8: Port Alfred – an important urban user

There can be large differences in the assurance of supply at which various users receive their water. It is therefore necessary to convert actual water allocations to the same assurance of supply, in order to determine a meaningful yield balance at that particular assurance.

There are large uncertainties associated with irrigation water use in this ISP area. Allocations from Government Water Schemes have been partially updated by DWAF Regional Office Staff as part of the preparation of this ISP and the information has been included in **Appendix 10**. Use estimates are however not based on these allocations. Irrigation use outside of the Government Water Schemes is not readily available and will have to be sourced from allocations registered on the WARMS database. These will need verification. Additional water use surveys may also prove necessary. Improved estimates of actual irrigation requirements should also be obtained so that allocations can better be matched to requirements. Record keeping is poor in terms of releases, freshening releases, and actual use, and requires urgent attention. The *Reliability of the Yield Balance Strategy*, Strategy 5.1, provides a more detailed evaluation of the uncertainties associated with water use in the ISP area.

Information on water use has been drawn from the NWRS, and approximately the same format of presentation has been followed. Available updated information has been included

and obvious errors have been corrected. The assurance level chosen for comparison purposes is 1:50 year failure or 98% assurance of supply. Water requirements, as shown in **Table 3.7**, are standardised at a 98% assurance of supply.

The differences between the water requirements as determined in the ISP and the NWRS water requirements are the following:

- The irrigation requirement in the Fish sub-area was corrected to 447 million m^3/a, compared to 453 million m^3/a for the NWRS. This as a result of:
  - the Kat River use that was changed to 17 million m^3/a, in line with allocations, compared to 14 million m^3/a;
  - a reduction in the irrigation water requirement from the Commando Drift Dam, which should not include the irrigation below Lake Arthur in the Tarka River catchment (as it does in the NWRS), as this (except for 180 ha) receives transferred Orange River water via the Fish River;
- The transfer into the Tsitsikamma to Coega ISP area from this ISP area, for use by the NMMM, was corrected to 11 million m^3/a, compared to 31 million m^3/a of the NWRS.
- A major difference between the ISP and NWRS is the presentation of flows to sea, which have been included in the ISP as downstream transfers out of the lowest sub-divisions, sub-areas and the ISP area. This was done to be able to show more realistic water balances, as this water is not used because of its very poor water quality. *An assumption is being made that the impact on these most downstream areas is equal to the flow out of the area, which of course is strictly speaking not necessarily so. These values likely do not correctly represent actual flows under 1:50 year drought conditions nor flows in average years, and should not be interpreted as that. For the purpose of this report they will be further reported on as transferred flows, simply to produce an improved yield balance with existing information;*
- These changes then lead to the following differences:
  - Total requirements in the Fish sub-area is 660 million m^3/a compared to 590 million m^3/a of the NWRS;
  - Water requirements in the Sundays sub-area is 200 million m^3/a compared to 213 million m^3/a of the NWRS;
  - Local requirements of the ISP area were determined as 671 million m^3/a compared to 677 million m^3/a for the NWRS;
  - Total requirements in the ISP area, is 759 million m^3/a, which includes transfers out of the area of 88 million m^3/a (most of which is due to freshening releases that flows to the sea), compared to 825 million m^3/a for the NWRS.

Table 3.7 also includes a column to illustrate the average irrigation use, while the 1:50 year irrigation water requirement, which is used to determine the yield balance, shows the requirement during a 1:50 year drought situation. At 94%, irrigation currently constitutes by far the largest user of water in the ISP area. The water is mainly used to grow vegetables, deciduous fruit, citrus, lucerne and maize, and for the irrigation of pastures. There is believed to be significant scope for more efficient use.

Table 3.7: Water requirements for the year 2000 (million m³/a)

Hydrological sub-division	Average	1:50 year assurance								
	Average irrigation use (1)	Irrigation (2)	Urban (3)	Rural (3)	Mining and bulk industrial (4)	Power generation (5)	Afforestation (5)	Total local requirements	Transfers out	Grand Total
Groot Brak	67	59	1	0	0	0	0	**60**	510	**570**
Tarka	14	12	0	1	0	0	0	**13**	2	**15**
Upper Fish	196	171	7	1	0	0	0	**179**	358	**537**
Upper Little Fish	52	45	1	0	0	0	0	**46**	148	**194**
Middle Fish	125	108	0	1	0	0	0	**109**	110	**219**
Koonap	23	20	1	1	0	0	0	**22**	0	**22**
Kat	17	16	2	1	0	0	2	**21**	0	**21**
Lower Fish	19	16	0	1	0	0	0	**17**	71 (6)	**88**
Fish Total	**513**	**447**	**12**	**6**	**0**	**0**	**2**	**467**	**193** (6)	**660**
Bushmans, Kowie/Kariega	13	11	9	2	0	0	0	**22**	0	**22**
Albany Coast Total	**13**	**11**	**9**	**2**	**0**	**0**	**0**	**22**	**0**	**22**
Upper Sundays	12	10	0	0	0	0	0	**10**	5	**15**
Middle Sundays	74	60	4	2	0	0	0	**66**	115	**181**
Lower Sundays	130	104	1	1	0	0	0	**106**	18 (6)	**124**
Sundays Total	**217**	**174**	**5**	**3**	**0**	**0**	**0**	**182**	**18** (6)	**200**
Total for ISP area	**743**	**632**	**26**	**11**	**0**	**0**	**2**	**671**	**88** (6)	**759**

1) Actual average irrigation use has only been included here to show the comparison with the 1:50 year requirement, and has not been included in the total requirement.
2) Irrigation requirements allows for canal losses.
3) Includes component of Reserve for basic human needs at 25 l/c/d.
4) Mining and bulk industrial water uses, which are not part of urban systems.
5) Quantities given refer to impact on yield only.
6) 70 Million m^3/a water flows to sea from the Fish River and 7 million m^3/a from the Sundays River, while 11 million m^3/a is transferred on from the Sundays sub-area to NMMM.

The urban requirements are spread throughout the area, with few large towns. Groundwater is mainly used to supply small towns and for rural water supply.

Water losses through urban distribution systems and inefficiencies in irrigated agriculture are significant. Sufficient information about irrigation water losses is not generally available.

It is very strongly recommended that more accurate water use values be generated, due to the large uncertainty associated with irrigation water use in this ISP area. Water allocations from government water schemes were checked and updated by DWAF Regional Office staff during

this ISP process, and the partially updated information has been included in **Appendix 10**. There is however still significant uncertainty about the water allocations outside GWSs and especially about water use. Refer to the *Reliability of the yield balance Strategy*, Strategy 5.1 for a more detailed evaluation of the uncertainties associated with water use in the ISP area.

Table 3.8 shows a calculation of the maximum Orange River water requirements of the ISP area. This shows a calculated maximum average allocated volume of 773 million m^3/a for transfer from the Orange River. A conversion to 1:50 year use (using the same factor as used in **Table 3.7**) indicates a maximum allocated quantity of 658 million m^3/a. Annual average transfers should therefore not exceed 773 million m^3/a. This transfer volume differs from the value in the Upper Orange ISP, where a 1:50 year annual transfer value of 575 million m^3/a have been used. Flows to sea at 1:50 year assurance are calculated as 70 million m^3/a from the Fish River and 7 million m^3/a from the Sundays River.

Table 3.8: Maximum Orange River requirements for the O-F-S Transfer Scheme (million m^3/a)

Description	Allocated quantity (million m^3/a)
Irrigation allocation of areas supplied with Orange River water in the Fish and Sundays (from Appendix 10)	582
Allocation for urban supply with Orange River water	9
Supply to Port Elizabeth (year 2000)	11
Total allocations	**602**
Canal losses allowed:	
25% of 18 478 ha @ 13 500 m^3/ha/a (1) =	62
25% of 14 185 ha @ 12 500 m^3/ha/a (2) =	44
15% of 16 644 ha @ 9 000 m^3/ha/a (3) =	23
Total canal losses	**129**
Allocation + canal losses	**731**
+ River losses (4)	112
+ Freshening releases average impact (5)	32
Gross allocated quantity	**875**
Less return flows in areas supplied with Orange River water (4)	102
Average maximum net allocated quantity	**773**
Maximum net allocated quantity at 1:50 year assurance	**658**

1) Upstream of Elandsdrift Weir (from Appendix 10).
2) Fish-Sundays Canal and Great Fish River (from Appendix 10).
3) Lower Sundays River.
4) From Table 3.4
5) From Table 3.5

The implications of this difference of 83 million m^3/a at 1:50 year assurance of supply, is that farmers could potentially use more water than have been allocated for transfer from the Upper Orange WMA. It is necessary to urgently address this difference in Strategy 5.1, *Reliability of the yield balance* and Strategy 5.5, *Reconciliation*, to ensure that the allocation of Orange River water to this ISP area and the licensed quantity, to use the transferred water, are the same.

The average use of Orange River water in the ISP area, from **Table 3.7**, that includes allowance for canal losses, are (664 +11) = 675 million m^3/a, for areas supplied with Orange River water (calculated by subtracting irrigation use in the Tarka, Koonap, Kat, Upper Sundays and Albany Coast areas from the total irrigation use and adding requirements of towns/NMMM supplied with Orange River water). The comparable maximum average requirement for Orange River water, from **Table 3.8,** is 731 million m^3/a. Use of Orange River water at a 1:50 year assurance of supply, from **Table 3.6,** is (563 + 9) = 572 million m^3/a (the difference with 575 million m^3/a is likely due to simplification), while the comparable maximum 1:50 year requirement for Orange River water, from **Table 3.8** (using the same factor as used in **Table 3.7**)**,** is 622 million m^3/a. This indicates that the allocation for transfer from the Upper Orange WMA is in line with actual water use, and do not reflect allocations, which is a concern.

3.4 YIELD BALANCE

3.4.1 Current situation

Table 3.9 shows the yield balance. The **yield balance** is: the *total available water* (the sum of the available local resources and the transfers into the area) compared or reconciled with *the total requirements* (the sum of the various water requirements and losses and the transfers out of the area).

The entire ISP area is practically in balance, mainly because transfers are sufficient to satisfy the demand. The Tarka catchment is stressed. There are unused and under-utilised water allocations in the Kat River. These unused allocations must be addressed, as well as the unlawful use of these current unused allocations. The big question is how the system is operated / managed, and how that operation can be improved or even optimised.

The surplus flows at the bottom end of the Fish River (71 million m^3/a) includes freshening releases made, unused irrigation releases, and return flows downstream of the last point of abstraction. The salinity of such flows may be too high for direct beneficial use without blending or treatment. This water is therefore generally not available for use. A total of 7 million m^3/a flows to sea from the Sundays River. Because the quality of the lower river is generally poor, there are no abstractions for use from that part of the river.

Freshening releases are normally made from Elandsdrift Weir and De Mistkraal Weir. The release in 2003 was 59 million m^3 from Elandsdrift Weir and 42 million m^3 from De Mistkraal Weir, i.e. a total of 101 million m^3/a (or >3 m^3/s). Further information on these releases was

not available. A DWAF view is that between 3 and 5 m^3/s typically runs down to the Fish River estuary and typically 2 to 4 m^3/s to the Sunday's River estuary. This perception that river flows in the lower parts of the Fish and Sundays rivers are higher than the water balance shows, could be due to the following reasons:

- The 1:50 year evaluation presents a serious drought situation – not an average situation;
- Releases for irrigation are requested by farmers but are not always fully used;
- Irrigation return flows may be more than modelled; and
- Operational losses may be more than modelled.

Table 3.9: ISP reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m^3/a)

Hydrological sub-division	Available yield				Water requirements			Balance (1)
	Local yield	Transfers in (2)	River Losses (3)	Total	Local require-ments	Transfers out (2)	Total	
Groot Brak	2	575	-6	571	60	510	570	**1**
Tarka	10	0	0	10	13	2	15	**-5**
Upper Fish	46	512	-20	538	179	358	537	**1**
Upper Little Fish	32	163	0	195	46	148	194	**1**
Middle Fish	32	220	-33	219	109	110	219	**0**
Koonap	22	0	0	22	22	0	22	**0**
Kat	22	0	0	22	21	0	21	**1**
Lower Fish	13	110	-35	88	17	71 (4)	88	**0**
Fish Total	**179**	**575**	**-94**	**660**	**467**	**193 (4)**	**660**	**0**
Bushmans, Kowie/Kariega	21	1	0	22	22	0	22	**0**
Albany Coast Total	**21**	**1**	**0**	**22**	**22**	**0**	**22**	**0**
Upper Sundays	14	0	0	14	10	5	15	**-1**
Middle Sundays	53	128	0	181	66	115	181	**0**
Lower Sundays	27	115	-18	124	106	18 (4)	124	**0**
Sundays Total	**94**	**123**	**-18**	**199**	**182**	**18 (4)**	**200**	**-1**
Total for ISP area	**294**	**575**	**-112**	**757**	**671**	**88 (4)**	**759**	**-2**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) The river losses resulting from evaporation and seepage for the transferred volumes have been included here. This was a best estimate from the ORRS modeling (16).
4) 70 Million m^3/a flows to sea from the Fish River and 7 million m^3/a from the Sundays River, while 11 million m^3/a is transferred on from the Sundays sub-area to NMMM.

3.4.2 Projected 2025 yield balance

a. Projected 2025 water requirements at 1:50 year assurance of supply

The Tsitsikamma to Coega ISP addresses the water requirements of the NMMM through the *NMMM future augmentation strategy*. In 2000, 11 million m^3/a was transferred from the Orange River via the Fish/Sundays system to Port Elizabeth. The Sundays River Scheme can potentially supply 25.6 million m^3/a Orange River water to Port Elizabeth if operated at full capacity throughout the year and if some additional treatment capacity is added to the current capacity of 20 million m^3/a.

Water for significant new envisaged resource - poor farmer developments (4 000 ha), involving a total estimated water requirement of about 38 million m^3/a of Orange River water to alleviate poverty, have been reserved for future transfers to this ISP area from the Upper Orange WMA. Refer to the Upper Orange WMA ISP Report No P WMA 13/000/00/0304 for more information.

Significant growth in urban water use in the Albany Coast sub-area is expected.

ISP area: Irrigation grows by 38 million m^3/a for resource-poor farmer schemes. It has been assumed that approximately 30% (11 million m^3/a) of this development will take place in the Fish River catchment and 70% (27 million m^3/a) in the Lower Sundays River catchment, approximately along the lines of recommendations made in the ORRS study. Requirement for transfer to the Tsitsikamma-Coega ISP area (NMMM) increases by 10 million m^3/a (to 21 million m^3/a), in accordance with the recommendations made in the Algoa Pre-Feasibility Study. Urban use grows by 11 million m^3/a.

Fish: Irrigation grows by 11 million m^3/a and urban use grows by 3 million m^3/a.

Albany Coast: Urban use grows by 7 million m^3/a, due to significant projected growth of especially coastal towns.

Sundays: Irrigation grows by 27 million m^3/a and urban use grows by 1 million m^3/a. Transfer out to the Tsitsikamma to Coega ISP area of the NMMM's requirement increases by 10 million m^3/a.

Table 3.10 on the following page shows the water requirements in 2025, in comparison to the year 2000 availability, as an indication of the expected shortfall that will need to be met with increased yield. The possibility that the requirement for transfers to the NMMM could increase significantly, in addition to the 10 million m^3/a that have been allowed for, should be borne in mind, taking the current spate of growth into account.

Table 3.10: ISP year 2025 water requirements and availability for 1:50 year assurance (million m³/a)

ISP sub-area	Available year 2000 yield				Water requirements in 2025			Balance
	Local yield	Transfers in (1)	River Losses (2)	Total	Local require-ments	Transfers out (1)	Total	
Fish	179	575	-94	660	481	193 (3)	674	-14
Albany Coast	21	1	0	22	29	0	29	-7
Sundays	94	123	-18	199	210	28 (3)	238	-39
Total for ISP area	**294**	**575**	**-112**	**757**	**720**	**98** (3)	**818**	**-58**

1) 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.
2) The river losses resulting from evaporation and seepage for the transferred volumes, which is a best estimate from the ORRS modeling, have been included here.
3) 71 Million m^3/a flows to sea from the Fish River and 7 million m^3/a from the Sundays River.

b. Projected 2025 water requirements according to the NWRS (Version 1) at 1:50 year assurance of supply

In the NWRS, provision was made for growth in irrigation use, through the development of an additional 4 000 ha under irrigation, for the establishment of new resource-poor farmers as a means of poverty eradication. Substantial growth in the urban water use of the NMMM was also allowed for, meeting their needs with increased transfers of Orange River water. The forecast was for significant growth in urban use in the Albany Coast sub-area, part of which would be associated with an increase in the standard of living. Little change in the requirements for water was foreseen for the inland and rural parts of the ISP area, where irrigation is dominant. Limited economic growth together with no or negative population growth was forecast.

A notable difference between the projected water requirements of the ISP, compared with that of the NWRS, is that most of the new resource-poor farmer development has been assumed to be in the lower Sundays River, in line with the ORRS study recommendations, whereas the NWRS assumed that all such development would be in the Fish River. The NWRS made greater provision for the transfer of Orange River water to the NMMM (an additional 28 million m^3/a), and significantly so in the high growth scenario (an additional 78 million m^3/a), whereas the ISP is in accordance with the recommendations made in the Algoa Pre-Feasibility Study (an additional 10 million m^3/a). There is however the concern that the need for increased transfers to the NMMM could indeed increase significantly.

c. Projected 2025 ISP water balance at 1:50 year assurance of supply

An additional quantity of 2 million m^3/a (for increased use of Orange River water by small Eastern Cape towns) has been included in the Upper-Orange ISP for future use. Together with the 38 million m^3/a reserved for future use by resource-poor farmers, a total of 40 million m^3/a has been reserved for future transfer from the Upper Orange WMA to this ISP area.

In a 1:50 year drought situation in the OFSWSS, freshening releases will depend on the availability of "surplus" water in the Upper Orange WMA, which is only available when Gariep and Van der Kloof dams are spilling. The water resource in that WMA is currently close to a balanced situation, and is expected to move to a situation where demand exceeds available resources. Availability of "surplus" water from the Upper Orange WMA is therefore likely to diminish, when compared with previous years, which may also influence the long term future availability of water to the NMMM. **Table 3.11** shows the ISP 2025 reconciliation of water requirements and availability at 1:50 year assurance.

It is envisaged that the increase in requirements will be met through the following interventions:

ISP area: As transfers for resource-poor farmers increase, irrigation return flows and river losses will increase accordingly. Provision must me made in the transfer volumes for losses as water is transferred through the system. The growing urban requirement is met by increased groundwater use and by a very limited increase in the supply of Orange River water. A possible requirement for increased freshening releases has not been allowed for. The overall balance and that of the sub-areas remain the same as in 2000.

Fish: Local yield (groundwater use) should increase by 2 million m^3/a. Transfer in of Orange River water increases by 55 million m^3/a, and onwards transfer from the Fish to the Sundays will be 40 million m^3/a. River losses accordingly increase by 5 million m^3/a and irrigation return flow by 2 million m^3/a.

Albany Coast: Local yield increases by 7 million m^3/a.

Sundays: Local yield (groundwater use) increases by 1 million m^3/a to meet increased urban needs. Transfer in of Orange River water from the Fish sub-area increases by 40 million m^3/a and transfers out to the NMMM increase by 10 million m^3/a. River losses increase by 3 million m^3/a. There will be no usable return flows.

Table 3.11: ISP year 2025 reconciliation of water requirements and availability at 1:50 year assurance (million m³/a)

ISP sub-area	Available yield				Water requirements			Balance (1)
	Local yield	Transfers in (2)	River Losses (3)	Total	Local require-ments	Transfers out (2)	Total	
Fish	183	630	-99	714	481	233 (4)	714	0
Albany Coast	28	1	0	29	29	0	29	0
Sundays	95	163	-21	237	210	28 (4)	238	-1
Total for ISP area	**306**	**630**	**-120**	**816**	**720**	**98** (4)	**818**	**-2**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) The river losses resulting from evaporation and seepage for the transferred volumes, which is a best estimate from the ORRS modeling, have been included here.
4) 70 Million m³/a flows to sea in the Fish River and 7 million m³/a in the Sundays River.

3.4.3 Approach to future reconciliation

a. Systems approach

Eventually, when all allocations have been taken up, the Orange System will be in balance and the Eastern Cape will have to make do with its allocation for long periods of time. The use of additional transfers, which may be available from time to time for further Fish-Sundays salinity reduction, will have to be weighed up against the cost of other lost opportunities (like power generation). The overall system will be very complex and good operation will be essential. At the moment there is still temporary operational latitude due to allocations not being fully utilised.

There are large uncertainties with regard to actual irrigation water use, which need to be accurately determined, to prepare an updated water balance that provides a more reliable picture of actual use vs. scheduled water use. This is addressed through the *Reliability of the yield balance Strategy*, Strategy 5.1.

Management of salinity in the OFSWSS will determine when and how freshening releases should be made and could influence where new development would be allowed. This should also be evaluated through the OFSWSS Management Strategy.

The future focus on water use in the ISP area will be to ensure optimal utilisation of the irrigation water allocation, improving efficiency of urban water use, and ensuring that water is made available to uplift the poor.

b. Intervention measures

With the entire ISP area as well as all the sub-areas approximately in balance, any further demands for commercial water use should preferably be addressed either through the trading of unused or under-utilised water use authorisations, or through increased efficiency. Unused or underdeveloped allocations, notably in the Kat River catchment, which is close to full allocation, but where there is a big demand from irrigators without allocations, needs to be resolved through trading, delisting or possibly reallocation, or a pricing system. Less could possibly be paid for water of poorer quality, or for water with a lower assurance of availability.

Water saved through WC&DM measures, such as e.g. the lining of earth canals, could make water available for development, although it would also mean that there would be less return flows. Many existing irrigators may also be in a position to use such "freed" water. This scenario needs to be carefully evaluated through the OFSWSS Management Strategy, Strategy 12.1.

c. Development options

Very limited potential for the development of new dams and other local water resource developments remains. Feasible dams development have however been identified and studied in the Kat River (Baddaford Dam) and Koonap River (Foxwood Dam). Groundwater also holds some real possibilities for development, specifically for urban water supply.

There have been recent proposals for further irrigation development in the lower Sundays and Fish Rivers. These proposals will have to be considered in the light of the Eastern Cape Provincial Growth and Development Strategy [(34)]. The use of water such schemes, if approved, should benefit resource-poor farmers and it should form part of the 4 000 ha allocation for new resource-poor farmer schemes.

d. Supply of Orange River water to NMMM

It is envisaged that additional Orange River water could also be transferred in future for industrial and urban use of the NMMM. This would depend on the balance of the Orange River System at the time, and more likely involve the development of additional storage infrastructure in the Orange River catchment (e.g. Boskraai Dam) to meet this and other needs. An allowance has been made in the Upper Orange ISP water balance, for use by the NMMM of 26 million m^3/a (of which 11 million m^3/a was used in 2000 and 17 million m^3/a in 2004). This will be reviewed in future water balances.

Although the current supply system from the Sundays River canals has spare capacity, the disadvantage is that that water needs to undergo additional treatment, which is costly. There is also some resistance by users. The Algoa Pre-feasibility Study concluded that the NMMM did not need to develop a new scheme / increase their current use of Orange River water until 2020. The current growth in the NMMM's water requirements is however very rapid, which could change the conclusions of the Algoa Pre-feasibility Study.

CHAPTER 4 – INTRODUCTION TO THE ISP STRATEGIES

The many issues and concerns identified in the ISP area will be addressed through the implementation of appropriate regional water management strategies. DWAF staff has identified some essential management strategies, and additional strategies may be developed in future.

Ten broad strategy groups, covering all necessary current and future water management activities, were identified from current DWAF Regional Office activities, the requirements of the NWA and the NWRS. These Main Strategies are:

- ⇨ Yield balance and reconciliation;
- ⇨ Water resources protection;
- ⇨ Water use management;
- ⇨ Water conservation and demand management;
- ⇨ Institutional development and support;
- ⇨ Social and environmental considerations;
- ⇨ Integration and co-operative governance;
- ⇨ Waterworks development and management;
- ⇨ Monitoring and information management; and
- ⇨ Implementation.

For each strategy, the following aspects are addressed:

- ***Management objectives*** in terms of the envisaged solutions for the strategy;
- ***Situation assessment;*** providing a synopsis of the current situation with a focus on the issues;
- ***Strategic approach;*** stating the approach or plan that DWAF will follow to reach its objectives for the strategy;
- ***Management actions;*** states the required actions to implement the strategy;
- ***Responsibility;*** the responsible offices or Directorates are named;
- ***Priority*** in terms of the ISP rating system (1 – 5, where 1 indicates the highest priority).

Responsibilities for Main Strategies and individual strategies were assigned to DWAF Directorates and/or Sections within the Eastern Cape RO as part of the "*Implementing the ISP*" Strategy. Responsible people or champions were identified where appropriate.

Twenty four individual strategies were developed for implementation under the ten Main strategy groups. Other strategies may become necessary later on and should be developed as they are identified. Some strategies cover aspects that may need to be further expanded into separate sub-strategies. The effectiveness, issues or problems encountered with water supply and sanitation programs in rural areas were not addressed in this ISP.

The various actions required to implement the ISP strategies have been identified and listed under each strategy. The general lack of adequate human and financial resources will influence the scope of work that can actually be addressed under each strategy. The various strategies have been prioritised, and in many cases specific actions under strategies have been prioritised as well. What is further required, following this study, is that the actions listed under each strategy should be revisited and prioritised to be in line with the available resources and funding to implement each strategy. The redirecting or retraining of DWAF's regional staff resources, to be in line with the identified relative strategy priorities, or of obtaining additional resources, must be seriously considered. Where various implementation options exist, the evaluation of each option should be documented, as well as the approach and decisions on implementation actions that were selected for immediate or later implementation. Specific targets or benchmarks to measure the progress of strategy implementation should also be developed and documented.

CHAPTER 5 – YIELD BALANCE AND RECONCILIATION STRATEGIES

NEED FOR YIELD BALANCE AND RECONCILIATION STRATEGIES

The various sectors within the ISP area have different overall water requirements and these requirements are generally at different levels of assurance of supply. Assurance of supply is mainly determined by whether an area receives transferred Orange River water or not. The yield balance situation and the current and future management perspectives and reconciliation options are discussed in *Chapter 4: Water resources perspective of the ISP area*.

Yield balance and reconciliation strategies address the need to:

- ⇨ Clarify uncertainties and information gaps regarding the availability of surface water and groundwater;
- ⇨ Undertake detailed water requirement investigations;
- ⇨ Determine and implement water reconciliation strategies for specific systems, geographical areas or water sectors;
- ⇨ Address the requirements for compulsory licensing.

Adequate amounts of water at acceptable assurances of supply are required, especially for irrigation, but also for towns.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

5.1 Reliability of the yield balance;
5.2 Groundwater;
5.3 Compulsory licensing;
5.4 Supply to local authorities;
5.5 Reconciliation.

It was considered unnecessary to develop strategies for specific water use sectors. There is no specific "water requirement" strategy, as this is adequately covered in the other strategies.

5.1 RELIABILITY OF THE YIELD BALANCE

Management objective:

To address the uncertainties, assumptions and gaps as identified in the estimates of water availability and requirements for especially the Fish-Sundays system, to obtain a higher confidence water balance, thus creating opportunities for improved water management and curtailing of wastage.

Situation assessment:

Available yield

Available yields are tabulated in Chapter 3 **Table 3.4**. The total yield is estimated at 757 million m^3/a, with a local yield of 160 million m^3/a and impacts of transfers in on yield of 575 million m^3/a. A calculation of the maximum Orange River water requirements of the ISP area however indicates a quantity of 658 million m^3/a. The implications of this difference of 83 million m^3/a at 1:50 year assurance of supply, is that farmers could potentially use more water than have been allocated for transfer from the Upper Orange WMA.

The rivers are generally adequately gauged for current large-scale yield modelling requirements, with the following qualifications. An additional flow gauge on the Bushmans River, closer to the estuary, would improve estimates. The Sundays River should also be gauged below Darlington Dam (and possibly also closer to the estuary), but no good sites are available. None of the estuaries have installed water level recorders. The numbers of evaporation stations are diminishing and there are not enough rainfall gauging stations. Water balances have not been undertaken for Commando Drift Dam and Lake Arthur.

As elsewhere, information on groundwater availability is very poor. Information on surface water availability is generally reasonable, except for information on required Reserves, which is either at low confidence levels for rivers or non-existent for most estuaries, wetlands and aquifers (refer to the *Reserve and Resource Quality Objectives Strategy*, Strategy 6.1).

Current water requirements

Volumes required by users are tabulated in Chapter 3 **Table 3.7**. The total requirement is estimated at 759 million m^3/a. The accuracy of available information related to irrigation water use is poor and it is important that it be improved. There is significant uncertainty regarding water use allocations which do not form part of existing government water schemes (GWSs). No up-to-date information on actual irrigation water use is available, either from GWSs or for the substantial irrigation outside GWSs. Farmers often do not inform system operators when they do not use their allocated water. No reliable observed data on the quantity of irrigation return flows are available. Irrigation return flows are best estimates by DWAF staff of percentages of use and are of low confidence. An improved operational model (refer to the *Orange-Fish-Sundays Water Supply System Management Strategy*, Strategy 12.1) could significantly improve estimates of river losses, which have a significant impact on water availability, as well as of irrigation return flows. Irrigation farmers in the Lower Sundays River Scheme notably use much less than their allocations.

Information about the volume of the available groundwater resources, depth, the distance between a suitable source and its intended use, quality, and its reliability (assuming proactive, appropriate aquifer management) is not conveniently available to planners and engineers in a readily understandable format. The existing available graphic information sources are too generalised and at too small a scale to be practically useful for aquifer exploration, development and management. The major hindrance to the optimal development of groundwater resources is the lack of and/or inaccessibility of area and aquifer-specific data at the scale of a quaternary catchment, or group of related quaternary catchments.

Water balance

The mass water balance of large portions of the ISP area was updated, as part of the Orange River Replanning Study (ORRS), and the requirements for annual transfer of Orange River water was refined in the Orange River Continuous Study. Both studies covered the hydrological period 1920 to 1987 for the Eastern Cape Rivers. The entire ISP area is approximately in balance, with most shortfalls in demand being met by transferred Orange River water.

Strategic approach:

With irrigation using 94% of all available water it is obvious that the focus should be on improving the reliability of irrigation water allocations, uses and return flows, to attain a reliable water balance. Specific attention should be paid to increasing the confidence in the accuracy of irrigation water allocations and use outside GWSs. The difference of 83 million m^3/a between the allocation of Orange River water to this ISP area and the maximum quantity that may be used will be urgently addressed. Adequate keeping of records is a major gap which requires attention.

The operational knowledge of the Orange-Fish-Sundays Water Supply System urgently needs improving and this can be achieved by promoting the installation of gauging stations, rain gauges at selected points in the catchment and water level recorders in identified estuaries to supply specific information needs that will support and improve effective management decisions. The paucity of groundwater information should be addressed by initiating focussed studies on regional aquifers where the demand warrants it and by installing systems that improve knowledge about groundwater availability. Little benefit will be gained by updating local hydrology (because local yield is such a small component of the total yield and because significant floods or droughts should have recently occurred to have an influence). Only undertake updates of a specific system or river when there is a specific need, such as a significant licence application in a tributary, or when there is good reason to believe that the hydrology will change after an update.

Management actions:

1. Ensure proper record keeping of actual water use in GWSs;
2. Compare scheduled quota amounts with actual use once actual use values are available;
3. Improve the confidence in irrigation use outside GWSs by verification of WARMS as a first step;

4. Urgently address the difference of 83 million m^3/a between the allocation of Orange River water to this ISP area and the maximum quantity that may be used;
5. Improve knowledge on river loss estimates when an improved operational model has been implemented;
6. Address gauging requirements. See the *Monitoring Networks and Data Capturing Strategy*, Strategy 13.1;
7. Determine the need to undertake water balances for Commando Drift Dam and Lake Arthur.

Responsibility:

RO.

Priority:

1 – Very high, due to the influence that improvements in the reliability of information may have on the water balance and hence on licensing decisions.

5.2 GROUNDWATER

Management Objective:

The management objective is to ensure the sustainable use of groundwater and the appropriate exploration, development and monitoring of the unexplored aquifers.

Situation Assessment:

Regional scale groundwater resource assessment and usage figures are available from studies such as the Fish to Tsitsikamma Water Resources Situation Assessment Study, based on the 1:500 000 DWAF map series and the NWRS evaluation. A spatially-weighted, aquifer-specific GIS-based estimation of groundwater potential is available from this study. These numbers are summarised in tabular form in **Appendix 2**.

Overviews of the patterns and controls of groundwater occurrence, anticipated yields, water quality variations and aquifer classification (scale 1:3 000 000), aquifer vulnerability (1:6 000 000) *inter alia* are summarised and illustrated. The regional maps are available from DWAF (hydrogeology map series at 1: 500 000) and the Water Research Commission.

Regionally there are four strategic aquifer systems in this ISP area. These are:

- The Katberg Sandstones (fractured rock aquifer);
- The Witteberg Quartzites (fractured rock aquifer);
- The Intergranular Coastal Aquifers (primary aquifer(s) of marine, fluvial and Aeolian origin);
- The Dolerite Dyke system (fractured rock aquifer), which can be considered as a strategic resource since it delivers reliable yields and acceptable water quality in the sub-areas otherwise dominated by regolith aquifers of very poor water quality and yield.

It is appreciated that groundwater is an affordable and flexible supply in the socio-economic and demographic conditions prevalent in this area. In some cases, e.g. for small Karoo towns and rural settlements (see the *Supply to local authorities strategy*, Strategy 5.4, which addresses current and potential future supply to towns), groundwater offers the only feasible option, either as sole supply or as an augmentation option. Many towns are fully or partially dependent upon groundwater (Nieu-Bethesda, Aberdeen, Jansenville, Paterson, Kenton-on-Sea, Alexandria and Kleinemonde for example). In Graaff-Reinet, Bedford and Pearston for example the water supply is one of combined surface and groundwater. Supply from springs is considered as groundwater supply because aquifer management would impact upon it. Throughout the ISP area groundwater is used seasonally for irrigation or stock watering.

This dependence means that economic and social costs can be high in the event of failure in respect of either quantity or quality of supply. At present it is unknown exactly how many boreholes are in operation throughout the WMA. A total of 7 535 boreholes are recorded on the NGDB and on the basis of a 30% national average success rate this suggests that approximately 2 260 boreholes are in operation. There is no information on illegal drilling and the number of boreholes which might not be recorded.

Aquifers under stress (which may also be the result of inadequate management) include the Albany Coast primary aquifers and the fractured dolerite and Karoo aquifers in the Middelburg, Graaff-Reinet, Tarkastad, Hofmeyr and Paterson areas. Recently there have been reports that the groundwater supply to Middelburg and Kenton-on-Sea has failed and R2 million has been allocated to Middleburg in terms of drought relief, as a response to supply failure.

It is of concern that *ad hoc* investment in groundwater supply schemes during droughts, while much needed at the time, do not thereafter insist on, or provide, the necessary investment to ensure that the root cause of the problem of perceived unreliability of groundwater – viz. lack of suitably designed and implemented monitoring networks and programmes, lack of understanding of appropriate groundwater management amongst persons tasked with this responsibility and timely expansion of wellfields as demand increases or as monitoring information indicates that it is needed, is addressed.

Determination of groundwater Reserves has been done at preliminary or rapid levels of determination (see the *Reserve and resource quality objectives strategy*, Strategy 6.1) in the P10B, P10E, and P20A catchments. Based on the present levels of data distribution, data accessibility, data validation, the frequency of monitoring and the uncertainty as regards resource quantification, any determination of the groundwater Reserve at intermediate or comprehensive levels for the various aquifers would be of a low confidence.

Current documentation, protection, monitoring and management of springs are inadequate. There is limited quantitative understanding of variations in spring discharge with climatic variability. So too there is little knowledge of natural impacts on base flow versus influences of anthropogenic factors. Current understanding of the relationship of different aquifers to spring flow and baseflow and to each other is not documented. This is of particular importance in evaluating the groundwater Reserves for estuaries, undammed rivers and in the protection of aquifers, both from a RQOs or a source-directed measures perspective.

Appreciation of the movement of contaminants in fractured rock aquifers is poor in this WMA and little attention is given to protection of the groundwater resource. With very little industry and mining this is not a major issue in this ISP area.

Strategic Approach:

Summarise the current understanding of availability/potential and possible use of groundwater for the whole ISP area into a Management Plan, and then improve on it by implementing the following actions in terms of the Management Plan:

1. Establish an immediate and urgent monitoring programme;
2. Initiate the planning of a GIS-based data and information base that will be web served and useful to local government, the Department of Economic Affairs, Environment and Tourism, The Department of Agriculture and Land Affairs, other DWAF Directorates, aid organisations, non-Government organisations and the private sector at WMA or larger scale. Any GIS-based system must provide data as well as information and best practice and/or planning guidelines relevant to any particular area and should be regularly updated;

3. Educate users and other professionals in the water industry in the risk and adaptive management approach most suited to groundwater management as well as the application of operations and maintenance rules;
4. Re-evaluate aquifer protection measures to distinguish ambient from anthropogenic influences impacting on the groundwater resource. The results of physical and chemical monitoring must be brought to bear in the planning, implementation and regulatory decisions;
5. A comprehensive audit of groundwater usage and current exploration is urgently required;
6. Include a strong groundwater management component as part of a future Integrated Water Resource Management team in the CMA;
7. Develop a trans-disciplinary strategy to address the extreme poverty in the area, since water supply and sanitation are key inputs.

Management Actions:

Human Resources

1. Establish scientific posts for personnel that would be responsible for the interpretation of data, dissemination of information and development of the GIS-based data, information and knowledge management;
2. Establish a mentorship programme that supports ongoing field and scientific training. This will promote confidence, competence and vision;

Groundwater Monitoring

3. Design, implement and expand the monitoring network with immediate effect. Upgrade as data, insight and information become available. Evaluate and interpret monitoring data and information and integrate the outcome into groundwater management actions;
4. Co-ordinate the groundwater and water quality monitoring and regular information exchange, particularly with respect to the management and monitoring of effluent from WWTWs and siting and construction of ventilated improved pit latrines;
5. Select preliminary sites based on the Working-for-Water and Working-for-Wetlands programmes to prioritise monitoring. Integrate the insights and results with other monitoring results;

Groundwater Management, Reserve and Resource Protection

6. Prioritise aquifers which are most stressed with respect to over-abstraction, poor management and threat of contamination, for purposeful intervention to improve groundwater management and resource protection. Align this initiative with disaster and drought management initiatives, particularly in Middelburg, Graaff-Reinet and Kenton-on-Sea;
7. Consider the implications and develop a strategy to address the possibility that DWAF will maintain the responsibility to authorise aquifer-specific management plans on a catchment and a wellfield scale. Similarly the Department could be required to support municipal and larger groundwater users to implement the operating rules of wellfield(s) and to adapt these as monitoring results become available;
8. Identify the rivers that are most dependent upon spring flow. Initiate a spring flow and water quality monitoring programme in order to obtain ground-truthing data about baseflow and/or groundwater contribution to surface water;

Impact on Ecosystems

9. Ensure that the impacts of the Working-for-Water and Working-for-Wetlands programmes on the groundwater regime are monitored;

Knowledge Management

10. Establish an effective and efficient GIS-based data, information and knowledge management system accessible to government and private sector. It is imperative that any GIS-based work has a sound physical process and theoretical basis;

Socio Economic Responsibility

11. Develop and implement a strategy to integrate the socio-economic factors and poverty eradication in groundwater resource evaluation, planning, implementation, management and maintenance of infrastructure. The factors must be addressed in terms of references for groundwater studies at all stages, i.e. planning, exploration, implementation, wellfield and aquifer management;
12. Rural supply and small town schemes should include a food garden allocation over and above the Human Reserve. Good nutrition and health is important given the social circumstance and the Aids epidemic;
13. Develop and implement a strategy for interfacing with existing education initiatives in order to support sustainable groundwater supply. Develop a concept document for groundwater education at various levels of government, community and schools.

Responsibility:

RO and water resources managers, assisted by Chief Directorate: Information Management.

Priority:

1 - Very high.

5.3 COMPULSORY LICENSING

Management objective:

To identify the need for compulsory licensing in stressed areas, prioritise such requirements and provide guidance regarding the initiation, implementation and management of the required process.

Situation assessment:

Compulsory licensing is the process of getting all water users in a catchment licensed. In the long-term everybody in the country will be licensed. Compulsory licensing will therefore over time be implemented in all catchments – stressed or not. It is firstly a tool for redressing imbalances and inequities and in these cases curtailments may well ensue. It is not necessarily, however, a threatening process.

The Tarka catchment is in stress as a result of over-allocation and over-utilisation of irrigation water, and diminished dam yields due to siltation. All other catchments in the ISP area are currently in a balanced situation. Deteriorating water quality towards the bottom ends of the major rivers are pushing sections of these rivers towards a stressed situation. Compulsory licensing may become necessary to reduce this trend.

There is significant uncertainty regarding the water use situation in the Kat River catchment, especially among the ex-Ciskei irrigators, which could potentially require compulsory licensing to correct the situation. DWAF's view is that the catchment is in balance, but that there are many unutilised water allocations, while unlicensed users make use of the allocated water not taken up.

Compulsory licensing is not seen as a priority in the remainder of the area.

Strategic approach:

The need to curtail water allocations through compulsory licensing will be avoided where possible (except perhaps to recover unused water). Other ways of bringing the required water back into the system must first be tackled, for example the clearing of invasive alien plants; verifying, recalculating and determining available water and water use; ensuring the implementation of water conservation and demand management etc. If a balanced situation cannot be achieved by these intervention measures, compulsory licensing will proceed in a phased, integrated manner as a step-wise process. If the situation is resolved following the implementation of any of the above approaches, the compulsory licensing may be delayed.

Management actions:

Implement the compulsory licensing process, according to national priorities, as follows:

- Do verification of existing registered use and the lawfulness of such use in:
  - The Tarka River to determine how much water has been over-allocated and is being used in the catchment;

- The Kat River to find out how much spare capacity actually exists in the system and how much water is illegally used;
- The Kamdeboo River area (N14C quaternary), where there is high water use, to sort out the perceived/alleged unlawful use of canals/dams, as a matter of urgency;

- Reconsider the need to implement the process further. Consider what other intervention measures, such as revisiting the Reserve, clearing invasive alien plants, water trading, water conservation and demand management etc. might do to achieve a balanced water situation and implement those interventions that will lead to a balanced situation.

If a balanced situation has not yet been achieved, implement the following steps, which will eventually also be implemented in all remaining catchments:

- Update the hydrology and set up water resources models as required by compulsory licensing to update the yields of these catchments;
- Revisit and refine the water requirements;
- Assess the social dynamics of the identified catchments and the potential economic impacts of allocation decisions;
- Revisit the current yield balance and potential yield balance scenarios in the identified catchments once the Reserve and detailed modelling studies are complete, and the social and economic issues are understood;
- Undertake scenario and operational assessments and the development of a set of water allocation rules, following the required participative stakeholder processes, ensuring that water for poverty eradication receives adequate priority;
- Publish water allocation schedules, following the quantification of multi-criteria decision-making recommendations and the required public, legal and administrative processes.

Responsibility:

The RO in consultation with D: WA, D: RDM and D: NWRP.

Priority:

2 – High, for the Verification component.
3 – Medium for the remainder of the process.

5.4 SUPPLY TO LOCAL AUTHORITIES

Management objective:

Through this strategy local authorities will know and understand the limitations to their water supply. IDPs, WSDPs and Water Sector Plans should reflect both the constraints as well as the opportunities pertaining to the availability of water. Local authorities will work together with the Department to access potential resources and to optimise the use of that water which is already available.

Situation assessment:

Appendix 3 contains a table of all municipalities in the ISP area and **Appendix 4** provides a table of towns per quaternary.

Table 5.1 presents detailed information on the water supply situation of the towns in the ISP area. There is continued urbanisation in many towns in the ISP area. Urban water requirements tend to grow, even though populations have become stagnant or are even slightly declining in some areas. Twelve towns receive transferred water from the Orange River, with most other towns being reliant on groundwater, some with poor quality. Many towns in this area occasionally run short of water and the DWAF perception is that this is often the consequence of poor water management. There is an identified need for augmentation at thirteen towns and services are being upgraded in many towns.

The Albany Coast Situation Assessment Study [21] is underway to review the water augmentation options of several coastal towns in the Albany Coast sub-area (Alexandria, Boknes, Canon Rocks, Kenton-on-Sea, Port Alfred, Kleinemonde and Bathurst). Current problems relate to high growth rates in coastal areas, high holiday peak water usage, inadequate sources in terms of quality and quantity and limited infrastructure capacity. The situation in Port Alfred is critical during peak demand and available sources are only adequate until 2005.

The town of Graaff-Reinet is vigorously campaigning for an additional water allocation, i.e. additional Orange River water through the Wapadsberg Scheme for both irrigation and primary use, although numerous previous investigations have shown that any such scheme would be far too expensive. The supply of primary water only via the proposed Bruintjieshoogte Scheme is less costly, yet still disproportionately expensive in relation to local sources, in particular groundwater. Since the yield of the Orange River is currently fully allocated in terms of the current level of development, these proposed schemes would have to buy out current water rights or obtain water from further resource development in the Orange River. The town should implement good water management practices and adequate water conservation measures, which should make the current supply adequate to 2032, after which other sources should be considered.

Strategic approach:

The approach will be to work with and to inform local authorities. Promote up-front liaison and agreement between DWAF and municipalities regarding proposed water resource developments as

mentioned in the WSDPs. Promote awareness at municipalities of the need to inform government of their water resource development plans and to consult with DWAF staff before making recommendations.

Encourage municipalities at any available forum, committee or other venues jointly attended by DWAF and local authorities to first pursue alternative augmentations options, such as improved management of water supply infrastructure, water demand management, groundwater abstraction, effluent re-use, water trading or the eradication of invasive alien plants in water stressed areas, before applying for additional surface water use. Further encourage municipalities to develop local schemes or to identify potential local schemes for augmentation. Where potential future supply cannot be identified in the WSDPs, further investigations must be identified and implemented by the local authorities. IDPs and WSDPs must become the documents that reflect the total municipal water strategies.

Address poor management through liaison and capacity building efforts. Plan and implement a programme to build capacity at district and local municipalities.

Aquifer management plans, inclusive of the monitoring of borehole levels, are essential for aquifers supplying the coastal towns, to avoid over-abstraction and saline intrusion. Such plans must be strictly adhered to.

Future planning should consider applicable social, environmental and economic impacts and costs, also at local authority planning level in the IDPs, WSDPs and water sector plans.

Management actions:

Water planning:

1. Urgently engage with municipalities that need augmentation now;
2. Clearly communicate to municipalities the need for Water Services Development Plans to:
    - More closely conform to the NWRS, ISP and catchment plans;
    - Highlight the current sources of supply and future anticipated sources of supply of the local authorities;
    - Refer to each other where applicable;
    - Address water demand management in sufficient detail and effluent re-use measures where appropriate;
3. Identify outstanding WSDPs and provide pressure to ensure that they are submitted. Review IDPs, WSDPs and water sector plans where necessary and propose feedback to the relevant municipalities to ensure that requirements are realistic;
4. Use the Regional Working Groups for WSDPs to ensure that WSDPs are in line with other planning documents;

Other actions:

5. Prepare to implement the anticipated recommendations of the Albany Coast Situation Assessment Study following its completion;
6. Implement recommendations of the Norwegian Agency for Development Cooperation (Norad) Groundwater Project (refer to the *Groundwater Strategy*, Strategy 5.2). Provide

available regional planning information and aquifer specific modelling information to local government as input to water planning. Engage the Water Research Commission (WRC0 to support the initiative;

7. Improve local water management by informing municipal employees at local and district level on what can and can't be done and inform them of their options;
8. Request D: WUE at DWAF head office and the regional Water Conservation division to prioritise assistance to municipalities regarding the development and implementation of WDM strategies, to overcome the technological barriers that many of the local municipalities in the area face;
9. Through co-operative governance, under the *Groundwater Strategy*, aim to improve monitoring of aquifers, especially the coastal aquifers, and have water management plans compiled.

Responsibility:

The RO must review the WSDPs and follow up with local authorities in cases where submissions are incomplete or have not been submitted. The RO must guide the local authorities with regard to development of local schemes, implementation of water demand management and implementing investigations where future sources of supply are uncertain.

Directorate Information Programmes and RO Sub-Directorate Hydrological information must investigate the need for coastal aquifer management plans and compile a strategy to deal with the situation.

Priority:

1 – Very high

Table 5.1 : Local authorities water supply situation assessment

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
Aberdeen	0.281 Mm^3/a	Good	Borehole supply		Yes	- Implement a WC&DM strategy - Telemetry for water supply system is required	- Additional boreholes required; - Investigate and establish safe yield of boreholes/aquifer; - Refurbish and upgrade bulk water supply infrastructure
Addo	0.1 Mm^3/a from ORP Water Supplied (rural) = 0.396 Mm^3/a	Good	Orange River Project	Occasional pollution problems at Caesar's Dam near Addo, from informal settlement	No		No further schemes planned
Adelaide		Unacceptable	Koonap River off-channel storage: scheme was recently upgraded using El Nínõ funds	Suffered serious water shortages in dry years	Yes		- Proposed: Extension of Bedford Scheme; - Koonap River is a suitable source for further augmentation; - Additional storage needed in water supply system; - Possible supply from proposed Foxwood Dam; - Groundwater is an option to be investigated.
Alexandria	0.6 Mm^3/a	Adequate	Borehole supply - coastal dunes. Existing source (Fish Kraal) and conveyance adequate until 2007	Moderate growth in water use. Situation is not yet critical. Conveyance system needs to be upgraded	No		- Surface Water (SW) scheme not required; - Can be supplied with GW from additional sources at Cape Pardone, Fish Kraals and Apies River: Ecological sensitivity is an issue, EIA report prepared; - Conveyance system needs to be upgraded

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
includes Shamwari Game Reserve	Water supplied (urban) = 0.178 Mm^3/a	Should meet water requirements to beyond 2020	Borehole supply and New Year's Dam		No	Unaccounted for water (UAW) is high, possibly leaking from the old KwaNonzwakazi Reservoir	The WTW needs refurbishment
Bathurst	0.30 Mm^3/a	Augmentation may be required	Mansfield, Sarel Hayward and Golden Ridge Dams, and the remainder from boreholes and rainwater tanks. Existing sources: Golden Ridge (a private dam) will be adequate until 2006	TDS of borehole water is high. It is not known if these boreholes have been abandoned. Moderate growth is expected. Portions of town rely on private sources - not reticulated	Yes		- Carry out Reserve determination study for Golden Ridge Dam. Supply from this source can continue; - Commence GW investigation to identify GW augmentation options
Bedford	Dam firm yield = 0.27 Mm^3/a Boreholes = 0.126 Mm^3/a Orange River Project = 0.48 Mm^3/a capacity Treatment works = 0.6 Mm^3/a		Orange River Project has been linked. Small dam and emergency boreholes for periods of drought		No		
Boknes, Cannon Rocks	0.24 Mm^3/a	Inadequate	Borehole supply. High growth in water use is expected	Poor quality water and failure of boreholes. Situation critical during peak. Concern regarding development of the Alexandria wellfield.	Yes		- Additional boreholes can be developed as required: sufficient GW resources at the Apies River mouth and Fish Kraal, but environmental constraints to be resolved with Sanparks; - SW resources not favourable.

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
							- New conveyance system to be built. - Can be supplied with GW from additional sources at Cape Padrone, Fish Kraals and Apies River: Ecological sensitivity is an issue, EIA report prepared
Bontrug		Good	Orange River Project		No		
Cannonvale		Good	Orange River Project, supplied by NMMM		No		
Cookhouse	0.4 Mm^3/a from ORP	Adequate	Orange River Project		No		
Cradock	3.5 Mm^3/a from ORP Allocation of ORP water = 6.6 Mm^3/a	Adequate to 2012	Orange River Project		No		
Enon	0.1 Mm^3/a from ORP	Good	Orange River Project		No		No further schemes planned
Fish River Mouth		Good	Receives water from Bira		No		
Fort Beaufort	2.6 Mm^3/a allocation from Kat River	Yield of Kat River fully allocated	Kat River Dam	Shares dam with irrigators and Seymour. Water services scheme falling into disrepair.	No	WDM needs investigation	Groundwater Several possible dam sites investigated in Kat River Basin Study
Graaff-Reinet	Water use = 2.23 Mm^3/a Nqweba Dam allocation = 3.3 Mm^3/a Mimosadale wellfield yield = 0.3 Mm^3/a	Adequate to 2032 on condition that system is: - Well managed; - Well maintained; - WC&DM is implemented	Nqweba Dam, Mimosadale Wellfield	Salinity is a problem. Nqweba Dam was almost empty when bought in 2001, and has not filled much since then.	No	- Telemetry for water supply system required. - A WDM plan was devised and Graaff-Reinet was requested to	- A site-specific hydrological/hydro-geological study and undertaking of metering/monitoring is required; - Upgrading of WTW required.

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
						implement, but they are slow in doing so.	- Construct booster pump station, rising main (Nqweba-Kroonvale) and water reticulation; - Upgrade Skuinsdak Reservoir; - Upgrade Tweededrif gravity mains pump station and rising main; - Replace Adendorp-Wolwas rising main; - Upgrade rising main from emergency wellfield to WTW.
Grahamstown	8.6 Mm^3/a	Adequate for foreseeable future	Orange River Project: Hermanuskraal Weir-tunnel-Glen Melville Dam. Water is also obtained from Howiesonspoort, Settlers, Jameson and Milner Dams. Supply setup is complex due to source and user level differences	Dense settlement problems e.g. night soil could potentially impact on groundwater quality	No	No structured meter maintenance in place. No leak detection surveys conducted.	Future sources when required: - Jan Kleynhans scheme; - Increased allocation from Glen Melville Dam; - Groundwater development.
Hofmeyr	0.09 Mm^3/a	Needs augmentation	Borehole supply	Boreholes unable to meet water demand	Yes		Expand the wellfield
Hogsback			Run-of-river and Plaatjies Dam		No		
Jansenville		Poor	Borehole supply	Poor water quality is a problem	Yes	- Investigate re-use of outfall water WC&DM - Plan prepared	- Additional boreholes can be developed to supplement southern field supply. - Upgrade water reticulation - Looking to possible abstraction from Darlington Dam (ORP water) in long term

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
Kenton-on-Sea, Bushmans River Mouth	0.58 Mm^3/a	Desalination plant was commissioned as a result of peak holiday season demand	Borehole supply at dunes and Diaz Cross. Reverse osmosis seawater desalination plant. Supply adequate to 2005	High growth in water use is expected. Situation critical even during low demand. A problem with the position of the RO plant is being experienced.	Yes		- Produce EIA report and develop Kwaaihoek wellfield; - Upgrade supporting infrastructure for the existing RO plant: electrical, intake, disposal. EIA required for disposal of brine from desalination plant; - Develop GW sources at Merweville and Bushfontein together with conveyance system; - Further studies to confirm the anticipated yields of the GW sources are recommended, but implementation can commence; - Alternatively expansion of the reverse osmosis plant or supply from SW can be considered.
Kirkwood	Water supplied = 0.624 Mm^3/a	Good	Orange River Project		No		No further schemes planned
Kleinemonde	0.11 Mm^3/a	Good	Supplied from Port Alfred and Wellington Dam	High growth in water use expected. Situation not critical yet. Supply from Wellington Dam has poor water quality (TDS), up to 2 500 mg/l at times. Source has sufficient capacity until 2007.	Yes		Identify suitable GW resources for future augmentation

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
Middelburg	0.75 Mm^3/a	Good if managed properly. Adequate to 2010	Borehole supply	Failure of boreholes due to poor management of system	No	Need to implement WC&DM urgently	Further borehole development
Middleton: Private Town			Orange River Project		Unknown		
Nieu Bethesda	0.01 Mm^3/a	Good	Borehole supply		Yes		- Additional boreholes required; - Augment bulk water supply and infrastructure as per current report. - Investigate and establish safe yield of boreholes/aquifer; - Construct pumping distribution water supply to commonage camps; - Water reticulation to 55 erven being installed at present
Paterson	Water supply (urban) = 0.120 Mm^3/a	Inadequate	Borehole supply	Inadequate yield	Yes		- Develop new boreholes. A successful borehole was drilled on a farmer's land without his permission. This issue must be resolved. - Possible use of ORP water from Addo WTW is a long-term option, but is expensive.
Pearston		Inadequate	Borehole supply	Inadequate yield	Yes		Groundwater development
Peddie	Dam, treatment works and pipeline have capacity of 0.11 Mm^3/a	Adequate for town	Supply from Keiskamma River		No		

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
Port Alfred	1.73 Mm^3/a	Inadequate	Mansfield and Sarel Hayward Dams and boreholes in coastal dunes	Situation is critical during peak demand. Available sources are adequate until 2005. Water in Sarel Hayward Dam becomes saline. Current source: poor water quality (TDS) of 1700 mg/l. GW resources not sufficient to supply full future requirement, but can postpone development until 2011.	Yes		- Develop GW resources at Sunshine Coast and Glendour to postpone SW scheme; - Undertake further studies to determine best surface water scheme: Glen Melville, Settlers and Sarel Hayward; - Undertake further GW studies to firm up on GW development potential of the Witteberg
Riebeeck-East	0.0285 Mm^3/a	Good	Borehole supply		No	Current water loss less than 10% of water consumption	- Additional boreholes can be developed as required; - An additional 300 kl of storage capacity is required to ensure 72 hr storage; - Reservoir required to serve Kwanomzamo
Riet River Mouth					Unknown		
Rosmead railway station					Unknown		
Seymour	Treatment plant capacity = 0.22 Mm^3/a	Yield of Kat River fully allocated	Kat River Dam and boreholes	May be conflict with Fort Beaufort and requirements of irrigators. Water services scheme falling into disrepair	No	WDM needs investigation	

Town/s	Water use	Assurance of water supply/reliability of the water source	Current supply source	Problems with current supply	Need to augment existing supply	Comment on WDM initiatives and success	Planned water schemes/studies
Somerset East	0.8 Mm^3/a from ORP Capacity of water supply scheme = 1.5 Mm^3/a	Adequate to 2005	Orange River Project, three small dams, boreholes and springs	Adequate	No		Further Orange River water supply
Steynsburg	Water availability is 0.6 Mm^3/a	Inadequate in summer	Borehole supply	Inadequate in summer. Problems with borehole water quality and quantity. One borehole abandoned.	Yes		- Possibility to link to Orange River Project – approved in principle; - Part funding is available; - Proposed abstraction point is an existing airshaft in ORP tunnel
Tarkastad	0.1 Mm^3/a Yield supply is 83.61 l/s = 2.6 Mm^3/a	Good	Supply from 3 boreholes		No		Additional boreholes can be developed as required; No plans have been made to increase the supply
Uitkeer		Good	Orange River Project		No		

5.5 RECONCILIATION

Management objective:

The strategy provides a guideline on how best to balance water requirements with existing resources to obtain a sustainable, balanced water situation, through recommended intervention measures and development guidelines. Adequate volumes of water at an appropriate quality should be made available when required to meet requirements at an acceptable assurance of supply and cost, whilst limiting negative environmental and social impacts.

Situation assessment:

Available yield:

The available surface water yield of the ISP area (with current developed water infrastructure) is 160 million m^3/a, groundwater use is 24 million m^3/a and usable return flows (mainly from irrigation with Orange River water) amount to 110 million m^3/a, totaling 294 million m^3/a of "local" resources. The 1:50 year impact of the large amounts of Orange River water transferred in from the Upper Orange WMA to meet requirements for irrigation and local towns, urban needs of the NMMM and freshening releases, is 575 million m^3/a. Total available yield is 757 million m^3/a, taking river channel losses of 112 million m^3/a (all ascribed to transfer of Orange River water) into account.

Current water requirements:

Irrigation accounts for 629 million m^3/a, at 1:50 year assurance of supply, of the total local requirements of 668 million m^3/a. The total ISP area requirement is 759 million m^3/a. A calculation of the maximum possible Orange River water requirements of the ISP area indicates a quantity of 83 million m^3/a in excess of the allocation of 575 million m^3/a at 1:50 year assurance of supply. The annual transfer to the NMMM amounts to 11 million m^3/a. Freshening transfers from the Orange River is allowed to flush through the system to flow to the sea, together with any natural runoff, in order to ensure a reasonable quality of water for abstraction.

Current water balance:

Table 5.2 shows the reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance, in million m^3/a.

The ISP area and sub-areas are in balance, with the shortfall in local yield being fully met by transferred Orange River water. Significant amounts of freshening flows are transferred for blending purposes to make poor quality water usable.

Table 5.2: Reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Available yield				Water requirements			Balance (1)
	Local yield	Transfers in (2)	River Losses (3)	Total	Local require-ments	Transfers out (2)	Total	
Fish	179	575	-94	**660**	467	193 (4)	660	**0**
Albany Coast	21	1	0	**22**	22	0	22	**0**
Sundays	94	123	-18	**199**	182	18 (4)	200	**-1**
Total for ISP area	**294**	**575**	**-112**	**757**	**671**	**88** (4)	**759**	**-2**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) The river losses resulting from evaporation and seepage for the transferred volumes have been included here. This was a best estimate from the ORRS modeling (16).
4) 70 Million m³/a flows to sea from the Fish River and 7 million m³/a from the Sundays River, while 11 million m³/a is transferred on from the Sundays sub-area to NMMM.

Current and future water demands:

Irrigation: There is a demand in the Fish River, Lower Sundays River and Kat River for further expansion of irrigation and for resource-poor farmers' irrigation development. Between Middleton and Hermanuskraal in the Fish River catchment some low quality water is still available for scheduling and applications have been received for such water use. This can be considered if irrigators accept the quality and if downstream impacts do not present a problem. An updated water balance is however needed before any decision can be reached.

A total of 4 000 ha (38 million m³) of identified future Orange River allocations have been reserved for new irrigation by resource-poor farmers in the ISP area. Of this, 180 ha have already been approved near Addo. If the proposed 860 ha of new irrigation (for Phases 3 and 4) at Tyhefu were developed, it would form part of the 4 000 ha new development. Other applications have also been received for new resource-poor farmers' schemes.

Rural use: Large dispersed communities in the ex-Ciskei region are in need of water (quaternary Q93C near Peddie). This would be allocated under water for Basic Human Needs, but should also include some additional water to allow for food gardening and other livelihood strategies.

Urban use: Limited growth is expected for local towns that use transferred Orange River water. The Algoa Pre-Feasibility Study recommended that the NMMM would not require significantly increased transfers before 2020. The NMMM can use 13.5 million m³/a from the Sundays River at the lower (Kouga) tariff, due to the exchange of water from the

Kouga system. Refer to the *Tsitsikamma to Coega ISP* for corresponding similar water use values of the NMMM.

Forestry: Applications have been received to establish small areas of new forestry in the Kat River catchment.

Future available Orange River water:

44 Million m^3/a remains in the Upper Orange WMA, after 12 000 ha has been allocated for resource-poor farmer irrigation development. This water is "reserved" for urban and industrial growth in the Orange River and Fish to Tsitsikamma WMA. Future water transfers of 38 million m^3/a (4 000 ha of the 12 000 ha) for resource-poor farmers in this ISP area have been reserved, as part of the current water balance. A further transfer of 28 million m^3/a from Gariep Dam, likely 26 million m^3/a for urban use by NMMM and 2 million m^3/a for small towns, has been used to determine the Upper Orange ISP's yield balance for 2025. Further transfers from the Orange River would likely require operational improvements or infrastructure development to increase the yield of the Orange River System.

Strategic approach:

Undertake an updated water balance of the area, with a focus on pin-pointing actual/current lawful requirements, before any decisions on future allocations are reached, apart from the reserved water for future Orange River transfers. The actual situation of scheduled vs. actual irrigation use needs to be established, especially for the Kat River catchment. Maximum possible use of Orange River water in the ISP area must be brought in line with the allocation for transfer from the Upper Orange WMA.

For supply to meet the forecast future requirements, the following reconciliation interventions appear to be favourable and are listed in order of current understanding of priority:

- **Further transfers from the Upper Orange WMA** will:
  - Meet the needs of new resource-poor farmers, up to 38 million m^3/a;
  - Partially meet growth in urban demands of towns in the ISP area as set out in the *Supply to Local Authorities Strategy*, Strategy 5.4, following the implementation of other measures such as water conservation and demand management, increased operational efficiency, sustainable development of groundwater or trading of water use authorisations;
  - Meet growth in urban and industrial use of the NMMM/Coega, through transfers via the Fish and Sundays River catchments, although further development in the Orange River may be needed (to be made available at the cost of augmentation) and if there are not higher priority competing uses;

- **Urban water demand management.** (Refer to the *Urban and industrial water conservation and demand management strategy, Strategy 8.1*). Water demand management is the most viable way to reduce the urban water demand, and must be vigorously pursued. The savings as a result of demand management are expected to be obtained by the reduction of site leaks, reservoir overflows, unmetered connections and behavioral change of consumers;

- **Agricultural water demand management. (**Refer to the *Agricultural water conservation and demand management strategy, Strategy 8.2*). Through conversion to higher value crops, more efficient irrigation methods and reduced distribution losses, water could become available for opportunistic or longer-term irrigation development or possibly for increased freshening releases;

- **Improved system operation.** (Refer to the *Orange-Fish-Sundays WSS management strategy, Strategy 12.1*). Implement an improved operational model, to reduce river losses, limit unused scheduled releases and spills, attain more effective freshening releases and test development scenarios;

- **Make full use of existing infrastructure.** Clarify the position of Kat River irrigators (allocated/unused water or illegal use of water) and rectify the situation to ensure that wastage does not occur;

- **Removal of invasive alien plants** holds potential especially in the coastal catchments, both for augmenting yield by clearing upstream of existing storage facilities or to make provision for the Reserve. A total of 4 million m^3/a could theoretically be released if complete eradication could be achieved. Working-for-Water projects should continue;

- **Water trading / buying out of irrigation rights.** The trading of existing licences can bring about a better use of available water without further impacting on the yield. By further trading of unused or under-utilised allocations more water could become available for use;

- Through registration and verification of lawful use, the extent of **unused allocations** will be determined. **Illegal users** will also be identified and such use put to an end, bringing water back into the system for use. (See the *Trading of water use allocations* and *Licensing strategies*);

- Ensure implementation of **sustainable management of stressed aquifers** such as the primary coastal aquifers and the fractured dolerite and Karoo aquifers (refer to the *Groundwater strategy, Strategy 5.2*);

- **New groundwater development.** (Refer to the *Groundwater strategy, Strategy 5.2*). Groundwater holds possibilities for development, in particular to augment the supply of towns;

- **New surface water schemes.** The proposed Foxwood Dam in the Koonap River will be costly. The proposed Baddaford off-channel dam in a Kat River tributary is being evaluated to supply a potential resource-poor farmer scheme. The potential Wapadsberg Scheme for Graaff-Reinet would be very costly and would likely be unaffordable for local consumers, even if additional Orange River water were available, which it is not.

The DWAF will not give consideration to licence applications for new schemes unless all other reconciliation options, such as water demand management and water re-use have been properly

explored and implemented, and if there are no options other than new development. Local development of groundwater schemes will be favoured over new surface water development, but financial viability will influence such decisions.

Off-channel storage is preferable to in-channel storage, particularly where river flow dynamics are important in sustaining the health of ecologically sensitive rivers and estuaries.

Consider all social, environmental and economic impacts and costs in the comparison and selection of future augmentation options.

Management actions:

1. Undertake an updated water balance;
2. Considered the dune fields in the Albany Coast area as an emergency supply option during peak requirement periods rather than as a primary or augmentation source of supply in the area. The Witteberg Quartzites are the appropriate source for regional aquifer development;
3. Actively promote the establishment of feasible and sustainable resource-poor farmer schemes, through the *Poverty eradication and land reform strategy, Strategy 11.1*;

Responsibility:

The D: NWRP is responsible for general planning pertaining to this strategy and D: Options Analysis is responsible for feasibility analyses of identified development or intervention options. They will be supported by the RO, D: RDM and the Environment and Recreation Sub-Directorate, Directorate Water Utilisation.

Priority:

1 – Very high.

CHAPTER 6 –WATER RESOURCES PROTECTION STRATEGIES

NEED FOR WATER RESOURCES PROTECTION STRATEGIES

The Water Resources Protection Main Strategy addresses the need to achieve the protection of water resources to ensure their continuing availability for human use by leaving enough water of appropriate quality in rivers and streams to maintain their ecological functioning, which will be achieved by:

- Classification of freshwater bodies and determination of their human and environmental Reserves;
- Setting resource quality objectives for freshwater bodies;
- Addressing water quality management, pollution control and sanitation and
- Addressing solid waste management.

Water required for socio-economic growth must therefore be balanced with the availability of water that is fit for use by all users, including the protection of the aquatic ecosystem. The NWRS defines two complementary approaches for the protection of water resources. **Resource Directed Measures** focus on the character and condition of the in-stream and riparian habitat, whilst **Source Directed Controls** focus on the control of water use at the point of potential impact, through conditions attached to water use authorisations.

These strategies aim to achieve adequate protection for surface and groundwater resources, in terms of the desired states of these resources, to reach a balance between protection and sustainable use.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

6.1 Reserve and resource quality objectives;
6.2 Water quality management.

6.1 RESERVE AND RESOURCE QUALITY OBJECTIVES

Management objective:

To develop a regional approach to the determination and implementation of management classes, Reserve requirements, and resource quality objectives for surface freshwater bodies, estuaries and groundwater, within the requirements of the national classification framework. This will be done according to the prescribed methodologies by using applicable methods of determination.

Situation assessment:

Table 6.1 shows the Reserve determinations undertaken to date, and the average runoff needed for the ecological flow requirements, by sub-area, compared to the respective MARs. The ecological flow requirements (EFR) studies that have been undertaken are limited and are at low levels of detail. No releases are currently made from dams to specifically support the ecological health of rivers, estuaries or wetlands, and no aquifer management plans are in place. There is a general lack of monitoring data, including biological monitoring, to support Reserve determinations in this ISP area.

In practice the reductions in surface water yield due to the preliminary ecological flow requirements are minimal (total 3.7 million m^3/a – see **Table 6.2**).

Table 6.1: Natural MAR and average EFR

Sub-area	Natural MAR (million m^3/a)	Ecological flow requirements (million m^3/a)
Fish	518	47
Albany Coast	174	15
Sundays	280	20
Total for ISP area	**972**	**82**

Table 6.2 shows the reduction in surface water yield, by sub-area, due to the requirement of the Reserve.

Table 6.2: Surface water yield at 1:50 year assurance

Sub-area	Surface water yield before reductions (million m^3/a)	Reduction in yield: Reserve (million m^3/a)
Fish	94.7	2.6
Albany Coast	17.1	0.0
Sundays	56.2	1.1
Total for ISP area	**168.0**	**3.7**

Rivers:

Reserves have been determined at several main stem river sites in the Great Fish River at Rapid 1 level (see **Table 6.3**) and at a site just upstream of the Sundays Estuary. An Intermediate Reserve determination of the Kat River is underway, funded by the Water Research Commission. Most Reserve determinations undertaken thus far were done so that decisions could be taken regarding the "prospective trading of water rights". The main stems of the Fish and Sundays Rivers, as well as certain tributaries, have been significantly modified due to the Orange-Fish Transfer Scheme. These rivers have too high winter flows and not enough flow variability, as well as a black fly problem. Estimates of ecological categories indicate that the present ecological conditions of most rivers in the ISP area are poor.

Estuaries:

No estuarine freshwater requirements have been determined for the estuaries in the ISP area. There are five permanently open estuaries, three of which are freshwater starved. The ecological importance of these estuarine systems needs to be established, together with their sensitivity to reduced flows and to changes in water quality, especially increased salinity. The Great Fish Estuary is highly rated as a system of ecological and economic importance. A Reserve determination should be done for the Bushmans Estuary due to a possible increased discharge of brine from the reverse osmosis plant on the banks of the estuary. The Kowie Estuary Reserve also needs to be undertaken.

Groundwater:

Three groundwater Reserves were determined to date. The political pressure to deliver potable water and sanitation has not taken adequate cognisance of sustainability and resource protection aspects, which is becoming more apparent as more local schemes are developed and the incremental impacts are being felt.

Wetlands:

No Reserves for wetlands have been determined.

The status of Reserve determinations in the various sub-areas is as follows:

Table 6.3: Approved Reserve determinations undertaken to date

Quaternary	Component	Surface water resource	Ground-water resource	Level of determi-nation	Virgin MAR or Recharge(1) (Mm^3/a)	Recom-mended ecological category	EWR as a % of Recharge
FISH SUB-AREA							
Q13C	River	Great Fish	N/a	Rapid 1	104.5	D	10
Q30E	River	Great Fish	N/a	Rapid 1	121.8	D	10
Q41C	River	Tarka	N/a	Desktop	20.4	D	11
Q41D	River	Tarka	N/a	Rapid 1	53.2	D	10
Q42B	River	Tarka	N/a	Desktop	15.4	D	11
Q50C	River	Great Fish	N/a	Rapid 1	194.6	D	10
Q70C	River	Great Fish	N/a	Rapid 1	222.1	D	10
Q80G	River	Little Fish	N/a	Rapid 1	46.3	D	10
Q91C	River	Great Fish	N/a	Rapid 1	288.9	D	10
Q92B	River	Koonap	N/a	Desktop	32.7	B/C	24
Q92C	River	Mankazana	N/a	Desktop	49.9	B/C	24
Q93A	River	Lower Fish	N/a	Desktop	4.3	D	11
Q93C	River	Lower Fish	N/a	Desktop	6.9	D	11
Q93D	River	Great Fish	N/a	Rapid 1	447.8	D	11
Q94B	River	Kat	N/a	Desktop	33.4	C	20
Q94C	River	Kat	N/a	Desktop	44.5	C/D	17
Q94D	River	Kat	N/a	Desktop	7.4	C	19
Q94F	River	Kat	N/a	Desktop	8.2	C	17
SUNDAYS SUB-AREA							
N40B	River	Sundays	N/a	Desktop	202.6	C	17
N40F	River	Lower	N/a	Rapid 1	244.2	D	10
ALBANY – COAST SUB-AREA							
P10B	Groundwate	N/a	Witpoort	Desktop	10.3	C	6
P10E	Groundwate	N/a	Witteberg	Desktop	14.9	B	1
P10F	Groundwate	N/a	Bushmans	Desktop	15.1	D	18

1) Recharge refers to the increased runoff due to transfers or to the MAR where water is not transferred into the catchment

Strategic approach:

In general DWAF's approach is to (at the very least) maintain the status and the present ecological state of rivers, set RQOs, ensure compliance and license according to the current level of use and the availability of water resources, taking into account the needs of the Reserve. Reserve determinations will continue to be done on an *ad hoc* basis as the need arises, depending on the availability of resources and information. Determinations must be done according to the latest RDM methodologies.

Higher conservation or classification values will be attached to rivers, estuaries, wetlands and aquifers in conservation areas. Any future human manipulation of river reaches that lie within conservation areas would require very strong motivation.

It is essential that Reserves be implemented once they have been determined.

Management actions:

- Implement classification at a regional level, when the classification framework becomes available;
- Initiate the drafting of flow management plans for the Fish and Sundays rivers/estuaries, with a focus on ecological protection and control of black fly (see the *Orange-Fish-Sundays Water Supply System Management Strategy*, Strategy 12.1);
- Ensure that the Water Quality Management Plan of the Orange-Fish-Sundays Water Supply System addresses releases for ecological requirements to counter water quality problems that occur when the river stops flowing for short periods (see the Orange-Fish-Sundays Water Supply System Management Strategy, Strategy 12.1);
- Initiate a regional initiative to identify potential aquifers that experience, or could soon experience, high ecological risk due to water and sanitation development initiatives. Initiate the drafting of Aquifer Management Plans for such higher-priority identified aquifers, to reduce the risk of major sustainability and resource impact problems;
- Ecological releases should be made from the Kat River Dam once the current Reserve study is complete and the water balance is adequately understood. Ensure that the Reserve determination now being undertaken for the Kat River is registered with D: RDM;
- Operational releases at dams must include releases for ecological requirements. Develop appropriate dam operating rules to achieve the aims of such Reserves. Review releases from dams to ensure that they serve downstream licensed users, once Comprehensive Reserves have been determined;
- Ensure adequate monitoring of rivers to ensure that the objectives of implemented Reserves are attained.

Responsibility:

The RO, in consultation with the D: RDM is responsible for implementing this strategy.

Priority:

Priority 1: Very high - Kat River, Bushmans Estuary;
Priority 2: High – Fish River and Estuary (link the flow management plan to the operational plan); Kowie Estuary, Tarka River;
Priority 3: Medium – Koonap River;
Priority 4: Low – Sundays, Kowie, Bushmans and Kariega rivers.

This is a continuous programme that requires immediate and ongoing attention.

6.2 WATER QUALITY MANAGEMENT

Management objective:

To improve management and control of point source pollution, diffuse pollution and spills, including solid and toxic waste sites and prevention of contamination.

Situation assessment:

Assessment and determination of water quality impacts of the OFSWSS, and associated water quality issues relating to irrigation water use, is addressed under the *OFSWSS Management Strategy*, Strategy 12.1.

A desktop level quality classification system for Eastern Cape rivers is under development, broadly focussed on the Water Quality Guideline Document.

Some local problems with wastewater works are encountered, but generally the situation is acceptable. Effluent from most towns typically evaporates from oxidation or maturation ponds, or may be absorbed by irrigation and infiltration. Re-use of effluent is very limited (Grahamstown).

Refer to **Appendix 5** for further information on wastewater treatment plants and to **Appendix 6** for solid waste disposal sites.

There are many unpermitted solid waste sites, which are potential sources of groundwater pollution, and the management at many of these sites is poor with little control. There are no toxic waste sites in the area. In terms of the ECA, DEAT is responsible for waste site approval, which responsibility is currently delegated to DWAF. This function will revert to DEAT within two years.

The nightsoil bucket system still operates in many of the small towns. These need to be phased out but must be adequately managed until then. Capacity of officials at local municipalities is however a limitation.

Albany Coast sub-area

Many dense settlement problems related to the informal housing areas are experienced in Grahamstown. The current level of services is inadequate and problems are for example being experienced with nightsoil. The Bucket Eradication Programme has been implemented in Grahamstown and sanitation is being improved. The Dense Settlements Programme has been implemented but some problems are still being experienced. There are large impacts on water resources, especially on the Bloukrans tributary of the Kowie River, which has an extremely high bacteriological population.

The brine of the desalination plant at Bushmans River Mouth goes to the estuary. It is being evaluated whether it should be pumped to sea.

Strategic approach:

Finalise and implement a regional Water Quality Management Plan in accordance with best management practice, which addresses:

- Water quality assessments of rivers and other water bodies;
- Point source and diffuse pollution control and pollution incidents;
- Wastewater treatment works;
- Solid and toxic waste;
- Sanitation and eradication of bucket systems;
- Waste discharge charges;
- Liaison with stakeholders and polluters;
- Capacity building at municipalities.

Management actions:

The required actions to address specific water quality management issues and concerns are as follows:

1. Complete and distribute the desktop level water quality assessment documentation;
2. Set water quality objectives under the *Reserve and RQOs Strategy*, Strategy 6.1;
3. Address protection of rivers from the negative impacts of irrigation return flows on river health under the *Reserve and RQOs Strategy*, Strategy 6.1;
4. Address operational issues with regard to water quality, including the requirements for freshening releases which are currently used to keep salinity under control, under the *Orange-Fish-Sundays WSS Management Strategy*, Strategy 12.1;
5. Address water quality monitoring requirements, under the *Monitoring Networks and Data Capturing Strategy*, Strategy 13.1;
6. Manage compliance to pollution-related authorisations and licences;
7. Keep minor point-source pollution under control with regular inspections. More attentively monitor storm water discharges and spillages from problem industries or areas in co-operation with municipalities;
8. Hold discussions with polluters in sensitive catchments to convey the importance of curtailing pollution;
9. Implement point-source discharge charges (polluter pays), as recommended in the draft *National Water Quality Framework* policy, once it has been approved;
10. Through co-operative governance with local authorities, build capacity to ensure that operators of WWTWs develop responsibilities and procedures for emergency control of spillages at pump stations, power failure or blockages and mechanical breakdown. Monitor the effectivity of oxidation ponds at the various municipalities at regular intervals;
11. Get buy-in from local authorities (who are responsible for waste management) on solid waste site strategies and implement the strategy and monitoring along with them. Create awareness at local municipalities to improve solid waste sites management and elimination of the nightsoil bucket system through co-operative governance. They have to commit however, allocate funds and implement. Political pressure on officials, through Provincial Liaison Committees, creates a higher chance of success, to overcome the problem of supporting the commitment of funds.

12. Through co-operative governance with local authorities, implement the Department's Sanitation Policy and monitor it;
13. Identify and address diffuse pollution from informal settlements through WUAs and the Dense Settlements Programme;
14. Ensure that Pollution Incident Management Plans in environmentally sensitive areas are operational and that local authorities and the South African National Roads Agency Limited (SANRAL) know what their responsibilities are;
15. Control diffuse pollution from intensive agricultural business ventures, e.g. feedlots and chicken pens, with the Department of Agriculture through co-operative governance;
16. Control site-specific measures for solid waste by setting appropriate pollution-control conditions in new licences issued;
17. Encourage district and local authorities to further develop and enforce bylaws, draft regulations *et cetera* to systematically deal with water quality problems with the long-term view of improving the water quality and riverine and groundwater environments.

Responsibility:

The RO is responsible for developing this regional strategy, assisted by D: WD&D and Sub directorate: WQP of Directorate: Water Resource Planning Systems.

Priority:

1 – Very high. This is an ongoing strategy.

CHAPTER 7 – WATER USE MANAGEMENT STRATEGIES

NEED FOR WATER USE MANAGEMENT STRATEGIES

Chapter 4 of the NWA describes the provisions by which water use may be progressively adjusted to achieve the Act's principle objectives of equity of access to water, and sustainable and efficient use of water. Controls over water, to achieve the NWA's aims, are exercised through various authorisations to use that water. Authorisation of water use, which may range from use under Schedule 1 to licensing, requires administrative control of water use by water management institutions. Registration and licensing form the basis upon which charges for water use are made, and provide for the collection of water-related data and information.

It is an eventual objective to license all water users. Until this is possible other measures need to be implemented strategically, so that users can be authorised without unreasonable procedures. Users that received licences under the previous or preceding Water Act, or through other means such as e.g. the Water Court, and have exercised that entitlement, are considered to be lawful users. All water use authorisations will be subject to verification. Users are further required to register their use.

The *Water Use Management Main Strategy* is required to address:

- ⇨ Management of Schedule 1 water use;
- ⇨ General authorisations to manage water use;
- ⇨ Verification of the lawfulness of existing water use;
- ⇨ Processing and issuing of new water use authorisations (licences);
- ⇨ Control of invasive alien plants and weeds; and
- ⇨ Implementation of pricing for water use.

A strategy for Schedule 1 use was not developed, as related management issues were regarded as having a low priority in this ISP area.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

7.1 General Authorisations;
7.2 Water allocations and licensing;
7.3 Water trading;
7.4 Managing invasive alien plants.

7.1 GENERAL AUTHORISATIONS

Management objective:

To ensure that General Authorisations (GAs) are correctly introduced and updated in the required geographical areas, to allow lower-impact water use and discharge to continue whilst using limited staff in DWAF more effectively.

Situation assessment:

Refer to **Appendix 7** for the selected GAs of this ISP area. Current GAs published in March 2004 [32] in terms of Section 39 of the NWA have stipulated the following:

GAs is a tool in the NWA aimed at reducing the pressure on the need to issue individual licences. All water use needs to be registered and ultimately licensed - but the NWA recognised that this could place an impossible or unnecessary burden on the regulatory authorities, especially in cases where there were many applications for new uses, and little doubt as to the acceptability of the water use – and therefore the issue of the licence.

The GA is therefore aimed at allowing a new user to commence with that use without having to apply for a licence – provided that use is within the scope and limitations of the GA. The GAs stipulate that a person may use water in a defined area without a licence if it does not impact on a water resource, or any other person's water use, property or land. While all use will have an impact on the resource or other users, use under GAs is meant to have a minimal impact. The user must still register that use, but it is automatically legal under the GA process and does not need special approval. Typically GAs are available for the taking and storage of water up to a certain limit per user – and these GAs are declared for areas where there may be plenty of water and no question of overuse, or where storage of water may provide no foreseeable threat to the resource. GAs may also be declared to allow the discharge of wastewater (again very strong conditions will apply), and most recently a GA has been formulated to allow for the modification of stream banks without the specific need for a licence. (A strict reading of the NWA otherwise requires, for example, that every stream culvert must be individually licensed).

GAs were, until 2004, handled as a national function and determined and gazetted centrally, although local input was obviously important. This situation has now been rationalised, a recognition both of the value of the GA as a tool, but also of the importance of reviewing and revising all GAs finely, frequently and at local scale. GAs can be proclaimed for very specific needs in very specific places. GAs is now reviewed at the level of the WMA authority (currently the Region) and may be at quaternary or even finer scale and changed annually or even more frequently if required. It is, indeed, extremely important that all GAs are very regularly reviewed. As soon as there is any indication that the resource needs to be brought under tighter control then the GA should either be rescinded or modified. It is up to the Region to keep track of the situation and to motivate such modifications as required.

It must be noted that a water use under GA (provided that use is registered) carries the same authority as use under a licence. Note that (a) the GA may be modified and this will affect new users – but will not affect the rights of users who commenced that use under the GA in force at the time, and (b) any exceedance of the conditions of use under the GA will constitute illegal use.

GAs are not available for Stream Flow Reduction Activities (SFRAs: Forestry). The reason for this is primarily because the control and licensing of forestry is a co-operative governance function and cannot be authorised only under the NWA. In practice the water-use aspect could be allowed for under a GA - but there is little point in this given that any application must be considered and evaluated by all co-operative governance partners. The mapping of suitable areas for forestry – with mapping outlining areas where water, environmental and agricultural constraints have all been suitably accounted for, is the closest that forestry has come to a GA. Such a map has not yet been produced for the Eastern Cape.

Areas excluded from GAs for the **taking of surface water** are the:

- Sundays River upstream of Nqweba Dam (N11, N12);
- Bushmans River (P10);
- Kowie River (P30);
- Kariega River (P40);
- Tarka River (Q41A, Q41B, Q41C, Q41D, Q44A, Q44B);
- Elands River (Q42A, Q42B)
- Vlekpoort River (Q43A, Q43B)
- Koonap River (Q92); and
- Kat River (Q94).

All of these catchments were excluded from the relaxation allowed by the GA because of the high level of development, mainly irrigation water use outside the area supplied with Orange River water, which limits the available resource in these catchments. (In other words care must be taken with regard to the issue of all further water use licences in these catchments).

GAs do not apply to stretches of rivers previously included in Government Water Control Areas. This effectively excludes those stretches of the Teebus, Great Brak, Great Fish, Little Fish, Schoenmakers and lower Sundays rivers which are used to convey Orange River water.

The following additional GAs have been proclaimed:

- **Groundwater abstraction zones** have been declared for many quaternaries throughout the ISP area in all the sub-areas, varying from no abstraction to 400 m^3/ha/a of allowable abstraction respectively;
- The Great Brak River (Q11, Q12) has been excluded from GAs for **discharge of waste or water containing waste** into a water resource through a pipe, canal, sewer or other conduit and; disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

Registration with DWAF is required for:

- Taking more than 50 cubic metres from surface water or 10 cubic metres from groundwater on any given day; or
- A combined storage of more than 10 000 cubic metres of water per property.

For the following uses, no areas within the ISP area have been excluded from GAs:

- Any **storage of water**;
- **Storage of water in excess of 10 000 m^3** and falling outside government control areas proclaimed under the Water Act No 54 of 1956;
- **Irrigation with waste or water containing waste** generated through any industrial activity or by a waterwork;
- Listed water resources where the **special limit** for ortho-phosphate as phosphorous is applicable;
- **RAMSAR listed wetlands** in the ISP area;
- **Disposing of waste** in a manner which may detrimentally impact on a water resource;
- **Removing, discharging or disposing of water found underground** if it is necessary for the efficient continuation of an activity or for the safety of people.

Additional GAs were proclaimed on 27 February 2004. In terms of this Government Notice, no areas within the ISP area have been excluded from GAs for the following:

- **Impeding or diverting the flow** of water in a watercourse;
- **Altering the bed, banks or characteristics** of a watercourse.

Strategic approach:

GAs are generally in place and have recently been updated. Water resources need to be managed at a WMA-scale and the effect of authorisations and impact of additional use under GAs should be closely monitored. The need for further changes or refinements will therefore continually be identified. Identified needs to change the GAs must be evaluated and motivated to enable changes to the GAs to be made.

Management actions:

1. DWAF staff must continuously identify and motivate any identified requirements for changes to the general authorisations;
2. Review the GAs on a continuous basis. Every GA must undergo a formal review at least once every two years.

Responsibility:

The RO is responsible for developing this strategy in consultation with the relevant head office Directorate.

Priority:

3 – Medium.

7.2 WATER ALLOCATIONS AND LICENSING

Management objective:

Implementation of a streamlined interim strategy to reach decisions on licence applications/ water use authorisations and to issue authorisations when required with the appropriate attached conditions, within the national and regional water management framework, taking local conditions into account.

Situation assessment:

Opportunities for development still exist, requiring licensing decisions, one being the many unused allocations in the ISP area, especially in the ex-Ciskei schemes such as the Kat River Scheme. Unscheduled irrigators currently use this "surplus" water from the Kat River Dam.

A total of 4 000 ha of additional allocations of Orange River water, involving an estimated 38 million m^3/a, has been reserved for resource-poor farmers in the Fish and Sundays rivers catchments. This will mainly involve new licensing, but small amounts of this water allocation have already been licensed. Further new licensing under the Orange-Fish River Scheme for commercial irrigation is not envisaged. Trading is expected to take place, and will be addressed through the *Trading of Water Use Allocations Strategy*, Strategy 7.3. Applications for creation of storage and for groundwater abstraction are being received and will be evaluated, subject to the Reserve determinations being done.

The accuracy of existing abstraction, storage and stream flow reduction activities (forestry) information on the WARMS database is unacceptable and many problems are encountered with the registered water use authorisations. The RO is busy with administrative checking of the registered information and correction of captured data. Registered water use generally decreases as information is improved.

There is a backlog in the processing of applications for new authorisations. The Regional Office has insufficient resources to undertake the Reserve determinations required for processing new authorisation applications and for the hydrological calculations. There is also extremely limited DWAF RO capacity to enforce, police or monitor activities regarding surface water and groundwater.

The investigation of complaints about illegal water use and control of such use are done *ad hoc*, and is severely restricted by staff capacity. Some cases are pending before the water tribunal regarding illegal groundwater use.

District municipalities and/or local municipalities do not, as a rule, address issues of sustainability adequately during planning of municipal groundwater supply schemes. The licensing process provides an opportunity for DWAF to set conditions relating to both monitoring and sustainable use.

a. Fish sub-area

There is a big demand in the Fish River for further irrigation development but there is currently no available surface water beyond that which can be traded or conserved. An augmentation scheme from Teebus to use Orange River water is being investigated for the town of Steynsburg. The Tarka River

catchment is a stressed area, with no demand for further development. The Koonap River catchment holds some opportunities for development, if additional storage is created.

The Kat River catchment seemingly holds some opportunities for development. There is a significant demand for further irrigation and therefore for trading or reallocation. There is uncertainty regarding the need for development initiatives by Government in this catchment. Only 777 ha of the listed 1 599 ha are scheduled and are receiving accounts, under the Kat River GWS. An application for water use has been received for the proposed Tamboekiesvlei Scheme, downstream of the Kat River Dam, which is a land restitution case at Mpofu. Some applications have been received to establish small areas of new forestry.

No applications have been received for water use licences in the Upper Fish. Most surface water resources in the Upper Little Fish and Middle Fish rivers are fully used and no additional water is available for allocation. In quaternaries Q91 A, B and C (lower Fish River), there is some utilisation of lower quality water by unscheduled water users, who have registered their use.

Trading is anticipated between current lower Fish River irrigators. The 1 450 ha allocation made to former Ciskei irrigators should be registered. On the existing Tyhefu Scheme, 380 ha at Glenmore has been licensed, and 680 ha must still be licensed, where irrigators have received allocations.

Large communities in the ex-Ciskei region are in need of water for basic use (quaternary Q93C).

b. Sundays sub-area

There is a very high demand for expansion of irrigated lands in the lower Sundays River. Potential also exists for new resource-poor farming development and this should be given priority. Requests for the trading of water use authorisations from the Upper Fish GWS to the Sundays GWS have been received.

Strategic approach:

The licensing approach will be to evaluate and process water use and storage licences only in those catchments or aquifers that clearly have allocable volumes of water, as well as identified and prioritised users for transfers of additional Orange River water (already planned). The processing will be subject to the constraints posed by the availability of resources and information. The establishment of Water Use Licensing Advisory Committees to assist in the development of indicators for the assessment of applications will be promoted. The establishment of a central register of licence applications is recommended, to ensure that the various offices that issue licences are aware of each other's activities, so that a holistic licensing approach is followed.

Evaluate and reject or authorise any application use that exceeds Schedule 1 or the limits of any General Authorisations, with a licence according to the guidelines provided in the "*Assessment of water use authorisations and licence applications"* document. As a transitional measure, in terms of the NWA, allow "existing lawful use" to continue until such time as it is licensed through compulsory licensing. An important step however is to verify that such use is indeed lawful, through verification, and to cancel all registrations of unlawful users. The SFRA Licence Assessment Advisory Committee

(LAAC) will continue to evaluate decisions with regard to forestry. Decisions with regard to water quality management will be evaluated against the DWAF Water Quality Guidelines. Conditions to be imposed regarding new licences will be made in terms of a hierarchy of principles.

Management actions:

1. Attach a high priority to correct registration of all water uses and users on WARMS;
2. Address conflicts regarding unlawful water use and control of such use through the establishment of WUAs, which should then internally address these issues;
3. Address the issue of new and unused allocations through the CCAW to try and reach a decision. This may be a political decision. Short-term trades can be arranged, e.g. in the Kat River;
4. Address re-allocation of any water saved through improved operation of the OFSWSS, and possibly some water saved through distribution canals through the CCAW according to the principle of sustainable and efficient use, as well as equity of access to water, where it is an issue. On-farm savings can be used for expansion of irrigation.
5. The RO must provide a very clear statement regarding groundwater scheme sustainability, with use and monitoring conditions as part of the recommendation accompanying licence assessment;
6. Explore the ramifications of allocating groundwater to Forums to distribute and manage such an allocation among themselves, under advice of the members to enable adequate aquifer management;
7. Investigation of the water situation in the Vlekpoort River, tributary of the Tarka River, will form part of the verification process;
8. Attach conditions when users in the Lower Fish are licensed, but water quality cannot be guaranteed.

No new licences will be issued for the following catchments:

- Tarka and Groot Brak rivers.

Licence applications for use from the following rivers could be authorised after very careful consideration (noting that no river has any significant allocable surface water quantity, without increasing storage capacity, notably in the Koonap and Kat River catchments):

- Storage and water abstraction can be considered in most catchments except in the Tarka and Groot Brak rivers;
- Groundwater licences may be considered where this does not impact on surface water resources.

Responsibility:

The RO in consultation with the Directorates WU, RDM, NWRP and Information Programmes (where applicable) and the SFRA LAAC is responsible for implementing this strategy.

Priority:

Priority 1 – Very high.

7.3 TRADING OF WATER USE ALLOCATIONS

Management objective:

A clear policy on the conditions for and evaluation of trading of water use authorisations for this ISP area is required.

Situation assessment:

This Strategy is a subset of Strategy 7.2 Water allocations and licensing. Because this is a sensitive issue, especially with regard to the way it affects or could affect the Eastern Cape Province and ex-Ciskeian irrigators, it has been written as a separate strategy.

Approximately 2 000 ha of mainly unused water use authorisations in the Fish River have recently been traded back to the Upper Orange WMA, especially from above Grassridge Dam, about 800 ha of this for a period of five years. Such trading back to the original source was a recommendation from the ORRS Study. The Eastern Cape Provincial Government is not happy with the idea that additional large volumes of water might be traded out of the Eastern Cape Province, because they are concerned that it could impact on the economy of the Eastern Cape. A decision needs to be taken on whether the Provincial or National interest should take precedence.

Requests for the trading of water use authorisations from the Upper Fish GWS to the Sundays GWS have also been received. There are still significant unused allocations in the ISP area, especially in the ex-Ciskei schemes such as the Kat River Scheme. Because the Kat River catchment holds opportunities for development, there is a significant demand for further irrigation and consequently for trading of water use authorisations, which could put currently unused water back into production. Trading is also anticipated between current Lower Fish irrigators.

Strategic approach:

As a general rule, it is preferred that unused or underdeveloped entitlements be sold (traded) before entitlements of water that is being used. These transactions, called trading of water use authorisations, must be addressed according to the Trading Procedure.

Address the issue of applications for the trading of unused allocations through the CCAW, to try and reach a decision. This may be a politically sensitive decision, taking socio-economics at a local and regional scale into account. Review the option of proposed trading from the Upper Fish GWS to the Sundays GWS in terms of the volumes to be traded and water quality impacts, taking losses, freshening releases etc. into account, by evaluating impacts through the Orange-Fish-Sundays WSS Model. Other trading applications must similarly be handled on merit. Temporary transfers of one to two years can be arranged.

Management actions:

1. Assess the potential impacts of trading scenarios on the operation of the Orange-Fish-Sundays Water Supply System;

2. Prepare a submission to the CCAW regarding all unused allocations in the ISP area (and WMA) that could be traded.

Responsibility:

The RO in consultation with the Directorates WU, RDM, NWRP and Information Programmes (where applicable), and possibly the SFRA LAAC, is responsible for implementing this strategy.

Priority:

Priority 1 – Very high.

7.4 MANAGING INVASIVE ALIEN PLANTS

Management objective:

To effectively implement the regional Working-for-Water (WfW) programme from a water resources perspective.

Situation assessment:

Invasive alien plants

The condensed area (equivalent area that the alien plants would occupy if it were condensed to provide a completely closed canopy cover) of invasive alien plants in the Fish to Sundays ISP area is 333 km², as estimated in 1999. The average calculated reduction in system yield is 4 million m³/a at a 1:50 year yield for this ISP area. The Albany Coast sub-area is by far the most heavily infested, while infestation in the remainder of the area is generally light.

Working-for-Water activities

Working-for-Water in the Eastern Cape is currently focusing on mainly state-owned and some private land through funding provided from the Poverty Relief Fund and through the DWAF trading account. Clearing activities have been focussed on riparian zones, and on high mountain areas where priority is on light infestations to reduce the spreading of seeds.

Priorities and planning

There are a number of considerations. The most important of these are the need to contain the problem by reducing further densification and spread of invasive alien plants (IAPs), after which the focus can be on improvements.

There are, however, a number of other driving forces: water, biodiversity, and the conservation of agricultural land are key forces but must be matched by the cost and availability of resources to tackle the problem, and the importance of the clearing programme as a job creation and poverty eradication initiative.

From a DWAF perspective the most important consideration is water supply. The first priority is to ensure that infestations do not spread, and thus further deplete supplies. The first task is therefore to reduce the risk of further invasions, and this is applicable to all catchments in the WMA. DWAF then sees the eradication of invasive alien plants as a way of improving water availability, and naturally targets the areas currently in deficit, and the catchments above dams. From **Table 3.3** it can be seen that a difference can be made to the yields of the Kat, Bushmans/Kowie/Kariega, and Upper Sundays catchments. There may be other smaller localised priorities well deserving of attention. The clearing of IAPs, thus increasing yield, is an important mechanism in providing water for equity allocations and in reducing the imperative for compulsory licensing.

DEAET, whose main concern is biodiversity, will also have containment and protection of previously uninvaded areas as top priority. Layers of biodiversity value, and the 'irreplaceability' of the natural vegetation have been developed under the Systematic Conservation Plans of the Cape (fynbos), STEP (thicket), and SKEP (succulent karoo) programmes, and these can be used to plan prioritisation from a biodiversity perspective.

Co-operative governance inputs to the WfW activity schedule are crucial if the needs of the different departments are to be simultaneously and satisfactorily met.

All clearing plans must be accompanied by a long-term and sustainable follow-up and maintenance plan. The principle is based on the fact that clearing without follow-up will ultimately have a negative impact on water and biodiversity.

. Current WfW priorities are as follows:

- The area approximately covering quaternary P30A near Grahamstown, in the Kariega and Kowie rivers, has a very high priority;
- The upper Kat and Koonap River catchments have a high priority, but this needs to be verified, because it is not clear how the area was prioritised;
- The Tarka River and western part of the Koonap and middle Fish Rivers ('upper' portion) has been identified as a second level (high) priority for clearing.

Current projects

A project is underway in the Koonap River near Post Retief, which is situated north of Fort Beaufort. Another project is underway above Grassridge Dam in the Teebus Spruit, a tributary of the Great Fish River. Additional funds are required to continue clearing. The Makana Local Municipality will undertake the Grahamstown longer-term follow-up clearing. Farmers realise the benefits of the process and sometimes provide logistical and other support.

Enforcement

Private ownership clearing can be enforced through the Conservation of Agricultural Resources Act (CARA), which is implemented by the National Department of Agriculture. This is however not easy or practical and other forms of incentive are being explored, including the idea of a Water Benefit. The approach should be to get landowners to recognise the risks of invasives and to willingly participate in containment and clearing activities. The forestry industry now has certification as a self-management measure and this is leading to improvements on the forest estates.

Waterweeds

Working-for-Water is responsible to deal with the requirement for weeds eradication. Water hyacinth is becoming a problem in the Grahamstown water supply dams (Settlers Dam etc.) and in the New Year's Dam in a tributary of the Bushmans River. Infestation by waterweeds seems to be very cyclic. Management of waterweeds is still handled in an *ad hoc* fashion. There is no clear overall strategy on how to deal with waterweeds in the WMA.

Strategic approach:

The clearing of Invasive Alien Plants and the activities of Working-for-Water are essential to the maintenance of catchments and the sustained production of water. Significant volumes of water can be returned to the system for use (4 million m^3/a in the case of the Fish-Sundays system) through the clearing of IAPs.

The clearing of invasives not only makes more water available to users, but also puts significantly **more** water into rivers over and above this. Clearing is also essential to the conservation of biodiversity, protects catchments from the dangers of erosion caused though destruction of the natural vegetation and the hot fires that often ensue, and maintains the productivity of agricultural and grazing lands.

The Department of Water Affairs and Forestry would like to see the activities of WfW aimed first and foremost at the maintenance of catchment productivity from a water resource perspective. The Department however also recognises biodiversity and other imperatives, and indeed these often go hand in hand with the protection of water resources. The approach is therefore to consult and advise Working-for-Water in the prioritisation of its activities through co-operative governance – primarily involving both DEAET and the Department of Agriculture.

DWAF will endeavour to provide the necessary water resource priorities which reflect the needs and benefits to be gained from the clearing of IAPs and the importance of this activity from a water resource management perspective.

DWAF supports the principle of containment and protection first – by tackling lightly infested areas and areas which exhibit the greatest risk of spread. Any additional resources should be used to remedy and reduce current levels of infestation. No clearing should be undertaken unless follow-up maintenance is guaranteed. DWAF is committed to supporting WfW in these endeavours.

DWAF believes that the clearing of IAPs is an ongoing process which requires the co-operation and buy-in of all landholders. Incentives are required to encourage landholders to maintain and manage their own holdings. It is important to shift the responsibility for IAPs off the shoulders of the State and onto those of the land and water users.

Management actions:

The following are required to manage the control of invasive alien plants:

1. Complete the current clearing projects;
2. Identify specific opportunities for clearing areas where this will relieve stressed situations by increasing base-flow conditions;
3. Clarify the priority for the Kat and Koonap River catchments;
4. Continuously provide input to clearing plans to help optimise clearing and job creation within available budgets and identify opportunities for job-creation through use of the biomass;
5. Devise a clear strategy on how to deal with waterweeds in the WMA;

6. Design a regional strategy of co-operation with the Department of Agriculture and Provincial Department of Environmental Affairs to educate farmers on the importance of invasive alien plant eradication.

Responsibility:

The RO is responsible, in consultation with D: WUE and Sub-Directorate Environment and Recreation.

Priority:

Priority 1: Very high. Programmes are ongoing.

CHAPTER 8 - WATER CONSERVATION AND WATER DEMAND MANAGEMENT STRATEGIES

NEED FOR WATER CONSERVATION AND WATER DEMAND MANAGEMENT STRATEGIES

The options for further augmentation of water supply through new physical infrastructure are limited in this ISP area. Attention needs to be devoted to managing the demand for water, encouraging its efficient and effective use, and the minimisation of loss or waste. The foundation of effective water conservation and demand management is the creation of a water conservation and demand management culture within all water management and water services institutions and among water users.

The National Water Conservation and Demand Management Strategy is based on the reasonable premise that many water users can maintain their quality of life and achieve the desired outcomes from their water use, whilst using less water. Significant reductions in water use can be achieved by changes in behaviour and the adoption of water-saving technologies. DWAF will continue to encourage all water users to voluntarily comply with the water conservation and demand management principles and strategies.

The *Water Conservation and Demand Management Main Strategy* is required to address urban, agricultural and industrial conservation measures and water demand management.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

8.1 Urban and industrial water conservation and demand management;
8.2 Agricultural water conservation and demand management;

8.1 URBAN AND INDUSTRIAL WATER CONSERVATION AND DEMAND MANAGEMENT

Management objective:

Utilisation of the opportunities created through the NWA to identify the need for regional urban and industrial water demand management measures and to promote the implementation thereof through co-operative governance, assistance, buy-in and capacity building.

Situation assessment:

As urban use is volumetrically small in this area, not that much can be saved. Many small towns are however in severe trouble (refer to **Table 5.1**, which contains information on WDM initiatives and successes, where known) and water conservation and demand management (WC&DM) is absolutely essential for these towns if they are to survive and grow. There is often little or no other source of supply.

The level of WC&DM is unacceptable for most municipalities in the ISP area. There is notably a need to urgently address it in areas such as Ngqushwa (larger Peddie area), Graaff-Reinet, Middelburg and Jansenville. There is a lack of information which is needed to prioritise the WC&DM initiatives for each municipality. It is up to the district municipalities and municipalities to implement demand management programmes – not always easy in the face of non-payment, illegal connections and unmetered water use.

WDM studies and projects

The Ngqushwa (larger Peddie area) Water Demand Management (WDM) Study showed that unaccounted for water (UAW) is above 60%, which is a general problem in the area. Many of the water services schemes in the area have been badly designed and there are many illegal connections.

A WDM Strategy was completed for Graaff-Reinet. WC&DM was a condition for Graaff-Reinet to acquire Nqweba Dam, although their progress with the implementation of WC&DM is still regarded as inadequate. Graaff-Reinet has poor water management, metering and maintenance. The municipality needs to advertise for a WC&DM post. Payment for water is good, up to 90%, while UAW is 37% and bulk meters have been installed.

A 'learn to value water' project was done by DWAF in Grahamstown, which was one of the first pilot towns for WC&DM. Chris Hani DM agreed to implement a holistic WC&DM project. Uitkeer also recently improved their WC&DM. WDM is insufficient in Bushmans River Mouth/Kenton-on-Sea.

Industrial water demand management

The ISP area has no mining activities of particular significance and no large-scale power generation. Most industries fall within municipal boundaries. Limited industrial demand management initiatives have so far been undertaken.

Strategic approach:

WC&DM must be promoted throughout the ISP area. Each town will be required to develop and implement a WDM Plan, according to identified priorities in terms of the WC&DM principles. Although District Municipalities are responsible for ensuring that local authorities implement WDM, DWAF should in the interim continue to assist, until the District Municipalities are capacitated financially and technically.

The only direct control which DWAF has over water use and its efficiency is through the issuing of licences. The implementation of further augmentation options that require infrastructural development will not be approved if serious and adequate steps have not been taken by municipalities and industries to ensure that water is not being wasted and UAW is at an acceptable level. Municipal water tariffs should also be increasingly used to contain water demand in order to avoid new expensive water schemes.

It is advisable that the DWAF head office and regional office, and/or the CMAs in future should assist the municipalities by appointing consultants to do situation assessments and to develop water demand management strategies, guide them with the implementation thereof and do monitoring and evaluation. Otherwise it is unlikely that such measures will be implemented in many municipalities. Funds for such studies could be generated through water tariffs.

Management actions:

Develop and implement a regional urban water conservation and demand management strategy as follows:

Promotion of WC&DM

1. Use the water allocation process to promote water conservation and demand management principles;
2. Promote the principles of water conservation and demand management through forums and the media. Encourage the use of printed and electronic media to disseminate information to all stakeholders and contribute regular articles to relevant publications to promote the concepts of water conservation and demand management;
3. Regularly liaise with responsible officials and if necessary politicians at municipalities where water demand management interventions are required and aggressively promote the implementation of demand management measures;

WSDPs

4. Ensure that the WSDPs of local authorities address the implementation of local water conservation and demand management strategies prior to the development of new schemes, as well as plans for the use of water saved through effective demand management measures;
5. Review submitted WSDPs to ensure that water conservation and demand management objectives have been adequately addressed;

WDM Plans

6. Facilitate the establishment of a water demand management plan for each local authority, according to priority, through co-operative governance;
7. Assist municipalities to draw up detailed local urban conservation and demand management strategies where required, co-operatively with the responsible District Municipality;
8. WC&DM plans should include benchmarking. Set benchmark targets for water savings with local authorities through co-operative governance;
9. Ensure through co-operative governance that the WDM Plan for Graaff-Reinet is properly implemented;
10. Promote the drafting and implementation of WDM Strategies through co-operative governance in Aberdeen, Alicedale, Middelburg, Jansenville, Fort Beaufort and Seymour, as well as in other small towns where it is required.

Capacity building and assistance

11. Build capacity of municipal officials in local authorities by providing appropriate support services where these are needed in local planning, development of new supply schemes or rehabilitation of existing schemes. Specific attention may be required for the Ngqushwa (larger-Peddie) area, where the responsibility rests with the Amatole DM;
12. Ask the Directorate Water Use Efficiency and the regional Water Use Efficiency division to assist district and local municipalities with the implementation of WDM, as a national priority, to overcome the technical barriers many municipalities face;
13. Assist the municipalities financially by appointing consultants to do situation assessments, to develop WDM strategies and to assist with the implementation thereof. The funds can be generated through water resource management tariffs.

Develop and implement a regional industrial water conservation and demand management strategy as follows:

1. Identify the largest water consuming industries;
2. Classify those businesses that have the greatest impacts on the water resources in terms of water utilised, wastewater discharged and the efficiency and effectiveness thereof;
3. Develop regional and local levels of databases for the purposes of monitoring the water-related performance of businesses, and prioritise;
4. Undertake performance auditing on identified industries;
5. Ensure or facilitate the implementation of measures in industries where wastage is noted, such as fixing leaks to reduce further wastage;
6. Analyse the efficiency of production processes to understand how water is being utilised;
7. Design and implement communication, public awareness and education programmes as required;
8. Set up water conservation forums;
9. Identify and undertake pilot projects;
10. Manage non-conforming industries.

Responsibility:

Water Service Authorities and large individual water users are responsible for implementing urban water use demand management programmes that have developed with the assistance of DWAF. The

RO has a regulatory and advisory role but will continue its monitoring and mentoring role to build capacity and to promote the concept. D: WUE is responsible for a national framework and the development of standardised demand management methods and procedures. District Municipalities are responsible for ensuring that local WC&DM Plans are compiled and are implemented by the local municipalities.

Priority:

Priority 1: Very high.

8.2 AGRICULTURAL WATER CONSERVATION AND DEMAND MANAGEMENT

Management objective:

To ensure that irrigation water is beneficially and effectively used and that water conservation and demand management principles are applied by the agricultural sector.

Situation assessment:

An evaluation of agricultural water conservation and demand management shows that irrigation accounts for 94% of water requirements (excluding the ecological Reserve) in the ISP area. Generally, but especially outside of government water schemes, not enough is known about the efficiency of use. Inefficiencies in irrigated agriculture are significant, although the irrigation in the Lower Sundays Irrigation Board area is regarded as very efficient.

Along with verification of existing use, agricultural WC&DM is the most important measure in refining the water balance and making more water available to users. WC&DM must therefore take account of the water saved and ensure that where possible this is returned to the system for further allocation.

Irrigation water losses are considered in two categories, namely:
- Canal and river losses incurred in conveying water from the dam in which it is stored to the farms where it is used for irrigation, and
- On-farm losses, which consist of (a) conveyance losses, which occur in conveying the water from the point at which it is abstracted from a canal, river or farm dam to field edge and (b) application losses due to inefficient technologies.

As reliable information on farm conveyance losses is not available, estimates of combined canal and on-farm conveyance losses were done by officials of the DWAF Eastern Cape Regional Office for ORP water use and have been allowed for in water quotas. River conveyance losses have been separately calculated for ORP water.

Irrigation water distribution from the main canals to field edge in most of the large schemes and in all the small schemes is via earth canals in the Fish River catchment. Canal losses are therefore significant. Improved monitoring is required to more accurately determine the losses. Inefficient forms of flood irrigation is still practiced widely outside GWSs.

River losses are very significant (112 million m^3/a in the ISP area) of which most is due to losses from transferred Orange River water for irrigation. There are also operational losses that can be reclaimed if operation of the water supply system is improved, although operation of the OFSWSS is already quite complex.

Implementation of WC&DM measures in the agricultural sector could result in more water being available to be used for:
- Resolving water over-allocations without resorting to compulsory licensing;
- Resource-poor farmers; and
- Expansion of agriculture and subsequent job creation.

Potential exists for the intensification of irrigated agriculture in the Fish and Sundays River catchments, through conversion to higher value crops, along with the establishment of an associated agricultural processing industry, as well as a move towards more efficient irrigation methods. Unused water rights, that was recently traded for use in the Orange River catchment, is a good example of water that was being used inefficiently (or not at all) and is now put to better use.

Leaching of soils is not widely practiced, although excess water to leach unwanted salts from the soils of irrigated lands is required, in especially the lower catchment areas.

Table 8.1 gives an indication of "usable" return flow in the ISP area, as used in calculations to determine the total local yield (see **Table 3.4**). These are best estimates of DWAF officials.

Table 8.1: Year 2000 estimated irrigation return flows as percentages of field edge irrigation requirements at 1:50 year assurance in million m^3/a

Hydrological sub-divisions	Irrigation use	"Usable" Return flow	% Return flow
Groot Brak	59	0	0
Tarka	12	0	0
Upper Fish	171	39	23
Upper Little Fish	45	11	24
Middle Fish	108	25	23
Koonap	20	1	5
Kat	13	1	8
Lower Fish	16	0	0
Fish Total	**444**	**77**	**17**
Bushmans, Kowie/Kariega	11	0	0
Albany Coast Total	**11**	**0**	**0**
Upper Sundays	10	0	0
Middle Sundays	60	12	20
Lower Sundays	104	10	10
Sundays Total	**174**	**22**	**13**
Total for ISP area	**629**	**99**	**16**

Each WUA/irrigation board must have a water management plan. In the Gamtoos Irrigation Board area (Tsitsikamma to Coega ISP area) a pilot study is underway by the WUE Directorate to test the National WC&DM strategy, by assisting the Board to develop a pilot water management plan. The study investigates the efficiency of irrigation water use and possible improvements to operational aspects. The Gamtoos Agricultural WC&DM Pilot Study final report will be available during 2004.

The WUE Directorate will compile a generic document on Agricultural WC&DM. They will then aim to apply it at for each WUA/irrigation board.

Strategic approach:

The approach will be to create awareness, promote WC&DM through co-operative governance and provide advice on efficient irrigation water use. Inefficient water users will be put under pressure to use water more efficiently.

Serious attention must be paid to the option of lining earth canals. Water that can be saved from off-farm distribution canals must be returned to the system. Incentives for WUAs to implement such water saving measures must be devised.

Once the recommendations from the Gamtoos WC&DM study are made, DWAF will formulate further initiatives on effective agricultural water conservation measures. Reuse of effluent from fruit processing/packing industries will be encouraged wherever possible in the agricultural sector.

Unnecessary losses caused by operation of the OFSWSS as well as the high river losses will be assessed, and ways of reducing these losses and putting saved water to better use will be pursued. Exact amounts of water should be ordered and delivered on time. Farmers and WUAs should be held responsible for all water losses once water has been delivered to their area of jurisdiction.

Management actions:

Implement a regional agricultural water conservation and demand management strategy as follows:

Efficiency initiatives

1. Study the results arising from the WUE Directorate study into agricultural water demand management options in the Gamtoos GWS and:
    a. Facilitate the implementation of applicable lessons learnt and make recommendations;
    b. Facilitate the undertaking of water development plans for other irrigation schemes;
2. Quantify losses in irrigation and canal systems and provide guidance on rehabilitation and management options;
3. Review the additional releases which are currently provided for canal losses;
4. Include the evaluation of the efficiency of agricultural water distribution (including river losses) and use, as well as salt management at farm level, in the evaluation of the system operation, under the *Orange-Fish-Sundays WSS Management Strategy*, Strategy 12.1;
5. Set targets with WUAs (co-operative governance) for improved water use efficiency;
6. Promote the use of more water efficient irrigation equipment in order to conserve water. Discourage the use of inefficient forms of flood irrigation, which should be accompanied by laser leveling;
7. Provide appropriate support services where these are needed in planning, development of new irrigation schemes and rehabilitation of existing schemes;

Awareness

8. Ensure that WUAs and irrigation boards promote efficient water use by its members;
9. Use the water allocation process to promote water conservation and demand management principles;
10. Encourage the use of the printed and electronic media to disseminate information to all stakeholders and contribute regular articles to local agricultural publications to promote the concepts of WC&DM;
11. Initiate awareness campaigns through workshops, discussion forums, and newsletters.

Responsibility:

WUAs, Irrigation Boards and individual farmers are responsible for implementing agricultural water demand management programmes and the development of Water Management Plans, with the assistance of DWAF where necessary. The RO has a monitoring and mentoring responsibility to build capacity and to promote the principle. D: WUE is responsible for a national framework and the development of standardised agricultural demand management policy, methodology and procedures.

Priority:

1 – Very high.

CHAPTER 9 - INSTITUTIONAL DEVELOPMENT AND SUPPORT STRATEGIES

NEED FOR INSTITUTIONAL DEVELOPMENT AND SUPPORT STRATEGIES

The NWA provides for a fundamental transformation of water resources management and governance, with the shifting of authority and responsibility to appropriate and representative regional and local institutions. Such institutions include any organisation or person fulfilling the functions of a water management institution. Typical water management institutions are Water User Associations and Catchment Management Agencies.

The *Institutional Development and Support Main Strategy* is required to address:

- International rivers joint management structures and related issues;
- Formation of Catchment Management Agencies;
- Catchment Forums and Advisory Committees related issues;
- Formation of Water User Associations.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

9.1 Water User Associations.

No international rivers flow within this ISP area. Although the Orange River is closely linked to this ISP area, these international strategies have been developed through the Orange River WMAs. Refer to the *Orange River System Overarching ISP* for such strategies.

9.1 WATER USER ASSOCIATIONS

Management objective:

To transform existing irrigation boards to Water User Associations (WUAs) or to form new WUAs as required.

Situation assessment:

WUAs are co-operative associations of individual water users who wish to undertake water-related activities at a local level for their mutual benefit (including previous irrigation boards). WUAs must include all water users within their management areas, and are required to prepare business plans and annual reports for institutional performance review. They should ensure that all users are monitored, both in terms of quantity of abstraction and discharge of waste.

The Great Fish River WUA (including Sub-Areas), Kat River WUA and the Sundays River WUA have been established. Van Rynevelds Pass Irrigation Board disestablished and sold their dam to Camdeboo DM for use by Graaff-Reinet, following the cessation of all irrigation. The Koonap Irrigation Board only exists on paper. The formation of the Tyhefu WUA has been significantly delayed because funding for a social consultant was not available to assist the community, which is not yet adequately capacitated [(20)]. A Trust is in charge at Tyhefu, and there is no longer an urgency to form a WUA there. There is a requirement for new WUAs to be formed for ex-parastatal schemes, but there is no longer a great urgency to do this as Trusts have been put in place at all these schemes. WUAs to be established in the ISP area have been prioritised.

Greater clarity on the requirements of the WUA formation process is required. There is an extremely high need for DWAF to standardise its process of formation of WUAs for all water users, and to keep such standards for longer periods. Consistent guidelines are required to ensure that the process is clear to all, to remove current stumbling blocks. At present, the guidelines in place are not entirely suitable for the smaller Irrigation Boards.

There is a need for the DWAF to employ social consultants to assist smaller irrigation boards that are experiencing financial difficulties and/or capacity problems with regard to the workshopping and the compilation of their WUAs proposals.

WUAs must be in place before they can take ownership of DWAF infrastructure and assume responsibility for it. Transfer of ownership of branch canals in smaller tributaries is envisaged at Somerset East, Sundays River, etc., once properly established WUAs are in place. Some Sundays River GWS infrastructure will also be transferred.

Up to October 2004, the DWAF could only supply subsidies on bulk infrastructure to resource-poor farmers if they were part of an existing or newly formed WUA. This has been changed, and the policy approved in October 2004 now allows for subsidies to be paid to any suitable statutory body at a collective irrigation scheme.

Strategic approach:

DWAF will continue to encourage and support the formation of WUAs large or small, if necessary providing advice or consulting support towards their establishment. It is important that WUAs function well. DWAF will hand over infrastructure, where appropriate and usually in good condition, to WUAs for local management. The WUAs will also be expected to monitor abstraction and use by its members to ensure a fair distribution of resources. The DWAF, in turn, will monitor the function of WUAs and will offer help as requested. WUAs will systematically be established according to priorities and demands, within the constraints posed by existing resources. Formation of WUAs will continue as soon as there is greater clarity on the required process, and internal capacity problems in the Region have been addressed.

Management actions:

1. Attach a high priority to the forming of WUAs (or possibly other suitable statutory bodies), where the needs of resource-poor farmers have been prioritised, once a scheme has been approved under the DWAF subsidy scheme;
2. Speed up formation of WUAs by assisting smaller irrigation boards (which have limited resources) with the compilation of their WUAs proposals, by financially contributing to the employment of consultants to aid them;
3. Continually update the need to form WUAs and ensure the formation of such WUAs;
4. Where WUAs are in a position to take over infrastructure then this should be transferred, with the proviso that it is in a satisfactory condition, or will be brought into a satisfactory condition by the DWAF in due course;

Responsibility:

The responsibility for developing the details of the WUA strategy lies with the RO, supported by D: Institutional oversight.

Priority:

Establishment of new WUAs in ex-Ciskei areas or the forming of WUAs (or other suitable statutory bodies) where the needs of resource-poor farmers have been prioritised has the highest priority. The priority therefore varies, but is generally high.

CHAPTER 10 – SOCIAL AND ENVIRONMENTAL CONSIDERATIONS STRATEGIES

NEED FOR SOCIAL AND ENVIRONMENTAL CONSIDERATIONS STRATEGIES

The *Social and Environmental Considerations Main Strategy* is required to address:

- ⇨ Public consultation and participation
- ⇨ Education and capacity building in the water sector
- ⇨ Community awareness;
- ⇨ Communications relating to water;
- ⇨ Compliance with environmental legislation;
- ⇨ Mitigation of environmental and social impacts;
- ⇨ The environmental development approval process;
- ⇨ Strategic Environmental Assessment.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

10.1 Public participation and communication;
10.2 Environmental considerations.

10.1 PUBLIC PARTICIPATION AND COMMUNICATION

Management objective:

To provide a guideline for a uniform approach to public awareness, consultation and participation processes, as well as capacity building.

Situation assessment:

Limited capacity and the inadequate level of water management awareness of staff at various levels of Government have been identified as major stumbling blocks towards effective water management. It is therefore necessary that managers who make decisions requiring or impacting on the water resource be adequately capacitated. Capacity of DWAF staff is unfortunately also severely limited.

Generic Departmental Public Participation Guidelines as well as many specific guidelines are available to provide guidance when dealing with stakeholders or the public.

A Communication Section has been established within the Regional Directorate: Planning, Development and Institutions. A wide range of RO staff is however responsible for the various public participation requirements, in line with their staffing line functions. Capacity building, public participation and communications already form an integral part of the functions of many staff. This should be formalised and should form part of a Plan for the ISP area.

Strategic approach:

The Departmental public participation guidelines will be followed to attain specific objectives in the required range of public consultation, education and capacity building, within the identified ISP strategies. In many cases, best or good practice and experience of what is appropriate for specific communities and circumstances will be followed. The Region should evaluate, or allow for an evaluation of both its skills and successes (and failures) in processes requiring public participation. Particular attention will be given to efforts to reach out to the less powerful groups and the poor, who are not accustomed to being drawn into the public debate.

Management actions:

1. Refine the requirements for public consultation and participation within the various strategies;
2. Identify the current and future public participation needs and develop and implement a regional public participation approach, based on Guidelines provided by Directorate Water Management Institutions Governance (WMIG) and the specific public consultation and participation requirements;
3. The Region will determine whether it has the capacity and capability to meet these needs by drafting a plan to indicate its level of skill in public participation in the Region and in the ISP area. The plan will list or at least indicate the skills that the Department may have to call upon locally, and those which it may have to import to achieve its public participation agenda and goals;
4. Ensure that the necessary resources are available;

5. Inform water users and relevant authorities of the implementation of the ISP;
6. Inform, liaise with and educate policy makers, officials, water users and the public as required by the various ISP strategies;
7. Support public awareness campaigns on the value of urban rivers as social amenities, and assist with cleaning campaigns in terms of water resource management issues;
8. Implement the water education programme;
9. Contribute to national communication programmes.

Responsibility:

The RO assisted by Directorates WMI Governance and WA&IU and WfW.

Priority:

Priority 1 – Very high.

10.2 INTEGRATED ENVIRONMENTAL MANAGEMENT

Management objective:

To successfully undertake water resource management planning and implementation within the broader framework of environmental legislation, whilst ensuring that the resource is managed in a manner which recognises and sustains the environment as a whole in an equitable and sustainable manner.

Situation assessment:

A vital requirement for ensuring sustainable conservation practices is the identification of conservation - worthy habitats or sensitive ecosystems. Many of the initiatives or projects that are undertaken or supported by the Department negatively impact on the environment. The DWAF has set up guidelines and policies to ensure that water resources are used in an equitable and sustainable manner. The Departmental role is to comply with environmental legislation and to promote compliance in an environmentally responsible manner. The Department therefore needs to maintain a good co-operative relationship with other government departments. Specific aspects of the environment in this ISP area are discussed below.

Terrestrial environment

There are a number of sensitive and protected environmental areas in the ISP area, as described in Chapter 2 Section 2.2.7. The Fish estuary is ecologically significant. All the rivers and tributaries should be properly managed to protect indigenous species.

Irrigation water in especially lower parts of rivers, as well as in large groundwater abstraction areas, has high salinities, and will result in salt accumulation in the soil if not leached. Leaching is however not practiced widely in this area. Soil that has elevated salinity from irrigation practices will not easily support natural growth.

Invasive alien plants infestation is dealt with in the *Managing Invasive Alien Plants Strategy*, Strategy 7.4.

Manage the siting and management of waste disposal onto land under the *Water Quality Management Strategy*, Strategy 6.2.

Alexandria Dune Field

A southern coastal strip that incorporates the Alexandria Dune Field, making up the largest coastal dune field in the world is set to become part of the Addo Elephant National Park. Alexandria/Cannon Rocks has a developed well field in the dune area. Groundwater seeps to sea in this area, resulting in a unique form of plankton blooms that should be monitored and protected. This proposed extension of the nature reserve to the coast may have an impact on the current abstraction of water from the Colchester dunes. A stringent Environmental Management Plan has been set, based on the Record of Decision issued by DEAET, to ensure good co-operative governance if rezoning does happen.

Aquatic environment

The Reserve requirements are detailed in the *Reserve and RQOs Strategy*; Strategy 6.1 and water quality issues are dealt with in the *Water Quality Management Strategy*, Strategy 6.2.

Wetlands

Wetlands are vulnerable to degradation due to over-abstraction of groundwater as well as physical modification, drainage and infilling. DWAF is responsible for the protection of wetlands, however DWAF funds that were earmarked for the Eastern Cape Wetlands Forum have been transferred to DEAET, who will be responsible for such management in future. An Eastern Cape Wetlands Forum, which consists of numerous government and non-government organisations bodies, was established to assist with the cataloguing, assessment and monitoring of wetlands in the province.

There is a lack of knowledge regarding wetlands in this ISP area. A wetland delineation guideline was funded by DWAF to define wetlands. Wetlands in the Lower Sundays River (N40) catchment have been mapped and sorted by type and landscape locations, as part of a recent DWAF project. Rehabilitation of the Grahamstown Featherstone Kloof Wetland has been done.

Preservation of the wetlands requires education programmes, monitoring and the clearing of invasive alien plants to ensure retention of critical wetland functions. There is a need for Working-for-Wetlands to initiate wetlands programmes, according to priorities.

Social environment

An overview of the ISP area's socio-economic situation is given in Chapter 2 Section 2.2.4.

Erosion

Significant parts of the ISP area have very high soil erosion potential. Removal of riparian vegetation has a significant impact on sedimentation and water quality. Land-use practices in the former Ciskei area caused land degradation and soil wash-off. A lack of post-farming rehabilitation leads to increased erosion.

Strategic approach:

See Chapter 1 paragraph 1.5 for DWAF's position regarding the environment.

Ensure compliance with the requirements of the National Environmental Management Act (NEMA), Environmental Conservation Act (ECA) and other related environmental legislation in terms of water resource management planning and implementation. Manage tributary rivers to protect indigenous species. Support the Eastern Cape Wetlands Forum initiatives and any other initiatives that promote water-related environmental protection and health.

Management actions:

1. Promote environmental awareness and creation of capacity;
2. Promote and undertake stakeholder empowerment, especially regarding socio-economic aspects;
3. Ensure compliance with environmental legislation (NEMA and ECA) through regional implementation of the Department's Consolidated Environmental Implementation and Management Plan, within the context of the DWAF Environmental Management Framework;
4. Prepare regular *State of Water Resources* Reports, which will build on the State of Rivers reports by the River Health Programme. The reports will describe progress in achieving the environmental objectives of the NWA, and indicate areas where new interventions or intensified efforts are required;
5. Plan for the introduction of a river health monitoring programme;
6. Make inputs to national environmental reporting by DEAT;
7. Use the Strategic Environmental Assessment (SEA) as a tool to, amongst others, determine forestry potential as and when required.

Responsibility:

The implementation of the Environmental strategy is the responsibility of all DWAF Directorates and the RO. The D: WA&IU responsibility is to oversee the development of environmental and social policies and procedures within the department.

Priority:

Priority 3 – Medium. To be implemented on a continuous basis as part of normal operations.

CHAPTER 11 - CO-OPERATIVE GOVERNANCE STRATEGIES

NEED FOR CO-OPERATIVE GOVERNANCE STRATEGIES

These strategies address co-operative data collection, information sharing, sharing of visions and plans, and co-operative making of joint decisions which are satisfactory or at least acceptable to all parties. The ISP strategies define the need to interface with those of other South African government Departments, local authorities, and water service providers. The strategies represent the inherent need for establishing co-operative relationships with such organisations. This is required to ensure that management and control of the water resources in the ISP area are integrated with the relevant strategies of other organisations, whilst meeting the requirements of the particular legislation with which it must comply.

Water for development or equity is a major focus that will be pursued under the Co-operative Governance Strategy. This addresses inequities of the past and the provision of an equitable share of the water to resource previously disadvantaged communities and to improve the livelihoods of the poor. The ongoing establishment of resource-poor farmers and the provision of water to areas where land restitution or redistribution is in progress must be prioritised as one of the ways to reduce poverty.

The *Integration and co-operative governance Main Strategy* is required to address:

- ⇨ Poverty eradication issues pertaining to resource-poor farmers and other water-related initiatives;
- ⇨ Water-related land reform issues;
- ⇨ Regional, local and sector-specific co-operative governance;
- ⇨ Capacity building and support, including job creation, financial support and educational issues;
- ⇨ Water services issues.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

11.1 Poverty eradication and land reform;
11.2 Co-operative governance.

11.1 POVERTY ERADICATION AND LAND REFORM

Management objective:

To provide water and assistance to prospective and current resource-poor farmers through the *Co-ordinating Committee for Agricultural Water* (CCAW) and the WUAs, for scheme revitalisation or for other poverty eradication and land reform initiatives, and so contribute towards social upliftment and equity in water use.

A further objective is the successful development of 5 000 ha of irrigation with Orange River water, that has been earmarked for development of new resource-poor farmer schemes in the Eastern Cape, of which 4 000 ha will be in the Fish and Sundays River catchments.

Situation assessment:

Resource-limited farmers schemes are summarised in **Appendix 8**. Current resource-poor farmer schemes are mainly the ex-Ciskeian Kat River Scheme and Tyhefu Scheme, where some refurbishment and development is taking place. None of these schemes are functioning well and irrigation quotas are seriously under-utilised or unutilised. The extent of inequity is therefore very large, with most significant resource-poor farmer schemes having failed, with the Tyhefu Scheme now being rehabilitated.

Through the CCAW, identification and short-listing of schemes for further evaluation have been undertaken. DWAF provided the water resource availability picture to aid the identification process. Many options exist for new resource-poor farmer development.

The Co-ordinating Committee on Small-scale Irrigation Schemes (CCSIS) formulates general policies on all matters relating to resource-poor farmer schemes and also subsistence schemes.

Ex-Ciskei schemes

The Ciskei Government developed the original Tyhefu Scheme [(33)]. It was based on some local storage and pumping out of the Fish River. The Lower Fish River Government Water Scheme was a joint RSA/Ciskei initiative which was intended to replace the Ciskei pumping scheme with a gravity supply from a main pipeline on the RSA side of the river, via three siphon crossings. During the final design it was concluded that only one crossing would be provided. As compensation a four km long pipeline was extended into Ciskei, but which was still insufficient to supply the whole potential area. Glenmore and Ndwayana are now supplied from this pipeline. The Lower Fish River GWS made provision to supply 1 440 ha within Ciskei and the bulk water supply works within the RSA were designed to accommodate this. The works were never completed. The long-standing 1 440 ha allocation to former Ciskei irrigators at the Tyhefu Scheme fell away with the dissolution of Ciskei. None of the Tyhefu Irrigation Scheme areas (consisting of Glenmore, Ndwayana, Ndlambe, Kalikeni, Pikoli, and Committees), involving 1 646 food-plots and 33 small commercial farmers, are functioning properly.

Parts of the Tyhefu Scheme are being refurbished, of which about 160 ha at Glenmore and 60 ha at Ndwayana have been completed. For the Phase 2 development of the scheme, a 1.2 m diameter

pipeline was recently lengthened to Ndlambe Dam. A distribution network still needs to be established by others, as well as a management structure. Further implementation of Phases 3 and 4 of the scheme, in co-operation with the Department of Agriculture is a possibility, but such further phases have not yet been planned.

There are many unused allocations in the ISP area, especially in the Kat River Scheme. Ulimocor (a parastatal) managed the Kat River and Tyhefu Schemes until its disbandment. The Kat River Scheme's high investment farms (except the ex-RSA portion) have fallen into disrepair due to a lack of maintenance, poor management and vandalism.

Future resource-poor farmer schemes

Potential exists at Tyhefu for the establishment of resource-poor farmers in the Lower Fish catchment. On the right bank 1 500 ha of irrigation was planned under the Lower Fish River GWS but only about 360 ha has been developed. On the left bank (former Ciskei) only about 100 ha was originally developed, but this is expected to increase significantly now that Phases I and II of the Tyhefu bulk water rehabilitation has been completed.

A standardised approach needs to be followed for the development of the 5 000 ha that has been earmarked for development of new resource-poor farmer schemes in the Eastern Cape. Water has been reserved from the Upper Orange WMA for this identified longer-term development. A total of 1 000 ha of this has been destined for development in the Upper Orange WMA (in the Eastern Cape Province) and 4 000 ha in the Fish and Sundays River catchments. Of this, 180 ha of irrigation have already been approved near Addo. All the other potential smaller new developments that had been identified will also form part of this process.

Land restitution

The Tamboekiesvlei Scheme is a land-restitution case at Mpofu, downstream of the Kat River Dam. A formal application for water use has been received. The study into the feasibility of the scheme is being undertaken by DWAF.

Land redistribution schemes

There has unfortunately been significant failure of many land-reform redistribution irrigation schemes for resource-poor farmers in the ISP area. It is clear that a different approach to these initiatives is required. These schemes are described in **Appendix 9**.

Strategic approach:

Pro-actively support poverty eradication and land reform principles, by initiating or supporting initiatives through co-operatives governance, via the various implementation vehicles provided by legislation.

Potential schemes must be proven feasible, before new water use licences will be issued. DWAF would refrain from contributing towards bulk infrastructure unless in-field development also takes place.

A more relaxed tariff structure for resource-poor farmers needs to be considered.

Ex-Ciskei schemes

The licensing situation at both the Tyhefu and Kat River Schemes must be sorted out. All current irrigators, either existing of irrigators that could start irrigating again following rehabilitation, should be licensed before the issuing of new licences is considered. Further support of refurbishment or development at Tyhefu will only be supported if in-field development also takes place.

New development with Orange River water

The allocation of the water from the Upper Orange WMA for resource-poor farmers is perceived as mainly a provincial matter within the technical constraints of delivery, along with concerns regarding impact on quality. It is up to the province to indicate where their priorities lie, and to address the needs of prioritised resource-poor farmers via the CCAW, through co-operative governance between the DWAF, the Department of Land Affairs, the Department of Agriculture, appropriate district municipalities and DEAET. Areas of poverty have been identified in the previous census, and should provide guidance in the identification and prioritisation of resource-poor farmer schemes.

DWAF will indicate which areas are too expensive to develop and especially where technical problems may arise, such as the salination of land or unacceptable levels of pollution, which will result in rivers exceeding their Resource Quality Objectives. In addition to technical advice, DWAF may offer opinions on the perceived suitability of water use in different schemes and may suggest alternative options, but the Province has been allocated water for resource-poor farmers and must ultimately decide on how to use that allocation.

Land restitution and redistribution schemes

Provide input through the CCAW, which is responsible to ensure that land-reform redistribution developments are reviewed and that proper planning and implementation of redistribution irrigation schemes are undertaken.

Management actions:

- Prepare a short report outlining exactly how much water is currently allocated, distributed and used in resource-poor farmer schemes, along with current availability and plans on the table, for use by the CCAW, provincial authorities and district municipalities;
- Initiate feasibility studies of short-listed and prioritised potential resource-poor farmer irrigation schemes. DWAF will provide input regarding water requirements and availability of every project being considered or implemented in a structured fashion. Implement results of such feasibility studies;

- Together with the PDA, develop a protocol for the structured transfer of information, particularly from DWAF and PDA, but also from District Municipalities, regarding potential resource-poor (and commercial) farmer irrigation development information and required water-resources information;
- Revisit ways in which the irrigation development needs of the PDA, in line with the provincial economic development strategy and various priority lists, can be effectively communicated to the CCAW;
- Via the CCAW, ask the district municipalities to provide information of potentially beneficial allocations to villages for agriculture and home gardens. Ask the PDA to review the position of farm workers and their existing need for water supplies;
- Ensure the availability of staff and funds to undertake planning studies, by lobbying at a political level, to ensure a higher priority for this within the Department and other Departments;
- Arrange payment of subsidies to appropriate WUAs and assist with the sourcing of such funds, if necessary, according to the procedure for funding and construction of resource-poor farmer schemes;
- Investigate how more water could beneficially be made available to villages for agriculture and home gardens;
- Review the position of farm workers and allocations to them to identify opportunities to eradicate poverty;
- Investigate if there are any opportunities for small grower forestry;
- The pricing strategy for resource-poor farmers will be revisited at national level, and will address the need for phasing in of charges over a longer period or even waiving of charges for a number of years.

Responsibility:

The development of this strategy is the responsibility of the RO, with the Department of Agriculture via the CCAW. Pricing strategies are lead by the Water Resources Finance and Pricing Directorate,

Priority:

1 – Very high.

11.2 CO-OPERATIVE GOVERNANCE

Management objective:

To improve co-operation between the RO and other authorities regarding shared decision-making and so achieve improved overall governance to better manage the water resources in the Fish to Sundays ISP area.

Situation assessment:

Good co-operation regarding integrated water resources management between DWAF and other government departments is necessary. Close co-operation exists between DEAET, PDA and local authorities regarding streamflow reduction activities management. A Licensing Assessment Advisory Committee for streamflow reduction activities (SFRA LAAC) has been established in this regard. There is a need to vastly improve co-operative governance regarding groundwater management, especially in terms of the sustainability of groundwater schemes. A critical issue is the lack of understanding of both the potential and the limitations of groundwater use.

The existing Provincial Liaison Committee and its sub-committees, such as the Co-ordinating Committee for Agricultural Water (CCAW) involves DWAF, the Department of Agriculture, DEAET and the Department of Land Affairs. The Eastern Cape Provincial Strategy [34] and this Internal Strategic Perspective on water should be fully aligned. There is a need for groundwater to receive more specific attention by the CCAW, because of the current unco-ordinated drilling, often unknown to DWAF, to meet service delivery targets. The allocation of 4 000 ha to resource-poor farmers for new irrigation will be addressed through the CCAW, as part of the *Poverty eradication and land reform Strategy*, Strategy 11.1.

The Eastern Cape Wetlands Forum is identifying and mapping wetlands and is undertaking preliminary assessments of their condition [18]. There are however no current projects in this ISP area. The Forum acts as a think tank and co-ordinating body for the development of wetland management research and education in the Eastern Cape. An existing Integrated Water Services Management Forum also exists.

The catchment forum/s that will be established will facilitate co-operative governance regarding water users.

The large impacts on water resources that are caused by informal settlements, especially on the Bloukrans tributary of the Kowie River, requires urgent intervention through co-operative governance. DWAF needs to provide further assistance to Makana Local Municipality to address the situation as part of the *Water Quality Management Strategy*, Strategy 6.2.

The integrated nature of the Orange-Fish transfer scheme requires close co-operation between DWAF and various organisations regarding future planning and development, specifically regarding the development of new resource-poor farmer schemes.

Strategic approach:

Owing to the extremely limited DWAF RO capacity to enforce, police or monitor water development, use and compliance, a platform of dialogue is required where different user groups and users can negotiate the disputes that cannot be solved at WUA level.

DWAF, through its RO, is currently fulfilling the role of the future Catchment Management Agency. This CMA will be, for all intents and purposes, a co-operative governance body. Water supply impacts on all development, and land uses in turn feed back to impact on water resources. Management of the resources is, by its nature, a co-operative governance activity.

DWAF is committed to manage the provision of water within a co-operative governance framework and will communicate extensively with all relevant partners to ensure information sharing, joint planning based on the realities of resource availability and possible impacts, and efficient use which meets the needs of the largest numbers of people.

The approach is to promote the effective management of water resources through co-operation between DWAF, other government departments, and provincial, district and local authorities. DWAF will be actively involved with existing co-operative bodies with responsibility regarding the use of water (e.g. the Provincial Liaison Forum, the CCAW and the SFRA LAAC) and will ensure active involvement in bodies that might be established.

Management actions:

1. Identify and assess all legislation that impacts on DWAF's activities, and set up liaison for additional problem areas that need to be addressed;
2. Define all the existing and required lines of communication and relationships. Document all levels of co-operative governance, e.g. how decisions will be made and the responsibilities of each party and aim for signed Memorandums Of Understanding;
3. Review the effectiveness of relevant committees and other liaison structures and propose changes as needed;
4. Provide feedback on the Provincial Situation Assessment done by the Eastern Cape Provincial Administration. Regularly liaise with the Eastern Cape Provincial Government. Assist with the compilation of the Provincial Growth and Development Plan wherever there are implications for the water resource and share information;
5. Manage data collection and sharing with other departments, local authorities and institutions through the *Information Management Strategy*, Strategy 13.1;
6. Arrange regular meetings between DWAF, PDA, DEAT and DEAET for improved co-operation regarding the management of wetlands, estuaries and invasive alien plant control programmes. Support the identification and undertaking of further phases of the Eastern Cape Wetlands Inventory study;
7. Implement a pro-active policy to inform infrastructure planning processes being undertaken by DWAF's co-operative government partners, that could potentially impact on water management, about DWAF views and requirements to take into account when planning;
8. Implement a pro-active policy regarding IDPs and WSDPs;

9. Establish a WC&DM initiative with local authorities, PDA and the Department of Housing;
10. Ensure groundwater representation on the CCAW and ensure that hydrogeologists play an active role in the catchment forum/s to be established, so as to promote sustainable groundwater development;
11. Maintain ongoing discussion with the Makana Municipality regarding the large water quality impact of informal settlements on the Bloukrans tributary of the Kowie River, to reduce the extremely high levels of pollution.

Responsibility:

Although the issues identified are at ISP level, the need for improved co-operative governance is a national and provincial requirement, with action from the RO on area specific matters.

Priority:

1 – Very high.

CHAPTER 12 – WATERWORKS DEVELOPMENT AND MANAGEMENT STRATEGIES

NEED FOR WATERWORKS DEVELOPMENT AND MANAGEMENT STRATEGIES

Alternative options for the future management and ownership of major water resource infrastructure currently owned and operated by DWAF, is being investigated at national level. There remains an ongoing need to economically and safely manage the existing water resource infrastructure at both national and regional level.

The Waterworks Development and Management *Main Strategy* is required to address:

- ⇨ Strategies for new proposed schemes;
- ⇨ Strategies for major infrastructure operational components;
- ⇨ Strategies for specific geographical areas or rivers;
- ⇨ Recreation relating to water resources;
- ⇨ Disaster management planning.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

12.1 Orange-Fish-Sundays Water Supply System Management;
12.2 Using water resources for recreation;
12.3 Public health and safety.

No major new supply scheme has been identified for implementation.

12.1 ORANGE-FISH-SUNDAYS WATER SUPPLY SYSTEM MANAGEMENT

Management objective:

Ensuring effective operation and maintenance of the water supply system bulk infrastructure and components and transfer of ownership of identified infrastructure.

Situation assessment:

System overview

This system supplies Orange River water to the Great Fish River valley and thence to the Sundays River valley, to supplement local water supply for irrigation and urban use. Water is also transferred to the Nelson Mandela Metropolitan Municipality (NMMM) via this system. The system will be referred to as the Orange-Fish-Sundays Water Supply System (OFSWSS). This strategy addresses management of the integrated system and sub-systems. The various components and some operational aspects of the system were discussed under Section 2.3.1 of Chapter 2, *Overview of the ISP area*. A detailed layout of the system is shown in **Figure 12.1**. Major infrastructural work and the identification of development options have not been included under this strategy, but the identification of such requirements will flow from it.

The system is currently managed and controlled through the use of the FISUN (Fish-Sundays) model with regard to scheduled releases, water quality and control of black fly. While additional water needs to be released to improve salinity, breeding of black fly can be controlled by rapidly dropping water levels, but nothing is being done at present. The existing model has an 11-day operational cycle. A typical problem encountered is that farmers often do not inform the system operator/s when they do not use their allocated water.

The system is functional but can be much improved, particularly when given better information on quantities and patterns of use. Some problems with major infrastructure, especially the Darlington Dam gates, should be urgently addressed. An improved operational system model is required to address, *inter alia*:

- evaluation of operational scenarios and making of recommendations on improved system operation;
- water quality;
- control of black fly; and
- improved monitoring to address modelling requirements is urgently required.

Current system management

The Free State RO manages transfer infrastructure of the Orange River Project up to the tunnel outlet at Teebus, and the Eastern Cape RO the remainder. The infrastructure of the transfer scheme is ageing, which requires higher maintenance, but no major problems are experienced. Control of black fly has a high priority, as it is a major problem in the area's rivers and canals. This pest species is currently controlled through flow discharge control, but it is not very effective. The problem is very difficult to control further away from control infrastructure. Control of black fly should also be addressed as part of the *Reserve and RQOs Strategy*, Strategy 6.1.

Water quality management is an important component of the management of the system, especially in the lower Fish River, where total dissolved solids can be in excess of 6 000 mg/l. Releases in the lower Fish River are made with the aim of achieving a water quality of less than 650 mg/l at Hermanuskraal Weir, where water for Grahamstown and the Lower Fish GWS irrigation is abstracted. This requires a large volume of water which is effectively lost to other users, inclusive of flows to the sea. The current operational objective of releases from Darlington Dam (where extensive citrus plantations are sensitive to chloride) is to try to keep the TDS of water released to below 600 mg/l.

System modelling requirements

An operational model is required which:

- Is user-friendly and does not demand a high level of technical skill in its operation and interpretation;
- Is understood and can be repaired, corrected or improved by any water resource engineer/programmer with an appropriate level of skill (i.e. this should not be dependent on one service provider or person);
- Has a 2-hourly time-step (for quality and quantity control);
- Receives and works with real-time water quality and quantity data;
- Receives and reacts to monitoring feedback, e.g. the weekly releases of water for irrigators.

The water supply system must be managed to control black fly, which causes damage by attacking sheep's eyes etc. Periodical disruption or loosening of black fly larvae is required. They breed at the edge of the water and are only killed when the water level is adequately dropped.

Water quality management

a. Water Quality Management Plan

An OFSWSS Water Quality Management Plan is required that addresses:

- Operational water quality requirements, i.e., where and when a specific water quality is needed;
- Releases for ecological requirements, to counter water quality problems that occur when the river stops flowing for short periods, especially in the Fish River system;
- Appropriately timed releases from system dams to counter high salinity releases, particularly from the off-channel Glen Melville Balancing Dam;
- Evaluation of the efficiency of water use and salt management at farm level;
- Management of irrigation return flow, which should also be addressed through the *Water allocations and licensing strategy,* Strategy 7.2, as follows:
  - Long-term sustainability intervention measures must take into account surface water-groundwater interaction;
  - Manage for more efficient irrigation to limit the amounts of return flows;
  - Aim to reduce irrigation return flow in the upper Fish catchment, which could improve the river water quality situation significantly, as concluded by the ORRS study;

- Address water quality impacts of irrigation through dialogue with the WUAs and irrigation boards;
- Plan new irrigation schemes in areas where resultant return flows will not cause even bigger problems;

- Flushing of the system should be scheduled for the rainy season

b. Fish sub-area

The highly elevated nutrient levels in especially the lower Fish River (which also occur naturally) are primarily caused by agricultural production (leaching and fertilizers). These nutrients stimulate organic growth. When the river stops flowing for short periods, as it does occasionally, the water goes stagnant and problems with algae follow. Water quality management is needed.

Salinity increases over time in the off-channel Glen Melville Balancing Dam due to evaporation. Saline water is then released down the river system. This could severely impact on downstream farmers if these releases (especially if made at the wrong time of the year) have a significantly poorer quality than the quality of water already flowing in the river stretches below the dam.

c. Sundays sub-area

There is significant eutrophication in the Sundays River downstream of Darlington Dam, probably as a result of agricultural activities.

The extensive citrus plantations in the lower Sunday River are sensitive to poor water quality. The current operational objective of releases from Darlington Dam is to try and keep the TDS to below 600 mg/l. The acceptable level of chloride presents a challenge, and many complaints about the water quality are received from affected farmers. There may however also be alternative soil management measures/irrigation practices to address the issue.

The NMMM is also experiencing problems with the water drawn from the Scheepersvlakte Balancing Dam. These include corrosion, high salinity, taste and odour problems and tri-halomethane generation. The reasons for these problems are inadequately understood but DWAF believes that the situation could be improved by changing some of the treatment processes based on a recent study which addressed the concerns.

System monitoring

Improved real-time water quality and quantity data is needed as input to the operational model. The current level of available data is not acceptable. There is no reliable recording of freshening releases and actual use by irrigation farmers. Monitoring of salt loads with regard to irrigation return flows and analyses of pesticide concentrations are not routinely done. Nutrient content needs to be monitored routinely in the Fish River to be able to manage water quality adequately.

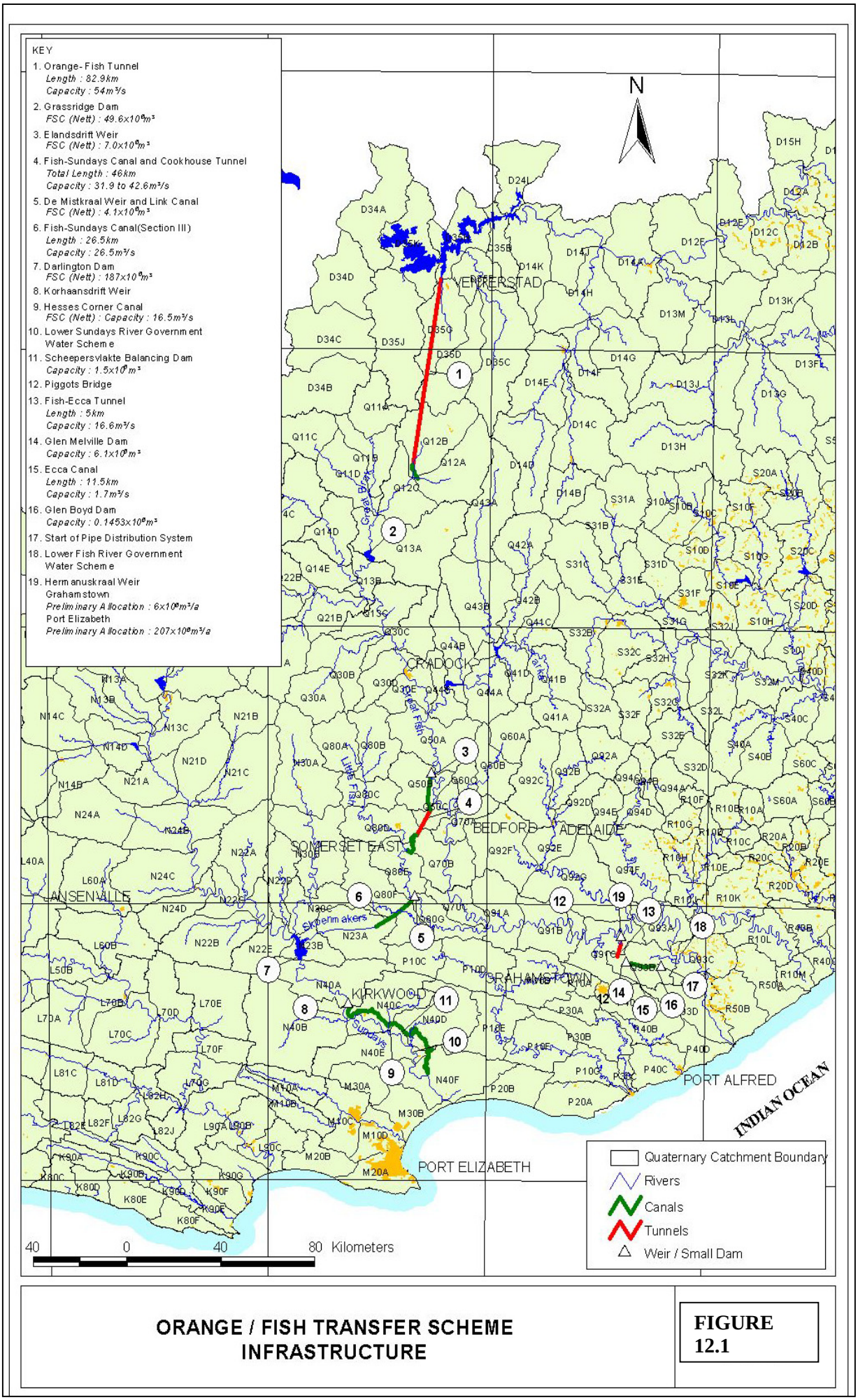

Figure 12.1: Orange-Fish-Sundays Water Supply System

Water quantity (flow) is in fact recorded at a fair number of sites, and many of these have electronic data loggers, but real time data is required. Security problems are also being experienced. Many areas have no cellphone coverage and it is recommended that satellite phones etc. be investigated as telecommunication options. Weekly requests for water by irrigators should be linked to monitoring, so as to reduce losses. Water quality data is also not provided in real-time, nor is enough sampling being done.

All data is currently processed and provided by the RO Technical Services Sub-Directorate. The level of technology used by them is quite advanced but is continually improving and thus changing. There is an identified need for technology used for operation of the system and for hydrological monitoring to match. This should be addressed through the requirements of an updated operational model.

Infrastructure maintenance

The Cookhouse Tunnel, which is unlined for most of its length (transfer from Great Fish to Little Fish River) presents a significant risk factor, as it is very difficult to undertake maintenance in the tunnel, and no transfer alternative is in place. Access is very restricted and the tunnel does not empty because of the alignment. It is a very difficult and slow process to remove rock-falls. Many smaller rock-falls occur in the tunnel, however not disastrous. Adequate maintenance equipment is not available.

Problems are being experienced with the pepper-pot valves in the Orange-Fish Tunnel outlet at Teebus, which could limit tunnel transfer capacity if failing.

Wave action has caused damage to the embankment protection at Grassridge Dam and the dam is being operated at the 30 to 40% level, partially because of this. A decision to repair the damage caused to the dam wall by wave action is required. Enlargement of Grassridge Dam is currently planned for 2014, but this depends on the growth of demand. Careful evaluation of the situation is required to decide what the best option is for fixing or refurbishing or enlarging the dam – or combinations thereof.

There is a need to establish the benefits of refurbishing the gates of Darlington Dam (which is managed by the Sundays River WUA) versus the estimated high cost. Such a decision will influence aspects such as storage and system yield, operation of the dam, irrigation opportunities, water quality, etc. These gates were not adequately maintained in the past. The dam is also heavily silted. The floodgates are permanently closed and the auxiliary gate is left open. Darlington Dam therefore does not fill to more than 46%. There is a concern with regard to safety during flooding.

Significant erosion of riverbanks in the Schoenmakers River takes place due to high flows resulting from the transfer of Orange River water. Bridges are affected on secondary roads and to farms. There has also been erosion of riverbanks along the upper Fish River because of the additional water in the system. Erosion protection works are costly and there are questions of responsibility for protection and liability for damage.

Maintenance of dams which form part of existing irrigation schemes, that have fallen into disrepair and are now being revitalized and further developed, needs to be improved. Such maintenance is currently done *ad hoc*.

Hydropower station

The only hydropower station in the ISP area is situated at the Teebus tunnel outlet of the Orange-Fish transfer tunnel. The small 600 kVA hydropower station has never been commercially used and was damaged in 1990. DWAF is at present evaluating the possibility of implementing a public/private partnership for its future operation.

Tariffing

Differentiated payment regarding the operation and maintenance tariff exists in the system, with users towards the lower end of the system paying more than users towards the upper end. A uniform system tariff is preferred but the users towards the top of the system are against it, as they perceive that it would negatively impact on them. The management ("functions and support") component of the tariff is the same throughout the system.

Transfer of ownership

Transfer of ownership of canals in smaller tributaries is envisaged at Somerset East, Sundays River, etc., once properly established WUAs are in place. Some Sundays River GWS infrastructure, e.g. below Scheepersvlakte Dam, will also be transferred.

Strategic approach:

This water supply system is the lifeblood of this ISP area and good management of it is essential. An integrated management approach to the system is immediately required, which will address overall system management, development planning, monitoring, releases and other operational aspects, freshening releases and other water quality aspects, control of black fly and routine maintenance. Improved system operation and the cutting of losses or spillages from the system will be addressed as key priorities.

In the longer term, the water supply system will be kept operational and the condition of its ageing infrastructure urgently needs to be improved, through continued revitalisation of components in disrepair, fixing of damage at dams, addressing erosion problems caused by transfers as well as some expansion of irrigation (4 000 ha). Any potential future operation of the hydro-power station must not influence the operation of the tunnel system. A *Long-Term Plan* must be put in place, with financing starting now. Areas where new development could take place (in areas which do not add to the problems) or where activities should be closed down through trading (in areas which feed the current problems) must urgently be identified and included in the Plan. Heavy investing in monitoring and modelling is required.

The need for a more user-friendly and understandable planning and operational model will be addressed. The model will *inter alia* be used to operate the system more efficiently to limit operational losses. A Water Quality Operational Plan component, which will form part of the overall OFSWSS Management Plan, will be drafted. The focus of the model will be to show what transfers are necessary, when and of what quality, and distinction will be made between releases for use and

freshening releases. In addition, control of black fly will be addressed in co-operation with catchment forums.

Management actions:

System management

1. Document the longer-term strategy of the water supply system (Long-Term Plan);
2. The existing operation and maintenance procedures for the OFSWSS should be documented, reviewed and amended;
3. Ensure that management plans are implemented for all major dams and promote adequate maintenance on non-DWAF operated dams;
4. Determine why farmers in the Lower Sundays use less than their allocation, and make recommendations;
5. Investigate the phasing in of regional systems tariffs and how users will be affected;

Monitoring

6. Undertake early planning of monitoring needs for an improved operational model;
7. Investigate the requirements for routine monitoring of salt loads and nutrient content, with regard to irrigation return flow, to adequately manage water quality in the Fish River and the Sundays River downstream of Darlington Dam, to support the requirements of a short time-step operational model;
8. Ensure proper record keeping of all freshening releases and releases for irrigation use made in the system;

System model

9. Initiate a study into the revised requirements for an *improved planning and operational model*, and develop the model;
10. Once an improved model is available, develop a better understanding of the system and calibrate the model;
11. Undertake planning and operational scenario evaluation, such as e.g.:
    a. Evaluating options to limit operational losses and to manage salinity;
    b. Limiting the large loss of water due to the need for freshening releases in the lower Fish River;
    c. Evaluate the sensitivity of citrus farmers in the lower Sundays River Valley to chloride content and the water quality requirements of the NMMM;
    d. Evaluate the fixing of Darlington Dam's gates and transferring water to it in winter, when there are no return flows, to make full use of dam storage and improve water quality;
    e. Filling up of dams by transferred additional volumes when there are surplus flows in the Orange River System;
    f. Transferring maximum amounts of water for flushing salts when large floods occur in the Orange River catchment;
12. Evaluate and review system operation, make recommendations, and implement;

Infrastructure maintenance

13. Review the requirements for repairs due the wave action damage at Grassridge Dam, along with the operational and management requirements of the system;
14. Annually inspect the Cookhouse Tunnel and problematic canal sections. Proper investigation and overall review of the integrity of the tunnel is required;
15. Clarify the responsibility of DWAF regarding the erosion of riverbanks in the Schoenmakers River due to the transfer of Orange River water. Initiate a study, along with the Department of Agriculture, to evaluate and make recommendations to address the problem;
16. Review the options to utilise the hydropower plant;
17. Continue the transfer of the ownership of components of the system to the Lower Sundays and Great Fish River WUAs.

Responsibility:

The D: NWRP is responsible for general planning. The D: WRPS is responsible for modelling, in conjunction with NWRP and the RO. The responsibility lies with the RO for operation and maintenance and upgrading of existing infrastructure and with D: Options Analysis for new infrastructure. The RO is responsible for developing this strategy (especially in the long-term) in consultation with the WUAs and irrigation boards.

Priority:

1- Very high.

12.2 USING WATER RESOURCES FOR RECREATION

Management objective:

Ensuring the sustainable and equitable management and regulation of the use of water resources, especially state-owned dams, for recreation.

Situation assessment:

Many dams, rivers and estuaries in the ISP area are extensively used for recreational purposes, such as boating, swimming, sailing, angling etc. and recreational use linked to tourism is growing. The annual Fish River canoe marathon, for which releases from dams are especially made, is a high-profile event. The extremely high levels of E-coli in the Bloukrans tributary of the Kowie River is a health hazard for recreational users and should receive urgent attention.

DWAF's *Policy for Using Water for Recreational Purposes* defines government's responsibility towards this water use, and the principles, aims and policy for regulating this water use. In an effort to meet the objectives of the NWA and this Policy relating to the creation of economic opportunities for historically disadvantaged people and improving quality of life, DWAF has initiated an Implementation Programme.

The *Sustainable Utilisation Planning Procedure* (SUPP) unlocks the socio-economic potential of water resources through the compilation of plans for sustainable access, utilisation and development. *Sustainable Utilisation Plans* (SUPs) are based on environmental constraints, community and water user needs and requirements, and sound business principles. All Government dams in the ISP area have O&M manuals in place, but no SUPs have been done, since it is still in its initial development stages.

The DWAF-owned dams in the ISP area are:

Fish sub-area:	Grassridge Balancing Dam (wall and appurtenant structures), Commando Drift Dam, Kat River Dam, Elandsdrift Weir, De Mistkraal Weir, Hermanuskraal Weir, Glen Melville Balancing Dam, Glen Boyd Balancing Dam;
Sundays sub-area:	Darlington Dam, Korhaansdrift Weir, Scheepersvlakte Balancing Dam;
Albany Coast sub-area:	None.

Grassridge Dam's surface area and surrounding land has not been zoned, as the water surface and surrounding property belongs to the GFRWUA. Commando Drift Dam falls within a Nature Reserve. Control has been delegated to Nature Conservation and it is therefore zoned as a "conservation area". The Nature Conservation Officer provides permission for the use of the surface water area and surrounds. Recreation is not allowed at De Mistkraal Weir. Darlington Dam and reservoir is located within the Addo Elephant National Park.

Strategic approach:

To effectively manage the use of water resources for recreation, management plans are required, combined with representative institutional structures, to take charge of the implementation thereof in an equitable manner. Although it is envisaged that management and control of this use will largely be based on self-regulation and compliance, the various role-players must understand their respective roles and functions regarding the regulation of this use. Such role-players are the Directorate Water Abstraction and Instream Use, Regional Offices, Delegated Authorities, and Water Management Institutions, i.e. CMAs and WUAs. The Department of Land Affairs will be responsible if a dam is in a former homeland area, else the Department of Public Works is responsible.

The approach to clarify DWAF's area-specific position and strategy will be:

- Establishing the necessary linkages with D: WA&IU for policy and protocol implementation;
- Compiling resource and asset inventories;
- Developing resource utilisation profiles;
- Evaluating existing institutionalisation and management delegations;
- Recording industry and private sector interest;
- Evaluating efficiency and representivity of community involvement and beneficiation mechanisms;
- Compiling an inventory of existing management and zoning plans;
- Prioritising the compilation, institutionalisation and empowerment of SUPs for water resources taking into consideration the area specific information; and
- Promoting implementation and regulation of SUPs.

Management actions:

In addition to the approach listed above, undertake the following:

1. Clarify the policy environment in which this use takes place, and implement the Departmental guidelines;
2. Review SUPs drafted by developers and regulate accordingly.

Responsibility:

The RO is responsible for implementing this strategy and D: WA&IU, Sub-Directorate: Environment and Recreation, Directorate Water Utilisation for the development and updating of policy and protocol based on results of performance and compliance reports.

Priority:

3 – Medium.

12.3 PUBLIC HEALTH AND SAFETY

Management objective:

To ensure effective disaster management planning and implementation relating to management of floods, operation during droughts, dam safety and emergency spills.

Situation assessment:

Disaster management

An Eastern Cape Disaster Management Forum has been established and there is a need for each District Municipality to have a disaster management forum. Operation and maintenance manuals, inclusive of emergency preparedness plans (EPPs), have been compiled for all Government dams in the ISP area.

Failure of the system due to a tunnel blockage

Failure of the Orange-Fish Tunnel or the Cookhouse Tunnel (see the discussion under the *OFSWSS Management Strategy*, Strategy 12.1) presents a significant risk factor, as no transfer alternative for Orange River water is in place. A blockage that takes a long time to clear is likely to be disastrous.

Drought management

The Directorate Strategic Planning has prioritised dams/areas for drought management nationally. Local plans, many undocumented, will be amended in the light of this. Drought management will be implemented for the Algoa Water Supply System. In this ISP area, a drought management plan is only in place for the Kat River Dam, although the requirements for these plans are currently not regarded as a high priority. Zones have been classified in the Kat River Dam, according to which releases are being made. Drought plans should include management of aquifer systems, to be addressed in the WSDPs. Simple methodologies are required for use by municipal staff.

Dam safety

The Darlington Dam floodgates were not adequately maintained in the past and now need to be refurbished at a high cost. There is a concern with regard to safety during flooding, although the gates can be manually operated. Darlington Dam does not fill to more than 46% because of the problem with the gates. The dam is already silted up to the bottom of the gates. The floodgates are permanently closed and the auxiliary gate is left open. The gates should be removed and the secondary overflow should be permanent left open. This would however likely be untenable from an operational viewpoint. A proposal has been made to replace the gates with stop-logs made of steel pipes to maintain a limited storage capacity.

Some damage caused by wave action at Grassridge Dam may have to be repaired in the longer term, but has a low priority. The dam is being operated at 30 to 40% level because of this. Enlargement of the dam is currently planned for 2014, but this will depend on the rate of growth of demand and what measures are adapted at Darlington Dam.

A Dam Safety Plan is needed for Nqweba Dam as there are some safety concerns regarding the dam. A Disaster Management Plan has been drafted.

Strategic approach:

Until such time as the Public Safety Unit has been established, an interim regional strategy will be implemented that will provide planning to avert or manage disaster situations by complying with required measures of disaster management and dam safety legislation and by co-operative governance initiatives. These planning measures will cater for the management of floods and droughts, dam safety measures and toxic or other spills that could potentially have hazardous impacts. Develop procedures for the implementation of restrictions in the agricultural sector. Address both surface and groundwater resources.

Address the risk of system failure that could spell disaster, by building awareness, both amongst water managers and users. The users would have to carry the losses, as DWAF cannot be held liable for failure to deliver. Users should carry this into their own management plans.

Address cholera outbreaks through co-operative governance with the Department of Health.

Management actions:

a. Disaster Management planning

1. Procedures on how to supply water during times of emergency need to be documented;
2. Reconcile any disaster management plans with the Disaster Management Act;
3. Develop emergency supply arrangements for various durations of possible non-supply from the system or components for the various user groups;
4. Encourage the establishment of disaster management forums in all District Municipalities, through the Water Management Institutional Framework Strategy;
5. Implement EPPs for all government dams in the ISP area, and ensure that owners of Category 2 private dams prepare EPPs for their dams.

b. Operation during floods

6. No identified action.

c. Operation during drought

7. Draw up a drought management plan and operating rules to operate government infrastructure during droughts, to be integrated with normal system management. Through co-operative governance draw up a drought management plan to deal with supply to local authorities during times of drought;
    - Review and document procedures adopted during previous droughts;
    - Identify shortcomings in terms of operation during previous droughts.

d. Dam safety

8. Undertake dam safety inspections and reporting;
9. Implement the requirements of the NWA regarding dam safety;
10. Process dam safety applications and issue authorisations as required;
11. Keep a regularly updated register of all dams with a safety risk;
12. Take actions against illegal or unsafe dams;
13. A decision is urgently required regarding the Darlington Dam floodgates, once it has been decided on how to best operate the system, which will be addressed through the *Orange-Fish-Sundays WSS Management Strategy*, Strategy 12.1;
14. A decision on the wave action damage to the Grassridge Dam wall is required. Review along with management of the system.

e. Emergency spills

15. Instruct the polluter to remedy its effects;
16. Contact relevant emergency services and disaster management centres.

Responsibility:

The RO is responsible for further developing this strategy, for upgrading existing government infrastructure as required in terms of this strategy, and for operation of government infrastructure during droughts. D: Civil Design is responsible for government water infrastructure.

Priority:

2 – High.

CHAPTER 13 - MONITORING AND INFORMATION MANAGEMENT STRATEGIES

NEED FOR MONITORING AND INFORMATION MANAGEMENT STRATEGIES

The Act requires the Minister to establish national monitoring systems for water resources to collect appropriate data and information. The Department is addressing the shortcomings of the current arrangements by amalgamating all existing and planned monitoring and assessment systems into a structured and coherent monitoring, assessment and information system.

Monitoring is required to better assess resource availability, to introduce billing, to ensure compliance with water authorisation conditions, and to control all water use.

The *Monitoring and information management Main Strategy* is required to address:

- ⇨ Water resources availability;
- ⇨ Water use control from freshwater bodies and bulk water infrastructure;
- ⇨ Monitoring networks and data capturing for physical, chemical and biological aspects of surface and groundwater;
- ⇨ Issues relating to information systems and
- ⇨ Information access and requirements.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategies have been developed further:

13.1 Monitoring networks and data capturing;
13.2 Information management.

13.1 MONITORING NETWORKS AND DATA CAPTURING

Management objective:

To install effective regional monitoring networks, undertake data capturing and processing and manage the networks and databases, to ensure adequate availability of data for the management of sustainable water use and protection of surface freshwater bodies and groundwater.

Situation assessment:

Detailed information on flow gauging stations is shown in **Appendix 12**.

A *Strategic Framework for National Water Resource Quality Monitoring Programmes and Guidelines for Designing Such Programmes* [28], as well as a Departmental national 5-year Monitoring Plan [30] has recently been completed.

The Strategic Framework document covers three main topics:

- a strategic framework for water resource quality monitoring;
- generic design guidelines for water resource quality monitoring programmes; and
- capacity building to support water resource quality monitoring.

The 5-year Monitoring Plan provides a summary of the current national monitoring programmes and also addresses potential and upcoming new programmes. It also identifies some critical interventions that need to be taken into account in the move towards integrated resource quality monitoring.

The following national monitoring programmes are addressed in the aforementioned two documents:

- National Microbial, Chemical, Eutrophication, Radioactivity and Toxicity Monitoring Programmes;
- River Health Programme, Ecological Reserve Determination and Monitoring, Hydrographic Surveys for sedimentation, Dam walls for dam safety, Hydrological Monitoring Programme and Geohydrological Monitoring Programme;
- Thirteen potential programmes.

The regional hydrological data capture systems and databases are generally acceptable to regional staff (monitoring and capturing of rainfall, evaporation, surface water, groundwater and water quality). The available information and monitoring systems to capture usable information are however not acceptable.

There is a lack of either personnel and equipment (DWAF for some monitoring functions) or skills (municipalities) to monitor adequately, and a lack of funds to increase monitoring points at an acceptable rate.

Closer co-ordination regarding monitoring is required between all DWAF RO functions that undertake monitoring. Hydrological, water quality and groundwater sampling and data collection as well as collection of borehole sampling information from municipalities should be better co-ordinated.

Registration of abstraction, storage and stream flow reduction activities (forestry) water uses and users on the *Water Use Authorisation and Registration Management System* (WARMS) has a high priority. *WARMS* is also used by DWAF to manage water billing. Accuracy of existing information is problematic and many problems are encountered with the registration of water use authorisations. The RO is busy with verification of the registered information and the correction of captured data.

Meteorological

Monitoring and capturing of rainfall and evaporation data are routinely done. The numbers of evaporation stations are however diminishing and there are not enough rainfall stations. The Regional Office Hydrology sub-Directorate monitors and makes meteorological data available. The level of technology used is good and is continually improving.

Surface water

Surface flow gauging in the ISP area is generally good. An additional flow gauge, closer to the Bushmans Estuary, would improve management. The Sundays River should also be gauged below Darlington Dam (and possibly also closer to the estuary), but no proper sites are available. None of the estuaries have water level recorders. There is a need to improve estuarine monitoring. Flow gauges should preferably also be installed in the rivers upstream of estuaries. Global Systems for Mobile Communication modems are used at some gauging weirs, which ensures that hydrological data is continuously available for management purposes. The intention is to install such a modem at every site.

Surface water hydrology information, but not water quality, is populated in the *Hydstra* database. The RO Hydrological Services section populates the database as well as processes information. The populated information is reliable, which can be attributed to good instrumentation.

Figure 13.1: Crump weir

Water quality

The Hydrology section monitors water quality at each gauging station fortnightly by taking one sample for macro-analyses. They also measure quality at a few boreholes. Routine water quality samples are taken monthly by DWAF and not two-weekly, as is preferable, due to a lack of manpower. Water quality information is populated in the *WMS* database.

Groundwater

Groundwater monitoring is inadequate. The location and status of monitoring boreholes in the ISP area is not well documented. In addition to the absence of sufficient monitoring boreholes, resource capacity for monitoring is a problem.

Borehole and spring water quality samples are sent to Pretoria for analyses and data capture into the Water Management System (WSM). There is however no current feedback to hydrogeology staff.

Groundwater data is continually entered into the National Groundwater Database (NGDB) from a dedicated link in the Port Elizabeth DWAF office. Groundwater quality monitoring is done bi-annually in May and September as part of the national monitoring network.

There was a loss of captured waste-site data in the RO due to inadequate backup facilities. There is ongoing capturing in the *Waste Manager* programme (information relating to licensing of waste sites) according to priority in the registration process.

The coastal strip incorporating the Alexandria Dune Field will become part of the Addo Elephant National Park. There are groundwater seepages to sea, which results in a unique form of plankton blooms in the Bay, which needs to be monitored. Seawater intrusion into the coastal dune aquifer as a result of over-utilisation is a risk, and DWAF should ensure that it is adequately monitored and managed.

River health:

There is a need for monitoring to support State-of-River / State-of-Environment Reports, and to ensure both Reserve compliance and that this compliance is resulting in the desired objective.

Strategic approach:

The Fish Sundays river system is very dependent on transferred Orange River water. This is a very valuable resource, provided at the cost of a significant historic investment. There is also significant opportunity cost in the light of national need. This puts a high prerogative on managing and using this water well. The uncertainties in availability, use, losses etc. are in fact very high, and improved management and monitoring is essential if DWAF is to meet its management responsibilities.

A major impetus needs to be given to monitoring in the Fish Sundays. This will require investment in a detailed situation assessment and the development of a co-operative strategy that goes beyond the realm of this ISP. The necessary resources must be provided to monitor the availability and use of surface and groundwater, water quality, and all ancillary parameters (from rainfall and climate to demographic and land-use change).

DWAF should not be shouldering the whole burden of monitoring, but is willing to take a leading role. Monitoring should be used as a co-operative governance activity with each authority monitoring those aspects or elements of most direct concern. The approach is therefore one of co-operation in data gathering (and information sharing). The identification of gaps on the one hand, and avoidance of duplication on the other, are key principles. So too would be some sharing of responsibility as appropriate.

The first step in developing a co-operative strategy lies in identifying role-players and in a joint assessment of needs, roles and responsibilities.

With regard to groundwater, far more responsibility needs to be devolved upon the individual users. A critical approach is both to impose a requirement and develop a culture whereby groundwater users recognise the absolute importance of sustainable management and the need to monitor the resource if that goal is to be achieved. No farmer fails to take notice of the level of water in a farm dam, and groundwater must be treated with the same mindset.

Management actions:

1. Develop a detailed regional strategy, in line with the national guidelines, as follows:
    a. Review or identify all aspects that need to be monitored. Group all monitoring needs into logical systems with common goals according to functional areas, which are then divided further into sub-systems;
    b. Develop a detailed information requirement and monitoring needs assessment for the various systems, which were grouped by functional areas;
    c. Identify and motivate required or additional monitoring points or functions;
    d. Amalgamate the identified existing and planned monitoring and assessment systems needs into a coherent and structured monitoring, assessment and information system;
    e. Review resources required for adequate monitoring of surface and groundwater;
    f. Motivate for the regional share of the national monitoring budget;
    g. Regularly review and update the regional monitoring strategy;
    h. Identify and meet with role-players that have relevant data or operate water-related monitoring, assessment and information systems and co-ordinate activities;
    i. Develop co-operative, collaborative relationships between the Department and other role-players.

2. Develop an Integrated Regional Monitoring Programme that includes the following:
    a. The situation regarding monitoring in the ISP area indicating what is being monitored, further monitoring requirements and what monitoring is duplicated or unnecessary;
    b. Include all monitoring functions within DWAF (Hydro, Geohydrology, Water Quality, Regional Office and Head Office and the River Health of the CMA);

c. Liaise and integrate with organisations with a strong water interest outside DWAF but within the ISP area (Dept. of Agriculture, other Provincial departments such as DEAET, Housing, Mineral and Energy Affairs, local authorities, Nature Conservation (Weather Bureau) and research institutions such as the CSIR, universities, non-Government organisations and the Agricultural Research Council.

3. The Programme must address:
   a. The co-ordinating structure and responsibilities;
   b. Who will be responsible to gather data, according to which methods and standards will it be gathered and at what frequency (standards should conform to the needs of all users and if international standards exist it should be the minimum standard);
   c. Agreement on who will fund the functions and whether it is financially feasible over the longer term;
   d. An Implementation Programme with required actions and budgets;
   e. Address custodianship of the databases and requirements for auditing of information or databases through the *Information Management Strategy*, Strategy 13.2;

4. Specific actions to be included in the Monitoring Programme are:
   a. Prioritise estuarine monitoring needs to obtain the relevant monitoring data;
   b. Regular biological sampling is required in the Bloukrans tributary of the Kowie River, which has extremely high levels of E-coli;
   c. Monitor salinity in the Glen Melville Dam, and compare with the situation in the downstream river, before making releases;
   d. Ensure adequate monitoring and availability of data from coastal aquifers;
   e. Meet with the Coastal and Marine Research Institute of the University of Port Elizabeth and ask them to assist with coastal and marine monitoring related to the Alexandria dune field;
   f. Consider the merits of outsourcing groundwater monitoring;
   g. Re-capture waste-related licence information in *Waste Manager*.

Responsibility:

The development of this strategy is the responsibility of the RO in consultation with the RDM Directorate and the Directorates of Information Programmes, Waste Discharge and Disposal and the Sub-Directorate: WQP of Directorate: Water Resource Planning Systems.

Priority:

Priority 2 – High. Implement over the medium term.

13.2 INFORMATION MANAGEMENT

Management objective:

To facilitate improved storage, manipulation, backup, archiving, dissemination, access to and sharing of information within the ISP area.

Situation assessment:

Except for a number of organised initiatives e.g. wetlands, information is not adequately managed and shared and adequate liaison regarding information management does not take place, both inside the Department, and with other Departments and organisations that have water management functions. The Department manages a number of databases, as discussed in the *Monitoring networks and data capturing Strategy,* Strategy 13.1. A groundwater data audit is also available for the Eastern Cape. Water Services manages a database of groundwater supply to towns. The GIS Section of the Premier's Office in Bisho has a GIS section that does GIS co-ordination, where DWAF should be represented.

A proper Information Management Plan for the ISP area (or larger area) is required. There is an urgent requirement for adequate data storage, backup and archiving systems for captured Eastern Cape data, since data is valuable and expensive.

The situation relating to regional databases are as follows:

Spatial data
DWAF is the custodian of an extensive GIS (UNIX based) corporate spatial database (CSDB) based in Pretoria and managed by the Directorate: Geomatics. The region keeps a copy of the CSDB which is updated regularly. It includes data obtained from other companies, state departments, consultants and academics. A list of available data with metadata is available on the DWAF website (www.dwaf.gov.za).

Aerial Photography
The Department owns 1: 30 000 aerial photography covering parts of the area, which was undertaken by the regional Working-for-Water programme.

Invasive Alien Plants Mapping
Invasive alien plants density mapping has been undertaken for the WMA in 1999-2001. Working-for-Water uses this mapping for planning purposes.

Surface Water Hydrology & Water Quality
The Hydrological Information System and related systems were replaced with an Australian hydrological database system called HYDSTRA in 2002. It is functioning effectively and is providing support for management decisions utilising water quality and quantity data.

WARMS
The Water Use Authorisation & Registration Management System (WARMS) is not currently supporting management sufficiently in the ISP area. The system is unable to provide basic information

(For example, it does not produce a list of all farmers scheduled in a particular quaternary). It also has no way of graphically displaying all registered users on a map. The registration data must be verified before it can be used for decision-making purposes. If, once verified, this information was publicly available it would allow for refinement and self-policing by other registered users, forcing more unregistered users to come into the fold. Maximum allowable water use is not captured, but only average use. It should be noted that assurance of supply is the same in all cases.

POLMON and WMS
The Pollution Monitoring Information System (POLMON) is still active. This is currently used in conjunction with the Water Management System (WMS) for water quality resource management.

Strategic approach:

Develop and implement an ISP area Information Management Plan.

The current resources in the RO (staff, hardware and software) to implement this strategy are inadequate. Skilled IT and GIS staff, funds to buy and properly manage the software and databases and technical staff to evaluate, manage and improve the systems and databases and to liaise with other information managers are required. The available staff is very stretched and address issues according to priorities. The most important approach is thus to source resources. Restructuring is under way in the RO, which is a difficult time to source resources, but is also opportune to divert resources to information management, which in the past generally seemed to be undervalued in importance.

Co-operation with other Government Departments in this respect and with other managers of water-related information is essential.

Management actions:

Develop and implement an ISP area Information Management Plan as follows:

1. Identify what information the Departmental information managers require;
2. Determine GIS-specific requirements such as hardware for storage;
3. Identify information requirements from other departments, provincial and local government and other organisations in the ISP area with a water interest;
4. Compile an *information sharing policy* with other departments, provincial and local government and other organisations and identify the following:
   - What information should be shared?
   - Who should have access to it?
   - What is the integrity of the information to be shared?
5. Implement the *information sharing policy* through co-operative governance with other departments, local authorities and institutions through various formal and informal committees or other forms of effective co-operation;
6. Address *custodianship* of the databases and requirements for auditing of information or databases for shared databases. Set time intervals between data gathering and availability on the databases and determine a policy of the costing aspects of making data available;
7. Install adequate storage, backup and archiving facilities and library systems in all DWAF Eastern Cape offices;

8. Formulate an approach to deal with available WARMS information.

Include the following specific *groundwater*-related actions in the Information Management Plan:

9. Obtain support for maintaining momentum on the current Groundwater Resources Information Project (GRIP) project underway in the Eastern Cape. All existing information (which is substantial) should be made available and be incorporated;
10. It should be a future condition of licences issued that all data collected through the course of studies (including electronic information) should be provided to DWAF;
11. Provide currently available regional planning information and aquifer-specific modelling information as input to local government planning;
12. Ensure proper co-ordination with the GIS Section of the Premier's Office in Bisho.

Responsibility:

The Chief Directorate Information Management is overall responsible. The development of the regional strategy is the responsibility of the RO. The Information Management Group in the Western Cape office will provide support to the Eastern Cape as well.

Priority:

1 – Very high.

CHAPTER 14: IMPLEMENTATION STRATEGIES

NEED FOR IMPLEMENTATION STRATEGIES

The *Implementation Main Strategy* is required to address:

- ⇨ Implementation programme for the ISP;
- ⇨ Resources to implement the ISP;
- ⇨ Delegation of responsibility;
- ⇨ Budgeting priorities.

RELEVANT IDENTIFIED STRATEGIES

The following specific strategy have been developed further:

14.1 Implementing the ISP.

14.1 IMPLEMENTING THE ISP

Management Objective

To ensure that the approaches, put forward by the Department through this ISP, are adopted and implemented in the Fish to Sundays ISP area. This will require commitment, funding and capacity.

Situation Assessment

The ISP is an internal document developed by the DWAF. The ISP sets out the approaches which the Department is taking towards water management in the Fish to Sundays ISP area – and lists suggested actions towards achieving good management of the water resources.

The wider public has had no direct input into the writing of this ISP – yet it is recognised that the approaches suggested have a significant impact on the people of the Fish to Sundays ISP area. 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 that situation. Interactions with the public have been an important influence in developing the approaches adopted.

This 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 – opening out the thinking and planning of the Department. 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.

Delegation of overall responsibility for the implementation of the ISP to a responsible official with the required level of authority is a critical factor to successfully implement the ISP. Organisational restructuring was undertaken during 2002-2003 and the new structure is being implemented during 2004 in the Southern Cluster (previously the Western and Eastern Cape ROs). The need to implement the ISP according to strategies must be reflected in the revised structure.

Strategic Approach

ISPs for each WMA are guided by the NWRS – and decisions affecting national resource distribution and use, as presented in the NWRS, are binding on each ISP. This ISP does, however, make a number of corrections and improvements which serve as knowledge updates to the NWRS, particularly as regards catchment water balances and the availability of water for purposes of allocation. The ISP is signed off by the Manager: NWRP and approved by the Department's Water Resources Functional Management Committee. It is also published on the Departmental website. It therefore has the status of an official document containing current best available knowledge with regard to water resource use and availability.

The ISP should be updated as and when new information becomes available and will serve as the primary source document for decision-making, within the framework provided by the NWRS.

Most actions in this ISP have been assigned to the RO. It is critically important that the tasks outlined are prioritised, budgeted for, and built into regional and national business plans and budgets.

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.

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 real constraints. 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 position with regard to the 'Authority of Information Contained in the ISP' is further set out in Paragraph 1.3.4 of Chapter 1 of this ISP document.

Management Actions

The following actions are required:

1. Publish the ISP to be accessible for public input and comment (consider hard-copy 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 opportunity for input;
2. Develop materials which help to take the ISP to Provincial, District and Local Government authorities, also to support the Water Services Development Plans, organised agriculture, emerging farmers, and others. Materials should be useful in preparation of the Provincial Growth and Development Strategy and other regional and provincial planning activities;
3. 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 WC&DM, is delivered forcefully to local authorities, other direct water users such as agriculture, and the wider public;
4. Collate and consider all comment in revising and improving the ISP;
5. The ISP should be open to continuous improvement, with updating on a regular basis;
6. All Regional Office water resource management staff, Working-for-Water, the NMMM and other major stakeholders should have access to, or copies of, the ISP;
7. 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;
8. The practicalities of implementation demands must always be considered.

9. 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;
10. Assign a senior official in the Southern Cluster to the implementation of the ISP;
11. Identify and delegate responsibility for the successful implementation of individual ISP strategies to specific officials in the responsible regional and head office functional groups/Directorates, as shown in **Table 14.1**;
12. Identify champions or contact persons in the Southern Cluster for more specialised functions. See **Table 14.1**.

Responsibility

The Southern Cluster is responsible for implementing this strategy.

Priority

This strategy has very high priority. The implementation is to be ongoing until the Fish to Tsitsikamma CMA is established and the ISP is superseded by a CMS.

Table 14.1: Responsibilities/champions for Main Strategies and Strategies

Main Strategies and Strategies (Numbers refer to Report chapters)	Regional Office Responsibility	Head Office Champions
5. Yield balance and reconciliation	**Theo Geldenhuys**	**NWRP / OA /WRPS**
5.1 Reliability of the yield balance	Theo Geldenhuys	NWRP: F. Stoffberg/OA: A. Brown
5.2 Groundwater	Dale Cobban	WRPS: Fanie Botha
5.3 Compulsory licensing	Theo Geldenhuys	WA: Ashwin Seetal
5.4 Supply to local authorities	M Labuschagne / Flip de Wet / Mfuzi Mpendu	NWRP: F Stoffberg / OA: A Brown
5.5 Reconciliation	Theo Geldenhuys	NWRP: F. Stoffberg
6. Water resources protection	**Andrew Lucas**	RDM / WDD
6.1 Reserve and resource quality objectives	Andrew Lucas / M. Labuschagne	RDM / WDD: Retha Stassen and Thoki Mbhele
6.2 Water quality management	Andrew Lucas	WDD
7. Water use management	**Theo Geldenhuys**	**WA&IU / WUE**
7.1 General authorisations	Flip de Wet / Andrew Lucas / Dale Cobban	WA&IU: Johan Wessels / WDD
7.2 Water allocations and licensing	Flip de Wet / Andrew Lucas	WA&IU: Johan Wessels
7.3 Water trading	Jacqui Murray	WA&IU: Johan Wessels
7.4 Managing invasive alien plants	Patrick Marsh	NWfW: Christo Marais
8. Water conservation and demand management	**Theo Geldenhuys**	**WA&IU / WUE**
8.1 Urban and industrial water conservation and demand management	Martin Labuschagne	WUE: Nigel Adams
8.2 Agricultural water conservation and demand management	Martin Labuschagne	WUE:
9. Institutional development and support	**Theo Geldenhuys**	**WMIG**
9.2 Water user associations	Stephen Mullineux	WMIG: Eiman Karar
10. Social and environmental considerations	**Mfuzi Mpendu**	**WMIG / WA&IU**
10.1 Public participation and communication	Mfuzi Mpendu	WMIG: E. Karar / WA&IU: Jean Msiza
10.2 Integrated environmental management	Glenn Daniel	WA&IU: Valerie du Plessis

Main Strategies and Strategies (Numbers refer to Report chapters)	Regional Office Responsibility	Head Office Champions
11. Integration and co-operative governance	**Zolile Keke**	**None**
11.1 Poverty eradication and land reform	Stephen Mullineux / Mfuzi Mpendu	WA&IU:
11.2 Co-operative governance	Zolile Keke	E. Karar
12. Waterworks development and management	**Dewald Coetzee**	**None**
12.1 Orange-Fish-Sundays Water Supply System management	Dewald Coetzee	None
12.2 Public health and safety	Piet Oosthuizen	WRPS: Chris Swiegers
12.3 Using water resources for recreation	Theo Geldenhuys	WA&IU : Lorraine Fick
13. Monitoring and information management	**Gerrit van Zyl**	**M: IM**
13.1 Monitoring networks and data capturing	Gerrit van Zyl	D: IP : Elias Nel
13.2 Information management	Gerrit van Zyl	CD: IM : A. Muller
14. Implementation	**M: Southern Cluster**	**None**
14.1 Implementing the ISP	M: Southern Cluster, Dr H. van Vliet	None

The abbreviations for the various DWAF Directorates, related organisations and designations are:

Information Management : IM
Information Programmes : IP
National Water Resources Planning : NWRP
National Working-for-Water : NWfW
Options Analysis : OA
Planning, Development and Institutions : PDI
Resource Directed Measures : RDM
Waste Discharge and Disposal : WDD
Water Abstraction and Instream Use : WA&IU
Water Allocation : WA
Water Management Institutions Governance : WMIG
Water Quality Planning : WQP
Water Resource Planning Systems : WRPS
Water Use Efficiency : WUE
Working-for-Wetlands : WfWetlands

Chief Directorate : CD
Manager : M

FISH TO SUNDAYS INTERNAL STRATEGIC PERSPECTIVE

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APPENDIX 1

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APPENDIX 2

Groundwater overview

FISH TO SUNDAYS ISP: GROUNDWATER OVERVIEW

1. INTRODUCTION

The Fish to Tsitsikamma Water Management Area (WMA) has, for ISP purposes, been divided into western and eastern ISPs areas. The eastern (**Fish-Sundays**) area incorporates three sub-areas, which are:

- **Fish**, which corresponds to the catchment of the Great Fish River (Drainage Region Q) with 71 quaternary catchments (30 300 km^2);
- **Sundays**, the catchment of the Sundays River (Drainage Region N) with 36 quaternary catchments (21 200 km^2),
- **Albany Coast**, consisting of the coastal catchments between the Fish and Sundays Rivers (Drainage Region P) with 16 quaternary catchments (5 300 km^2).

Within the whole Fish-Sundays ISP area the drainage basins of the Great Fish and Sundays Rivers comprise 85% of the quaternary catchments. Most of the Sundays sub-area is situated in the Great Karoo. The upper basin of the Great Fish sub-area is also situated in an arid area. The Albany Coast sub-area consists of steep, bush covered hills with deeply incised river valleys. The ISP sub-areas are shown in **Figure 2.1**.

2. WMA CONTEXT AND ISSUES

The Fish-Sundays ISP area is located in the transition between the arid to semi-arid western part of South Africa (longitude < 26°E), where mean annual precipitation (MAP) is generally less than 400 mm, and the relatively well-watered eastern part (longitude > 27°E), where MAP, mostly as summer rainfall, is generally in excess of 600 mm. The highest annual rainfall (800-1 000 mm) occurs in a narrow belt along the crest of the Winterberg-Katberg ranges (Q94A quaternary), and to a lesser degree (700-800 mm) in the southernmost part of the Albany Coast (P20A quaternary).

Because of the comparatively poor endowment of surface water over much of this area, groundwater is well established as a water resource for the Great Karoo towns (notably Graaff-Reinet and Middelburg), at a number of smaller towns and many rural villages and settlements as well as for stock farming (see **Table 1**). The Fish and Sundays sub-areas form part of the Orange-Fish-Sundays Water Supply System, which supplies Orange River water to the Great Fish River Valley and thence to the Sundays River Valley, to supplement local, mainly agricultural water supply. Water is also transferred to the Nelson Mandela Metropolitan Municipality via this system.

There is a lack of sound scientific understanding of the mechanism of groundwater occurrence and flow, compounded by a lack of good quality information (see the following Section 2.2).

2.1 GUIDING PRINCIPLES

Under the National Water Act (NWA, 1998), that gives equal weight to groundwater and surface water, the four guiding principles of an Integrated Water Resources Management (IWRM) strategy are:

- Groundwater resources are integral to water resource development planning, to the extent that groundwater is a preferred source where additional resources are required. It is only where groundwater is proven to be inadequate that surface water will normally be considered;
- The optimal use of available resources is promoted through conjunctive use of surface and groundwater, where feasible;
- Water demands must be optimally reconciled with all available resources;
- All water use must follow the principles of sustainability, equity and efficiency.

2.2 AVAILABILITY OF INFORMATION

Information about the volume of the available groundwater resource, depth, the distance between a suitable source and its intended use, quality, and its reliability (assuming proactive, appropriate aquifer management) needs to be conveniently available to planners and engineers in a readily understandable format. General background information is published in map form at 1:2 500 000 scale on the poster sheet "Groundwater Resources of the Republic of South Africa" (Vegter, 1995), and regional information appears at 1:500 000 scale on the set of The Department of Water Affairs and Forestry hydrogeological maps.

However, these graphic information sources are too generalised and at too small a scale to be practically useful for aquifer exploration, development and management. There is a growing national consensus emerging from the ISP process that graphic information (hydrogeological maps) at a minimum scale of 1:50 000 is needed, and that a complementary geographic information systems (GIS)-based or "geoinformatics" approach to hydrogeological data management and information dissemination is also required.

The major hindrance to the optimal development of groundwater resources is the lack of and/or inaccessibility of area and aquifer-specific data at the scale of a quaternary catchment, or group of related quaternary catchments. In the Limpopo WMA and in other WMAs of the Eastern Cape, GRIP envisages 1:50 000 scale hydrogeological maps, beginning with the most stressed and ecologically sensitive catchments, depicting the groundwater resources, groundwater quality and exploration/ development potential, based upon the needs of the end user.

2.3 GROUNDWATER RESOURCES IN THE FISH-SUNDAYS

As in other WMAs around South Africa, groundwater use can be distinguished in five general categories:

- **Rural Domestic**: ranges from individual boreholes for primary water supply to rural

landowners, villages, schools clinics, hospitals, through small-scale reticulation over short distances (2-5 km), to larger schemes based on several boreholes;

- **Livestock/agricultural**: individual boreholes for stock watering, vegetable gardening etc.;
- **Irrigation**: larger schemes requiring well-developed groundwater resources;
- **Bulk water supply**: wellfields consisting of several high-yielding boreholes in large or extensive aquifer systems;
- **Industrial (including mining)**: medium to large-sized reticulation schemes based on several boreholes or a wellfield.

Table 1 summarises the usage of groundwater in the above categories as estimated on a quaternary catchment basis.

Table 1: Groundwater use in the Fish to Sundays ISP area

Use	Annual volume (million m^3/a)	% of total use
Irrigation	16.7	70
Agricultural/Livestock	4.5	17.5
Rural domestic	0 (1)	0 (1)
Municipal (bulk water)	3.5	12.5
Industrial/Mining	0	0
Total	**24.7**	**100**

1) The zero usage of groundwater for rural supply is questionable and should be addressed.

It is stated in the Fish to Tsitsikamma WMA Water Resources Situation Assessment Report that the groundwater is considered to be under-utilised in the Albany Coast sub-area, heavily to over-utilised in many parts of the Upper and Middle Fish zones of the Great Fish sub-area and moderately to heavily utilised in the middle parts of the Sundays sub-area. This requires verification, as do the usage figures.

The under-developed groundwater potential in the Fish-Sundays ISP area is contained in the fractured rock aquifers of the Katberg and Witteberg Formations (middle to lower reaches of the Great Fish sub-area and the Albany Coast sub-area). It is suggested that improved borehole siting and wellfield management would significantly increase both the yield and the reliability of the groundwater resource in the upper and middle reaches of the Great Fish sub-area. These areas are currently thought to be heavily over-utilised, but in reality there may be quite a bit more water still available.

A purposeful exploration strategy is required to quantify and realise the groundwater usage and resource in this ISP area. In areas where the groundwater yield is low and/or the aquifers are vulnerable to mismanagement and are generally recharged in the extreme precipitation events it is imperative that the groundwater usage values are correct and up to date. If not, planning is impacted upon and areas in which there appears to be available resource could in fact be stressed and *vice versa*.

2.4 GROUNDWATER QUALITY

Groundwater quality is one of the main factors affecting the development of available groundwater resources. The majority of serious water quality problems are related to total dissolved solids (TDS), nitrates (NO_3) and fluorides (F) and toxic trace elements arising from both natural and anthropogenic sources. In the absence of chemical analyses, TDS may be roughly estimated from electrical conductivity (EC) measurements (1 mS/m ≅ 6.5 mg/l). **Figure 3.5** is a map of groundwater quality.

2.4.1 Natural

Groundwater quality is generally controlled by the lithology and geochemistry of aquifer host-rocks. In the Fish-Sundays ISP area, the higher part of the Karoo sedimentary sequence presents no real problem to groundwater quality. However, weathering of shale formations in the Dwyka and Ecca Group, and in the lower Beaufort Group (Adelaide Subgroup), may adversely affect groundwaters. Consequently, base flow in the arid, poorly recharged Sundays River basin where these formations are dominant in the regolith aquifer, is heavily mineralised. Sulphide-mineralised zones within some Karoo dolerite intrusions may locally be associated with undesirable trace-element hydrochemistry of through-flowing groundwaters.

2.4.2 Pollution

Refer to **Figure 6**. The threat of groundwater pollution increases with population growth and development, and can result from:

- Domestic use in centres of concentrated human settlement;
- Agriculture;
- Industrial and mining activity;
- Waste disposal;
- Poor sanitation; and
- Mismanagement of wastewater treatment works (WWTWs).

All sewerage works pose a threat to the groundwater quality in these areas if they are inadequately maintained or managed. This is because discharged wastewater flows directly into the surface water streams and pollutes surface water directly and indirectly via recharge to the groundwater. In general these rivers are located along zones of weakness related to lithological and structural controls, making them more accessible to groundwater pollution.

2.5 MANAGEMENT AND MONITORING REQUIREMENTS

The protection of the groundwater resource, and its long-term sustainability of supply, requires effective monitoring and “adaptive“ management. In this region, however, the monitoring undertaken is very restricted spatially and temporally. Thus it is not always

possible to timeously identify areas of over-abstraction, nor is it possible to prioritise areas where determination of ecological flow requirements or compulsory licensing is required, from a groundwater perspective. **Figure 5** contains a map of NGDB boreholes and DWAF monitoring sites.

The hydrological data collected by the King William's Town office is not being populated in the NGDB on a regular basis. The flow of hydrogeological data from projects implemented by DWAF or other agents (who may or may not use consultants) is irregular at best. Furthermore, the data is not being interpreted and translated into useful accessible information either for intra or extra-governmental users. It is necessary that the NGDB is kept up-to-date through systematic input of relevant data, that data verification and validation is undertaken and that an audit trail be available. Data must be interpreted and used.

At present the data, information and knowledge base is distributed among diverse persons, institutions, sources and modes, still requiring to be cohered into a readily accessible, useful and understandable format for different users.

Groundwater monitoring programmes must involve regular measurements of:

- water levels;
- water quality (macro and trace elements and biological indicators);
- abstraction volumes;
- climatic variables - rainfall, temperature, evaporation, and snowfall; and
- hydrologic variables – spring flow (altitude, volume, water quality, seasonal and/or climate event- related variation), baseflow in rivers.

There is an imperative need for a strategic, regional monitoring network and strategically placed *observation boreholes* exclusively dedicated to groundwater monitoring in locations distant from production wellfields. Even one suitably located monitoring borehole, preferably placed furthest from outflow boundaries to surface waters and/or away from sites that are likely to be affected significantly by surface abstraction or by local (artificial) recharge from surface irrigation, can provide substantial information about the overall state of the resource. This is because the dynamic variability of groundwater levels throughout an aquifer has some components that are common to all wells in that aquifer.

Dynamic behaviour as a leaky storage for natural recharge is the defining characteristic of an aquifer as a groundwater resource (Bidwell, 2003). Most of the temporal variation in piezometric levels is caused by temporal variations in land-surface recharge, together with the effects of pumped abstraction. Due to the common dynamic components related to the seasonal variability of recharge, the value of groundwater level observations increases more with length of record than with the number of observation sites. It is particularly important in a fractured rock environment that the observation wells are correctly sited and intersect preferred flow paths, and that others are drilled into the matrix of the aquifer.

The amount of groundwater stored in an aquifer at any instant in time is governed by dynamic relationships between recharge inflows through the overlying land surface and from rivers, and outflows to surface waters and pumped abstraction. Aquifer storage acts as a buffer

between highly variable, climatically driven inflow processes and the less variable outflow that supports surface water ecosystems. Because abstractions of groundwater for human use, and also land-use changes of certain kinds, alter this dynamic balance between recharge and the state of surface waters, the objective of groundwater resource management is "to determine the regime of abstraction that results in acceptable environmental effects" (Bidwell, 2003).

The strategy of "adaptive management", sometimes described as a process of "learning by doing" (Lowry & Bright, 2002), entails the development of policies as "experiments that test the responses of ecosystems to changes in people's behaviour", and is also conceived as "managing the people who interact with the ecosystem, not the management of the ecosystem itself" (Lowry and Bright, quoted in Bidwell, 2003). An adaptive approach to groundwater management necessarily requires appropriate analytical tools or models to support it, which are (op. cit):

- conceptually presentable and plausible to stakeholders, and expressive of a collective understanding of participants;
- physical operation of the groundwater system;
- assessment of uncertainties;
- prediction of the effects of various management actions;
- capable of implementation in "real-time" mode consistent with the time scale of adaptive decision-making;
- suitable for use with (often sparse) available data.

At present there is very limited data collection in the Fish-Sundays. The regional Hydrology Section takes surface water, and some borehole and spring water quality samples which are sent to Pretoria. Results are input into the WSM system but there is no feedback to hydrogeology staff. There is limited to no data validation, contract information is not routinely put into the regional data system, and no coliform testing at springs or routine trace element or biological sampling is undertaken. The lack of access and staff make data collection for monitoring and operations difficult to maintain and it would not be possible to establish detailed models.

Land degradation arising from overgrazing and/or inappropriate land use leads to reduced infiltration and increased overland flow, turbidity and siltation. Less infiltration means less soil water and reduced recharge to aquifers. The loss of soil, wetlands and riparian areas, especially through gully and riverbank erosion, means that there is less to hold and store rainwater, and therefore less opportunity for this to percolate into the groundwater zone. In general reduced recharge results in an induced soil drought and reduced spring flow, with obvious consequences to water supply and society. This is a cross cutting issue that is noted here given that the use of remote sensing provides an effective early warning as well as a monitoring method for management.

A Knowledge Management Strategy is required, that:

- includes proactive engagement with new telemetric and teledetection technologies potentially suitable for upgrading approaches to groundwater monitoring in this challenging environment, and for obtaining regional and aquifer-specific information;
- understands how best to use information and communication technology to access knowledge, insight and local understanding, both within and outside of DWAF, to both mentor and network with personnel as well as the greater scientific community;
- establishes and maintains communication and data exchange with local service providers, consultants, the research community, other government departments, and also between divisions within DWAF, in particular Water Quality Management and Water Resources Management; and
- initiates a remote sensing-based programme for the monitoring of spring flow, vegetation change, land use impact, wetland status and health, and (de)forestation effects, all in the wider context of quantifying groundwater/surface water interaction.

2.6 POVERTY ERADICATION

Groundwater development impacts positively on poverty eradication and general quality of life through:

- supply of more and/or cleaner water;
- saving of time on water collection, particularly affecting women, which could otherwise be given to small-scale economic activities (vegetable gardening, stock rearing, etc.) that require ready access to water;
- improvement of health (clean water and food production);
- Time and energy available to contribute to community life and decision making (notably allowing women to become more involved);
- Time and energy available for education of children and women; and
- Time and energy to develop the social resilience and coherence needed in these times of change.

The potential of groundwater to contribute to poverty eradication and empowerment of small-scale and resource-poor farmers is very significant in this ISP area. Groundwater development is incremental and acquiring skills is also an incremental process. Paradoxically the poor perception of groundwater is an education opportunity and a necessity that will allow and facilitate a holistic approach to water resource development operations and maintenance.

It is strongly recommended that a holistic enviro-socio-economic approach to services (sanitation and water supply in particular) upgrade, economic empowerment, land-use practise, health and hygiene education (arising from cholera outbreaks and HIV interventions) and skills transfer in the beneficiation of water is mapped out and undertaken. The socio-economic benefits of additional water supply and or the socio-economic costs of limited supply must be factored into the cost equation when making decisions regarding cost effectiveness of a water supply.

Groundwater development is not very capital intensive, although depth and yields do greatly affect local costs, and the real and perceived risks are accordingly reduced. The chances of successful groundwater development are increased if the wellfield supply is co-ordinated with education and support for beneficiation activities, improved infrastructure and ongoing support to master the operations and maintenance of supply.

Because poverty eradication is a multidisciplinary activity it is necessary to map those areas with the most overlap of groundwater potential, soils, and positive social factors, and then to stimulate/catalyse these ingredients with education (e.g. trench gardening and health and hygiene) and other support programmes. This will require co-ordination of initiatives by different government departments and DWAF directorates. It is recommended that a *Participatory Rural Appraisal Approach* be considered in this effort. See Chambers (1983) and DWAF (2002) for more information on participatory methodologies.

Awareness at community level is necessary to achieve consensus and to obtain commitment from communities to engage in a programme of change. There can be controversial choices and/or possible political consequences, such as the re-allocation of funds from visible development projects to projects that will limit or eliminate the impact of a medium to longer-term threat of the failure of a groundwater supply. It is a challenge to persuade people to invest time and money to prevent something happening that most do not believe will ever happen or do not see as their responsibility (implementing operations and maintenance rules in a wellfield or at a borehole). The achievement of such objectives will require a public education process to increase awareness about the causes and consequences of hazards.

3. OVERVIEW OF GROUNDWATER BY ISP SUB-AREA

The hydrogeological provinces outlined in **Table 2** on the following page differ from the three sub-areas used in this ISP. The table summarises the catchments and stratigraphic formations that fall within the Hydrogeological or "Hydrogeotectonic" provinces that are proposed for IWRM strategic purposes within this ISP area (see **Figure 3.4**). For consistency this text uses the ISP sub-areas as defined for surface water.

Table 2: Hydrogeological divisions of the Fish to Sundays ISP area

Hydrogeological Province (Subprovince)	Tertiary/ Quat. Catchments	Geology/ Hydrogeology	Preferred Groundwater Targets
Algoa-Albany Basin-and-Range			
Algoa Basin	N40B-F, S part of P10E, P20A-B	Algoa Group Uitenhage Group Suurberg Group Witteberg Group Bokkeveld Group Table Mountain Group (Nardouw Subgroup)	Primary aquifers in Algoa Group and parts of Uitenhage Group; Witteberg fractured-rock along basin border faults TMG (sub)outcrop in basin floor
Albany Coastal Range	N40A, N parts of N40B-D, P10, P30, P40, Q93D	Dwyka Formation (outlier synclines) Witteberg Group Bokkeveld Group (inlier anticlines)	Fractured quartzite of Witpoort Formation (Witteberg Gp)
Southern Karoo Foreland	N24, N22, N23, N30B-C, Q80E-G, Q70, Q91, Q92E-G, Q93A-C, Q94F	Karoo dolerite (local dykes) Beaufort Group (Adelaide Sgp) Ecca Group Dwyka Formation	WNW/ESE dykes; Regolith aquifers overlying Ecca and Adelaide aquicludes
Sundays-Great Fish Uplands			
Camdeboo-Winterberg Escarpment	N14, N13, N12, N21, N30A, Q21A, Q30A-B, Q30D-E, Q44A&C, Q50, Q60, Q92A-D, Q94A-E	Karoo dolerite (sills & dykes) [Katberg Formation (outliers)] Adelaide Subgroup (Balfour Formation Middleton Formation)	Karoo sill and dyke structures in conjunction with minor sandstone units within Middleton and Balfour formations
Upper Great Fish Basin	Q14, Q11, Q12, Q13, Q30C, Q44B, Q43, Q42, Q41	Tertiary-Quaternary alluvials Karoo dolerites Molteno Formation Burgersdorp Formation Katberg Formation [Balfour Formation]	Karoo dyke and ring (sill) structures; Fractured Katberg sandstone

The current groundwater usage documented for each ISP sub-area is taken from the WRSAS Report and the available unexploited groundwater is based on 50% (in high recharge, moderate to high storage potential areas) and 20% (in low recharge, low storage and flood hydrology dominated areas) of the difference between recharge (Vegter, 1995; Umvoto, 2004)

and baseflow estimates (Vegter, 1995), less current usage. This value implicitly takes into account aquifer storage and accessibility as well as groundwater contribution to the Reserve.

The ***Algoa-Albany Basin-and-Range*** province incorporates Groundwater Regions 50 (very minor), 64 and 52, but has also been extended to the "Southern Karoo Foreland" subprovince (southern parts of Groundwater Regions 42 and 43), where topography and drainage is structurally controlled by fold and fracture structures in lower Karoo strata. The northern parts of Groundwater Regions 42 and 43 are incorporated into the ***Sundays-Great Fish Uplands*** province, divided into generally E/W-trending escarpment zone and an upland area consisting of the Great Fish headwaters (Q1 and Q4 secondary catchments). The base of the Katberg Formation sandstone is the main geological factor controlling this subdivision (see **Figure 3.4**).

There are some area-specific issues which are addressed per sub-area. The generic issues have been addressed in the groundwater strategy.

3.1 ALBANY COAST

The Albany Coast consists of the Bushmans-Kowie/Kariega (P1, P2, P3 & P4) catchments. A separate report detailing groundwater supply options for this sub-area has been submitted to DWAF. The summary results are included in this section.

Folded sedimentary rocks of the ***Cape Supergroup*** (***Bokkeveld*** and ***Witteberg Groups***) and ***lower Karoo Supergroup*** (***Dwyka, Ecca Group***) are the dominant bedrock units in the southern coastal belt, which constitutes the eastern part of "*Groundwater Region No. 52*" (Grootrivier-Klein Winterhoek-Suur-Kaprivier Ranges) as defined by J.R. Vegter ("Groundwater Development in South Africa and an Introduction to the Hydrogeology of Groundwater Regions", WRC Report No. TT 134/00, 2001).

The ***Algoa Basin subprovince*** is a major fault-bounded basin on the Sundays River coastal plain (N4 & P1 / P2 secondary catchments), which constitutes *Groundwater Region No. 64* (Algoa Basin; Vegter, 2001). This subprovince has the highest rainfall and, although dominated by a mixture of Karroid vegetation and Coastal Tropical Forest which could reduce infiltration through interception and evapotranspiration, a favourable recharge. The groundwater potential here is therefore good, with the fractured Witteberg Aquifers and primary Algoa Aquifer showing the highest groundwater potential in the coastal belt.

The Algoa Basin subprovince contains subordinate ***Suurberg Group*** volcanics and volcaniclastic sediments overlain by generally shaley sediments of the Uitenhage Group. Coarse conglomerate and grit of the Enon Formation (***Uitenhage Group***) occurs in the hanging wall of the major E-W border fault stretching from Paterson in the East to south of Wolwefontein in the west. Unconsolidated to semi-consolidated, palaeo-coastal calcareous sand and conglomerate deposits of the younger ***Algoa Group*** occur within the eastern portion of the Algoa Basin and the Bushmans coastal plain.

Algoa beds are overlain by Quaternary alluvium in much of the Sundays River valley south of Kirkwood. Recent and reworked coastal sands occur within a narrow dune zone between Cannonvale and Port Alfred.

The ***Albany Coastal Range subprovince*** south and east of Grahamstown exhibits an elevated borehole concentration, consistent with high groundwater usage in this arid coastal belt. In this area there is a relatively strong correlation between the borehole distribution and the aquifer type, with most boreholes situated in the fractured Witteberg Aquifer, and to a lesser degree, within the primary intergranular Algoa Aquifer and coastal dune belt.

The Witpoort Formation secondary fractured rock aquifer of the Witteberg Group, which outcrops extensively within the Albany Coast Basin and Range, is considered to represent an under-utilised hydrogeological resource with **capability to produce significant, sustainable yields of high quality groundwater**. It is recommended that this aquifer be explored and developed on a regional scale rather than in a piecemeal fashion. A regional cross section below illustrates the regional extent and depth of this aquifer that also receives a significant percentage of the rain in this sub-area.

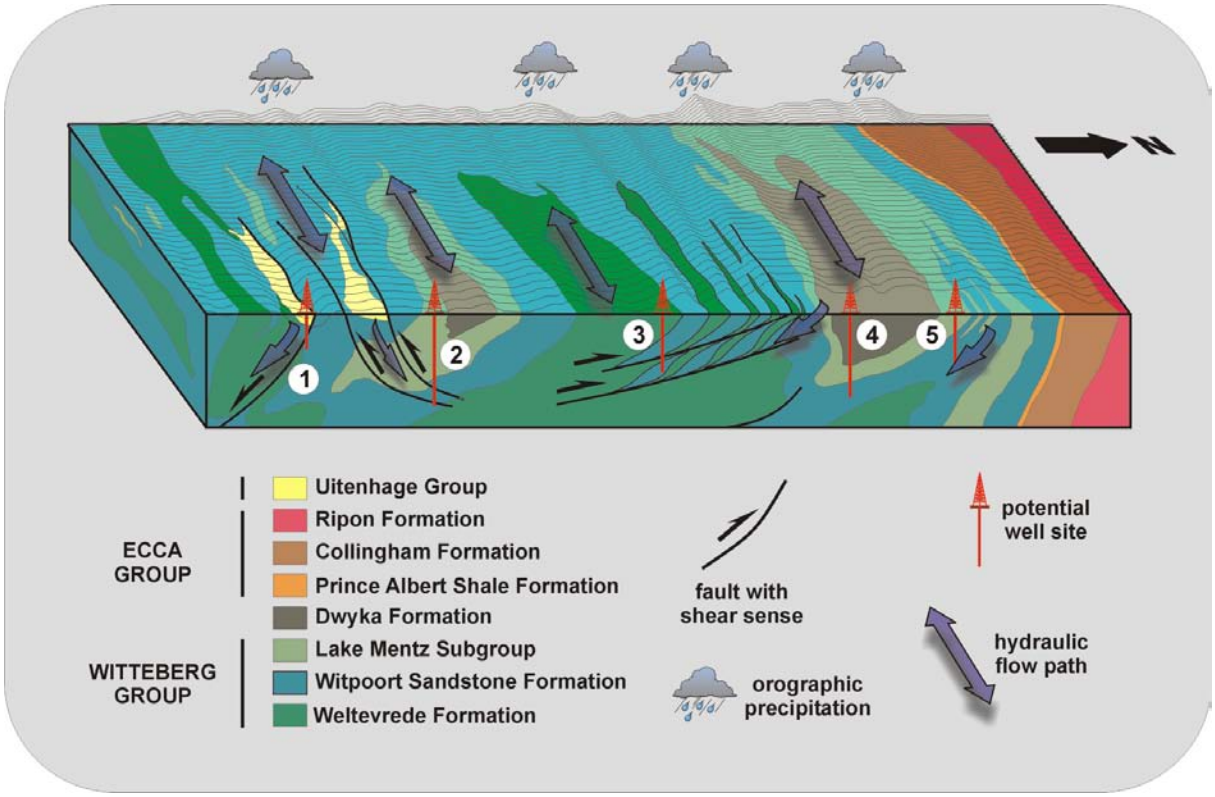

Figure 1: Hydrogeological model for the Witteberg Aquifer System

Significant hydrogeological research effort is required to evaluate the recharge / discharge balance, storage capacity and other hydraulic parameters to determine sustainable abstractability limits of the Witteberg secondary aquifer system. Both regional and focused structural geological mapping carried out in concert with exploratory core drilling, will be required to improve our understanding of the three-dimensional geometry, internal tectonic character and hydraulic parameters of the Witteberg Formation secondary aquifer. These data

are essential to define the hydraulic parameters. At present the development of sophisticated structural geological models in support of regional groundwater exploration strategies is frustrated by the lack of fundamental data in the area. It is recommended that pilot studies be initiated to identify high yield structures and to derive empirical data by which the groundwater potential of the Witteberg Aquifer can be reliably evaluated.

The primary intergranular Algoa Aquifer and coastal dune belt is reportedly among the world's largest and will become part of the Addo Elephant National Park. The wellfield at Alexandria supports a groundwater-dependent community. Additionally, the springs in the Albany Coast sub-area are thought to be supplied from the Cenozoic Alexandria Formation conglomerate and equivalent palaeo-coastal deposits of the Algoa Group.

In the Albany Coastal Range groundwater of poor quality (TDS >2000 mg/l) is associated with outcrops of the Bokkeveld Group and the Dwyka-basal Ecca formations.

A revised average annual vertical (or surface) recharge estimate of 251 million m^3/a is obtained for this sub-area (See **Table 3**), compared with earlier estimates in the range of 215 to 255 million m^3/a. Of this total, 118 million m^3 annually recharges the exposed portions of the Witteberg (Witpoort) fractured-rock aquifer, and 39 million m^3/a recharges the shallow intergranular-and fractured zone overlying surrounding rock units. About 94 million m^3/a enters the primary aquifer.

The average depth in the primary aquifers is less than 50 m and yields vary between 2 and 20 l/s. In the fractured or weathered aquifers the average depth is less than 100 m and the average yield is less than 5 l/s. From a groundwater development perspective, recent work has suggested that the yields in the fractured rock aquifers can be much higher. In the true fractured rock aquifers the boreholes should be about 300 m deep with potential yields of 20 l/s.

Total annual groundwater use in this sub-area was estimated at 1.6 million m^3/a by NWRS and 4.8 million m^3/a in 2000 (DWAF, 2002), but could be higher. For the purposes of this report the figure of 4.8 million m^3 is used.

The annually available unexploited groundwater is estimated to be 119 million m^3/a *in the "best case" and 45* million m^3/a *in the "base case".* As explained in **Table 5** and recommended, the 'base case' is calculated as 20% of (recharge – baseflow) less usage, while the 'best case' assumes that 50% of (recharge – baseflow) is available. The narrow bounds to the estimates of unused groundwater potential in this sub-area suggest with some certainty that groundwater could contribute to widespread provision of water for basic human needs, allocations for food gardening or small scale agriculture, as well as water for small town supply.

Issues

Desalination of groundwater, abstracted along the Bushmans River Estuary, through reverse osmosis (for purification) is too costly for resource-poor farmer schemes coming on line at

Bushmans River and DWAF is currently exploring the Witteberg quartzites as an alternative regional source. Results suggest improved yields (blow yield of 20 l/s) and suitable water quality from the Witteberg quartzites.

The groundwater table at the Kenton-on-Sea scheme is reported to be dropping. Problems of failure have also been experienced in the Alexandria dunefields.

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities are not addressing issues of sustainability in the planning stages of water supply schemes.

Routine monitoring, operations and maintenance, and interpretation of the data to adjust pumping regimes on supply wellfields are not being undertaken.

3.2 FISH

The Fish ISP sub-area is divided, geomorphologically and geologically, into three zones.

The southern zone, ***Southern Karoo Foreland subprovince,*** consists of the main stem of the Lower Fish River (Q91-Q93), and the lower portions of the Little Fish (Q80E-G), Middle Fish (Q70A-C), Koonap (Q92E-G), and Kat (Q94F) tributaries. These rivers flow generally ESE to SE in deeply incised meanders, below a post-African land surface on the northern foreland of the Cape Fold Belt, underlain mainly by Dwyka tillite and Ecca shales.

The middle zone, ***Camdeboo-Winterberg Escarpment subprovince***, consists of the catchments of the upper Kat (Q94AA-E), upper Koonap (Q92A-D), upper Middle Fish (Q50A-C, Q60A-C), and the upper Little Fish (Q80A-D). These catchments drain the steeper topography of an escarpment zone between the dissected post-African plain and interior mountain areas (e.g., Winterberg-Amatolas in the east) that rise above the older African land surface, and are the type area of the lower Beaufort Group (Adelaide Subgroup, after the town of Adelaide in the Q92D catchment).

The northern zone, ***Upper Great Fish Basin subprovince***, consists of the Groot Brak (Q1-Q3) and Tarka (Q4) headwaters of the Great Fish basin. These catchments drain a high amphitheatre of False Karoo veld, enclosed on its southern side by ridges underlain by the fractured-rock aquifer of the Katberg sandstone and associated Karoo dolerite sills, with Pure Grassveld vegetation. To the northeast the Burgersdorp Formation underlies the smaller remainder of the sub-area, to a steep escarpment zone along its northern margin, underlain by Molteno sandstones and Karoo dolerite sills.

Groundwater quality is generally good (TDS < 450 mg/l) in the more elevated parts of the Upper Great Fish area. Areas of good quality groundwater occur also in the northeastern part of the middle zone, below the Winterberg Range, most likely supplied by overflow or "rejected recharge" from the Katberg fractured-rock aquifer. Groundwater quality is, however, generally brackish (450 to 2 000 mg/l) to poor in parts of the Southern Karoo Foreland subprovince with EC values > 2 000 mg/l over wide areas in the south.

A revised average groundwater recharge estimate of 626 million m^3/a is obtained for this sub-area (**Table 3 –** Recharge and baseflow), compared with earlier estimates in the range 677 to 765 million m^3/a. Of this total, 74 million m^3/a recharges the exposed portions of the Katberg fractured-rock aquifer, and 490 million m^3/a recharges the shallow intergranular-and fractured zone above surrounding (lower and higher) Karoo rock units. About 60 million m^3/a enters the fractured Karoo dolerites. Recharge to the primary or intergranular aquifers amounts to only 360 million m^3/a.

Total annual groundwater use in this sub-area was estimated at 18 million m^3/a in 2000 (DWAF, 2002) and 6.3 million m^3/a by the NWRS. A total of 18 million m^3/a is recommended in this report.

Of the recharge of approximately 800 million *m^3/a the annually available unexploited groundwater is estimated to be 115* million *m^3a /in the "best case" and 105* million *m^3 in the "base case".* Groundwater could significantly contribute to the betterment of socio-economic conditions in this ISP area and the rural provision of the basic human Reserve as well as additional allocation for food support.

Issues

The groundwater tables are reported to be dropping at many schemes. Middelburg and Graaff-Reinet are reported to be in difficulties with wellfield supply, with Middelburg being granted a R2m drought relief fund.

The RDM office is responsible for determining the Groundwater Reserve (i.e. the contribution of groundwater to the Surface Water Reserve).

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities are not addressing issues of sustainability in the planning stages of water supply schemes.

Numerous small towns and rural settlements are solely or partially reliant on groundwater. Despite this, routine monitoring operations, and maintenance and interpretation of the data to adjust pumping regimes on supply wellfields is not being undertaken

3.3 SUNDAYS

The Sundays ISP sub-area is also divided into three parts, the two northern zones of which are western extensions of the two southern zones of the adjacent Fish sub-area. The Katberg sandstone, which is the southern boundary unit of the Upper Great Fish Basin subprovince (**Table 2**), does not extend into the Sundays basin, only as outliers along the northern Sundays-Fish divide. The Upper Sundays (N14, N13, N12, N21, N30A catchments) falls within the western ***Camdeboo-Winterberg subprovince***, underlain by lower Beaufort (Adelaide Subgroup) strata and intrusive Karoo dolerites. The Middle Sundays (N24, N22, N23, N30B-C catchments) lies within the ***Southern Karoo foreland subprovince***, in which

structural control of drainage by WNW/ESE tectonic trends of the Cape Fold Belt (CFB) is evident in the western and eastern tributaries of the incised main river channel. The Lower Sundays catchments (N40) are divided between the ***Albany Coastal Range and Algoa Basin subprovinces***, mainly the latter.

A revised average annual groundwater recharge estimate of 352 million m^3 is obtained for this sub-area (**Table 3** – Recharge and baseflow), compared with earlier estimates in the range 307 to 367 million m^3/a. Of this total, 28 million m^3/a recharges the CFB fractured-rock aquifers (Witteberg in the Albany Coastal Range and Table Mountain Group in the southwestern corner of the Algoa Basin) in the south, and 284 million m^3/a recharges the shallow intergranular-and fractured zone units. About 18 million m^3/a enters fractured Karoo dolerites, mostly in the Upper Sundays area. Recharge to the alluvial and coastal primary aquifers in the south amounts to 22 million m^3/a.

Groundwater quality in the higher catchments of the Upper Sundays, e.g., around Nieu Bethesda, is locally good (EC < 450 mg/l), but is otherwise brackish (TDS 450 to 2 000 mg/l) even in this zone, with a belt of poor quality (2 000-6 500 mg/l) between Aberdeen and Graaff-Reinet. In the Middle and Lower Sundays, the groundwater quality is rarely good, and belts of poor quality (2 000-6 500 mg/l) are widespread, generally related to Bokkeveld, Dwyka-Ecca and Uitenhage Group strata.

Total annual groundwater use in this sub-area was estimated at 30 million m^3 in 2000 (DWAF, 2002) and 15.6 million m^3 by the NWRS. A total of 30 million m^3/a is recommended in this report.

The annually available unexploited groundwater is estimated to be 54 million m^3 *in the "best case" and 39* million m^3 *in the "base case".* Groundwater quality, rather than quantity, may be the greater limitation to "best case" levels of aquifer development.

It is suggested that it would be appropriate strategy to consider rainfall harvesting, i.e. the improving of recharge into the groundwater aquifers.

Issues

Groundwater usage in this area is considered to be moderately to heavily utilised in the middle Sundays area. This is both for rural settlement and agricultural supply. Despite this, and reports that the groundwater tables on many schemes are reported to be dropping, routine monitoring operations and maintenance and interpretation of the data to adjust pumping regimes on supply well-fields is not undertaken.

Licence conditions should always require that abstraction be within the limits of sustainable yield, but district and local municipalities do not address issues of sustainability in the planning stages of water supply schemes.

There are no licence applications at present waiting for attention; there is one disputed licence application near the hamlet of Sundays River. This involves the Paterson Municipality which has drilled on a private landowner's land without knowledge and permission. This is a co-operative governance affair and requires confirmation that there is no alternative source.

4. GROUNDWATER/SURFACE WATER LINKAGE

There is little to no quantitative knowledge of surface/ groundwater interaction in the Fish-Sundays. However the environmental and tourist importance of the estuaries, the goods and services that the wetlands/vleis deliver in the high-lying areas and the implementation of the Reserve, are factors contributing to the importance of managing the groundwater contribution at low-flow times.

Estimates of baseflow contribution by different researchers vary significantly for the Fish-Sundays area. It is important that the evaluation of the baseflow contribution is realistic, particularly in the Albany Coast sub-area and in the lower Fish sub-area because, this being an area of relatively high dependency on groundwater, good estimates could mean the difference between there being some spare groundwater potential in certain areas, or over-exploitation. Preliminary assessment of spring distribution patterns in this ISP area suggests that the surface-groundwater interaction is geologically controlled, i.e. situated at lithological and/or structural (therefore also geomorphologically) defined regions.

Baseflow is negligible to low in the regolith and flood hydrology dominated sub-areas of the upper and middle Fish and Sundays sub-areas, indicating a very low to negligible impact on surface water or ecosystems other than at site specific springs and seep zones associated with the dolerite dyke and sill systems. Most of the streams and rivers in the upper regions and the relatively dry areas of the WMA are considered *detached* (piezometric level at all times below streambed and no discharge to surface water), *intermittent* (piezometric level slopes towards the stream and recharge occurs at intervals or occasionally) or *famished* (piezometric level slopes towards the stream, but groundwater does not reach due to evapotranspiration (definitions by Vegter and Pitman, 1996).

The bigger seasonally effluent reaches of rivers with riparian zones, constituting the alluvial aquifers, are located in climatic regions of low rainfall and high evaporation. These aquifers are not considered relevant for water resource development in this ISP area. Rivers normally do not act as source for groundwater recharge. However, in the event of floods or large-scale transfers the river becomes influent and recharges the groundwater, if the storage capacity is sufficient. The primary consideration in this ISP area is the pollution threat to the fractured rock aquifers arising from this recharging.

Relevant surface/ groundwater interaction is therefore largely limited to perennial springs (see above) and very occasionally rivers embedded in alluvial aquifers. Alluvial aquifers are not of much significance in this area, and primary aquifers are concentrated along the coast and arise from wind action, not fluvial action.

The springs and seep zones discharging from the Katberg Formation, the Witteberg formation and the dolerite dykes and sills support perennial reaches of river, vleis and wetlands (see **Figure 1**). Interaction between surface and groundwater in the river courses is likely limited to these few areas.

The springs in this area need to be thoroughly mapped and monitored. The relationship of spring and seep discharge to river flow needs to be established and groundwater contribution to baseflow needs to be verified. This is particularly important since the aquifers in this area generally have a low storage capacity and many people depend on run-of-river and or groundwater for supply.

Recognising this, it does not mean that a spring flow cannot be replaced by groundwater pumped out of a borehole. In many instances groundwater discharge can be better managed in a wellfield context than in a natural context by supplementing the decrease in spring flow from managed wellfields.

In the fractured rock dominated areas of the WMA (where the Witteberg outcrops in the Albany Coast sub-area and where aquifers behind dolerite dykes and sills have been developed in the other sub-areas), elevation and depth of boreholes is a more critical factor to consider than distance from a river in regulating groundwater abstraction with regards to impact on baseflow.

A strategy of purposeful and managed drawdown of the groundwater table in summer in order to enhance recharge in the winter and optimise the evaporation-free storage can be adopted in the management of the storage available in the Katberg and Witteberg Aquifers.

Table 3: Recharge and baseflow

ISP Sub-area	Recharge (Umvoto model)	Recharge (Vegter)	Baseflow (Pitman)	Baseflow (Hughes)
Great Fish	626	728	21	114.6
Albany Coast	251	155	3	29.2
Sundays	352	409	2.5	45.2
Total	**1 230**	**1292**	**26**	**189**

NOTE: The baseflow of Pitman is ~14% of that of Hughes; the baseflow of Hughes is up to 19% of recharge.

Table 4: Groundwater usage

ISP Sub-area	Usage (NWRS)	Usage (Baron and Seward 2000)	Usage (based on NGDB and WRC Yield map) [1]	Usage (ISP)	Comment
Great Fish	6.3	18	111	18	To be conservative the Baron & Seward estimate is preferred
Albany Coast	1.6	4.8	26	4.8	
Sundays	15.6	30	69	30	
Total	**23.5**	**53**	**206**	**52.8**	

(1) The method used to estimate usage would significantly over-estimate for the Karoo-dominated sub-areas due to high percentage of dry boreholes and assumed pumping regime in model.

Table 5: Groundwater available for development[1]

Sub-area	Recharge (Umvoto)	Baseflow (Pitman)	Usage (ISP)	Groundwater Available for Development	Comment
Great Fish	626	21	18	103	NWRS usage figures would increase available groundwater
Albany Coast	251	3	4.8	45	
Sundays	352	2.5	30	40	
Total	**1 230**	**26**	**52.8**	**188**	

(1) 20% of (Recharge – Baseflow) less usage/ supply = Groundwater Available for Development. The amount could be as low as 10% or as much as 80% - but additional information is required to improve on the current estimate. The Potential for Development in the Albany Coast sub-area is estimated very conservatively given that the exploration of the Witpoort Formation has only been initiated recently.

Table 6: Comparison of Values for 'Groundwater Available for Development'

Sub-area	Harvest Potential	Exploitation Potential (WSM 2000)	NWRS	ISP	Comment
Great Fish	824	455	95.7	105	
Albany Coast	325	154	25.6	48	Witteberg aquifer not emphasised in NWRS
Sundays	385	223	67.8	54	
Total	**1 534**	**206**	**189.1**	**217**	

NOTE: The Groundwater Potential estimated in this study is considered to be very conservative for reasons discussed in text and table notes. *We recommend that the NWRS numbers be revised accordingly (see Table 7 below).* The total Groundwater Potential for development would be 217 million m^3/a. In the event that the Baron and Seward (2000) usage figures are used, the NWRS and ISP values are very comparable.

Table 7: Summary table of potential and current supply

Item	Groundwater available for exploitation/ development	Current groundwater supply
Unit	Million m^3/a	Million m^3/a
Ref	ISP	NWRS
Formula	Recharge – baseflow/2 or 5 less supply	
Great Fish	115	6.3
Albany Coast	48	1.6
Sundays	54	15.6
Total	**217**	**23.5**

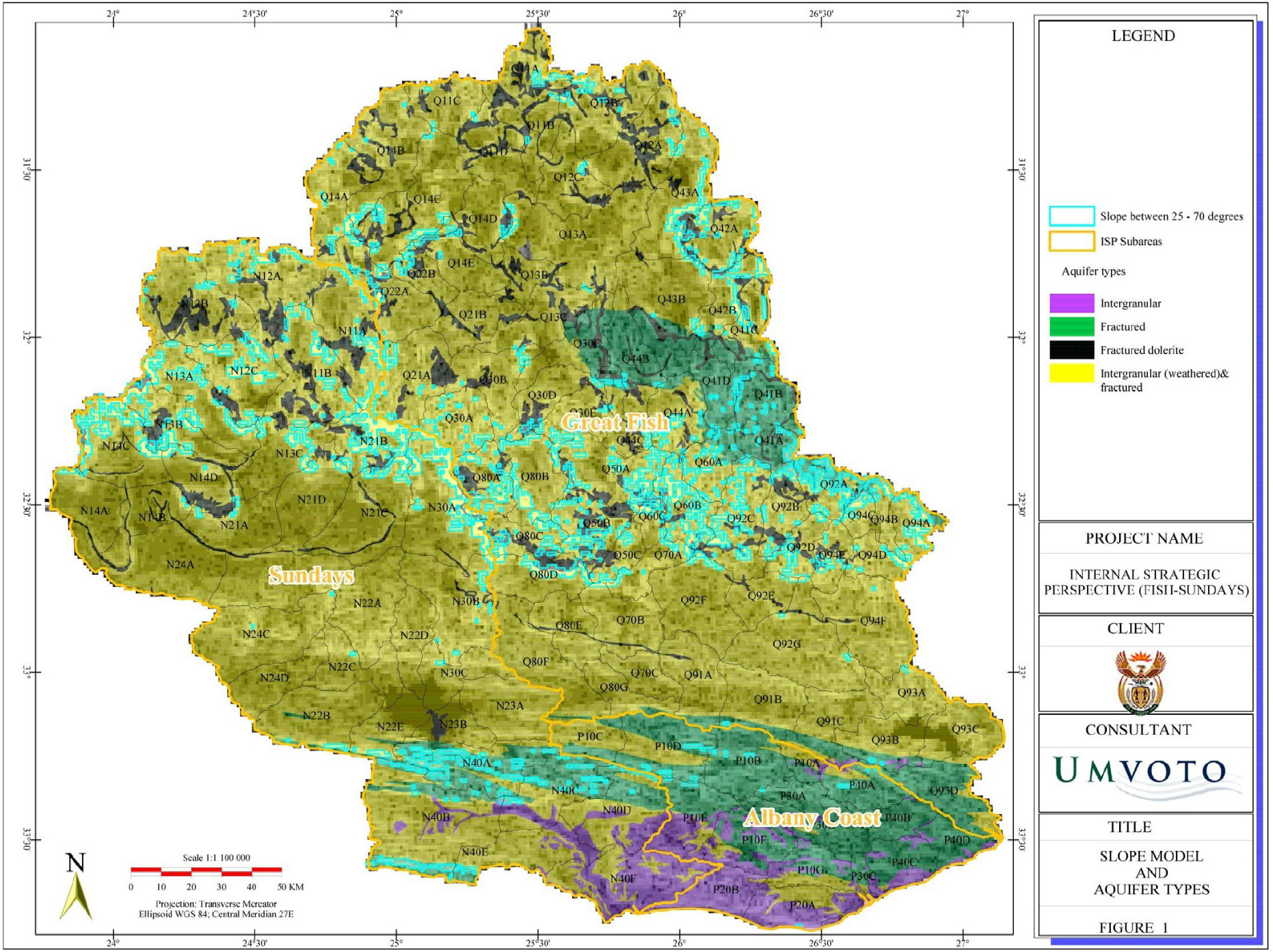

Figure 2: Slope model and aquifer types

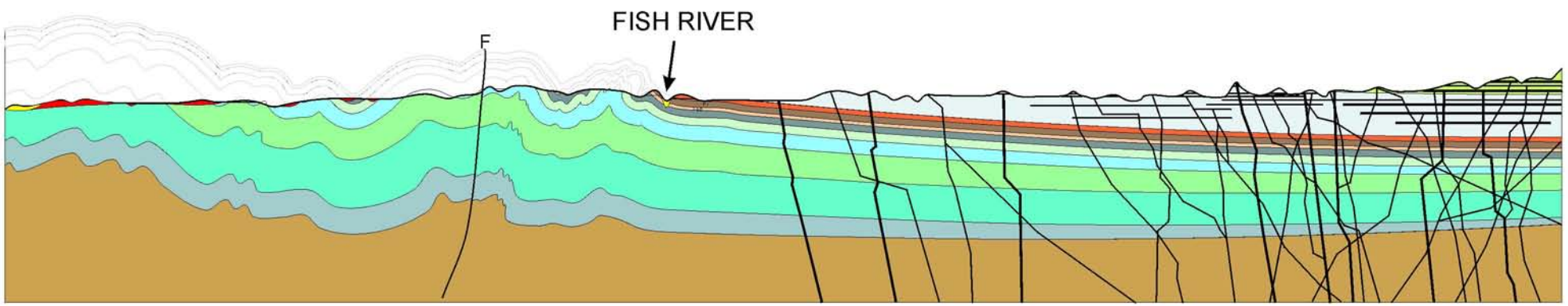

Figure 2. Schematic geological cross-section

Figure 3: N-S Geological cross-section

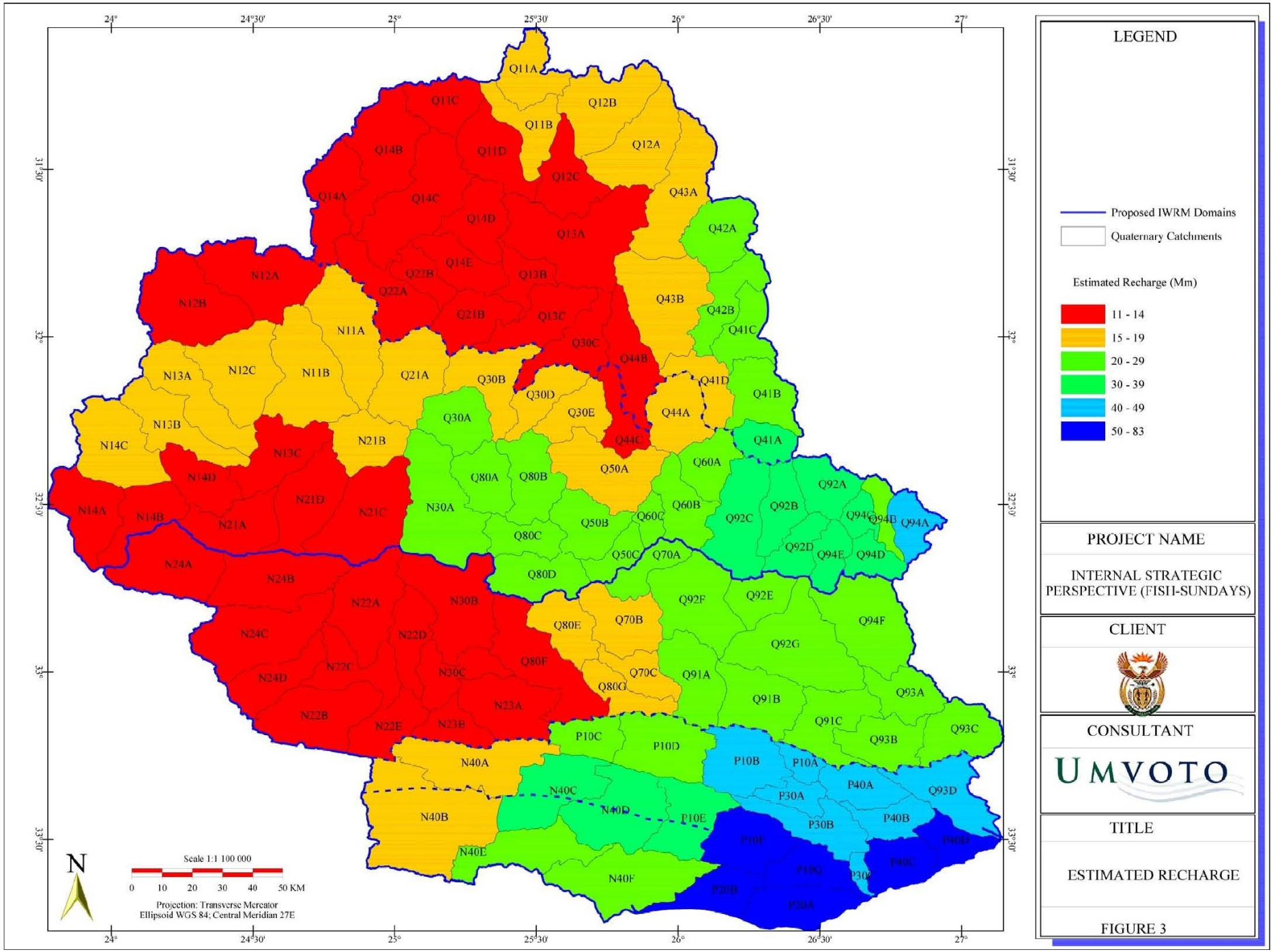

Figure 4: Estimated recharge

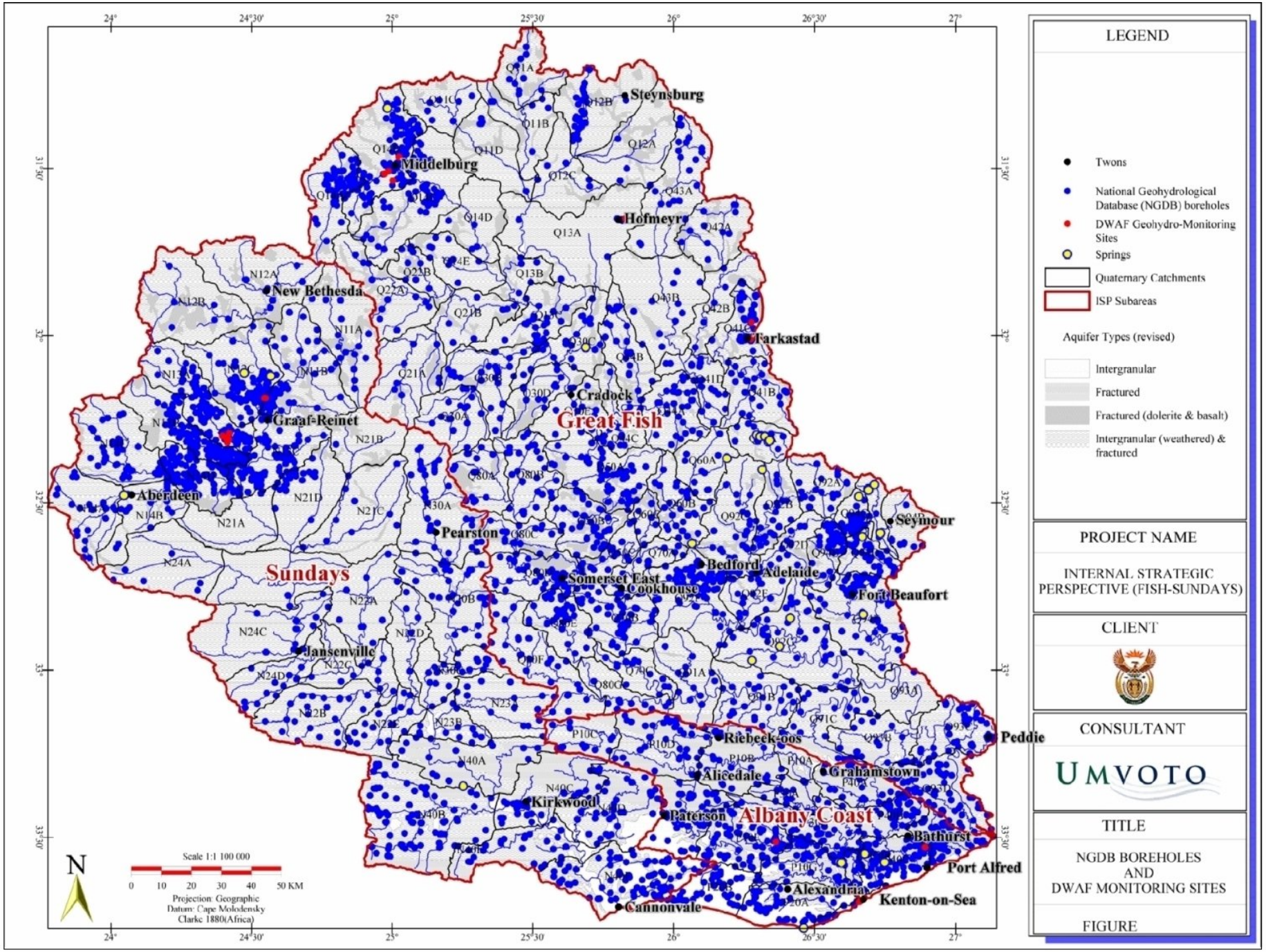

Figure 5: NGDB boreholes and DWAF monitoring sites

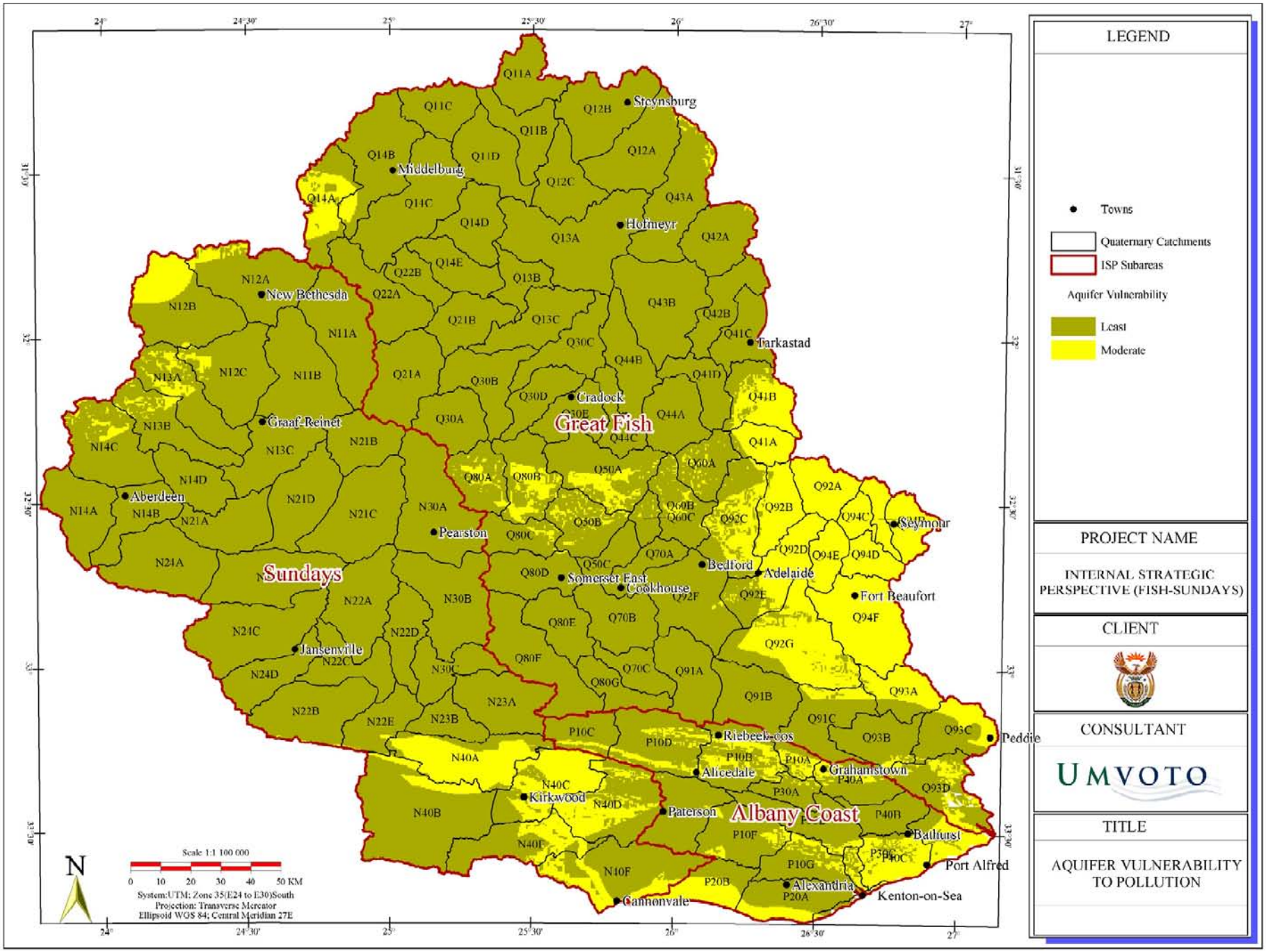

Figure 6: Aquifer vulnerability to pollution

APPENDIX 3

Municipalities in the ISP area

MUNICIPALITIES IN THE ISP AREA

District/Metropolitan Municipality	Local Municipality	Town
Central Karoo District (DC5)	(Very small area)	None
Cacadu District (DC10)	Blue Crane Route Municipality	Cookhouse, Somerset East, Pearston
	Camdeboo Municipality	Graaff-Reinet, Nieu-Bethesda, Aberdeen
	Ikwezi Municipality	Jansenville
	Makana Municipality	Alicedale, Grahamstown, Riebeeck-East
	Ndlambe Municipality	Alexandria, Bathurst, Kenton-on-Sea, Port Alfred, Bushmans River Mouth, Cannon Rocks, Boknes, Kleinemonde
	Sunday's River Valley Municipality	Kirkwood, Sunland, Addo, Bontrug, Enon
Amatole District (DC12)	Ngqushwa Municipality	Peddie
	Nkonkobe Municipality	Alice, Fort Beaufort, Middledrift, Seymour, Hogsback
	Nxuba Municipality	Adelaide, Bedford
Chris Hani District (DC13)	Inxuba Yethemba Municipality	Cradock, Middelburg
	Tsolwana Municipality	Hofmeyr, Tarkastad
Ukhahlamba District (DC14)	Gariep Municipality	Steynsburg
Nelson Mandela Metropolitan	N/a	Colchester, Cannonvale

APPENDIX 4

Rivers and towns

RIVERS AND TOWNS

Quaternaries	Rivers / river reaches	Towns / suburbs
Sundays		
N11A	Sundays River	
N11B	Sundays River	
N12A	Gats River	Nieu Bethesda
N12B	Bloukrans River	
N12C	Gats River, Pienaars River	
N13A	Moordenaars River, Droë River	
N13B	Swart River	
N13C	Sundays River, Swart River	Graaff-Reinet
N14A	Kraai River	
N14B	Kraai River	Aberdeen
N14C	Kamdeboo River	
N14D	Kamdeboo River	
N21A	Sundays River, Karee River	
N21B	Melk River	
N21C	Melk River	
N21D	Klip River	
N22A	Lootskloof River	
N22B	Driekop River	
N22C	Sundays River	
N22D	Riet River	
N22E	Wortelkuil River	
N23A	Schoenmakers River	
N23B	Volkers River	
N24A	Bul River	
N24B	Bul River, Sundays River	
N24C	Brak River, Sundays River	Jansenville
N24D	Delport River	
N30A	Voël River	Pearston
N30B	Voël River	
N30C	Voël River	
N40A	Sundays River, Kruis River	
N40B	Kariega River, Sundays River	
N40C	Wit River	Bontrug, Enon, Kirkwood
N40D	Krom River	Paterson
N40E	Sundays River	
N40F	Sundays River	Cannonvale
Albany Coast		
P10A	New Years River	
P10B	New Years River	Riebeeck-East
P10C	Bushmans River	
P10D	Bushmans River	Alicedale

Quaternaries	Rivers / river reaches	Towns / suburbs
P10E	Bushmans River	Paterson
P10F	Bushmans River	
P10G	Bega River, Bushmans River	
P20A	Boknes River	Alexandria, Cannon Rocks, Boknes
P20B	Bega River	
P30A	Kariega River	
P30B	Assegaai River, Kariega River	
P30C	Kariega River	
P40A	Bloukrans River, Kowie River, Kafferkraal River	Grahamstown
P40B	Kowie River	
P40C	Kowie River	Bathurst, Port Alfred
P40D	Riet River	
Fish		
Q11A	Great Brak River	
Q11B	Great Brak River	
Q11C	Oorlogspoort River	
Q11D	Oorlogspoort River	
Q12A	Strydpoort River	
Q12B	Teebus Spruit	Steynsburg
Q12C	Teebus Spruit	
Q13A	Great Brak River, Kwaai River	Hofmeyr
Q13B	Great Fish River, Great Brak River	
Q13C	Great Fish River	
Q14A	Little Brak River	
Q14B	Little Brak River	Middelburg
Q14C	Little Brak River	
Q14D	Little Brak River	
Q14E	Great Fish River	
Q21A	Willem Burgers River	
Q21B	Willem Burgers River	
Q22A	Elandskloof River	
Q22B	Small Seekoei River	
Q30A	Pauls River	
Q30B	Kareebos River, Pauls River	
Q30C	Great Fish River	
Q30D	Wilgebooms River	
Q30E	Great Fish River	Cradock
Q41A	Tarka River	
Q41B	Tarka River	
Q41C	Tarka River	Tarkastad
Q41D	Poort River	
Q42A	Elands River	
Q42B	Elands River	
Q43A	Vlekpoort River	
Q43B	Vlekpoort River	
Q44A	Tarka River	
Q44B	Gunstelingstroom River	

Quaternaries	Rivers / river reaches	Towns / suburbs
Q44C	Golden Glade River	
Q50A	Riet River	
Q50B	Great Fish River	
Q50C	Great Fish River	
Q60A	Poort River	
Q60B	Poort River	
Q60C	Baviaans River	
Q70A	Great Fish River, Droë River	Cookhouse
Q70B	Great Fish River	Uitkeer
Q70C	Great Fish River	Sheldon
Q80A	Great Blyde River	
Q80B	Little Fish River	
Q80C	Little Fish River	
Q80D	Little Fish River, Naude's River	Somerset East
Q80E	Little Fish River	
Q80F	Brak River	
Q80G	Small Fish River	
Q91A	Great Fish River	
Q91B	Great Fish River	
Q91C	Bothas River, Great Fish River	
Q92A	Koonap River	
Q92B	Braambos River, Koonap River, Tarka River	
Q92C	Koonap River	Adelaide
Q92D	Kaalhoek River	
Q92E	Koonap River	
Q92F	Kat River	Bedford
Q92G	Koonap River	
Q93A	Great Fish River	
Q93B	Brak River	
Q93C	Blue River, Paradise River	Peddie
Q93D	Great Fish River, Rufane River	
Q94A	Esk River	Seymour
Q94B	Kat River	
Q94C	Kat River	
Q94D	Kat River	
Q94E	Blinkwater River	
Q94F	Kat River	Fort Beaufort

APPENDIX 5

Wastewater treatment works

WASTEWATER TREATMENT WORKS

Quats	Controlling authority	Name	Capacity	Disposal
Fish sub-area				
Q12B	Gariep Municipality	Steynsburg Oxidation Ponds	200 m^3/d	Irrigate
Q13A	Tsolwana Municipality	Hofmeyr Sewage Treatment Works	Small < 1 000 m^3/d	Pond System
Q14B	Inxuba Yethemba Municipality	Grootfontein Agri College Sewage Treatment Works	Small < 1 000 m^3/d	Irrigation
Q14B	Inxuba Yethemba Municipality	Middelburg Sewage Treatment Works	1 000 m^3/d	Discharge & irrigate
Q30E	Inxuba Yethemba Municipality	Cradock Sewage Treatment Works	4 000 m^3/d	Great Fish River
Q41C	Tsolwana Municipality	Tarkastad Sewage Treatment Works	Small < 1 000 m^3/d	No irrigation
Q70A	Blue Crane Route Municipality	Cookhouse Sewage Treatment works	Small < 1 000 m^3/d	Evaporate / pond system
Q80D	Blue Crane Route Municipality	Somerset East Sewage Treatment works	Small < 1 000 m^3/d	Irrigate
Q91C	Makana Municipality	Rini STW		Irrigate
Q92C	Nxuba Municipality	Adelaide Sewage Treatment works	Small < 1000 m^3/d	Koonap River
Q92F	Nxuba Municipality	Bedford sewage Treatment works	Small < 1 000 m^3/d	Koonap River
Q92F	Bedford Hospital	Bedford Hospital Sewage treatment Works		Irrigation
Q93C	Ngqushwa Municipality	Peddie Sewage Treatment works	Small < 1 000 m^3/d	Paradise (Ngqushwa River)
Q94A	Nkonkobe Municipality	Seymour Sewage Treatment Works	250 m^3/d	Irrigation
Q94F	Nkonkobe Municipality	Fort Beaufort Sewage Treatment Works	2 000 m^3/d	Irrigation / pond
Albany Coast sub-area				
P10D	Makana Municipality	Alicedale Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate / Irrigate
P10E	Sundays River Valley Municipality	Paterson Oxidation Ponds	Influent received is 230 m^3/d	Evaporate
P10G	Ndlambe municipality	Bushmans River Mouth Sewage Treatment Works	Small < 1 000 m^3/d	Bushmans River
P10G	Ndlambe municipality	Kenton-on- Sea		Kariega River

Quats	Controlling authority	Name	Capacity	Disposal
		Sewage Treatment Works		
P20A	Ndlambe municipality	Alexandria Sewage Treatment Works	Small < 1 000 m^3/d	Irrigate
Q93B	Makana Municipality	Glen Melville Sewage Treatment Works (Grahamstown)		
P40A	Makana Municipality	Grahamstown Sewage Treatment Works	4 000 m^3/d	Blaauwkrantz River
P40C	Ndlambe Municipality	Bathurst Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate / Irrigate
P40C	Ndlambe Municipality	Port Alfred Sewage Treatment Works	1 000 m^3/d	Irrigate
Sundays sub-area				
N13C	Camdeboo Municipality	Graaff-Reinet Sewage Treatment Works	3 000 m^3/d	Discharge / Pond System
N14B	Camdeboo Municipality	Aberdeen Sewage Treatment Works	Small < 1 000 m^3/d	Evaporate
N14B	Camdeboo Municipality	Tembelesiswe Oxidation ponds (Aberdeen)	Small < 1 000 m^3/d	Irrigation
N24C	Ikwezi Municipality	Jansenville oxidation ponds		Evaporate
N30A	Blue Crane Route Municipality	Pearston oxidation ponds		Discharge
N40C	Cacadu District Municipality (DC10)	Enon oxidation ponds	153 m^3/d	Evaporate / Irrigate
N40C	Sunday's River Valley Municipality	Kirkwood Sewage Treatment works	Small < 1 000 m^3/d Influent received is 1 197 m^3/a	Discharge
N40C	Kirkwood Prison	Kirkwood Prison Sewage Treatment Works	Small < 1 000 m^3/d	Discharge
N40E	S A National Parks	Addo Elephant National Park oxidation ponds	40 m^3/d	Soak away
N40E	Addo Research Station	Addo Research Station Sewage Treatment Works	Small < 1 000 m^3/d	Pond System
N40E	Sunday's River Valley Municipality	Addo Town Sewage Treatment Works	Small < 1 000 m^3/d Influent received is 553 m^3/d	Irrigation / pond

APPENDIX 6

Solid waste disposal sites

SOLID WASTE DISPOSAL SITES

Quaternary catchment	Area	Local authority	District Municipality	Type of site
Fish sub-area				
Q12B	Steynsburg	Gariep	Ukhahlamba (DC14)	Class C
Q13A	Hofmeyr	Tsolwana	Chris Hani (DC13)	Class C
Q14B	Middelburg	Inxuba Yethemba	Chris Hani (DC13)	Class S
Q30E	Cradock	Inxuba Yethemba	Chris Hani (DC13)	Class M
Q41C	Tarkastad	Tsolwana	Chris Hani (DC13)	Existing: Class C New: Class C
Q70A	Cookhouse	Blue Crane Route	Cacadu	C: G: B-
Q70B	Uitkeer	DWAF		C: G: B-
Q80D	Somerset East	Blue Crane Route	Cacadu (DC10)	Class S – Class 2 site
Q92C	Adelaide	Nxuba	Amatole (DC12)	Class S
Q92F	Bedford	Nxuba	Amatole (DC12)	Existing: Class C New: Class S
Q94A	Hogsback	Nkonkobe	Amatole (DC12)	Class CSAFCOL Class C
Q94F	Fort Beaufort	Nkonkobe	Amatole (DC12)	Class S (Closed) New Class C (No official facility)
Sundays sub-area				
N12A	Nieu Bethesda	Camdeboo	Cacadu (DC10)	Proposed A and an existing Class C site
N13C	Graaff-Reinet	Camdeboo	Cacadu (DC10)	Class S
N14B	Aberdeen	Camdeboo	Cacadu (DC10)	Old Class C (closed) + New Class C
N24C	Jansenville	Ikwezi	Cacadu (DC10)	Class C
N30A	Pearston	Blue Crane Route	Cacadu (DC10)	Class C
N40B N40C	Kirkwood Corr. Services Kirkwood	Public Works Sundays River Valley	Cacadu (DC10)	Class C – Class 2 site Class C – Class 2 site
N40E	Addo Langbos	Sundays River Valley	Cacadu (DC10)	Class C
N40E	Addo (Mistkraal)	Sundays River Valley	Cacadu (DC10)	Class C – Class 2 site
N40F	Cannonvale/Colchester Caravan Park (C. Botha)	Sundays River Valley	Cacadu (DC10)	Class C Class C - Private
Albany Coast sub-area				
P20A	Cannon Rocks	Ndlambe	Cacadu (DC10)	Class C Domestic Class C Garden

Quaternary catchment	Area	Local authority	District Municipality	Type of site
P10A	Grahamstown	Makana	Cacadu (DC10)	Class M G: M: B +
P40C	Bathurst	Ndlambe	Cacadu (DC10)	Class C
P40C	Port Alfred	Ndlambe	Cacadu (DC10)	Class S – Class 2 site
P10B	Riebeeck-East	Makana	Cacadu (DC10)	Class C – Class 2 site
P40D	Kleinemonde	Ndlambe		C: G: B+
P40D	Riet River Mouth	Ndlambe		C: G: B+
P30B	Salem	Ndlambe		C: G: B-
P30C	Kenton-on-Sea	Ndlambe		C: G: B+
P10D	Alicedale	Makana	Cacadu (DC10)	Class C
P10E	Paterson	Sundays River Valley	Cacadu (DC10)	Class C G: S: B
P10G	Bushmans River Mouth	Ndlambe	Cacadu (DC10)	Old: Class C Class 2 New: Class C
P20A	Alexandria	Ndlambe	Cacadu (DC10)	Class S
P20A	Boknes	Ndlambe	Cacadu (DC10)	Class C Rural

APPENDIX 7

General authorisations tables

GENERAL AUTHORISATIONS

GAZETTE NO 26187

GOVERNMENT NOTICE

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

NO. 399 **26 March 2004**

REVISION OF GENERAL AUTHORISATIONS IN TERMS OF SECTION 39 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

SCHEDULE

1. THE TAKING OF WATER FROM A WATER RESOURCE AND STORAGE OF WATER

[Sections 21(a) and (b)]

TABLE 1.1 Areas excluded from General Authorisation for the taking of surface water

Primary drainage region	Secondary/Tertiary/Quaternary drainage region and excluded resources	Description of main river in drainage region for information purposes
N	N11, N12	Sundays River upstream of Nqweba Dam
P	P10 P30 P40	Bushmans River Kowie River Kariega River
Q	Q41A, Q41B, Q41C, Q41D, Q44A, Q44B Q42A & B Q43A & B Q92 Q94	Tarka River Elands River Vlekpoort River Koonap River Kat River

Table 1.2 Groundwater Taking Zones: Quaternary Drainage Regions

The Table refers to the size of the property on which the General Authorisation is applicable

Zone A NO WATER MAY BE TAKEN FROM THESE DRAINAGE REGIONS EXCEPT AS SET OUT UNDER SCHEDULE 1 AND FOR SMALL INDUSTRIAL USERS.	**Zone B 45 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone C 75 M^3 PER HECTARE PER ANNUM MAY BE TAKEN -FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone D 150 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**	**Zone E 400 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND FOR SMALL INDUSTRIAL USERS.**
N14B-D	N12C	N11A, B	N40F	P20B
N21A	N13A-C	N12A, B	P20A	
N22A, E	N14A	N21B, D		
N23B	N21C	N40A, B, D, E		
N24B-D	N22B-D	P10A, B, D-G		
N30A-C	N23A	P30A-C		
N40C	N24A	P40A-D		
Q12C	P10C	Q11A-D		
Q13B, C	Q13A	Q12A, B		
Q14A-C, E	Q22A	Q14D		
Q21B	Q30A	Q21A		
Q22B	Q43A, B	Q41A-D		
Q30B-E	Q50C	Q42A, B		
Q44A-C	Q60A, B	Q91C		
Q50A, B	Q70A-C	Q92A, B, D, E, G		
Q60C	Q80D, E, G	Q93A-D		
Q80A-C, F	Q91A, B	Q94A-F		
	Q92C, F			

TABLE 1.3 (a) Areas excluded from General Authorisation for any storage of water

Primary drainage region	**Secondary/Tertiary/Quaternary drainage region**	**Description of main river in drainage region for information purposes**
None	None	None

TABLE 1.3 (b) Areas excluded from General Authorisation for storage of water in excess of 10 000 cubic metres and falling outside government control areas proclaimed under the Water Act No 54 of 1956.

Primary drainage region	**Secondary/Tertiary/Quaternary drainage region**	**Description of main river in drainage region for information purposes**
None	None	None

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2. ENGAGING IN A CONTROLLED ACTIVITY, IDENTIFIED AS SUCH IN SECTION 37(1): IRRIGATION OF ANY LAND WITH WASTE OR WATER CONTAINING WASTE GENERATED THROUGH ANY INDUSTRIAL ACTIVITY OR BY A WATERWORK

[Section 21(e)]

3. DISCHARGE OF WASTE OR WATER CONTAINING WASTE INTO A WATER RESOURCE THROUGH A PIPE, CANAL, SEWER OR OTHER CONDUIT; AND DISPOSING IN ANY MANNER OF WATER WHICH CONTAINS WASTE FROM, OR WHICH HAS BEEN HEATED IN, ANY INDUSTRIAL OR POWER GENERATION PROCESS

[Sections 21(f) and (h)]

TABLE 3.3: Listed Water Resources

	WATER RESOURCE		
	Great Brak River		
	LISTED WATER RESOURCES WHERE SPECIAL LIMIT FOR ORTHO-PHOSPHATE AS PHOSPHOROUS IS APPLICABLE (Crocodile (West) Marico Water Management Area)		
	None		
	RAMSAR LISTED WETLANDS:	**PROVINCE**	**LOCATION**
	None	None	None

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4 DISPOSING OF WASTE IN A MANNER WHICH MAY DETRIMENTALLY IMPACT ON A WATER RESOURCE

[Section 21(g)]

TABLE 4.1 Subterranean government water control areas excluded from General Authorisation for disposal of waste

Primary drainage region	**Tertiary/ Quaternary drainage region**	**Description of subterranean government water control area**	**Government Notice No.**	**Government Gazette Date**
None	None	None	None	None

APPENDIX 8

Resource-poor farmers schemes

RESOURCE- POOR FARMER IRRIGATION SCHEMES

Scheme/Area	Implementing authority / Comment
Fish sub-area	
Tyhefu: (380 ha)	Bulk supply rehabilitation for Phases I and II are in place, as well as in-field works for Phase I (380 ha). DWAF and DLA will only become involved with further capital development once there are significant production from Phase I and II. No definite implementing authority has been identified for the additional potential 860 ha, which would form part of Phase III of the project. Total envisaged eventual irrigation is about 1 400 ha, which includes the additional 860 ha.
Cradock (18 ha)	This has already been fully developed with help from DLA and Inxuba Yethemba Municipality, and is mainly small commercial cash crop plots just downstream of Cradock.
Masipatisane (20 ha)	No development yet of this potential irrigation scheme, and no plans for development known at present.
Kwa Nojoli (84 ha)	No development yet of this potential irrigation scheme, and no plans for development known at present
The proposed sugar beet project is a possible user that may use part, or whole of the allocation for resource-poor farmers.	Sugar Beet S.A. would be the implementing agent if such a scheme was implemented. A Strategic Environmental Assessment is proposed for this project. Note that the use of water for this project would preclude the implementation of some of the other listed proposals, which already total more than 5 000 ha.
Albany Coast sub-area	
No identified schemes for resource-poor farmers.	
Sundays sub-area	
Barkley Bridge: The ORRS Study identified 3 000 ha in the Barkley Bridge area.	DWAF originally indicated that they will only become involved when there is a definite demand from the end users for development, which there is not at present. The Sunday River WUA (SRWUA) is very keen to have the area developed for empowerment and other purposes, and may look for willing partners to aid in development. DWAF is currently reconsidering undertaking a study of the possible development of the area, as part of a greater resource-poor farmer planning study.
Enon Mission (296 ha)	No development as yet. The SRWUA feels that some body (e.g. DLA) needs to take the responsibility to get aspirant resource-poor farmers together, to create a need for development, and find willing development partners. The SRWUA has informed the EC MEC for Agriculture as such.
Vaalhoedskraal (188 ha)	An application for a licence for resource-poor farmers has been made to DWAF, for development just downstream of Vaalhoedskraal. The Implementing Authority is the Provincial Department of Agriculture. Any future proposed development (in excess of 188 ha) would have to form part of the identified 4 000 ha if the licence application is successful.
Addo (690 ha)	No development as yet. SRWUA feels that some body (e.g. DLA) needs to take the responsibility to get aspirant resource-poor farmers together, to create a need for development, and find willing development partners. The SRWUA has informed the EC MEC for Agriculture as such.

APPENDIX 9

Land reform (redistribution) schemes

LAND REFORM (REDISTRIBUTION) SCHEMES

Farm /Scheme	Water Source	Scheduled Area (ha)	Region	Comment
Bedrog CPA	ORP	122.7	Klipfontein, near Cookhouse	After unsuccessful attempts to retain resource-poor farmers on property, it was sold early 2004. Back in hands of commercial farmer.
Masizame Trust	ORP	50	Somerset-East	Infrastructure vandalised and fallen into disrepair. Used as communal grazing area at present.
Sonder Trust	ORP	?	Klipfontein, near Cookhouse	
Masizakhe Trust	ORP	4	Lower Sundays River	Handed over to lawyers to claim owed water bills. Seems as if farm will be sold in total.
Nomzamo Stock Farmers Trust	ORP	29	Kirkwood, under SRWUA	About to sell out altogether to cover all debts, including ± R60 000 owed to SRWUA.
Masiphathisane Trust	ORP	5	Lower Sundays River	Handed over to lawyers to claim outstanding amounts. Total sale of property imminent.
Dept of Agriculture Project	ORP	?	Addo	Handed over to lawyers to claim outstanding debts to SRWUA.
Perks Hoek	ORP	?	Tyhefu area, Lower Fish River	Infrastructure fallen into disrepair, or sold to bring income to community.
Glenmore	ORP	93 ha, but rising to 160 ha when rehabilitated scheme in full production	Tyhefu, Lower Fish Area	Recently rehabilitated by DWAF and Dept Agriculture. Community (through a Project Steering Committee) to find donors/ developers to start production.

APPENDIX 10

Irrigation schemes

UPDATED INFORMATION ON SCHEDULED IRRIGATION AREAS AND WATER DEMANDS: November 2004

Because some of this information still requires clarification, much private irrigation has not yet been included and the breakdown between hydrological sub-divisions has not been fully clarified, this information was not used in the hydrological calculations. The RO is busy refining these values.

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q12B	Teebus	Orange River water via Teebus tunnel – Teebus Spruit (Canals)	1 246.8		13 500	16.83	Unknown	Groot Brak
Q12C, Q13A	Upper Grassridge	Orange River water via Teebus Tunnel – Teebus Spruit (Canals)	3 069.1		13 500	41.43	Unknown	Groot Brak
SUB-TOTAL		**Groot Brak River (Teebus-Grassridge)**	**4 315.9**		**13 500**	**58.26**	**Unknown**	**Groot Brak**
Q13B	Brak River	Brak River	875.1		13 500	11.81	Unknown	Upper Fish
Q13C	Knutsford	Great Fish River	3 387.8		13 500	45.74	Unknown	Upper Fish
Q13C	Baroda	Great Fish River	1 857.9		13 500	25.08	Unknown	Upper Fish
Q30D	Marlow	Great Fish River	1 944.7		13 500	26.25	Unknown	Upper Fish
Q30E	Scanlen	Great Fish River	1 749.2		13 500	23.61	Unknown	Upper Fish
Q30E	Tarka	Great Fish River	1 743.2		13 500	23.53	Unknown	Upper Fish
Q50A	Mortimer	Great Fish River	1 391.2		13 500	18.78	Unknown	Upper Fish
Q13 &Q30, Q50?	Upper and Middle Great Fish River (Private)	Great Fish River	1 212.8		13 500	16.37	Unknown	Upper/Middle Fish?
SUB-TOTAL		**Great Fish River (Grassridge-Elandsdrift)**	**14 161.9**		**13 500**	**191.17**	**Unknown**	
Q50C	Renfield	Great Fish River	1 447.3		12 500	18.09	Unknown	Middle Fish
Q70A	Hougham Abrahamson	Great Fish River	2 901.4		12 500	36.27	Unknown	Middle Fish
Q70B	Middleton	Great Fish River	2 171.0		12 500	27.14	Unknown	Middle Fish

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q50? & Q70	Lower Great Fish River (Private)	Great Fish River	459.6	0	12 500	5.75	Unknown	Middle Fish?
Q70C	Sheldon	Great Fish	40.0	0	12 500	0.50	Unknown	Middle Fish
SUB-TOTAL		**Great Fish River (Elandsdrift-Junction Drift)**	**7 035.5**	**0**	**12 500**	**87.75**	**Unknown**	
Q50B	Klipfontein	Fish/Sundays Canal	2 281.3	0	12 500	28.52	Unknown	Middle Fish
Q50B	Boschberg	Fish/Sundays Canal	617.7	0	12 500	7.72	Unknown	Middle Fish
Q50B	Somerset East	Fish Sundays Canal	1 281.1	0	12 500	16.01	Unknown	Middle Fish
Q80E	Sheldon	Little Fish (Rockcliffe Canal)	70.2	0	12 500	0.88	Unknown	Upper Little Fish
Q80E	Upper Little Fish (Private)	Little Fish	720.4	0	12 500	9.01	Unknown	Upper Little Fish
SUB-TOTAL		**Fish-Sundays Canal and Little Fish (Elandsdrift–De Mistkraal)**	**4 970.7**	**0**	**12 500**	**62.14**	**Unknown**	
Q80G	Sheldon	Little Fish (Canal)	807.6	0	12 500	10.10	Unknown	Middle Fish
Q80E	Sheldon	Little Fish (Fish-Sundays Canal)	256.7	0	12 500	3.21	Unknown	Upper Little Fish
Q80G	Lower Little Fish (Private)	Little Fish	432.7	0	12 500	5.41	Unknown	Middle Fish
SUB-TOTAL		**Little Fish River (De Mistkraal-Junction Drift)**	**1 497.0**	**0**	**12 500**	**18.72**	**Unknown**	
Q70C, Q91 *	Pumps (25 ha permit area)	Great Fish River		647.2	9 000	5.82	Unknown	Middle/Lower Fish
Q93B	Glenn Melville	Glenn Melville Dam	394.4	0	12 500	4.93	Unknown	Lower Fish
SUB-TOTAL		**Lower Fish (Junction Drift-Hermanuskraal)**	**394.4**	**647.2**	**Various**	**10.75**	**Unknown**	

Quaternaries	Irrigation Board / Irrigator	Water Source/River	Scheduled Irrigation area (ha)	Water rights not scheduled (ha)	Water quota (m3/ha/a)	Scheduled water demand (Mm3/a)	Actual average water use (Mm3/a)	ISP hydro sub-division
Q44A, Q44B,Q44C	Commando Drift	Tarka River (Commando Drift Dam and Lake Arthur)	920.7	0	13 500	12.43	Unknown	Tarka
SUB-TOTAL		**Tarka River**	**920.7**	**0**	**13 500**	**12.43**	**Unknown**	**Tarka**
Q92	Private	Koonap river	Unknown	0		19.6	Unknown	Koonap
SUB-TOTAL		**Koonap**	**Unknown**	**0**		**19.6**	**Unknown**	**Koonap**
Q94B, C, D, F	Kat River	Kat River Dam	1 599.2	0	10 900	17.43	Unknown	Kat
SUB-TOTAL		**Kat**	**1 599.2**	**0**	**10 900**	**17.43**	**Unknown**	**Kat**
TOTAL		**FISH SUB-AREA**	**34 895.3**	**647.2**	**Various**	**478.25**	**Unknown**	**FISH TOTAL**
	Private	Bushmans, Kowie/Kariega	0	0	Unknown	11.0	Unknown	Albany Coast
TOTAL		**ALBANY COAST SUB-AREA**	**0**	**0**	**Unknown**	**11.0**	**Unknown**	**Albany Coast**
N11, N12	Private	Above Nqweba Dam	0	0		9.8	Unknown	Upper Sundays
SUB-TOTAL		**Upper Sundays**	**0**	**0**		**9.8**	**Unknown**	**Upper Sundays**
N23A, B	Schoenmakers	Schoenmakers	287.8	0	12 500	3.60	Unknown	Middle Sundays
N30A,B	Blyde River	Blyde River Dam (not GWS)	86.3	0	10 900	0.94	Unknown	Middle Sundays
SUB-TOTAL		**Middle Sundays**	**374.1**	**0**	**Various**	**4.54**	**Unknown**	**Middle Sundays**
N40B, C, E	Lower Sundays River	Orange River water from Korhaansdrift Weir	16 644.4	0	9 000	149.80	Unknown	Lower Sundays
SUB-TOTAL		**Lower Sundays**	**16 644.4**	**0**	**9 000**	**149.80**	**Unknown**	**Lower Sundays**
TOTAL		**SUNDAYS SUB-AREA**	**17 018.5**	**0**	**Various**	**164.14**	**Unknown**	**SUNDAYS**
GRAND TOTAL		**ISP AREA**	**51 913.8**	**647.2**	**Various**	**653.39**	**Unknown**	**ISP AREA**

APPENDIX 11

Irrigation schemes in disrepair

IRRIGATION SCHEMES IN DISREPAIR

Quats	Irrigation scheme	Location	Water Source/River	Areas Covered/ Owner	Total area (ha)	Food plots (ha)	Commercial farmers (ha)	Description	Comments
Q94D, F	Kat River, (Mpofu) Tyume and Ripplemead Schemes	N/A	N/A	N/A	N/A	N/A	N/A	Kat River Scheme: These schemes (except the ex-RSA portion of Kat River) are in disrepair due to lack of maintenance. Payment problems are experienced	Widespread bankruptcies are common. These high-investment farms have fallen into a state of disrepair. Ex-RSA section of Kat River scheme is functioning well.
Q93A, B, C	Tyhefu Irrigation Scheme	Tyhefu, Lower Fish Area	Fish River, Orange River Scheme (ORP)	Kalileni, Pikoli, Ndlambe, Ndwayana, Glenmore, Committees	Kalileni -145 ha Pikoli -13 ha Ndlambe-151 ha Ndwayana-60 ha Glenmore-160 ha Committees-55 ha	1 646 food-plots (0.2 ha - 0.5 ha)	33 small commercial farmers (4 ha each)	Condition of the scheme is good in some areas but none of the schemes are properly functioning.	Ex-Ciskei schemes are being refurbished. ± 160 ha at Glenmore and ± 60 ha at Ndwayana. Ndwayana Phase 2: 1.2 m diameter pipeline was lengthened to Ndlambe Dam at a cost of R38 million. Future phases 3 and 4 are envisaged in co-operation with Dept. of Agriculture.
N40	Lower Sundays	The farm borders on the Valencia Township near Addo	ORP	DLA Project	N/A	N/A	N/A	No activity on this property at present.	

Sources:

- Report on investigations into ways of rehabilitating the water supply aspects of certain irrigation schemes in former Transkei and Ciskei, drawn up by the DLA/DWAF scheme-rehabilitation task team for presentation to provincial and national ministries, August 1997.
- DWAF, Division of Advisory Services Cradock, "*Update on the creation of new WUAs and the transformation of irrigation boards to WUAs*", compiled by T. Sombeselele and S. Mullineux, October 2003.

APPENDIX 12

Flow gauging stations

FLOW GAUGING STATIONS

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Sundays							
N1H001	Graaff-Reinet	Sundays River	32 : 14 : 15	24 : 31 : 48	3681	11/1921	02/1932
N1H002	Bloemskraal	Gats River	32 : 09 : 40	24 : 32 : 56	1787	03/1927	07/1947
N1H003	Klipdrift	Swart River	32 : 23 : 18	24 : 28 : 10	1040	03/1927	02/1932
N1H004	Broederstroom	Broederstroom	32 : 12 : 52	24 : 34 : 43	134	11/1927	02/1932
N1H005	Roodebloem	Sundays River	32 : 10 : 26	24 : 35 : 21	1265	11/1927	03/1932
N1H006	Buffelshoek	Pienaars River	32 : 10 : 52	24 : 25 : 29	196	03/1927	07/1948
N1H007	Groote Vlakte	Kamdeboo River	32 : 25 : 31	24 : 17 : 29	1669	11/1927	06/1947
N1H008	Aberdeen	Kraai River	32 : 29 : 47	24 : 03 : 00	490	11/1927	06/1947
N1H009	Sevenfontein	Koloniesplaas-Eye	31 : 59 : 36	24 : 48 : 44		06/1963	04/1974
N1H010	Grasrand	Moordenaars River	32 : 19 : 13	24 : 27 : 29		06/1961	12/1971
N1H011	Onbedacht	Toorberg Spruit No 1	32 : 10 : 08	24 : 04 : 35	14	05/1957	11/1991
N1H012	Lange Fontein	Toorberg Spruit	32 : 09 ; 39	24 : 07 : 35	0.6	06/1961	11/1991
N1H013	Graaff-Reinet	Mackies Puts-Eye	32 : 14 : 05	24 : 31 : 45		01/1925	09/2002
N1H014	Bloemhof	Bloemhof-Eye	32 : 02 : 08	24 : 40 : 23		05/1961	11/1991
N1H015	Onbedacht	Toorberg Spruit 1	32 : 10 : 08	24 : 04 : 35		07/1961	11/1991
N1H016	Lange Fontein	Toorberg Spruit 2	32 :0 9 : 39	24 : 07 : 35		07/1961	11/1991
N1H017	Sevenfontein	Canal from Kolonies-Plaas-Eye	31 : 59 : 35	24 : 48 : 44		06/1963	03/1974
N1H018	Sevenfontein	Canal from Kolonies-Plaas-Eye	31 : 59 : 35	24 : 48 : 44		06/1963	03/1963
N1H019	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H020	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H021	Graaff-Reinet	V. Ryneveldspas Dam	32 : 14 : 05	24 : 31 : 45		01/1925	11/2003
N1H022	Graaff-Reinet	V. Ryneveldspas	32 : 14 : 33	24 : 31 : 54		12/2001	08/2002
N1R001	Graaff-Reinet	Sundays River	32 : 14 : 06	24 : 31 : 44	368	01/1925	11/2003
N2E001	Darlington	Dwaas	33 : 12 : 37	25 : 08 : 34		10/1925	10/2003
N2E002	Jansenville		32 : 56 : 00	24 : 40 : 00		06/1957	10/1980
N2H001	Riet River	Sundays River	33 : 07 : 00	25 : 07 : 30	16047	01/1918	01/1922
N2H002	Jansenville	Sundays River	32 : 57 : 00	24 : 40 : 08	11395	10/1923	12/1992
N2H003	Blaauwkrans	Sundays River	32 : 48 : 31	24 : 40 : 00	10620	09/1928	09/1947
N2H004	Schoemans Vlakte	Melk River	32 : 37 : 53	24 : 40 : 46	1128	03/1927	01/1932
N2H005	Waterford	Sundays River	33 : 04 : 32	25 : 00 : 56	13419	09/1928	09/1947
N2H006	Brand Kraal	Sundays River	32 : 29 : 53	24 : 28 : 17	7124	12/1933	05/1934
N2H007	De Draay	Sundays River	33 : 06 : 02	25 : 00 : 44	13428	09/1974	01/2004
N2H008	Groene Leegte	Riet River	33 : 04 : 49	25 : 04 : 41	341	09/1974	11/2003
N2H009	Volkers River	Volkers River	33 : 06 : 28	25 : 13 : 43	536	09/1978	02/1989
N2H010	Dwaas	Left Canal from Dam	33 : 12 : 26	25 : 09 : 00		01/1923	11/2003
N2h011	Dwaas	Left Canal from Dam	33 : 12 : 27	25 : 08 : 59		10/1986	11/2003
N2R001	Dwaas	Sundays River	33 : 12 : 22	25 : 08 : 50	16826	01/1923	11/2003
N3H001	Riet River	Voel River	32 : 58 : 47	25 : 11 : 25	1597	09/1928	07/1948
N3H002	Riet Vley	Voel River	33 : 00 : 06	25 : 09 : 41	1744	06/1978	04/1992
N4E001	Addo		33 : 34 : 06	25 : 41 : 32		01/1960	09/2002
N4H001	Korhaanspoort	Sundays River	33 : 22 : 43	25 : 21 : 17	17485	11/1914	12/2003
N4H002	Strathsomers Estate	Sundays River	33 : 25 : 05	25 : 28 : 56	18909	03/1917	05/1921
N4H003	Addo Drift East	Sundays River	33 : 34 : 53	25 : 40 :28	20460	10/1984	05/1997
N4H004	Landrost Veeplaats	Sundays River	33 : 27 : 46	25 : 32 : 29	18952	03/1986	
N4H005	Selborne	Coerney River	33 : 30 : 43	25 : 38 : 52	590	03/1986	12/2003

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
N4H006	Korhaanspoort	Sundays River	33 : 22 : 47	25 : 21 : 14		11/1914	12/2003
N4H007	Strathsomers Estate	Left Canal from Sundays River	33 : 25 : 05	25 : 28 : 56		02/1919	05/1921
N4H008	Slagboom	Wit River	33 : 22 : 11	25 : 40 : 00	196	02/1955	07/1974
N4H009	Slagboom	Pipeline from Slagboom Dam	33 : 22 : 11	25 : 40 : 00		02/1955	07/1974
N4R001	Slagboom	Wit River	33 : 22 : 11	25 : 40 : 00	196	02/1955	06/1980
Albany Coast							
P1H001	Thornkloof	Gaitu River	33 : 15 : 18	26 : 18 : 41	158	12/1948	10/1950
P1H002	Hilton	New Years River	33 : 14 : 49	26 : 21 : 41	124	12/1948	10/1953
P1H003	Donker Hoek	Boesmans River	33 : 19 : 48	26 : 04 : 40	1479	02/1957	12/2003
P1H004	New Years Drift West	Pipeline from Nuwejaars Dam	33 : 19 : 05	26 : 04 : 51		06/1978	08/2002
P1R003	New Years Drift West	Nuwejaars Spruit	33 : 18 : 13	26 : 06 : 44	408	04/1978	12/2003
P3E001	Howinsonspoort Dam	Thomas Baines Natres	33 : 23 : 15	26: 29 : 15		01/1963	10/1983
P3H001	Smithfield	Kariega River	33 : 33 : 08	26 : 36 : 07	588	07/1969	12/2003
P3R001	Palmiet River	Palmiet River	33 : 23 : 16	26 : 26 : 15	33	12/1966	12/1982
P3R002	Newingreen	Kariega River	33 : 24 : 44	26 : 30 : 33	176	12/1966	12/1982
P4H001	Bathurst	Kowie River	33 : 30 : 24	26 : 44 : 40	576	07/1969	12/2003
Great Fish							
Q1E001	Grassridge Dam	Klipheuvel	31 : 45 : 30	25 : 28 : 00		01/1926	11/2003
Q1E002	Grootfontein College		31 : 29 : 00	25 : 02 : 00		06/1935	03/1995
Q1E003	Middelburg		31 : 30 : 30	25 : 04 : 00		01/1954	05/1959
Q1H001	Katkop	Great Fish River	31 : 54 : 11	25 : 28 : 56	9091	03/1918	02/1993
Q1H002	Klipheuvel	Great Brak River	31 : 46 : 55	25 : 27 : 10	4385	10/1920	10/1923
Q1H003	Connay Farm	Little Brak River	31 : 44 : 11	25 : 20 : 00	2412	01/1926	07/1947
Q1H004	Kwaayaplaats	Kwaai River	31 : 56 : 53	25 : 33 : 12	141	01/1927	07/1947
Q1H005	Weltevreden	Hongerskloof River	31 : 28 : 00	25 : 41 : 00	449	03/1927	03/1942
Q1H006	Jan Blaauws Kop	Teebus River	31 : 34 :42	25 : 32 : 21	1577	03/1927	05/1948
Q1H007	The Kuur	Great Brak River	31 : 36 : 00	25 : 29 : 37	3296	01/197	10/1932
Q1H008	Brakke Kuilen	Little Brak River	31 : 33 : 05	25 : 10 : 00	1870	01/1927	06/1947
Q1H009	Buffels Valey	Little Brak River	31 : 31 : 58	25 : 04 : 29	1211	02/1959	02/1974
Q1H010	Tafelburg	Little Brak River	31 : 36 : 37	25 : 14 : 39	2046	02/1959	03/1974
Q1H011	Rietfontein	Little Brak River	31 : 32 : 21	24 : 54 : 36	492	02/1959	03/1974
Q1H012	Jan Blaauws Kop	Teebus River	31 : 34 : 04	25 : 32 : 37	1567	07/1977	01/2004
Q1H013	Zeeven Fontein	Little Brak River	31 : 46 : 40	25 : 19 : 06	2445	07/1982	01/2004
Q1H014	Brakleegte	Teebus Canal from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		10/1976	01/2004
Q1H015	Brakleegte	Irrigation Canal from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		11/1985	01/2004
Q1H016	Katkop	Left Canal from Great Fish River	31 : 54 : 4	25 : 28 : 58		03/1918	03/1993
Q1H017	Zoutpansdrift	Right Canal from Great Fish River	31 : 54 : 11	25 : 28 : 56		03/1918	03/1993
Q1H018	Teebus	Irrigation Pipe from Ovis Tunnel	31 : 25 : 12	25 : 38 : 14		05/1988	09/2002
Q1H019	Klipheuvel	Left Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		05/1985	01/2004
Q1H020	Klipheuvel	Right Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		01/1924	01/2004

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Q1H021	Klipheuvel	Left Canal from Grassridge Dam	31 : 46 : 05	25 : 28 : 00		05/1985	01/2004
Q1H022	Klipheuvel	Outlet to Great Brak River	31 : 46 : 05	25 : 28 : 00		06/1985	08/1990
Q1H023	Klipheuvel	Great Brak River	31 : 46 : 05	25 : 28 : 00	4325	09/1925	01/1934
Q1R001	Klipheuvel	Great Brak River	31 : 46 : 05	25 : 28 : 00	4325	02/1924	11/2003
Q2H001	Zoutpansdrift	Great Fish River	31 : 54 : 50	25 : 25 : 09	1702	12/1926	07/1948
Q2H002	Zoutpansdrift	Great Fish River	31 : 54 : 18	25 : 25 : 48	1713	07/1973	11/2003
Q3E001	Hales Owen	Halesvlakte	32 : 13 : 16	25 : 41 : 24		06/1959	08/2002
Q3H001	Doorn River	Pauls River	32 : 02 : 31	25 : 30 : 13	867	12/1926	04/1948
Q3H002	Rietfontein	Jenkins Spruit	32 : 04 : 53	25 : 35 : 09	289	10/1930	02/1937
Q3H003	Cradock	Great Fish River	32 : 11 : 37	25 : 39 : 15	11282	01/1934	12/1938
Q3H004	Coutzenburg	Pauls River	32 : 02 : 00	25 : 31 : 15	872	10/1973	11/2003
Q3H005	Rietfontein	Great Fish River	32 : 05 : 18	25 : 34 : 34	10830	04/1977	11/2003
Q3H006	Cradock	Great Fish River	32 : 10 : 05	25 : 36 : 45	8498	03/1986	
Q4E001	Lake Arthur Dam	Vrischgewaagd	32 : 13 : 30	25 : 49 : 15		01/1926	11/1996
Q4E002	Commando Drift	Almondsfontein	32 : 16 : 30	26 : 02 : 30		11/1978	10/2003
Q4H001	Teeken Fontein	Tarka River	32 : 14 : 13	25 : 48 : 15	4508	01/1914	10/1931
Q4H002	Roberts Kraal	Vlekpoort River	31 : 57 : 44	26 : 00 : 00	1273	11/1959	12/1964
Q4H003	Roberts Kraal	Vlekpoort River	31 : 58 : 06	26 : 00 : 06	1300	12/1964	12/1992
Q4H004	Beestekraal	Tarka River	32 : 04 : 57	26 : 11 : 22	671	09/1966	06/1987
Q4H005	Bridge Farm	Tarka River	32 : 18 : 50	25 : 44 : 29	4742	07/1973	07/1980
Q4H006	Vrischgewaagd	Canal from Lake Arthur	32 : 13 : 32	25 : 49 : 06		08/1959	11/1996
Q4H007	Vrischgewaagd	Right Canal from Lake Arthur	32 : 13 : 32	25 : 49 : 06		08/1959	11/1996
Q4H008	Vrischgewaagd	Tarka River	32 : 13 : 32	25 : 49 : 06		04/1925	11/1996
Q4H009	Commando Drift	Main Canal from Commando Drift Dam	32 : 06 : 39	26 : 02 : 27		01/1956	12/2003
Q4H010	Commando Drift	Return Flow Canal to River	32 : 06 : 39	26 : 02 : 27		12/1979	12/2003
Q4H011	Commando Drift	Irrigation Canal	32 : 06 : 40	26 : 02 : 27		04/195	12/2003
Q4H012	Teeken Fontein	Tarka River	32 : 14 : 13	25 : 48 : 15	4508	01/1914	03/1930
Q4H013	Bridge Farm	Tarka River	32 : 18 : 50	25 : 44 : 29	4742	07/1980	01/2004
Q4R001	Vrischgewaagd	Tarka River	32 : 13 : 32	25 : 49 : 06	4497	02/1925	04/1997
Q4R002	Commando Drift	Tarka River	32 : 06 : 36	26 : 02 : 41	3632	03/1956	12/2003
Q5E001	Elandsdrift Dam	Elandsdrift	32 : 31 : 45	25: 45 : 00		08/1977	11/2003
Q5H001	Vader Landsche Wilge	Kromspruit	32 : 29 : 16	25 : 48 : 12	52	01/1927	06/1947
Q5H002	Vrischgewaagd	Rietspruit	32 : 25 : 24	25 : 46 : 37	158	02/1927	12/1940
Q5H003	Elandsdrift	Sluice to River	32 : 31 : 49	25 : 45 : 15		01/1977	01/1993
Q5H004	Fonteins Hoek	Great Fish River	32 : 38 : 23	25 : 45 : 15	17260	07/1977	07/1983
Q5H005	Van Stadens Dam	Great Fish River	32 : 20 : 10	25 : 43 : 21	1003	03/1987	
Q5H006	Elandsdrift	Left Canal from Dam	32 : 31 : 49	25 : 45 : 15		01/1977	12/2003
Q5R001	Elandsdrift	Great Fish River	32 : 31 : 45	25 : 45 : 10	16864	08/1976	01/1993
Q6H001	Belvedere	Baviaans River	32 : 34 : 00	25 : 56 : 50	694	10/1918	12/1937
Q6H002	Melrose	Baviaans River	32 : 37 : 44	25 : 53 : 0	819	09/1973	08/1980
Q6H003	Botmansgat	Baviaans River	32 : 36 : 21	25 : 53 : 05	814	09/1980	10/2003
Q6H004	Botmansgat	Left Canal from Baviaans River	32 : 36 : 19	25 : 53 : 06		09/1980	06/1990
Q7E001	Golden Valley	Altona	32 : 49 : 00	25 : 47 : 00		03/1973	11/1979
Q7E002	Middelton	Voorspoed	32 : 59 : 00	25 : 50 : 00		12/1979	07/1995
Q7H001	Moordenaars Drift	Great Fish River	32 : 57 : 16	25 : 48 : 56	18989	01/1906	11/1928

Station No	Place or description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
					km^2	From	To
Q7H002	Doringdraai	Great Fish River	32 : 43 : 11	25 : 50 : 33	18452	08/1922	10/1948
Q7H003	Leeuwe Drift	Great Fish River	32 : 46 : 42	25 : 50 : 23	18534	11/1928	10/1948
Q7H004	Cookhouse	Great Fish River	32 : 44 : 34	25 : 48 : 41	18485	11/1948	10/1973
Q7H005	Sout Vleij	Great Fish River	33 : 01 : 40	25 : 53 : 37	19134	06/1972	12/2003
Q7H006	Cookhouse	Great Fish River	32 : 44 : 34	25 : 48 : 41	18485	11/1948	10/1973
Q8E001	Power Station	Somerset-East	32 : 44 : 00	25 : 35 : 00		12/1960	10/1980
Q8E002	De Mist Kraal Dam	Mist Kraal	32 : 58 : 10	25 : 40 : 25		10/1987	10/2003
Q8H001	Buffelfontein	Little Fish River	32 : 38 : 36	25 : 26 : 29	980	07/1922	10/1947
Q8H002	Somerset-East	Little Fish River	32 : 44 : 21	25 : 34 : 17	1369	12/1930	12/1963
Q8H003	Farm 370 Glen Evon	Naude's River	32 : 43 : 00	25 : 39 : 00	54	03/1955	03/1965
Q8H004	Grootvlakte	Little Fish River	32 : 33 : 49	25 : 26 : 44	810	03/1957	02/1987
Q8H005	Luns Klip	Little Fish River	32 : 37 : 28	25 : 27 : 21	917	03/1957	06/1981
Q8H006	Wellington-Grove	Little Fish River	32 : 59 : 11	25 : 41 : 08	1879	01/1960	
Q8H007	Nieuwe Grond	Little Fish River	32 : 49 : 58	25 : 39 : 21		08/1978	12/2003
Q8H008	Doorn Kraal	Little Fish River	32 : 47 : 10	25 : 36 : 54	1512	01/1979	11/2003
Q8H009	Wellington-Grove	Little Fish River	32 : 59 : 18	25 : 41 : 10		06/1979	
Q8H010	Grootvlakte	Little Fish River	32 : 33 : 39	25 : 26 : 44	808	09/1986	11/2003
Q8H011	Rietfontein Junction Drift	Little Fish River	33 : 5 : 29	25 : 57 : 14	22	05/1987	
Q8H012	Luns Klip	Left Canal from Little Fish River	32 : 37 : 28	25 : 27 : 21		03/1957	05/1981
Q8H013	Mist Kraal	Left Canal from Dam	32 : 58 : 05	25 : 40 : 19		09/1987	112/2003
Q8H014	Somerset-East	Canal from Little Fish River	32 : 44 : 21	25 : 34 : 17		05/1958	12/1963
Q8R001	Mist Kraal	Little Fish River	32 : 58 : 05	25 : 40 : 19	1873	10/1987	10/2003
Q9E001	Kat River Dam	Weltevreden	32 : 34 : 21	26 : 45 : 13		02/1968	09/2002
Q9H001	Fort Brown Peninsula	Great Fish River	33 : 08 : 21	26 : 36 : 20	23582	01/1913	
Q9H002	Adelaide	Knoonap River	32 : 42 : 50	26 : 17 : 48	1245	09/1926	12/2003
Q9H003	Koesters Drift	Great Fish River	33 : 07 : 10	26 : 30 : 21	23465	10/1926	11/1935
Q9H004	Fort Armstrong	Kat River	32 : 33 : 37	26 : 41 : 36	404	10/1926	05/1964
Q9H005	Linton	Mankazana River	32 : 331 : 00	26 : 15 :13	231	08/1926	12/1931
Q9H006	Committees Drift	Great Fish River	33 : 09 : 32	26 : 50 : 19	28937	09/1928	05/1975
Q9H007	Mesopotamia	Balfour River	32 : 33 : 28	26 : 40 : 19	82	05/1928	03/1943
Q9H008	Heald Town Fingo	Kat River	32 : 42 : 40	26 : 34 : 43	748	12/1921	09/1971
Q9H009	Drumbae	Mankazana River	32 : 39 : 13	26 : 41 : 35	78	09/1928	09/1938
Q9H010	Blaauw	Great Fish River	33 : 12 : 31	26 : 51 : 58	29328	06/1930	03/1956
Q9H011	Harringay	Kat River	32 : 34 : 05	26 : 41 : 03	539	03/1931	10/1960
Q9H012	Brandt Legte	Great Fish River	33 : 05 : 53	26 : 26 : 41	223067	10/11935	10/2003
Q9H013	Kat River	Kat River Mountains	33 : 21 : 19	26 : 51 : 43	46	01/1963	01/1993
Q9H014	Frisch Gewaagd	Koonap River	32 : 27 : 53	26 : 30 : 39	246	01/1964	04/1986
Q9H015	Spioenkop	Koonap River	32 : 29 : 15	26 : 26 : 54	321	01/1964	07/1965
Q9H016	Schurftekop	Koonap River	32 : 29 : 57	26 : 21 : 56	489	09/1966	03/1993
Q9H017	Blinkwater	Blinkwater River	32 : 42 : 29	26 : 34 : 43	226	06/1965	11/2003

APPENDIX 13

Major dams

MAJOR DAMS

Quat	Dam name	Live storage (million m^3)	YIELD (million m^3/a)				Owner	Assurance of supply
			Domestic supplies	Irrigation	Other	Total		
Fish sub-area								
Q13A.	Grassridge	49.60	0	Balancing dam	0	0	DWAF	
Q14C	Kelly Patterson						Private farmer	
Q14D	Biggs							
Q41D	Commando Drift	55.7	0	7	0	7	DWAF	
Q44B	Lake Arthur	10.95	0	Negligible	0	0	Great Fish River WUA	
Q94A	Kat River	24.8	1.68	11	0	12.68	DWAF	1:10
Q50B	Elandsdrift Weir	7 (1994)	0	Diversion weir	0	0	DWAF	
Q80E	De Mistkraal Weir	3.1	0	Diversion weir	0	0	DWAF	
Q91C	Hermanuskraal Weir	1.2	0	Diversion weir	0	0	DWAF	
Q93B	Glen Melville	6.13	Balancing dam	0	0	0	DWAF	
Q93B	Glen Boyd	0.15	Balancing dam	400 ha at present, but can rise to ± 3000 ha. Glen Boyd supplies water for irrigation to Tyhefu and Lower Fish	0	0	DWAF	
Sundays sub-area								
N12C	Nqweba	47	4.5	0	0	4.5	Graaff - Reinet	1:50
N14D	De Hoop	16	0	Negligible	0	0	Private	
N23B	Darlington	187	0	28.3 when operated to FSL - Reduced yield due to problem with gates is unknown	0	28.3	DWAF	
N40A	Korhaansdrift Weir		0	Diversion weir	0	0	DWAF	
N40D	Scheepersvlakte	1.5	Balancing dam				DWAF	
Albany Coast sub-area								
P10B	New Years	4.5	3.3	0	0	3.3	Makana Municipality	
P30A P30B	Howiesons Poort Settlers	0.8 5.57	2.2	0.9	0	3.1	Makana/Ndlambe Municipality	
P40B	Sarel Hayward Mansfield	2.5 0.2	1.6	0	0	1.6	Ndlambe Municipality	

APPENDIX 14

Major infrastructure and transfer schemes

MAJOR INFRASTRUCTURE AND TRANSFER SCHEMES

PURIFICATION PLANTS

Quats	Name	Owner	Capacity (Ml/d)	Raw water source			
				Name	Urban yield		Yield allocated to other users ($10^6m^3/a$)
					$10^6m^3/a$	Ml/d	
Fish							
Q92C	Adelaide	Nxuba Municipality	0.4 (est)	Koonap River	0.4		
Q92F	Bedford	Nxuba Municipality	2	Small dam, boreholes, Orange River	0.4 0.5	1.1 1.3	
Q30E	Cradock	Inxuba Yethemba Municipality	19	Orange River	6.6	18	
Q70A	Cookhouse	Blue Crane Municipality		Existing WTW to be decommissioned			
Q70A	Cookhouse	Blue Crane Municipality	1.4 (new)	Orange River.	0.4	1.1	
Q93C	Peddie	Ngqushwa Municipality	0.3	Khewekazi Dam	0.11		
Q80E	Somerset East	Blue Crane Municipality	1.5	Orange River/ J. van der Walt/ Lake Bertie dams	0.8	2.2	
Q80E	Besterhoek Somerset East	Blue Crane Municipality	1	Bosberg/ Besterhoek dams			
Q92F	Bedford	Nxuba Municipality					
Q94A	Kat River Dam	Nkonkobe Municipality					
Q94F	Fort Beaufort	Nkonkobe Municipality	4.5	Kat River Dam	1.36		
Q94A	Seymour	Nkonkobe Municipality	0.74	Kat River Dam	0.22		
Q93B	Glen Boyd Dam	Makana Municipality					
Q93B	Glen Melville Dam	Makana Municipality					
Sundays							
N40E	Addo	Sundays River Valley Municipality	1.8	Orange River	0.1	0.27	
N40C	Enon	Sundays River Valley Municipality	0.6	Orange River	0.1	0.27	
N13B	Graaff-Reinet	Camdeboo Municipality	7	Nqweba Dam Mimosa Wellfield Graaff-Reinet Aquifer	3.3 0.3 2.2	9 0.8 6	
N40C	Kirkwood	Sundays River Valley Municipality	2.3	Orange River	0.9	2.5	
N40E	Nooitgedacht	NMMM	70	Orange River	207	567	
N23B	Darlington Dam	Blue Crane Municipality					
N24C	Jansenville	Ikwezi Municipality					
Albany Coast							
P10B.	Alicedale	Makana Municipality	1.2	Nuwejaars Dam	3.3	9	
P10G.	Bushmans River Desalination Plant	Albany Coast Water Board	0.4	Bushmans River Mouth wellfield			
P40A	Grahamstown	Makana Municipality	11	Orange River Glen Melville, Settlers, Milner, Howiespoort, Jameson dams	0.8 ~ ~ 2.2 ~	8	
P20A	Kenton-on-Sea	Ndlambe Municipality					
P40C	Port Alfred	Ndlambe Municipality	6	Mansfield and Sarel Hayward dams Coastal Dunes	1.6 1.73	4.7	

PIPELINES

Description	Approximate Length (km)	Capacity (MI/d)	Diameter (cm)
Source to supply end: main pipeline to Port Elizabeth			
Scheepersvlakte – Nooitgedacht Water Treatment works		105	
Nooitgedacht WTW -Grassridge reservoir - Motherwell Reservoir		105	
Other pipelines			
Somerset East - Cookhouse			
Somerset East – Q80C			
Sarel Hayward Dam – Port Alfred			
Coastal Wellfields - Alexandria			
Settlers Dam - Grahamstown			
Glen Boyd Dam – Peddie (regional water supply)			

CANALS

Quaternaries	Description
Fish	
Q12B, Q12A	Canal from Orange/Fish Tunnel to Teebus Spruit
Q50B, Q50C	Fish- Sundays Canal from Elandsdrift Weir to Cookhouse Tunnel
Q70B, Q80E	Fish-Sundays Canal Cookhouse Tunnel to Little Fish
Q80G, N23A.	De Mistkraal Weir (Little Fish) to Schoenmakers canal – Schoenmakers River
Q93B, Q93B	Ecca Canal from Glen Melville Dam to Glen Boyd Dam
Sundays	
N40B, N40C, N40D	Hesses Corner Canal from Korhaansdrift Weir to Scheepersvlakte Balancing Dam

TUNNELS

Quaternaries	Description
Fish	
D35H, D35G, D35D, Q12B.	Orange Fish River Tunnel from Gariep Dam to Teebus River Canal
Q50C, Q70B.	Cookhouse Tunnel from Fish-Sundays Canal to Fish-Sundays Canal
Q91C, Q93B	Fish-Ecca Tunnel from Hermanuskraal Weir to Glen Melville Dam
	Heatleys Krantz tunnels – Lower Sundays River Canals

TRANSFER SCHEMES

From	To	Component
D35H	Q12B	Orange Fish-Tunnel, Length: 82.9 km, Original capacity was 54 m^3/s and has since decreased by about 10%. Testing has shown that the transfer capacity improves when very large volumes are transferred.
Q12	Q12A	Canal from Orange-Fish Tunnel to Teebus Spruit
Q50B	Q50C	Fish-Sundays Canal (section 1) from Elandsdrift Weir to Cookhouse Tunnel, 158 Mm^3/a
Q50C	Q70B	Cookhouse Tunnel from Fish-Sundays Canal (section 1) to Fish-Sundays Canal (section 2), 158 Mm^3/a
Q70B	Q80E	Fish-Sundays Canal (section 2) Cookhouse Tunnel to Little Fish, 158 Mm^3/a
Q80G	N23A	Fish-Sundays Canal (section 3) from De Mistkraal Weir to Schoenmakers River, Length 26.5 km Capacity: 22.1 m^3/s, 117 Mm^3/a
N40A	N40D	Hesses Corner Canal from Korhaansdrift Weir to Scheepersvlakte Balancing Dam, Capacity: 16.5 m^3/s. Supply from Orange/Sundays River to Port Elizabeth 11 Mm^3/a
Q91C	Q93B	Fish-Ecca Tunnel From Hermanuskraal Weir Glen Melville Dam, Length: 5km, Capacity: 16.6 m^3/s or 6 Mm^3/a
Q93B	Q93B	Ecca Canal from Glen Melville Dam to Glen Boyd Dam, Length: 11.5 km, Capacity: 1.7 m^3/s

HYDROPOWER

600 kVA Francis Turbine driven alternator driven by water discharged by Orange-Fish tunnel outlet at Teebus (unused).

URBAN BOREHOLE SUPPLY

Quatenary	Town supplied
Fish	
Q13A	Hofmeyr
Q14B	Middelburg (adequate to 2010)
Q12B	Steynsburg
Q41C	Tarkastad
Q80D	Somerset East
Sundays	
N14B	Aberdeen
N13C	Graaff-Reinet
N24C	Jansenville
N12A	Nieu Bethesda
N40D	Paterson
N30A	Pearston
Albany Coast	
P10B	Riebeeck East
P10E	Paterson
P10G	Bushmans River Mouth Kenton-on-Sea (Yield 1.1 Mm^3/a)
P20A	Alexandria
P20A	Cannon Rocks, Boknes
P20A	Kenton-on-Sea
P40C	Port Alfred