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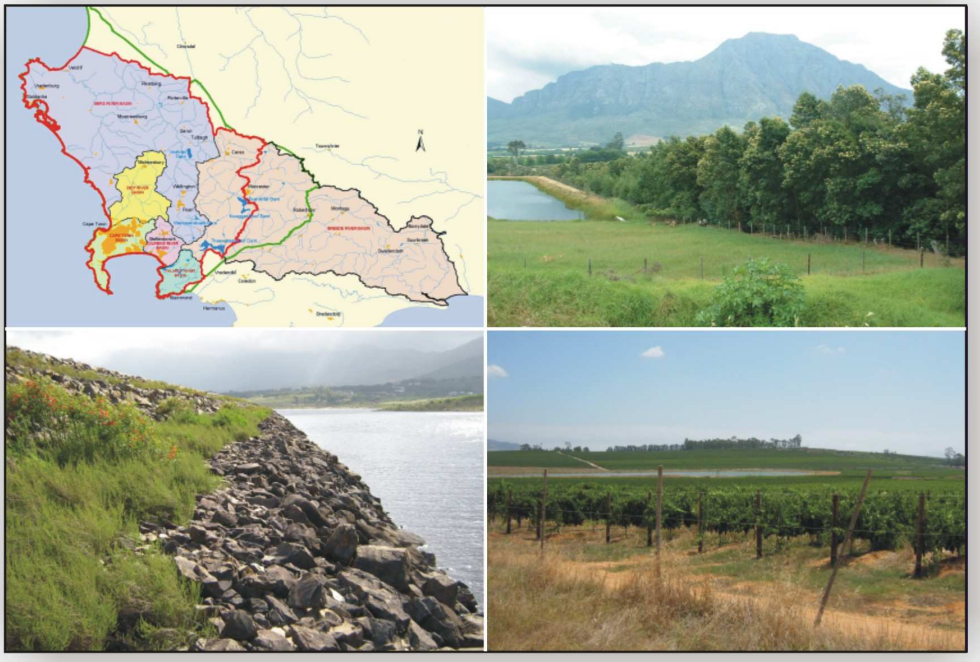
Department of Water Affairs and Forestry

Directorate: National Water Resource Planning

The Assessment of Water Availability in the Berg Catchment (WMA 19) by means of Water Resource Related Models

Report No. 4 : Land Use and Water Requirements

Volume 1 : Data in Support of Catchment Modelling



FINAL **MAY 2009**

Submitted by:
Ninham Shand (Pty) Ltd
in Association with
Umvoto Africa (Pty) Ltd

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DEPARTMENT OF
WATER AFFAIRS AND FORESTRY

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

Report No. 4

LAND USE AND WATER REQUIREMENTS

Volume 1

DATA IN SUPPORT OF CATCHMENT MODELLING

FINAL

Submitted by:

Ninham Shand in association with Umvoto Africa (Pty) Ltd

May 2009

Department of Water Affairs and Forestry
Directorate National Water Resource Planning

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

APPROVAL

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AUTHORS	:	V Jonker & L Hayes
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STUDY TEAM : Approved for Ninham Shand

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REPORT No	REPORT TITLE	VOLUME No.	VOLUME TITLE
1	Final Summary Report		
2	Rainfall Data Preparation and MAP Surface		
3	The Assessment of Flow Gauging Stations		
4	Land Use and Water Requirements	Vol 1	Data in Support of Catchment Modelling
		Vol 2	Invasive Alien Plant Mapping
		Vol 3	Water Use and Water Requirements
5	Update of Catchment Hydrology	Vol 1	Berg River
		Vol 2	Upper Breede River
		Vol 3	Peripheral Rivers
6	Water Quality	Vol 1	A Literature Review of Water Quality Related Studies in the Berg WMA, 1994 - 2006
		Vol 2	Updating of the ACRU Salinity Model for the Berg River
		Vol 3	Update Monthly FLOSAL Model to WQT
7	(Report No Not Used)		
8	System Analysis Status Report		
9	Groundwater Model	Vol 1	Overview of Methodology and Results
		Vol 2	Data Availability and Evaluation
		Vol 3	Regional Conceptual Model
		Vol 4	Regional Water Balance Model
		Vol 5	Cape Flats Aquifer Model
		Vol 6	Langebaan Road and Elandsfontein Aquifer System Model
		Vol 7	TMG Aquifer, Piketberg Model
		Vol 8	TMG Aquifer, Witzenberg – Nuy Model
		Vol 9	Breede River Alluvium Aquifer Model
10	Berg and Mhlathuze Assessment Studies (Refer to Report No.1)		
11	Applicability of the Sami Groundwater Model to the Berg WAAS Area		

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

LAND USE AND WATER REQUIREMENTS DATA IN SUPPORT OF CATCHMENT MODELLING

TABLE OF CONTENTS

Page No

1. INTRODUCTION 1

1.1 BACKGROUND 1
1.2 OBJECTIVES 1
1.3 APPROACH 3

2. LAND USE 4

2.1 OVERVIEW 4
2.1.1 Berg River Catchment 4
2.1.2 Eerste and Lourens River Catchments 4
2.1.3 Palmiet and Steenbras River Catchments 4
2.1.4 Diep River Catchment 5
2.1.5 Upper Breede River Catchment 5
2.1.6 Upper Riviersonderend Catchment 5
2.2 HISTORICAL LAND USE 5
2.2.1 Western Cape System Analysis (WCSA) (DWAF, 1993/1994) 5
2.2.2 Skuifraam Dam Feasibility Study (SDFS) (DWAF, 1997) 5
2.2.3 Voëlvlei Augmentation Scheme Feasibility Study (VAFS) (DWAF, 2001) 6
2.2.4 Breede River Basin Study (BRBS) (DWAF, 2003) 6
2.3 PRESENT-DAY LAND USE 6
2.3.1 Irrigation 6
2.3.2 Forestry 10
2.3.3 Farm Dams 10
2.3.4 Invasive alien vegetation 14
2.4 PRESENTATION OF DATA 15

3. ABSTRACTIONS AND RETURN FLOWS 18

3.1 MUNICIPAL ABSTRACTIONS 18
3.1.1 Tulbagh 18
3.1.2 Paarl 18
3.1.3 Saron 19
3.1.4 Robertsvlei 19
3.1.5 Stellenbosch 19
3.1.6 Grabouw 19

3.1.7 Ceres 20
3.1.8 Worcester....20
3.2 IRRIGATION ABSTRACTIONS 20
3.2.1 Twenty-Four Rivers Irrigation Board....20
3.2.2 De Hoek Estates....20
3.2.3 Perdeberg Irrigation Board 21
3.2.4 Eerste River Abstraction....21
3.2.5 Palmiet River Catchment....21
3.2.6 Koekoedouw Irrigation....22
3.2.7 Rooikloof and Ben Etive Dams....22
3.2.8 Rietvlei Irrigation Board 22
3.3 RETURN FLOWS....22
3.3.1 Tulbagh....23
3.3.2 De Hoek Estates....23
3.3.3 Paarl and Wellington....23
3.3.4 Malmesbury 23
3.3.5 Stellenbosch 23

4. GROUNDWATER USE....24

5. INTER-BASIN TRANSFERS AND DIVERSIONS....26

5.1 RIVIERSONDEREND/BERG RIVER GOVERNMENT WATER SUPPLY SCHEME 26
5.1.1 Theewaterskloof Tunnel 26
5.1.2 Banhoek Tunnel....26
5.1.3 Wolwekloof Tunnel 26
5.1.4 Jonkershoek Tunnel 27
5.2 UPPER BREEDE INTER-BASIN TRANSFER (WHITE BRIDGE DIVERSION) 27
5.3 KLEIN BERG, LEEU RIVER AND TWENTY-FOUR RIVERS DIVERSIONS 27
5.4 WIT RIVER INTER-BASIN TRANSFER....28
5.5 PALMIET/STEENBRAS TRANSFER....28
5.6 DU TOITS RIVER INTER-BASIN TRANSFER 28

6. CONCLUSION....29

REFERENCES 30

LIST OF TABLES

Table 2.1: Present-day (2004) irrigation areas (km^2) and crop types 8
Table 2.2: Present-day (2004) areas (km^2) of afforestation 11
Table 2.3: Present-day (2004) farm dam volumes (Mm^3) 11
Table 2.4: Present-day (2004) Invasive Alien Plant condensed areas (km^2) 16
Table 4.1: Groundwater Use: Annual Abstraction (Mm^3/a) 25

LIST OF FIGURES

Figure 1.1: Study Area 2
Figure 2.1: Present-day (2004) extent of irrigation 9
Figure 2.2: Present-day (2004) extent of afforestation 12
Figure 2.3: Present-day (2004) extent of farm dams 13
Figure 2.4: Present-day (2004) extent of Invasive Alien Plants 17

APPENDICES

A: Historical and Present-day Land Use per Calibration Subcatchment

B: Abstraction and Return Flow Data

C: Groundwater Use

D: Inter-basin Transfers and Diversions

COMPACT DISC

- GIS Land Use Data (Metadata and ArcGIS 9.2 Shapefiles)
- Abstraction Records (text files in WRSM2000 format)
- Return Flow Records (text files in WRSM2000 format)
- Inter-basin Transfers and Diversions (text files in WRSM2000 format)

ABBREVIATIONS

BRBS	Breede River Basin Study
DWAF	Department of Water Affairs and Forestry
GIS	Geographical Information System
GRA II	Groundwater Resource Assessment Phase II
IAP	Invasive Alien Plant
NLCD	National Land Cover Database
NGDB	National Groundwater Database
SDFS	Skuifraam Dam Feasibility Study
VAFS	Voëlvlei Augmentation Scheme Feasibility Study
WAAS	Water Availability Assessment Study
WARMS	Water-use Authorisation and Registration Management System
WCSA	Western Cape System Analysis
WCWSS	Western Cape Water Supply System
WfW	Working for Water
WMA	Water Management Area
WUA	Water User Association
WWTW	Wastewater Treatment Works

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

LAND USE and WATER REQUIREMENTS

DATA in SUPPORT of CATCHMENT MODELLING

EXECUTIVE SUMMARY

A key task of the Berg Water Availability Assessment Study (WAAS) relates to the hydrological modelling of the study catchments involved. This task is informed by information on historical and current water use within the study area, which facilitates the calibration of the hydrological models and the subsequent naturalisation of flow sequences.

In order to assess the availability of water and the use thereof in the Berg WAAS area, which is characterised by extensive areas of irrigation, forestry and invasive alien plants (IAPs), accurate information on land use is a prerequisite. Furthermore, for the purpose of catchment modelling, land use data are required at different time intervals in order to model the growth (or decline) in water use during the calibration period.

This report provides land use information in the Berg WAAS surface water study area in support of the preparation of historical and present-day water demand sequences, as well as information with regard to localised municipal and irrigation abstractions and return flows, inter-basin transfers, river diversions and groundwater use for the purpose of hydrological modelling. For the purpose of this study, historical data were obtained from previous studies, while current land use and water use data were based on recent aerial photographs and information supplied by various regulatory bodies including: the Department of Water Affairs and Forestry, irrigation boards, Water User Associations and municipalities. Registered water use information were also acquired and processed.

Information on historical and present-day land use are presented per Berg WAAS calibration catchment, while electronic, spatial datasets of the present-day land use are provided in ArcGIS 9.2 format. Monthly demand, transfer and return flow sequences, in a format which is compatible with WRSM2000, are also included.

1. INTRODUCTION

1.1 BACKGROUND

A key task of the Berg Water Availability Assessment Study (WAAS) relates to the hydrological modelling of the study catchments involved. This task is informed by information on historical and current water use within the study area which facilitates the calibration of the hydrological models and the subsequent naturalisation of flow sequences.

The study area for the Berg WAAS is shown in Figure 1.1 and includes the Berg Water Management Area (WMA 19) as well as the Palmiet, upper Breede and upper Riviersonderend catchments, which form part of the Breede WMA (WMA 18). In order to assess the availability of water and the use thereof in the study area, which is characterised by extensive areas of irrigation, forestry and invasive alien plants (IAPs), accurate information on land use is a prerequisite. This report provides land use information in support of the preparation of historical and present-day water demand sequences as well as information with regard to localised municipal and irrigation abstractions and return flows, inter-basin transfers, river diversions and groundwater use for the purpose of hydrological modelling.

It is important to note that this report does not address water use data that are required for the update of the existing system models, e.g. actual irrigation and streamflow reduction demand sequences, information on urban abstractions from reservoirs, the water requirements of the Ecological Reserve and information on major water supply infrastructure. This information is presented in *Report No. 4, Volume 3: Land Use and Water Requirements: Water Use and Water Requirements* (DWAF, 2008a), which supports the yield analyses undertaken as part of the system modelling.

1.2 OBJECTIVES

The key objectives under the Berg WAAS task aimed at the collection of land use and other relevant data for hydrological modelling were:

- the provision of historical and present-day land use information per Berg WAAS calibration subcatchment:
    - irrigation (area and crop type)
    - farm dams (surface area and volume)
    - commercial forestry (area and tree type)
    - alien vegetation (area, age, species and density)
- an assessment of historical demand sequences and return flows:
    - municipal abstractions and return flows
    - irrigation abstractions and return flows
- an assessment of inter-basin transfers and river diversions
- an assessment of groundwater use
- the capture of updated spatial land use data in GIS.

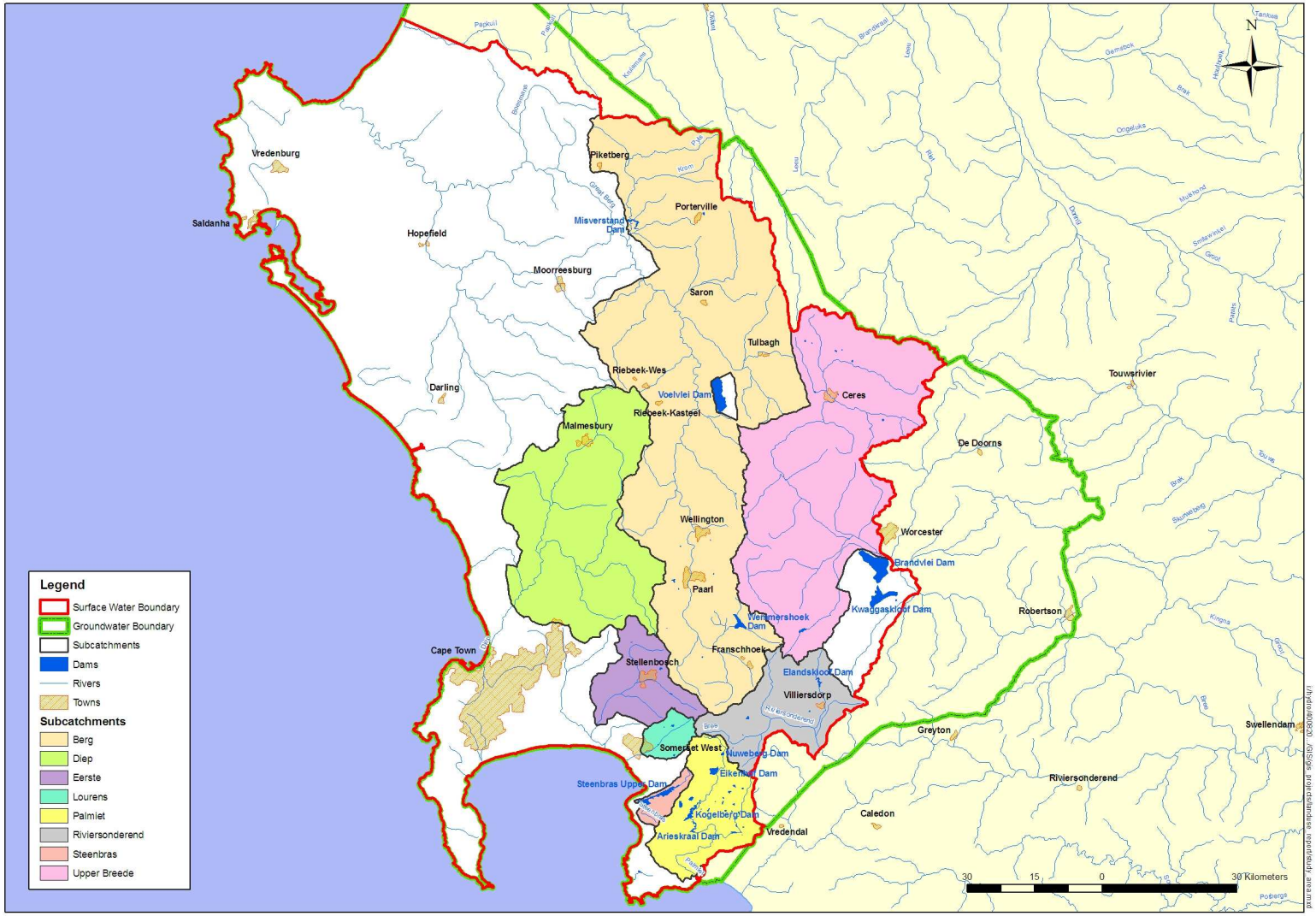


Figure 1.1: Study Area

1.3 APPROACH

Data collection for the purpose of calibrating the hydrological models necessitated the identification and assessment of all water use activities in the study area. Not only did this include land use mapping but also the collection of data and information that were readily available from regulatory bodies and industries including: the Department of Water Affairs and Forestry (DWAF), irrigation boards, Water User Associations (WUAs) and municipalities. Registered water use information were also acquired and processed.

For the purpose of catchment modelling, land use data are required at different time intervals in order to model the growth (or decline) in water use during the calibration period. Typically, a distinction is made between historical land use data and present-day land use data. In the case of the Berg WAAS, historical data were obtained from previous studies while current land use data were based on recent aerial photographs and information supplied by various regulatory bodies. Extensive aerial photography of adequate resolution and age was available for all of the study area, with the minor gaps that existed in the coverage at the Inception Phase having been filled in and completed. Land use and water use information in the upper Breede River Basin, which forms part of the Berg WAAS area, were based on data contained in the Breede River Basin Study (BRBS) (DWAF, 2003a) and were not updated during this study.

This report presents historical and present-day land use data in the Berg WAAS surface water study area. Monthly records of localised water use and return flows as well as inter-basin transfers and diversions are also presented along with spatial data in the form of GIS coverages of all present-day land use.

2. LAND USE

This Chapter presents both present-day and historical land use data in tabular format, along with maps showing the extent of the present-day land use within the study area.

2.1 OVERVIEW

2.1.1 Berg River Catchment

The upper and middle Berg River catchment areas are primarily used for wine farming and to a lesser extent fruit farming. Lucerne, vegetables and other crops are also grown, but only in small amounts. Irrigation water is either collected in farm dams or abstracted directly from the river. The Klein Berg River Valley is similar to the Upper Berg catchment, except that fruit cultivation is predominant. In the Lower Berg River, towards the north, utilisation changes from wine farming to dryland grain farming.

Forestry dominates in the high altitude and high rainfall areas, while Fynbos is found in most areas and varies from dense concentrations in gulleys to sparse coverings on rocky mountain slopes. The Berg River catchment is heavily infested by IAPs, which occur throughout the catchment at sparse to medium density levels. Invaded areas are dominated by Pines, Eucalyptus and Wattle. In general, riparian areas, especially along the main river channels, are more heavily infested than the upland catchment areas.

2.1.2 Eerste and Lourens River Catchments

Within the Eerste River catchment, extensive use is made of land for agricultural purposes, predominantly for vineyards and to a lesser extent vegetables. Irrigation is either by water collected in farm dams or abstracted directly from the river. Afforestation is concentrated mainly in the Jonkershoek Valley where high rainfall occurs, but is also found in smaller pockets scattered throughout the catchment.

Land in the Lourens River catchments is also used for vineyards and orchards, while afforestation occupies a higher proportion of the land in the Lourens River catchments than in the Eerste River catchment.

Black Wattle and Eucalyptus are the predominant species of alien vegetation in these catchments. Significant alien infestation is present in the upper parts of the Eerste River catchments (Klippies and Krom river subcatchments) as well as in certain localised areas in the Lourens River catchment. In the Eerste River catchment, upland alien vegetation dominates.

2.1.3 Palmiet and Steenbras River Catchments

There is a significant amount of agricultural land use (predominantly fruit farming and some small areas of vineyards) in the upper Palmiet catchment. Crops are irrigated with water from various dams. The upper catchment of the Steenbras River, as well as parts of the upper Palmiet, is also used extensively for afforestation. The lower part of the Palmiet catchment forms part of the Kogelberg Nature Reserve and is dominated by mountainous landscape and natural fynbos vegetation. The extent of IAPs in the Palmiet and Steenbras catchments is less than in the other study subcatchments.

2.1.4 Diep River Catchment

Vineyards make up most of the irrigated land in the Diep River catchment and are mainly found in the upper catchment areas. Fruit and vegetable cultivation comprises the rest of the irrigation demand and is found in the middle and lower catchment areas where dryland wheat is also grown. There is no afforestation in the catchment area and the natural vegetation is fynbos. Alien vegetation, including Black Wattle, Pines, Eucalyptus and Port Jackson, are scattered throughout the catchment in both upland and riparian zones.

2.1.5 Upper Breede River Catchment

The Upper Breede River catchment (tertiary catchment H10), which forms part of the Berg WAAS area, has a relatively small proportion of irrigation compared to the Breede River basin as a whole. Similar to the rest of the basin though, the main irrigated crops are vineyards and orchards, while pasture make up most of the remaining demand. There is relatively little afforestation, but widespread, scattered to dense areas of alien vegetation.

2.1.6 Upper Riviersonderend Catchment

Most of the upper parts of the Riviersonderend Basin have retained their natural vegetation with little agricultural development. However, lower down where the slopes are flatter, fruit farming (apples in particular) predominates, with smaller areas under vineyard and afforestation. Numerous farm dams in the area supply most of the irrigation, while a small portion of the irrigation water comes directly from rivers. A formal irrigation scheme exists in the vicinity of Villiersdorp where farmers' irrigation requirements are almost exclusively met by abstractions from Elandskloof Dam. The Upper Riviersondered catchment exhibits extensive areas of IAPs, mainly Pines, which occur mostly in the upland areas.

2.2 HISTORICAL LAND USE

Historical land use data, which conjunctively cover the period from 1950 to 1996, were obtained from the several hydrological studies which have previously been completed in the study area. These include:

2.2.1 Western Cape System Analysis (WCSA) (DWAF, 1993/1994)

The WCSA focused on the Berg, Palmiet, Steenbras, upper Riviersonderend, Molenaars and Cape Town basins. Land use data representing different historical time intervals were collected from various sources including relevant topographical maps, aerial photograps, field surveys, irrigation- and agricultural boards and remote sensing. Areas of irrigation, farm dams and forestry were digitised from aerial photographs and topographical maps and captured in GIS using ARC-INFO. No information with regard to IAPs were provided.

2.2.2 Skuifraam Dam Feasibility Study (SDFS) (DWAF, 1997)

The SDFS investigated the proposal of the Skuifraam Dam (subsequently renamed as the Berg River Dam), which was put forward during the WCSA, to meet the increasing urban demands in the greater Cape Town area. The study focussed on the upper catchment areas of the Berg, Riviersonderend and Molenaars rivers. The study made use of the WCSA database, which was extended for an additional 5 years based on observed hydrological and meteorological data.

Afforestation and irrigation areas as well as farm dam information were not updated. Limited information on alien vegetation was provided.

2.2.3 Voëlvlei Augmentation Scheme Feasibility Study (VAFS) (DWAF, 2001)

The VAFS investigated the proposal to increase the supply of water to Voëlvlei Dam by means of pumping from the Berg River during wet winter months. The study area comprised the incremental Berg River catchment, downstream of the flow gauging station at Dal Josafat (G1H020) and upstream of Misverstand Weir (G1R003. The study used historical land and water use information from the WCSA, while present-day land use information, at 1996 development levels, were derived as follows:

- Farm dam areas were based on a combination of information supplied by DWAF and 1993 satellite imagery from the National Land Cover Database (NLCD)
- Irrigation areas at 1996 development levels (where available) were obtained from the Department of Agriculture and verified with data from the NLCD, various fruit growers associations and co-operatives within the study area
- Afforestation areas were based on the NLCD.

No information with regard to IAPs were provided.

2.2.4 Breede River Basin Study (BRBS) (DWAF, 2003)

The BRBS essentially entailed an update of the Breede River Hydrological Study (DWAF, 1995). The latter presented the extent and spatial distribution of irrigated areas and farm dams at various historical time intervals, based on a combination of aerial photography and orthophotos. The BRBS updated this information for the year 2000 by digitising land use information from 1:30 000 colour aerial photographs. In addition, spatial and attribute data on IAPs in the Breede River catchment were obtained from Cape Nature Conservation and classified as tall tree, medium tree or tall shrub as well as upland or riparian.

2.3 PRESENT-DAY LAND USE

A present-day land use coverage of the Berg WAAS surface water study area was compiled from 1:10 000 aerial photography provided by DWAF. Although the photographs were flown between November 2001 and February 2002, they were considered to be representative of the 2004 levels of development in the study area. In terms of agricultural land use, this assumption was motivated by the extended drought experienced in the catchment since late 1990/early 2000, which would have resulted in a loss of income to agriculture over this period and a subsequent incapacity to initiate new agricultural development due to a lack of funds (Van Zyl, pers com, 2007).

The imagery obtained from DWAF was projected in Tranverse Mercator 19 (LO19) after which electronic coverages of irrigation, farm dams, forestry and invasive alien vegetation were captured in ArcGIS 9.2 by on-screen digitising. The Klein Berg catchment was selected as a pilot study area in which mapping techniques were verified by means of ground-truthing.

2.3.1 Irrigation

The mapping of irrigation areas entailed the identification and digitising of land use that could be identified as cultivated, irrigated land. As far as possible, crop type categories were also

discerned, at a relatively coarse scale, and classified as vineyards, orchards, vegetables, lucerne or pasture. Areas of dryland agriculture were not digitised.

Verification of crop types was undertaken during three separate field trips while crop distributions were further verified in consultation with local WUAs. The distribution of orchards, obtained from Deciduous Fruit Producers Trust statistics (2005), and vineyards (dry, table and wine grapes), from South African Wine Industry Statistics (SAWIS) (2006), were also used to verify the results of the mapping and ground-truthing exercises. The industry statistics indicated that, of an estimated total production area of 1 200 km^2 in the Berg WAAS area, about 35% of irrigated land is under orchards (comprising apples, apricots, nectarine, peaches, pears, plums) or table grapes with the remainder almost exclusively under vineyards for wine production. This corresponds well with the Berg WAAS figures in Table 2.1 which indicates that vineyards constitute about 74% of the irrigation, followed by orchards (22%). Furthermore, it is interesting to note that the total irrigation area of 1 200 km^2 is almost double the 1990 irrigation area of 650 km^2 as modelled in previous studies (WCSA and BRBS).

Figure 2.1 displays the extent of present-day irrigation in the Berg WAAS area.

Table 2.1: Present-day (2004) irrigation areas (km^2) and crop types

	CATCHMENT								
CROP	**Berg[2]**	**Eerste**	**Lourens**	**Diep**	**Palmiet**	**Steenbras**	**Upper Rivierson-derend[1]**	**Upper Breede[1]**	**Total**
Lucerne	5	2	0	2	1	0	0	1	**11**
Orchard	33	1	7	3	84	0	44	95	**268**
Pasture	5	0	0	0	1	0	0	12	**18**
Vegetables	12	7	0	7	0	0	0	1	**28**
Vineyards	428	152	3	145	29	0	21	103	**887**
Total	**483**	**162**	**10**	**157**	**115**	**0**	**65**	**212**	**1204**

(1): From BRBS (DWAF, 2003)
(2): Excludes Quaternaries G10K, G10L, and G10M

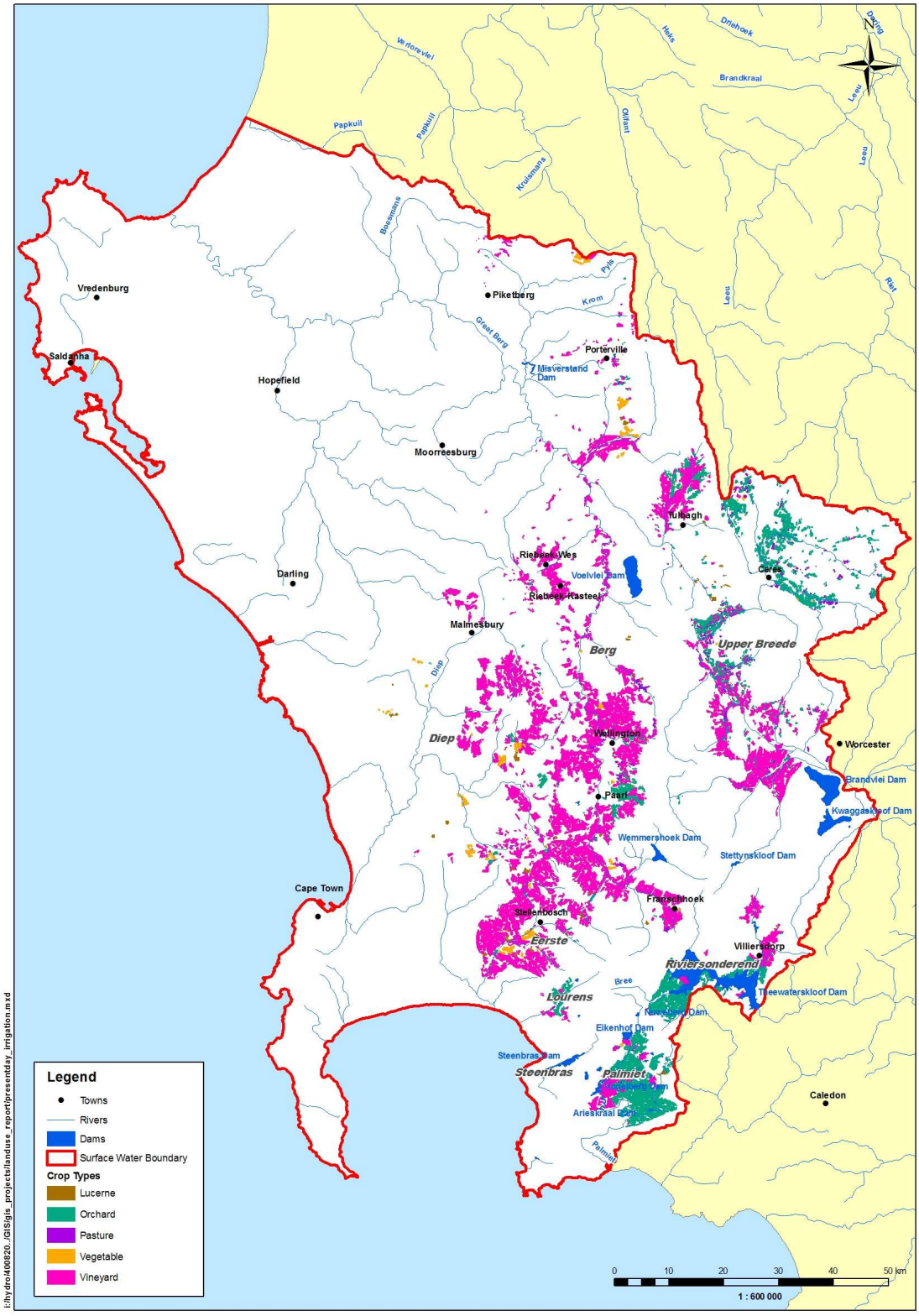


Figure 2.1: Present-day (2004) extent of irrigation

2.3.2 Forestry

Present-day areas of afforestation were digitised from the DWAF 1:10 000 aerial photographs and by using the WCSA forestry coverage as a guide. Most areas of commercial forestry have reduced since the decommissioning of commercial plantations was initiated in the late 1990s. The Berg WAAS mapping exercise indicated a current commercial forestry area of about 200 km^2, compared to close to 260 km^2 as estimated in previous studies (WCSA). However, a review of the WCSA forestry coverage revealed that in some cases, areas that were previously classified as afforestation are in fact areas of dense infestation and these were mapped as such in Berg WAAS. Furthermore, forestry plantations that are currently not managed or abandoned were also classified as IAPs in the Berg WAAS, with only well-maintained and functioning plantations digitised as forestry.

The dominant areas of afforestation in the study area are situated in the Upper Berg catchment, Klein Berg catchment, upper Eerste and Lourens catchments near Stellenbosch and upper parts of the Palmiet and Steenbras catchments near Grabouw and Elgin. The remainder of the study area displays no significant areas of forestry. The main species that is grown in the study area is Pine, while small areas of Eucalyptus are also maintained. Apart from small, localised forests in the mountain ranges, there are no significant areas of indigenous forest in the study area.

Table 2.2 presents the current areas of forestry in the Berg WAAS area, while Figure 2.2 shows the present-day extent of forestry.

2.3.3 Farm Dams

Farm dam areas within the study area were digitised from the 1:10 000 aerial photographs and verified with the most up-to-date 1:50 000 topographical maps. Extensive efforts went into the evaluation of farm dam storage volumes during the WCSA and the BRBS respectively. In the case of the WCSA, this involved the development of digital terrain models for various farm dams by means of a Stereo Photographic Digitiser and the derivation of full-supply capacities and area-capacity curves by means of area-height integration methods (DWAF, 1994). In the BRBS, farm dam capacities and area-capacity relationships were derived based on various sources of information including the DWAF dam safety register, Surface Water Resources of South Africa 1990 (Midgley *et al*., 1994) and previous studies. Based on the WCSA and BRBS area-capacity curves, the present-day farm dam surface areas were converted to corresponding storage volumes.

Table 2.3 lists present-day volumes of farm dams in the Berg WAAS area per subcatchment and shows that the total volume of farm dams equals approximately 400 Mm^3, which represents a significant increase compared to the previous 1990 estimate of about 190 Mm^3 (WCSA and BRBS).

Figure 2.3 shows the present-day extent of farm dams in the Berg WAAS area.

Table 2.2: Present-day (2004) areas (km^2) of afforestation

Catchment	Berg[(2)]	Eerste	Lourens	Diep	Palmiet	Steenbras	Upper Rivierson-derend	Upper Breede[(1)]	Total
Forestry Area	84	12	22	0	48	14	6	17	**203**

(1): From BRBS (DWAF, 2003)
(2): Excludes Quaternaries G10K, G10L, and G10M

Table 2.3: Present-day (2004) farm dam volumes (Mm^3)

Catchment	Berg[(2)]	Eerste	Lourens	Diep	Palmiet	Steenbras	Upper Rivierson-derend	Upper Breede[(1)]	Total
Volume	240	37	13	40	16	0	9	48	**403**

(1): From BRBS (DWAF, 2003)
(2): Excludes Quaternaries G10K, G10L, and G10M

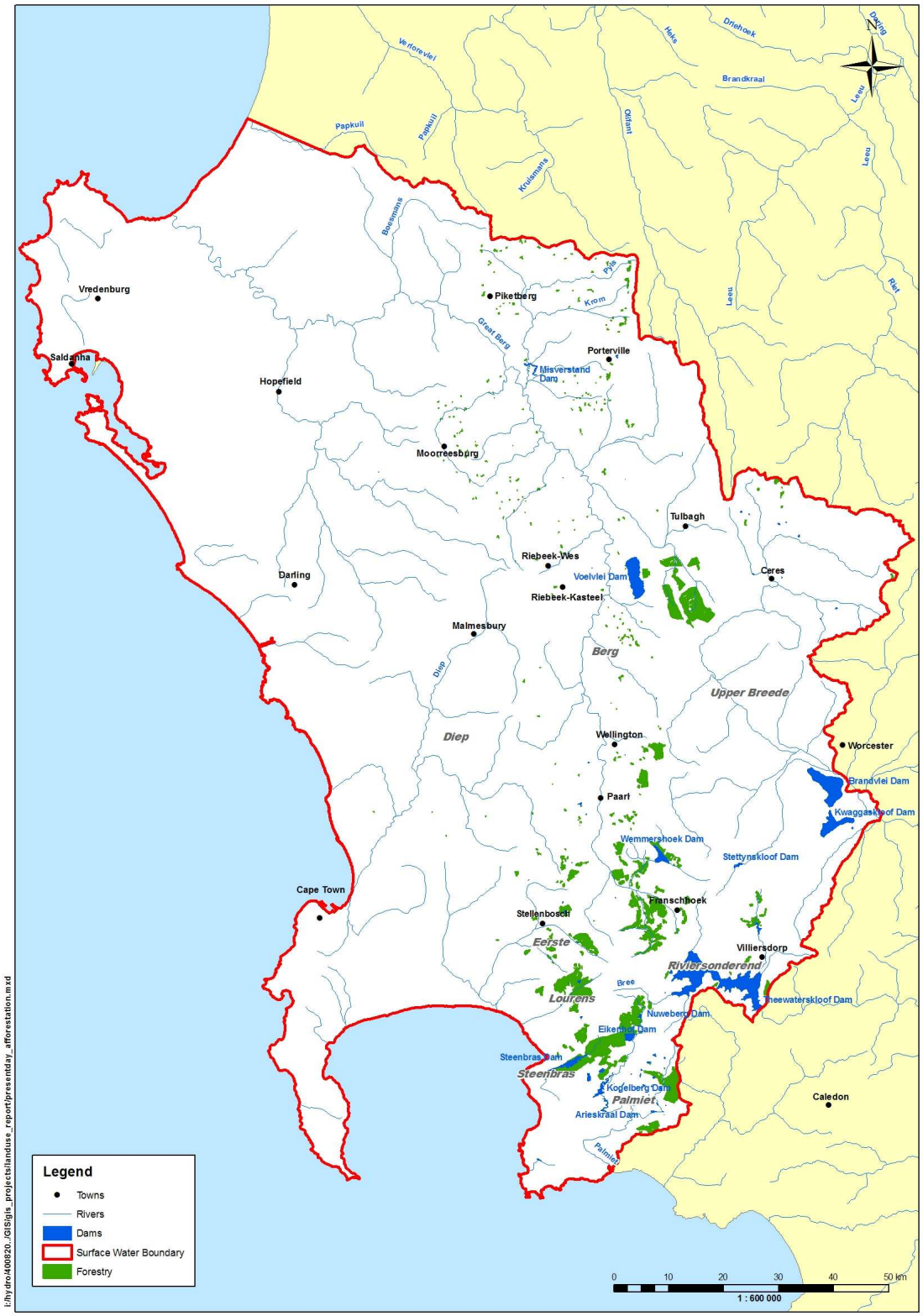


Figure 2.2: Present-day (2004) extent of afforestation

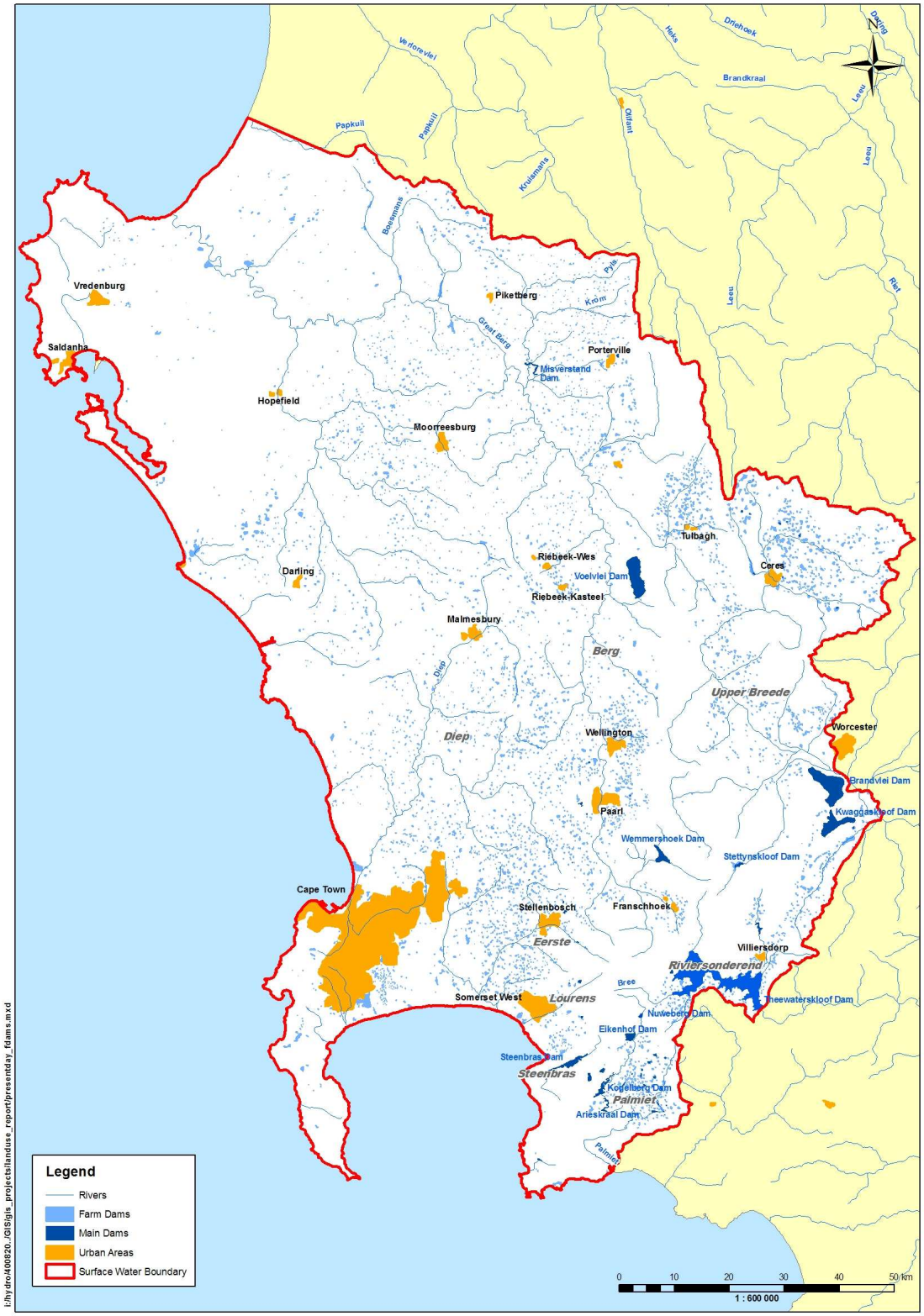


Figure 2.3: Present-day (2004) extent of farm dams

2.3.4 Invasive alien vegetation

During the Inception Phase of the Berg WAAS, it was acknowledged that the mapping of IAPs as part of the Berg WAAS would support Working for Water (WfW). However, at the time of the Inception Phase, the extent of the mapping had yet to be defined. In order to familiarise the Ninham Shand GIS team with the common IAP types and to determine the ease with which species identification, age and density could be determined from the available photography, Ninham Shand in collaboration with the regional WfW office, undertook a review of the available aerial photography as well as ground-truthing field trips to the Banhoek and Franschhoek valleys. The outcome of these activities, coupled with WfW's expectations of the Berg WAAS study as a broad-level planning tool to assist with the identification of priority areas for clearing, made it clear that, within the limitations of the Berg WAAS, an attempt at species identification would only be possible at a coarse level (i.e. pines, eucalyptus, acacias, black wattle, etc.). Furthermore, age classification would be based on size of tree (i.e. tall trees of a species would be considered as mature and smaller trees of the same species as young) and estimates of density would be approximate and based on canopy cover. Furthermore, it was agreed that Hakea infestations cannot be recognised from the available mapping and as such would not be digitised. (Although there are localised areas of Hakea infestation within the study area, WfW indicated that the spreading of Hakea has stablised and that the clearing of Hakea does not currently demand the same priority as other, more prominent invasive species.)

The following general guidelines towards the mapping of IAPs for the Berg WAAS was subsequently agreed to with WfW:

- in mountain catchment areas, concentrated vegetation occurring in high-lying gulleys and along steep flow paths would be considered as indigenous vegetation
- in the Berg River catchment upstream of Paarl, riparian vegetation is most likely to be Black Wattle or a mix (with primarily Black wattle)
- downstream of Paarl, riparian vegetation is likely to be Eucalyptus or a mix (with primarily Eucalyptus)
- Rooikrantz, which was originally introduced for dune stabilisation, is most common along the Cape Flats coastal area
- along the West Coast and the N7 (Diep River and Swartland), Port Jackson (an acacia) is known to be predominant. This invader is also not generally found above altitudes of 1 000 masl
- in the upper Breede River and upper Riviersonderend catchments, the BRBS IAP coverage would be used. This coverage was developed based on high-resolution colour aerial photography (1999) and was verified in collaboration with WfW and Cape Nature Conservation
- individual wind-rows would not be captured
- ground-truthing to verify IAP types would be undertaken in selected areas on an *ad hoc* basis
- previous forestry plantations that are currently not managed or abandoned, would be classified as IAPs, with only well-maintained and functioning plantations digitised as forestry.

In accordance with the above guidelines, the present-day extent of IAP infestation within the study area was updated based on the 1:10 000 aerial photographs. For each polygon that was digitised, the following fields were populated:

- riparian or upland (riparian = main river channels and tributaries)
- species (black wattle, pine, acacia, eucalyptus, poplar, other (excluding hackea))

- estimate of density in terms of canopy cover (0% - 25%: scattered; 25% - 75%: moderate; >75%: dense)
- estimate of age based on tree size (tall trees of a type = mature; other of same type = young)
- ground-truthing (where this has taken place)
- size category (tall tree, medium tree or tall shrub).

Table 2.4 lists the current condensed areas and species of IAPs per subcatchment and indicates that the Upper Berg and Eerste River catchments, followed by the Upper Breede catchment are characterised by significant levels of invasion. Furthermore, the Table shows that upland alien vegetation dominates in all the catchments except in the Berg where riparian infestations constitute almost 70% of the IAPs. Figure 2.4 displays the present-day extent of Invasive Alien Plants in the Berg WAAS area.

2.4 PRESENTATION OF DATA

As stated previously, the aim of this report was to support the preparation of historical and present-day water demand sequences for the purpose of hydrological modelling in the Berg WAAS area. Within this context, the historical and present-day land use data that were collected were disaggregated per calibration subcatchment in the Berg WAAS area and are presented in **Appendix A**, which includes a map showing the location of the calibration subcatchments. (The delineation of the calibration subcatchments is detailed in the Berg WAAS Report No. 5: Update of Catchment Hydrology (DWAF, 2008b)).

Electronic, spatial datasets of the present-day land use are provided in ArcGIS 9.2 format on the CD attached to this report. These include information on:

- irrigation areas and crop types
- farm dam surface areas
- forestry areas
- Invasive Alien Plants: area, age, species, density, location (riparian or upland).

Metadata on each of the datasets are also included on the CD.

Table 2.4: Present-day (2004) Invasive Alien Plant condensed areas (km^2)

Catchment	Berg [2]	Eerste	Lourens	Diep	Palmiet	Steenbras	Upper Riviersonderend	Upper Breede[1]	Total[3]
Black Wattle	11	2	1	0	0.5	0	0	No Species Data	16
Pine	7	1	0	0	0.5	0	1		11
Eucalyptus	9	4	1	1	0	0	0.5		14
Poplar	0	0	0	0	0	0	0		0
Port Jackson	1	0	0	1	0	0	0		1
Rooikrans	0	0	0	0	0	0	0		0
Other	1	0	0	0	0	0	0.5		1
Total	**28**	**8**	**2**	**2**	**1**	**0**	**2**	**98**	**141**[4]
Upland (%)	31	74	50	60	7	100	90	67	47
Riparian (%)	69	26	50	40	93	0	10	33	53

(1): From BRBS (DWAF, 2003) ; No species information
(2): Excludes Quaternaries G10K, G10L, and G10M
(3): Excluding Upper Breede
(4): Including Upper Breede

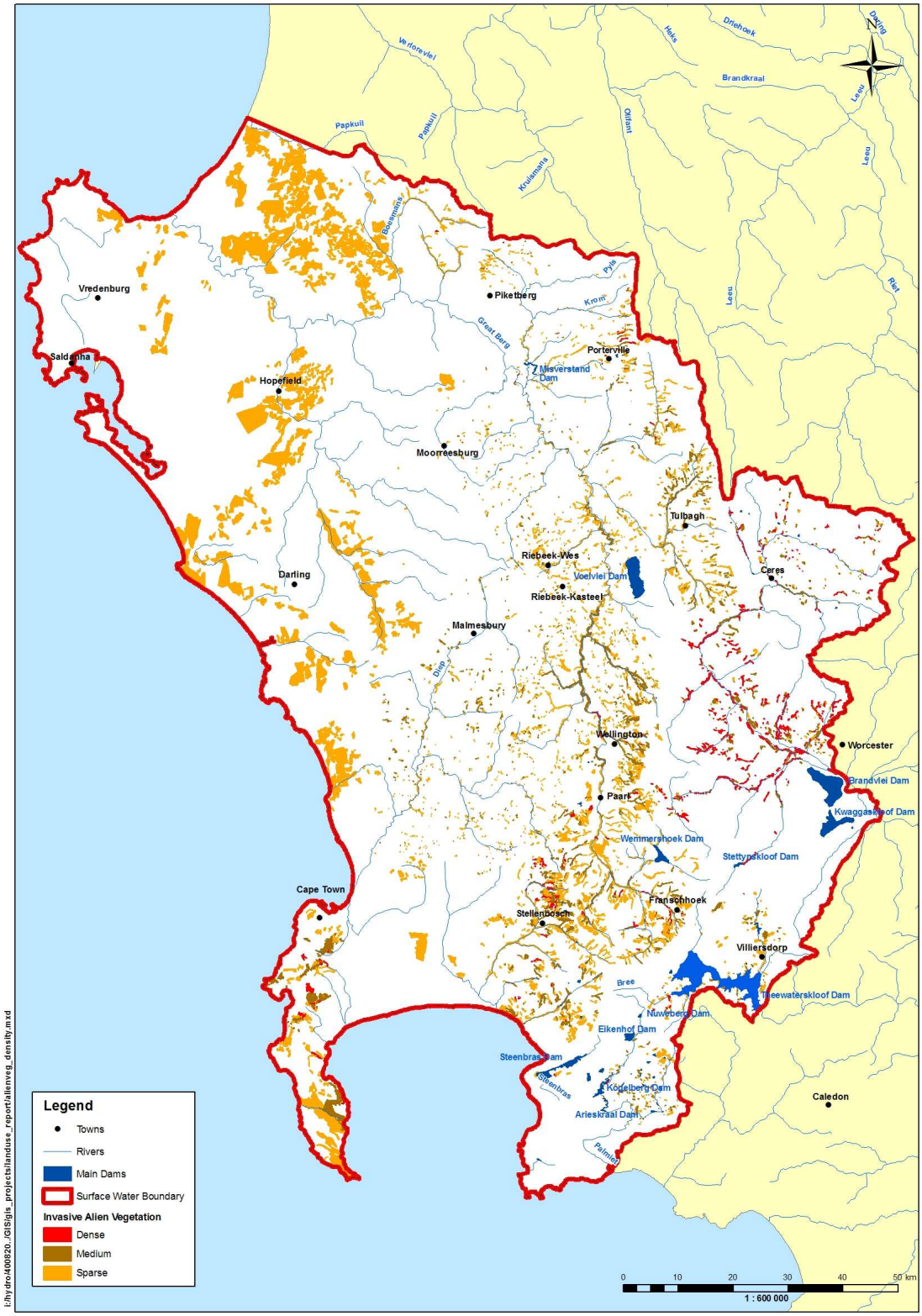


Figure 2.4: Present-day (2004) extent of Invasive Alien Plants

3. ABSTRACTIONS AND RETURN FLOWS

The bulk of the urban water demand in the Berg WAAS area is supplied by the Western Cape Water Supply System (WCWSS), comprising sources from the Table Mountain and Southern Peninsula supply as well as Voëlvlei, Wemmershoek, Steenbras and Theewaterskloof dams. These bulk abstractions are not relevant to the hydrological modelling approach, on a subcatchment scale, as adopted in the Berg WAAS, and are therefore not addressed in this report. For a detailed description of bulk water use and associated supply infrastructure in the Berg WAAS area, please refer to Berg WAAS Report No. 4 Vol. 3: Water Use and Water Requirements (DWAF, 2008), which supports the yield analyses undertaken as part of the Berg WAAS system modelling.

This Chapter focuses on abstraction and return flow information which are required for the successful calibration of the Berg WAAS hydrological model. These include recorded municipal and irrigation abstractions that are sourced directly from local surface water sources as well as irrigation and wastewater effluent return flows that discharge into rivers upstream of flow gauges that are used for calibration. The information that are presented in this Chapter were obtained from various municipalities, WUAs, irrigation boards, the regional DWAF office, existing databases and previous studies. The data are presented as monthly flow sequences (attached as **Appendix B**), while electronic text files, in a format which is compatible with WRSM2000, are also included on the CD attached to this report.

3.1 MUNICIPAL ABSTRACTIONS

Although there are various small towns or settlements within the Berg WAAS area that obtain water from local surface water sources via run-of-river abstractions or storage dams, most of these abstractions are insignificant compared to the total catchment runoff and were therefore excluded from the hydrological modelling. Examples include Wolseley, Rawsonville, Villiersdorp and Prince Alfred Hamlet. Some towns e.g. Wellington, Strand,. Paarl, Somerset West and Malmesbury abstract relatively small volumes of water from local sources in order to augment their bulk supply from larger schemes, such as the Western Cape Water Supply System, and these were also not modelled. A few towns within the Berg WAAS area, however, are characterised by localised water abstractions which are significant enough to warrant its incorporation in the hydrological model, and relevant information in this regard is provided below.

3.1.1 Tulbagh

The VAFS estimated that a volume of approximately 1.5 Mm^3/a is abstracted by the Oubiqua Prison, Kruisvalley Farm, the South African Preserving Company and Tulbagh. This estimate was confirmed by the DWAF Regional Office, who also provided information on the monthly municipal demand pattern of Tulbagh. The total monthly demand sequence is included in Appendix B.1.1. . Based on the historical average monthly discharge pattern from the effluent record at Tulbagh WWTW, the annual demand of 1.5 Mm^3 was disaggregated to monthly volumes and is included in Appendix B.1.2.

3.1.2 Paarl

Paarl has a current demand of about 11 Mm^3/a, which has reduced by 38% from 18 Mm^3/a in 2000 due to the implementation of effective water conservation and demand management

measures. The bulk of this demand is supplied from the Wemmershoek Scheme, from which Paarl has an allocation of 17.5 Mm^3/a included in Appendix B.3. Up to about 1.5 Mm^3/a of Paarl's demand can be supplied from the local Bethel and Nantes Dams, which have a combined catchment area of approximately 10 km^2. As the Bethel Dam and Nantes Dam catchments are negligible compared to the Berg River catchment, the dams, and the abstractions from these dams, were not modelled in the Berg WAAS. However, storage in these dams is augmented by pumping from the Berg River whenever the water quality in the river is of an acceptable standard. Pumping records from the Berg River to these dams, as made available by Drakenstein Municipality for the period between 2000 and 2004, were therefore modelled and were supplemented with historical abstraction data from both the WCSA and SDFS.

3.1.3 Saron

The Saron Municipality and De Hoek Estates are supplied directly from a diversion scheme on the Leeu River which is located upstream of flow gauge G1H029. The diverted water is directed towards a division structure, which divides the water equally between Saron Municipality and the De Hoek Estate Irrigators. A 300 mm diameter pipeline, with an estimated capacity of 125 l/s, supplies water from the division structure to Saron, where the water is pumped into a 2 Ml storage reservoir. The total estimated combined supply to Saron Municipality and De Hoek Estates equals 4.47 Mm^3/a (DWAF, 2001) and the same monthly distribution that was used in the WCSA was also assumed for the Berg WAAS. The monthly demand sequence is included in Appendix B.4.1.

3.1.4 Robertsvlei

Robertsvlei is a small settlement that is situated along the upper Berg River, south west of Franschhoek. Water for supply to Robertsvlei is abstracted upstream of flow gauge G1H038 on the Wolwekloof River, a tributary of the Berg River. As no flow records are available for this abstraction, a demand of 2.2 Mm^3/a, as estimated in the WCSA based on the capacity of the existing pipeline, was used and is included in Appendix B.6. A constant monthly abstraction rate was assumed.

3.1.5 Stellenbosch

Water for municipal use in Stellenbosch is abstracted via pipelines from the Jonkershoek River at flow gauge G2H008. The water is treated at the Swartberg Treatment Plant and the surplus is stored in the Idas Valley Dams for use during the summer months. Due to unreliable flow records and significant missing data, a synthetic historical record was calculated for the period 1947 to 1988 in the WCSA, based on the capacities of the pipelines. This was extended to 2004 based on abstraction records from Stellenbosch Municipality for the period between January 2001 and December 2006 and is included in Appendix B.7. The missing data period (1989 to 2000) was patched by means of linear interpolation.

3.1.6 Grabouw

Grabouw Municipality abstracts water for urban use from the Palmiet River at Eikenhof Dam. A historical record was available for the period 1978 to 1987 in the WCSA, while an abstraction record from 1992 to date was obtained from DWAF (Gauge G4H032). The missing data period (1988 to 1991) was patched by means of linear interpolation. The monthly demand sequence for Grabouw is included in Appendix B.11.1.

3.1.7 Ceres

Ceres Municipality is supplied from the Ceres Dam, which is situated on the Koekedouw River, a tributary of the Dwars River. The urban water use of Ceres has increased steadily from about 1.2 Mm^3/a in 1967 to more than 3 Mm^3/a in 2000. The BRBS provided a monthly abstraction record for the combined domestic and irrigation abstraction from Ceres Dam up to 1990. For the Berg WAAS, this record was extended to 2004 based on recorded water use figures by Witzenberg Municipality and by assuming that the irrigation demand remained constant. The monthly demand sequence for Ceres is included in Appendix B.14.1.

3.1.8 Worcester

The municipal demand for Worcester is supplied by a pipeline from the Stettynskloof Dam on the Holsloot River. Stettynskloof Dam supplies Worcester exclusively for its urban demand. The urban water use of Worcester has increased from about 3 Mm^3/a in 1958 to 11.7 Mm^3/a in 2004. The monthly volume supplied to the town is gauged by DWAF at H1H031 and is included in Appendix B.13.

3.2 IRRIGATION ABSTRACTIONS

In the Berg WAAS area, water for irrigation is mostly abstracted by individual farmers, either directly from rivers (diffuse irrigation) or from farm dams and the volumes are typically not recorded. Records of irrigation use are therefore limited to Irrigation Boards and WUAs and this section provides readily available information with regard to these bulk abstractions.

3.2.1 Twenty-Four Rivers Irrigation Board

The Twenty-Four Rivers Canal, which was constructed in 1971, conveys water from diversion structures on the Twenty-Four Rivers and Leeu River respectively to Voëlvlei Dam. The Twenty-Four Rivers Irrigation Board has an annual allocation of approximately 21 Mm^3/a from this canal. Based on a mass-balance calculation, which considered the difference in recorded flows in the canal at the diversion structure inlets and at the inflow to Voëlvlei Dam, monthly irrigation abstraction volumes were estimated. The mass-balance indicated an annual average irrigation abstraction of 20.7 Mm^3, which compares favourably with the allocation of 21 Mm^3/a. The monthly abstraction records that were calculated in the WCSA and VAFS and which conjunctively cover the period from 1971 to 1996, were assumed for the Berg WAAS. These were extended to 2004 based on the historical monthly average volumes and are included in Appendix B.2.

3.2.2 De Hoek Estates

As detailed in Section 3.1.3,, Saron Municipality and De Hoek Estates are supplied directly from a diversion scheme on the Leeu River which is located upstream of flow gauge G1H029. The diverted water is directed towards a division structure, from where a 200 mm diameter pipeline supplies water to De Hoek Estates. This pipeline passes through a small residential settlement where some of the water is abstracted for domestic use and is eventually discharged into an irrigation dam. Spills from this dam are diverted back into the Twenty-Four Rivers canal. During the dry summer months, the De Hoek Estate irrigation demand is supplemented through pumping from the Twenty-Four Rivers canal. The combined supply to Saron Municipality and De Hoek Estates is estimated at 4.47 Mm^3/a (DWAF, 2001) and the same monthly distribution that was

used in the WCSA was also assumed for the Berg WAAS. The monthly demand sequence is included in Appendix B.4.1.

3.2.3 Perdeberg Irrigation Board

The Perdeberg Irrigation Board abstracts water from the Berg River main stem downstream of Wellington, between the Krom River and Doring River confluences. The Board has been abstracting water for irrigation purposes since 1984 and owns and operates various pumps and pipelines that distribute the abstracted water to farm dams from where it is used for irrigation. The volume of water abstracted for the 1996 development level was estimated to be 2.1 Mm^3/a in the VAFS. The VAFS monthly abstraction record was based on information supplied from the DWAF Western Cape Regional Office as well as the Perdeberg Irrigation Board, and was also used in the Berg WAAS. This record, which covered the period up to 1996, was extended to 2004 by using the historical monthly average volumes and is included in Appendix B.5.1.

3.2.4 Eerste River Abstraction

Immediately upstream of flow gauge G2H020 in the Eerste River, an irrigation canal, which has been operational since 1976, diverts water for irrigation use further downstream. Processed abstraction records at this canal, which is gauged at G2H030, were received from DWAF and are included in Appendix B.10. However, cognisance should be taken of the fact that this gauge received a poor accuracy rating in the WCSA.

3.2.5 Palmiet River Catchment

The Palmiet River catchment is characterised by intense irrigation, mainly orchards, in its middle to upper reaches. Irrigation requirements are predominantly supplied from the various dams on the Palmiet River that were specifically constructed for this purpose. These include:

- Nuweberg Dam. This dam supplies the Vyeboom Experimental Farm as well as the irrigation requirements of the Nuweberg Dam Syndicate via river releases. The dam has a capacity of 3.9 Mm^3. The reader is referred to Appendix B.11.2.
- Eikenhof Dam. This dam is owned by the Groenland Irrigation Board and primarily supplies water for irrigation via four pipelines: the Groenland, Highlands, Applegarth and ElfCo pipelines. River releases are also made for riparian users downstream, while Grabouw also abstracts water from this dam. The dam's spillway was raised in 1998 to increase its capacity to 29 Mm^3. The reader is referred to Appendix B.11.3 - 6.
- Appelthwaite Dam. This dam is owned by Elgin Orchards who abstracts water via a pipeline. It has a capacity of 3.5 Mm^3 and supplies irrigation requirements only. A scour outlet pipe is used for river releases during winter months. This abstraction is represented by a variable monthly abstraction from Applethwaite Dam in the hydrological model that supplies approximately 10.22 Mm^3/year.
- Arieskraal Dam. This dam is used to supply surrounding irrigation users by means of direct abstractions from the dam. River releases are also made for riparian users downstream. The dam has a capacity of 4.4 Mm^3/a.
- Grootvlei Dam. This dam, which is situated on the Klein Dwars River, a tributary of the Palmiet River, has a capacity of 1.6 Mm^3 and supplies Elgin Orchards by means of a pipeline. No river releases are made from this dam.

Recorded irrigation abstractions from the Nuweberg Dam were available from the WCSA for the period 1978 to 1987. As no recent records are available, the WCSA time series was extended to 2004 based on the monthly averages of the last 5 years. In the case of Eikenhof Dam, records of

monthly irrigation volumes that were abstracted via the four main pipelines were obtained from DWAF. For the remainder of the dams, the irrigation water demands during hydrological modelling will be based on water requirements as simulated by the irrigation routine that is incorporated in WRSM2000.

3.2.6 Koekoedouw Irrigation

The Koekoedouw Irrigation Board abstracts water for irrigation from the Ceres Dam, which is situated on the Koekoedouw River, a tributary of the Dwars River. Monthly abstraction volumes from the Ceres Dam, which include both irrigation and urban abstractions, were available from the BRBS up to 1990. For the Berg WAAS, this record was extended to 2004 based on recorded water use figures by Witzenberg Municipality and by assuming that the irrigation demand remained constant. The monthly irrigation demand sequence is included in Appendix B.14.1.

3.2.7 Rooikloof and Ben Etive Dams

The Rooikloof Dam is situated in the Rooikloof River, which drains part of the so-called Agtertuin subcatchment within the Ceres Basin. Approximately 3.2 Mm^3/a is abstracted from this dam by the Rooikloof Irrigation Board to supply an area of almost 350 ha. 95% of this water is diverted into the Ceres (Dwars River) catchment for irrigation purposes, while the remaining 5% is stored in farm dams within the Agtertuin catchment. A time series of monthly abstraction volumes for the period 1971 to 1990 was obtained from the BRBS, which was extended to 2004 based on the monthly averages of the last five years. The monthly irrigation demand sequence is included in Appendix B.12.2.

Another dam which is situated within the Agtertuin subcatchment is the Ben Etive Dam on the Vals River. Although the dam was only constructed in 1969, water to supply the Warm Bokkeveld Irrigation Scheme has already been diverted from this site on the Vals River since 1964. Approximately 6 Mm^3/a is abstracted from this dam and similar to the Rooikloof Dam, about 95% of this water is diverted into the Ceres (Dwars River) catchment for irrigation purposes, while the remaining 5% is stored in farm dams within the Agtertuin catchment. A time series of monthly abstraction volumes was obtained from the BRBS for the period 1964 to 1990 and this was extended to 2004 based on the monthly averages of the last five years. The monthly demand sequence is included in Appendix B.12.1.

3.2.8 Rietvlei Irrigation Board

The Rietvlei Irrigation Board abstracts water from the Titus River catchment to supply approximately 100 ha of irrigation within the Agtertuin catchment. The scheme supplies an estimated 1.03 Mm^3/a. A time series of monthly abstraction volumes was obtained from the BRBS and was extended to 2004 based on the monthly averages of the last five years. The monthly demand sequence is shown in Appendix B.12.3.

3.3 RETURN FLOWS

Information on return flows that are considered significant in terms of the Berg WAAS hydrological modelling are presented below. These include urban return flows (wastewater effluent), which account for almost 90% of return flows in the Berg WMA, as well as irrigation return flows. Most of the irrigation return flows in the Berg WAAS area are generated from water that is lost in

conveyance to irrigated land as well as surface runoff and seepage from irrigated areas. Based on DWAF (2002) estimates, between 2% and 5% of the water that is applied to irrigated lands end up as irrigation return flows (DWAF, 2002).

3.3.1 Tulbagh

Return flows from the Tulbagh WWTW discharge into the Klein Berg River upstream of flow gauge G1H008. A record of monthly return flow volumes for the period between 1991 and 2007 was obtained from the DWAF regional office and this was extended backwards based on monthly averages. The monthly return flow sequence is included in Appendix B.1.2.

3.3.2 De Hoek Estates

Return flows from a portion of the De Hoek Estate Irrigation Scheme discharge into the Leeu River upstream of flow gauge G1H029. Estimates of total monthly return flow volumes up to 1988 were obtained from the WCSA and these were extended to 2004 based on average monthly volumes. The monthly return flow sequence is included in Appendix B.4.2.

3.3.3 Paarl and Wellington

Return flows from both the Paarl and Wellington Wastewater Treatment Works (WWTWs) are discharged to the Berg River upstream of flow gauge G1H036. Return flow data for these works were obtained from the WCSA for the period 1982 to 1989 and from the VAFS for the period 1991 to 1996. For the Berg WAAS, up-to-date information was obtained from Paarl and Wellington municipalities and is included in Appendix B.5.2.

3.3.4 Malmesbury

Return flows from the Malmesbury WWTW, which was constructed in the late 1950s, discharge into the Diep River upstream of flow gauge G2H012. A record of monthly return flow volumes for the period 2001 to 2007 was obtained from the DWAF regional office and this was extended backwards assuming a linear growth trend. (The Malmesbury WWTW is currently being upgraded). The monthly return flow sequence is included in Appendix B.8.

3.3.5 Stellenbosch

Return flows from the Stellenbosch WWTW discharge into the Eerste River downstream of flow gauge G2H020 and upstream of flow gauge G2H015. Estimates of monthly return flow volumes up to 1988 were obtained from the WCSA. This sequence entailed recorded flows for the period 1978 to 1988 and a synthetic record for the period before 1978. For the Berg WAAS, this record was extended based on data that were made available by Stellenbosch Municipality and is included in Appendix B.9.

4. GROUNDWATER USE

The WRSM2000 software, which is used for hydrological modelling in the Berg WAAS, accommodates surface water/groundwater interaction by means of the Sami model routine and therefore necessitates information on groundwater use within the Berg WAAS area.

Groundwater is an important component of the water resources in the Berg WAAS area with about 8% of the total water requirements in the Berg WMA in 1995, estimated to be supplied from groundwater (DWAF, 2002). It is expected that the water supply from groundwater has increased in the last years and will continue to do so due to limitations of the available surface water supply as well as increasing demand. Most of the groundwater use in the Berg WAAS area is for irrigation, with the remainder accounting for municipal and other uses where surface water resources are scarce or require supplementing. Towns utilising groundwater sources for their municipal supply are primarily located along the West Coast and include Yzerfontein, Atlantis and Mamre, while local springs or boreholes are used to supplement surface water supplies in Prince Alfred Hamlet, Wolseley, Villiersdorp, Rawsonville, Franschoek and Somerset West.

Groundwater is mainly abstracted by means of boreholes or springs from the coastal intergranular aquifers as well as the fractured rock aquifers of the TMG (DWAF, 2003b). Table 4.1 provides estimates of groundwater use in the Berg WAAS area as extracted from two data sources, viz. the recently completed Groundwater Resource Assessment Phase II (GRA II) (DWAF, 2004) and the National Groundwater Database (NGDB). In addition, data from DWAF's Water Use Authorisation and Registration Management System (WARMS) were used to supplement the above databases. (It is important to note that none of these data sets are aquifer specific. A method to disaggregate and recalculate the distribution of groundwater abstraction per aquifer is further discussed and detailed in the Berg WAAS Groundwater Model Report (DWAF, 2007).

Table 4.1 shows that the total groundwater use in the Berg WAAS area is in the order of 104 Mm^3/a to 136 Mm^3/a. Most of the groundwater abstraction occurs in the Upper Breede catchment where it is used extensively for irrigation, while significant abstractions, also for irrigation, occur in the Berg and Diep River catchments. The West Coast catchments and the Cape Town Basin are also characterised by significant abstractions. Along the West Coast, groundwater abstraction is mainly for municipal use from the Cape Flats Aquifer at Atlantis, where artificial recharge is practised, while groundwater use in the Cape Town Basin relates to agricultural and municipal use.

In addition to estimates of groundwater abstractions per quaternary catchment, the GRA II database also provides information on groundwater use per water use sector and confirms that most of the abstracted groundwater within the Berg WAAS area (approximately 70%) is used for irrigation, mainly in the G10E and H10C quaternary catchments (above 10 Mm^3/a each), and in the G10J, H10F and H10G quaternary catchments (above 5 Mm^3/a each). Urban domestic use accounts for about 13% and is concentrated in the G21B (Atlantis, 8.5 Mm^3/a) and the G22D quaternary catchments (Cape Flats, 5.9 million m^3/a). Significant abstractions for domestic use also occur in the G22B and H10C catchments.

Appendix C provides a summary of groundwater use per calibration subcatchment.

Table 4.1: Groundwater Use: Annual Abstraction (Mm^3/a)

CATCHMENT	GRA II	NGDB (WARMS)
Berg	27.0	37.1
Eerste	0.6	3.5
Lourens	0.6	0.7
Diep	5.3	13.7
Palmiet	0.0	1.3
Steenbras	0	0
Upper Riviersonderend	0.5	1.8
Upper Breede	43.4	58.7
West Coast	15.0	11.3
Cape Town Basin	11.6	7.8
Total	**104**	**136**

5. INTER-BASIN TRANSFERS AND DIVERSIONS

Several government water schemes are in place for transferring water between the Breede, Eerste, Riviersonderend and Berg River catchments respectively, while storage within the Berg and Breede river catchments is also augmented by various within-basin transfers. This Chapter provides relevant detail on these transfers along with historical monthly flow sequences (attached as **Appendix D**). In addition, electronic text files in a format which is compatible with WRSM2000 are included on the CD attached to this report.

5.1 RIVIERSONDEREND/BERG RIVER GOVERNMENT WATER SUPPLY SCHEME

The Riviersonderend/Berg River Government Water Supply Scheme transfers water between the upper Berg, upper Riviersonderend (Theewaterskloof Dam) and Eerste River catchments through a series of tunnels. Water from this scheme is mainly used for urban supply as part of the WCWSS and for irrigation in the Berg River catchment. The net export from the Breede WMA is 161 Mm^3/a, while about 25 Mm^3/a is diverted from the upper Berg River into Theewaterskloof Dam. The tunnels transfer water as follows:

5.1.1 Theewaterskloof Tunnel

Water for irrigation is released from Theewaterskloof Dam into the upper Berg River, upstream of flow gauge G1H004, via the Theewaterskloof tunnel. Flow releases are gauged by station G1H044, which provides an up to date, monthly time series of releases into the Berg River since 1983. Periods of missing data in the DWAF records were patched with monthly averages. The estimated monthly transfer volumes are shown in Appendix D.1.

5.1.2 Banhoek Tunnel

In addition to the Wolwekloof tunnel, the Banhoek tunnel also diverts water from the Upper Berg catchment to Theewaterskloof Dam. The water is diverted from the Banhoek River, upstream of flow gauge G1H019, and the diverted flow is recorded at station G1H063. This station also has a poor accuracy rating (DWAF, 1993), which resulted in the Banhoek transfers not being modelled in the WCSA. However, similar to the approach that was followed for the Wolwekloof Tunnel, estimates of diverted flow into the Banhoek tunnel (for the period up to 1993) were made during the SDFS. As there is no DWAF record available for gauge G1H063, the SDFS time series was extended to 2004 for use in the Berg WAAS based on the historical monthly averages. The estimated monthly transfer volumes are shown in Appendix D.4.

(Gauges G1H019 and G1H063 are currently being upgraded.)

5.1.3 Wolwekloof Tunnel

The Wolwekloof tunnel transfers water from the Wolwekloof River in the Upper Berg catchment at flow gauge G1H038 to Theewaterskloof Dam. Although flow in the Wolwekloof tunnel is gauged at the tunnel inlets (G1H061), this station has a poor accuracy rating of zero (DWAF, 1993) with the result that there is low confidence in the flow record (Mouski F, pers com, 2007). This resulted in these transfers not being modelled in the WCSA. In the SDFS, this problem was overcome by assuming that there are no diversions into the tunnel during the summer months (October to March) and by estimating flows into the tunnel during the winter months based on recorded stage

levels at flow gauge G1H038. For the Berg WAAS, the SDFS data were used for the period up to 1993, after which the G1H061 observed record was used (with the summer month values set to zero) to provide a complete monthly time series up to 2004. Missing months in the DWAF record were patched with monthly averages. The estimated monthly transfer volumes are shown in Appendix D.6.

5.1.4 Jonkershoek Tunnel

Water from Theewaterskloof Dam is diverted via the Jonkershoek tunnel through the Klein Drakenstein mountains to a balancing dam at Kleinplaas in the Jonkershoek River, from where water is transferred to the Faure Water Treatment Works. As Kleinplaas Dam effectively acts as a balancing dam for the transfer of water from Theewaterskloof Dam to the Cape Town Basin, which results in rapid variations in the volume of water in storage due to large inflows and outflows, neither Kleinplaas Dam nor the inter-basin transfers via the Jonkershoek tunnel were modelled in the Berg WAAS. (This approach was also adopted in the WCSA without any significant impact on model calibration).

5.2 UPPER BREEDE INTER-BASIN TRANSFER (WHITE BRIDGE DIVERSION)

The White Bridge transfer scheme involves the diversion of water from the Upper Breede River (Breede WMA) to the Klein Berg River catchment (Berg WMA) via a canal, which diverts water immediately upstream of flow gauge H1H006 in Michell's Pass (Refer to Appendix D.2.). The water is mainly used for irrigation in the Wolseley and Tulbagh areas and the annual volume, as estimated in the BRBS, equals 18.5 Mm^3/a. A portion of this water is abstracted from the canal and used for local irrigation in the Breede River catchment, before the canal crosses the watershed into the Klein Berg catchment. This abstraction is estimated to be about 5.5 Mm^3/a. This transfer is metered by DWAF at flow gauge H1H022. For the Berg WAAS, the BRBS time series was used for the period up to 1990, while the observed DWAF record was used to extend the time series to 2004. Periods of missing data in the DWAF record were patched with monthly averages.

5.3 KLEIN BERG, LEEU RIVER AND TWENTY-FOUR RIVERS DIVERSIONS

The Twenty-Four Rivers canal conveys water that has been diverted from both the Twenty-Four Rivers and Leeu River catchments to Voëlvlei Dam. The diversions are measured at flow gauges G1H058 and G1H059 respectively. The Klein Berg River canal diverts water from the Klein Berg River, a short distance downstream of flow gauge G1H008, to Voëlvlei Dam. The flow records at these diversion structures are relatively inaccurate and contain considerable missing data with frequent exceedences of the rating curves. However, both canals are additionally gauged as they enter Voëlvlei Dam: flow gauge G1H067 records flow in the Twenty-Four Rivers Canal, while G1H066 records flow in the Klein Berg Canal. The quality of data from these two gauging stations are considered more reliable than those at the diversion structures and records at these stations were therefore used to determine monthly time series of diverted flows for the Berg WAAS shown in Appendix D.3.1 and D.3.2.

5.4 WIT RIVER INTER-BASIN TRANSFER

Since the mid 1800's, water for irrigation purposes has been transferred from the Wit River, in the upper Breede WMA upstream of flow gauge H1H007, to the Krom River in the Berg WMA upstream of flow gauge G1H037, via a diversion scheme which became known as "Gawie se Water". The BRBS presented an average figure of 4.9 Mm^3/a for this diversion, which corresponds to estimates by the Kromme River Irrigation Board who operates the scheme (VAFS, 2001). In the BRBS, variable monthly volumes were assumed for the summer months (October to April), while constant monthly diversions were assumed for the winter months (May to September). The Kromme River Irrigation Board, however, indicated that the bulk of the water is diverted during the summer months and, for the Berg WAAS, the annual volume of 4.9 Mm^3/a was therefore distributed evenly over the months October to April, with zero flow during the winter months. The water that is transferred is abstracted directly from the Krom River and is not stored in farm dams. The monthly diversion volumes are shown in Appendix D.5.

5.5 PALMIET/STEENBRAS TRANSFER

The Palmiet River Government Water Supply Scheme supplements the Steenbras Scheme by means of a dual purpose water transfer and hydro-electric pumped storage scheme in the Palmiet River. The scheme entails the diversion of excess water that is pumped from Kogelberg Dam to Rockview Dam in the Palmiet catchment, over and above that required for power generation, into Upper Steenbras Dam. A time series of monthly volumes transferred via this scheme was obtained from the City of Cape Town and is included in Appendix D.7.

5.6 DU TOITS RIVER INTER-BASIN TRANSFER

Water is imported from the Du Toits River, upstream of flow gauge H6H007 into the upper Riviersonderend catchment (Breede WMA), to supplement municipal use in Franschhoek (Berg WMA). As the volume of water which is transferred only equals about 0.16 Mm^3, based on information supplied by the Stellenbosch Municipality, coupled with the fact that there are no additional recorded data for the period prior to 2004, this transfer is considered to be insignificant and was therefore not modelled in the Berg WAAS.

6. CONCLUSION

The key objectives as defined in the Berg WAAS Inception Report under the task aimed at the collection of land use and other relevant data for hydrological modelling, were successfully met. Data collection included land use mapping as well as the collection of data and information that were readily available from regulatory bodies and industries including: the Department of Water Affairs and Forestry (DWAF), irrigation boards, Water User Associations (WUAs) and municipalities. Registered water use information were also acquired and processed.

This report presents the results of this task and essentially provides land use information in support of the preparation of historical and present-day water demand sequences as well as information with regard to localised municipal and irrigation abstractions and return flows, inter-basin transfers, river diversions and groundwater use for the purpose of hydrological modelling. Information on historical and present-day land use are presented per Berg WAAS calibration catchment, while electronic, spatial datasets of the present-day land use are provided in ArcGIS 9.2 format. Monthly demand-, transfer and return-flow sequences, in a format which is compatible with WRSM2000, are also included.

REFERENCES

Department of Water Affairs and Forestry, South Africa. February 1993. *Western Cape System Analysis: Hydrology of the Berg River Basin.* Prepared by Ninham Shand Inc. in association with BKS Inc. DWAF Report No. P G000/00/2491.

Department of Water Affairs and Forestry, South Africa. 1993. *Western Cape System Analysis: Hydrology of the Palmiet/Steenbras River Basin.* Prepared by Ninham Shand Inc. in association with BKS Inc. DWAF Report No. P G000/00/2391.

Department of Water Affairs and Forestry, South Africa. October 1993. *Western Cape System Analysis: Hydrology of the Eerste, Lourens and Sir Lowry's Pass River Basins.* Prepared by Ninham Shand Inc. in association with BKS Inc. DWAF Report No. P G000/00/2691.

Department of Water Affairs and Forestry, South Africa. 1994. *Procedure for the Evaluation of farm dams.* Prepared by RR Berg and R Thompson of Ninham Shand Inc. in association with BKS Inc. as part of the Western Cape System Analysis. DWAF Report No. P G000/00/1790.

Department of Water Affairs and Forestry, South Africa. January 1994. *Western Cape System Analysis: Hydrology of the Riviersonderend Basin, Upper Molenaars and Elandspad River Catchments.* Prepared by Ninham Shand Inc. in association with BKS Inc. DWAF Report No. P G000/00/2791.

Department of Water Affairs and Forestry, South Africa. August 1994. *Western Cape System Analysis: Hydrology of the Diep River Basin.* Prepared by Ninham Shand Inc. in association with BKS Inc. DWAF Report No. P G000/00/3593.

Department of Water Affairs and Forestry, South Africa. 1995. *Breede River hydrological study. Hydrological Investigation: Calibration and Flow Generation*. Prepared by J M M Stassen on behalf of the Directorate: Project Planning. DWAF Report No. P H000/00/0892.

Department of Water Affairs and Forestry, South Africa. 2001. *Voëlvlei Augmentation Scheme Feasibility Study Hydrology Report*. DWAF Report No. PB G100/03/0799. Gibb Africa/FST.

Department of Water Affairs and Forestry, South Africa. June 2002. *Berg Water Management Area: Water Resources Situation Assessment.* Prepared by Ninham Shand (Pty) Ltd in association with Jakoet & Associates. DWAF Report No. P19000/00/0101.

Department of Water Affairs and Forestry, South Africa. 2003. *Hydrology.* Prepared by J. van Rensburg of Ninham Shand Inc. as part of the Breede River Basin Study. DWAF Report No. P H00/00/2402..

Department of Water Affairs and Forestry. 2004. *Groundwater Resource Assessment, Phase II Task 1 – Groundwater Quantification*, Version 2.0 Final.

Department of Water Affairs and Forestry, South Africa. 2007. *The Assessment of Water Availability in the Berg Catchment (WMA 19) by Means of Water Resource Related Models: Groundwater Modelling Report, Volume 3: Regional Conceptual Model*. Prepared by Umvoto Africa (Pty) Ltd in association with Ninham Shand (Pty) Ltd on behalf of the Directorate: National Water Resource Planning. DWAF Report No. P WMA19/000/00/0908.*(report to be submitted in subsequent phases of Berg WAAS).*

Department of Water Affairs and Forestry, South Africa. 2008a. *The Assessment of Water Availability in the Berg Catchment (WMA 19) by Means of Water Resource Related Models: Report 4, Volume 3: Land Use and Water Requirements: Water Use and Water Requirements.* Prepared by Ninham Shand (Pty) Ltd in association with Umvoto Africa on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA19/000/00/0908*. (report to be submitted in subsequent phases of Berg WAAS).*

Department of Water Affairs and Forestry, South Africa. 2008b. *The Assessment of Water Availability in the Berg Catchment (WMA 19) by Means of Water Resource Related Models: Report 5: Land Use and Water Requirements: Update of Catchment Hydrology.* Prepared by Ninham Shand (Pty) Ltd in association with Umvoto Africa on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA19/000/00/0908*. (report to be submitted in subsequent phases of Berg WAAS).*

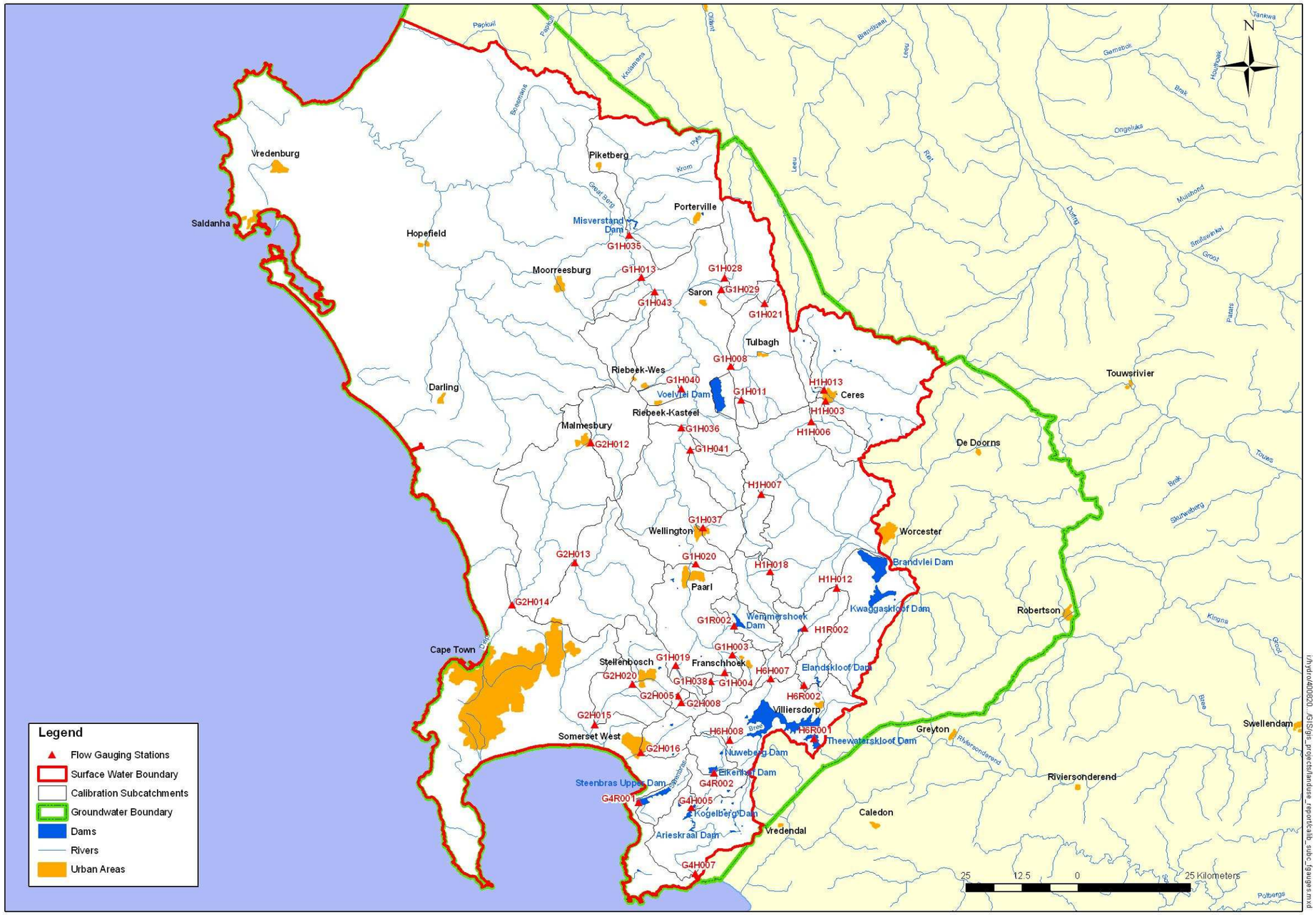
Midgley DC, Pitman WV and Middleton BJ. Water Research Commission. 1994. *Surface Water Resources of South Africa 1990*. WRC Report No. 298/4.1/94.

Mouski, F. 2007. Personal communication. Department of Water Affairs and Forestry, Western Cape Regional Office.

Ninham Shand Inc. 1997. *Hydrology*. Prepared by J Larsen on behalf of the Department of Water Affairs and Forestry as part of the Skuifraam Dam Feasibility Study. Report No. P G000/00/0796.

Van Zyl, G. 2007. Personal communication. Department of Water Affairs and Forestry, Western Cape Regional Office.

APPENDIX A
LAND USE PER CALIBRATION SUBCATCHMENT



Location of Streamflow Gauges used for Calibration in Berg WAAS

APPENDIX B
ABSTRACTION AND RETURN FLOW DATA

REF	BERG WAAS CALIBRATION GAUGE	DESCRIPTION	GAUGE/ RECORDER	TYPE
B.1.1	G1H008	Tulbagh and other urban abstractions	N.A.	Municipal abstraction
B.1.2		Tulbagh return flows to Klip River	N.A.	Wastewater effluent
B.2	G1H013	Twenty Four Rivers Irrigation Board abstraction from Twenty Four Rivers Canal	N.A.	Irrigation abstraction
B.3	G1H020	Paarl abstraction from Berg River	N.A	Municipal abstraction
B.4.1	G1H029	De Hoek Estates and Saron abstraction from Leeu River	N.A.	Municipal/Irrigation abstraction
B.4.2		De Hoek Estates return flows to Leeu River	N.A.	Irrigation return flows
B.5.1	G1H036	Perdeberg Irrigation Board Abstraction from Berg River	N.A.	Irrigation abstraction
B.5.2		Paarl and Wellington return flows to Berg River	N.A.	Wastewater effluent
B.6	G1H038	Robertsvlei abstraction from Wolwekloof River	N.A.	Domestic use
B.7	G2H037	Stellenbosch abstraction from Jonkershoek River	N.A.	Municipal abstraction
B.8	G2H012	Malmesbury return flows to Diep River	N.A.	Wastewater effluent
B.9	G2H015	Stellenbosch return flows to Eerste RIver	N.A.	Wastewater effluent
B.10	G2H020	Irrigation abstraction from Eerste River	G2H030	Irrigation abstraction
B.11.1	G4R002	Grabouw abstraction from Eikenhof Dam	G4H032	Municipal abstraction
B.11.2		Nuweberg Dam: Irrigation abstraction	N.A.	Irrigation abstraction
B.11.3		Eikenhof Dam: Elfco Pipeline	G4H027	Irrigation abstraction
B.11.4		Eikenhof Dam: Applegarth Pipeline	G4H026	Irrigation abstraction
B.11.5		Eikenhof Dam: Groenland Pipeline	G4H024	Irrigation abstraction
B.11.6		Eikenhof Dam: Highlands Pipeline	G4H025	Irrigation abstraction
B.11.7		Grootvlei Dam: Irrigation abstraction	N.A.	Irrigation abstraction
B.12.1	H1H003	Ben Etive Dam: Irrigation abstraction	N.A	Irrigation abstraction
B.12.2		Rooikloof Dam: Irrigation abstraction	N.A	Irrigation abstraction
B.12.3		Rietvlei Irrigation Board abstraction from Titus River	N.A	Irrigation abstraction
B.13	H1H012	Pipeline to Worcester from Stettynskloof Dam	H1H031	Municipal abstraction
B.14.1	H1H013	Ceres Dam: Domestic and Irrigation demand	N.A	Municipal/Irrigation abstraction
B.14.2		Ceres Power Station abstraction	N.A	Industrial abstraction

B.1.1

Tulbagh and other urban abstractions

File : TULBAGHA.ABS
Units : Mm3
Descrip. : Flows for 1990 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1991	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1992	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1993	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1994	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1995	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1996	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1997	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1998	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
1999	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
2000	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
2001	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
2002	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
2003	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
2004	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
AVE :	0.11	0.09	0.12	0.12	0.10	0.13	0.12	0.14	0.14	0.15	0.14	0.13	1.5
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

B.1.2

Return Flows from Tulbagh WWTW

File : TULBAGHR.RET
Units : Mm3
Descrip. : Flows for 1990 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.06	0.06	0.06	0.02	0.02	0.3
1991	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.2
1992	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.3
1993	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.2
1994	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.3
1995	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.04	0.04	0.3
1996	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.02	0.3
1997	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.3
1998	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.3
1999	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.3
2000	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.2
2001	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.2
2002	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03	0.3
2003	0.03	0.01	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.05	0.3
2004	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.3
AVE :	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.3
SD :	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.0

B.2

Twenty Four Rivers Irrigation Abstraction

File : 24RIV.NSI
Units : Mm3
Descrip. : *** for 1972 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1972	1.749	2.560	2.026	2.115	1.704	1.699	1.687	1.069	0.580	1.590	0.340	0.500	17.6
1973	1.741	2.041	2.382	2.011	1.621	1.787	1.775	0.745	1.010	0.380	0.000	0.000	15.5
1974	0.820	1.635	2.032	2.226	2.023	2.053	1.509	0.830	0.200	0.000	0.000	1.307	14.6
1975	1.651	2.060	2.433	2.175	1.854	1.771	1.016	0.513	0.620	0.000	0.000	0.836	14.9
1976	1.095	1.040	0.422	0.842	1.736	2.275	1.165	0.000	0.000	0.000	0.000	0.000	8.6
1977	1.621	2.106	2.081	2.534	2.362	2.258	1.585	1.126	0.871	1.493	1.220	0.000	19.2
1978	0.000	1.790	2.077	1.982	1.676	1.039	1.878	1.630	0.230	0.790	0.770	0.000	13.8
1979	0.000	2.173	1.721	2.749	2.062	2.002	1.155	0.000	1.030	1.235	1.290	1.486	16.9
1980	1.889	2.180	2.080	1.821	1.477	2.091	1.665	1.790	0.000	0.000	0.000	0.000	15.0
1981	1.636	1.832	1.924	2.925	1.887	0.701	1.894	1.155	1.640	1.110	1.470	1.286	19.4
1982	1.720	2.040	2.311	1.383	2.518	2.491	2.537	2.160	0.880	3.040	1.500	3.280	25.8
1983	2.620	2.737	2.395	2.278	1.986	2.128	2.120	1.020	1.176	0.180	0.280	1.350	20.2
1984	2.090	2.429	3.229	2.343	2.434	5.130	2.420	2.720	1.680	0.000	0.229	1.845	26.5
1985	2.629	2.570	2.803	2.346	1.958	2.340	2.087	2.030	2.870	1.800	0.000	0.736	24.1
1986	2.207	2.606	2.496	2.523	2.132	2.202	1.990	1.820	2.320	1.030	0.856	1.110	23.3
1987	1.924	2.422	2.340	2.486	1.991	2.043	2.121	2.250	2.610	0.592	0.787	1.030	22.6
1988	2.647	3.198	2.770	2.379	2.115	2.580	1.770	2.640	1.800	3.190	1.430	1.360	27.9
1989	2.470	2.784	3.118	2.743	2.239	2.193	1.951	2.070	1.330	0.000	0.501	2.356	23.7
1990	3.053	2.740	2.774	2.333	2.112	2.233	2.402	2.609	2.410	0.720	1.050	1.860	26.3
1991	3.200	3.020	3.069	2.349	2.385	2.788	2.460	2.260	1.110	3.310	5.960	6.440	38.3
1992	3.520	2.970	3.098	2.985	2.576	2.416	2.590	1.280	1.810	0.000	1.427	2.397	27.0
1993	3.320	3.165	2.810	2.112	1.774	1.938	2.024	1.823	0.000	0.000	0.250	1.300	20.5
1994	1.730	3.071	2.560	2.135	1.762	1.872	1.947	1.952	2.040	2.000	1.490	1.300	23.8
1995	1.590	3.059	3.626	3.062	2.390	2.383	2.536	2.398	0.910	0.560	0.830	0.000	23.3
1996	2.540	1.500	3.301	4.085	3.464	3.030	2.427	2.569	1.710	1.480	0.630	1.230	27.9
1997	3.176	2.930	2.872	2.431	2.308	2.372	2.389	1.954	1.694	0.485	0.550	2.237	25.4
1998	2.869	2.830	3.736	3.061	2.295	2.324	1.970	1.800	1.110	0.620	1.550	1.790	25.9
1999	3.106	3.732	3.977	3.341	2.560	2.373	2.228	2.351	0.710	1.270	2.230	2.130	30.0
2000	3.637	3.867	3.563	3.107	2.438	2.401	2.383	2.540	1.740	0.000	0.760	2.876	29.3
2001	2.973	3.732	4.019	3.329	2.972	2.881	2.487	2.330	1.950	1.790	0.818	1.703	30.9
2002	2.746	3.422	3.774	3.142	2.363	2.716	2.640	2.555	2.235	2.261	0.450	0.000	28.3
2003	2.646	3.645	3.711	2.949	2.463	2.473	2.586	2.707	2.536	2.931	2.330	3.468	34.4
2004	3.670	4.312	3.693	2.942	2.254	2.432	2.718	3.386	3.940	3.970	4.000	4.440	41.7
AVE :	2.25	2.67	2.76	2.52	2.17	2.28	2.06	1.82	1.42	1.15	1.06	1.56	23.7
SD :	0.94	0.74	0.78	0.61	0.41	0.69	0.45	0.82	0.92	1.14	1.22	1.40	7.2

B.3

Paarl abstraction from Berg River

File : PAARL.NSI
Units : Mm3
Descrip. : 80-88 (WCSA) 1989-1993 (VAFS) 1994-1999 monthly avg 2000-2004 Recorded for 1980 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	0.190	0.010	0.020	0.140	0.190	0.210	0.170	0.130	0.150	0.050	0.000	0.100	1.4
1981	0.000	0.000	0.000	0.090	0.000	0.040	0.100	0.120	0.070	0.130	0.110	0.210	0.9
1982	0.160	0.150	0.130	0.060	0.140	0.180	0.110	0.010	0.000	0.000	0.000	0.000	0.9
1983	0.000	0.000	0.040	0.100	0.130	0.050	0.000	0.040	0.110	0.080	0.160	0.090	0.8
1984	0.010	0.000	0.000	0.000	0.020	0.050	0.160	0.080	0.030	0.000	0.000	0.000	0.4
1985	0.000	0.000	0.000	0.000	0.030	0.140	0.040	0.000	0.030	0.000	0.000	0.000	0.2
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.010	0.0
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.090	0.060	0.000	0.2
1988	0.020	0.100	0.150	0.200	0.000	0.000	0.000	0.000	0.000	0.120	0.180	0.010	0.8
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1990	0.000	0.000	0.000	0.000	0.000	0.110	0.210	0.040	0.000	0.000	0.020	0.110	0.5
1991	0.200	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.2
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.090	0.1
1994	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
1995	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
1996	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
1997	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
1998	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
1999	0.040	0.020	0.020	0.040	0.040	0.060	0.060	0.030	0.040	0.030	0.040	0.040	0.5
2000	0.080	0.040	0.050	0.080	0.070	0.110	0.110	0.060	0.070	0.060	0.070	0.080	0.9
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2003	0.040	0.020	0.020	0.040	0.030	0.050	0.050	0.030	0.030	0.030	0.030	0.040	0.4
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
AVE :	0.04	0.02	0.02	0.04	0.03	0.05	0.05	0.03	0.03	0.03	0.03	0.04	0.4
SD :	0.06	0.03	0.04	0.05	0.05	0.06	0.06	0.04	0.04	0.04	0.05	0.05	0.4

B.4.1

De Hoek and Saron abstraction

File : SARON.NSI
Units : Mm3
Descrip. : 1975-1988 (WCSA) 1989-1996 (VAFS) 1997-2004 monthly average for 1975 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1975	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1976	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1977	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1978	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1979	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1980	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1981	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1982	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1983	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1984	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1985	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1986	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1987	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1988	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1989	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1990	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1991	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1992	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1993	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1994	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1995	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1996	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1997	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1998	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
1999	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
2000	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
2001	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
2002	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
2003	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
2004	0.380	0.340	0.340	0.300	0.260	0.300	0.300	0.450	0.450	0.450	0.450	0.450	4.5
AVE :	0.38	0.34	0.34	0.30	0.26	0.30	0.30	0.45	0.45	0.45	0.45	0.45	4.5
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

B.4.2

De Hoek and Saron return flows

File : SARON.RET
Units : Mm3
Descrip. : 1975-88 WCSA 1989-04 interpolated 2002-05 Municipality for Saron only for 1975 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1975	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1976	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1977	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1978	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1979	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1980	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1981	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1982	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1983	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1984	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1985	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1986	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1987	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1988	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1989	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1990	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1991	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1992	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1993	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1994	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1995	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1996	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1997	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1998	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
1999	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
2000	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
2001	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
2002	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
2003	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
2004	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
AVE :	0.15	0.08	0.08	0.08	0.08	0.08	0.11	0.23	0.23	0.23	0.23	0.23	1.8
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

B.5.1

Perdeberg Irrigation Board abstraction from Berg River

File : PERDBERG.NSI
Units : Mm3
Descrip. : 1984-1996 (VAFS) 1997-2004 (monthly avg) for 1984 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1984	0.210	0.380	0.390	0.390	0.350	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1985	0.210	0.380	0.390	0.390	0.350	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1986	0.210	0.380	0.390	0.390	0.350	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1987	0.210	0.380	0.390	0.390	0.370	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1988	0.210	0.380	0.390	0.390	0.350	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1989	0.210	0.030	0.450	0.450	0.370	0.380	0.000	0.000	0.000	0.000	0.000	0.000	1.9
1990	0.210	0.360	0.450	0.450	0.400	0.320	0.000	0.000	0.000	0.000	0.000	0.000	2.2
1991	0.210	0.060	0.440	0.420	0.350	0.320	0.000	0.000	0.000	0.000	0.000	0.000	1.8
1992	0.210	0.030	0.400	0.380	0.360	0.220	0.000	0.000	0.000	0.000	0.000	0.000	1.6
1993	0.210	0.420	0.420	0.420	0.420	0.420	0.000	0.000	0.000	0.000	0.000	0.000	2.3
1994	0.210	0.420	0.420	0.420	0.420	0.420	0.000	0.000	0.000	0.000	0.000	0.000	2.3
1995	0.210	0.380	0.380	0.380	0.380	0.380	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1996	0.210	0.380	0.390	0.390	0.350	0.390	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1997	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1998	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
1999	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
2000	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
2001	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
2002	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
2003	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
2004	0.210	0.310	0.410	0.400	0.370	0.370	0.000	0.000	0.000	0.000	0.000	0.000	2.1
AVE :	0.21	0.31	0.41	0.40	0.37	0.37	0.00	0.00	0.00	0.00	0.00	0.00	2.1
SD :	0.00	0.12	0.02	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.2

B.5.2

Paarl-Wellington return flows

File : PRLWELR.NSI
Units : Mm3
Descrip. : 1982-88 (WCSA) 1989-2001 interpolated 2002-05 records from Municipality for 1979 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1980	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1981	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1982	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1983	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1984	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1985	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1986	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1987	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1988	0.600	0.500	0.500	0.500	0.500	0.600	0.500	0.600	0.700	0.800	0.800	0.700	7.3
1989	0.617	0.514	0.514	0.514	0.514	0.617	0.514	0.617	0.720	0.822	0.822	0.720	7.5
1990	0.634	0.528	0.528	0.528	0.528	0.634	0.528	0.634	0.740	0.845	0.845	0.740	7.7
1991	0.652	0.543	0.543	0.543	0.543	0.652	0.543	0.652	0.760	0.869	0.869	0.760	7.9
1992	0.670	0.558	0.558	0.558	0.558	0.670	0.558	0.670	0.782	0.893	0.893	0.782	8.1
1993	0.689	0.574	0.574	0.574	0.574	0.689	0.574	0.689	0.803	0.918	0.918	0.803	8.3
1994	0.708	0.590	0.590	0.590	0.590	0.708	0.590	0.708	0.826	0.944	0.944	0.826	8.6
1995	0.728	0.606	0.606	0.606	0.606	0.728	0.606	0.728	0.849	0.970	0.970	0.849	8.8
1996	0.748	0.623	0.623	0.623	0.623	0.748	0.623	0.748	0.873	0.997	0.997	0.873	9.0
1997	0.769	0.641	0.641	0.641	0.641	0.769	0.641	0.769	0.897	1.025	1.025	0.897	9.3
1998	0.791	0.659	0.659	0.659	0.659	0.791	0.659	0.791	0.922	1.054	1.054	0.922	9.6
1999	0.813	0.677	0.677	0.677	0.677	0.813	0.677	0.813	0.948	1.083	1.083	0.948	9.8
2000	0.835	0.696	0.696	0.696	0.696	0.835	0.696	0.835	0.975	1.114	1.114	0.975	10.1
2001	0.859	0.716	0.716	0.716	0.716	0.859	0.716	0.859	1.002	1.145	1.145	1.002	10.4
2002	0.485	0.593	0.622	0.744	0.748	0.633	1.055	1.047	1.057	1.555	2.013	2.271	12.8
2003	0.119	0.152	0.172	0.195	0.258	0.248	0.520	1.576	1.500	1.354	1.352	1.552	8.9
2004	0.731	0.886	0.906	0.920	0.929	0.790	0.760	0.640	0.632	0.604	0.582	0.617	9.0
AVE :	0.64	0.56	0.56	0.57	0.57	0.66	0.58	0.72	0.82	0.93	0.94	0.86	8.4
SD :	0.14	0.12	0.12	0.13	0.12	0.12	0.12	0.20	0.18	0.20	0.27	0.34	1.3

B.6

Robertsvlei Abstraction

File : RVLEI.NSI
Units : Mm3
Descrip. : Estimated for 1959 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1959	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1960	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1961	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1962	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1963	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1964	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1965	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1966	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1967	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1968	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1969	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1970	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1971	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1972	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1973	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1974	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1975	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1976	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1977	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1978	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1979	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1980	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1981	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1982	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1983	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1984	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1985	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1986	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1987	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1988	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1989	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1990	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1991	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1992	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1993	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1994	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1995	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1996	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1997	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1998	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
1999	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
2000	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
2001	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
2002	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
2003	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
2004	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	2.2
AVE :	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	2.2
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Stellenbosch Municipality Abstraction

File : SBOSCH.NSI
Units : Mm3
Descrip. : 1947-88 WCSA 1989-2000 interpolate 2001-04 Observed data for 1947 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1947	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1948	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1949	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1950	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1951	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1952	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1953	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1954	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1955	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1956	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1957	0.110	0.110	0.060	0.030	0.050	0.030	0.110	0.110	0.110	0.110	0.110	0.110	1.0
1958	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1959	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1960	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1961	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1962	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1963	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1964	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1965	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1966	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1967	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1968	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1969	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1970	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1971	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1972	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1973	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1974	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1975	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1976	0.320	0.180	0.090	0.050	0.070	0.050	0.190	0.440	0.440	0.440	0.440	0.440	3.1
1977	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1978	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1979	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1980	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1981	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1982	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1983	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1984	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1985	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1986	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1987	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1988	0.470	0.260	0.130	0.080	0.100	0.080	0.290	0.780	1.020	1.020	1.020	0.650	5.9
1989	0.430	0.240	0.120	0.070	0.090	0.070	0.270	0.720	0.940	0.940	0.940	0.600	5.4
1990	0.390	0.220	0.110	0.070	0.080	0.070	0.240	0.650	0.850	0.850	0.850	0.540	4.9
1991	0.350	0.200	0.100	0.060	0.080	0.060	0.220	0.590	0.770	0.770	0.770	0.490	4.5
1992	0.310	0.170	0.090	0.050	0.070	0.050	0.190	0.520	0.680	0.680	0.680	0.430	3.9
1993	0.270	0.150	0.080	0.050	0.060	0.050	0.170	0.460	0.600	0.600	0.600	0.380	3.5
1994	0.240	0.130	0.070	0.040	0.050	0.040	0.150	0.390	0.510	0.510	0.510	0.330	3.0
1995	0.200	0.110	0.050	0.030	0.040	0.030	0.120	0.330	0.430	0.430	0.430	0.270	2.5
1996	0.160	0.090	0.040	0.030	0.030	0.030	0.100	0.260	0.340	0.340	0.340	0.220	2.0
1997	0.120	0.070	0.030	0.020	0.030	0.020	0.070	0.200	0.260	0.260	0.260	0.160	1.5
1998	0.080	0.040	0.020	0.010	0.020	0.010	0.050	0.130	0.170	0.170	0.170	0.110	1.0
1999	0.040	0.020	0.010	0.010	0.010	0.010	0.020	0.070	0.090	0.090	0.090	0.050	0.5
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2001	0.650	0.650	0.550	0.610	0.420	0.200	0.010	0.560	0.230	0.200	0.170	0.210	4.5
2002	0.180	0.220	0.150	0.190	0.170	0.320	0.220	0.600	0.680	0.520	0.560	0.570	4.4
2003	0.690	0.580	0.390	0.880	0.920	0.860	0.640	0.650	0.570	0.570	0.620	0.680	8.1
2004	0.730	0.770	0.850	0.060	0.080	0.060	0.250	0.510	0.570	0.510	0.440	0.090	4.9
AVE :	0.31	0.20	0.11	0.08	0.09	0.07	0.19	0.44	0.51	0.50	0.50	0.39	3.4
SD :	0.16	0.13	0.13	0.13	0.12	0.11	0.10	0.24	0.33	0.33	0.33	0.21	1.9

Return Flows from Malmesbury WWTW

File : MALMESB.RET
Units : Mm3
Descrip. : Flows for 1960 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1960	0.09	0.03	0.03	0.01	0.03	0.03	0.02	0.04	0.04	0.01	0.04	0.03	0.4
1961	0.09	0.04	0.04	0.01	0.03	0.04	0.03	0.04	0.04	0.01	0.04	0.03	0.4
1962	0.10	0.04	0.04	0.01	0.03	0.04	0.03	0.04	0.04	0.01	0.04	0.04	0.5
1963	0.10	0.04	0.04	0.01	0.04	0.04	0.03	0.04	0.04	0.01	0.04	0.04	0.5
1964	0.11	0.04	0.04	0.01	0.04	0.04	0.03	0.04	0.04	0.01	0.05	0.04	0.5
1965	0.11	0.04	0.04	0.01	0.04	0.04	0.03	0.04	0.05	0.01	0.05	0.04	0.5
1966	0.11	0.05	0.04	0.01	0.04	0.04	0.03	0.05	0.05	0.01	0.05	0.04	0.5
1967	0.12	0.05	0.05	0.01	0.04	0.05	0.03	0.05	0.05	0.01	0.05	0.04	0.6
1968	0.12	0.05	0.05	0.01	0.04	0.05	0.03	0.05	0.05	0.01	0.05	0.05	0.6
1969	0.13	0.05	0.05	0.01	0.05	0.05	0.04	0.05	0.05	0.01	0.05	0.05	0.6
1970	0.13	0.05	0.05	0.01	0.05	0.05	0.04	0.05	0.06	0.01	0.06	0.05	0.6
1971	0.14	0.05	0.05	0.01	0.05	0.05	0.04	0.05	0.06	0.01	0.06	0.05	0.6
1972	0.14	0.06	0.05	0.01	0.05	0.06	0.04	0.06	0.06	0.01	0.06	0.05	0.7
1973	0.14	0.06	0.06	0.01	0.05	0.06	0.04	0.06	0.06	0.01	0.06	0.05	0.7
1974	0.15	0.06	0.06	0.01	0.05	0.06	0.04	0.06	0.06	0.01	0.06	0.06	0.7
1975	0.15	0.06	0.06	0.01	0.06	0.06	0.04	0.06	0.06	0.01	0.07	0.06	0.7
1976	0.16	0.06	0.06	0.01	0.06	0.06	0.04	0.06	0.07	0.01	0.07	0.06	0.7
1977	0.16	0.06	0.06	0.01	0.06	0.06	0.05	0.06	0.07	0.01	0.07	0.06	0.7
1978	0.17	0.07	0.06	0.01	0.06	0.07	0.05	0.07	0.07	0.01	0.07	0.06	0.8
1979	0.17	0.07	0.07	0.01	0.06	0.07	0.05	0.07	0.07	0.01	0.07	0.06	0.8
1980	0.18	0.07	0.07	0.01	0.06	0.07	0.05	0.07	0.07	0.01	0.08	0.07	0.8
1981	0.18	0.07	0.07	0.01	0.07	0.07	0.05	0.07	0.08	0.01	0.08	0.07	0.8
1982	0.18	0.07	0.07	0.01	0.07	0.07	0.05	0.07	0.08	0.01	0.08	0.07	0.8
1983	0.19	0.08	0.07	0.01	0.07	0.07	0.05	0.08	0.08	0.01	0.08	0.07	0.9
1984	0.19	0.08	0.08	0.01	0.07	0.08	0.05	0.08	0.08	0.01	0.08	0.07	0.9
1985	0.20	0.08	0.08	0.01	0.07	0.08	0.06	0.08	0.08	0.01	0.09	0.07	0.9
1986	0.20	0.08	0.08	0.01	0.07	0.08	0.06	0.08	0.09	0.01	0.09	0.08	0.9
1987	0.21	0.08	0.08	0.01	0.07	0.08	0.06	0.08	0.09	0.01	0.09	0.08	0.9
1988	0.21	0.08	0.08	0.02	0.08	0.08	0.06	0.08	0.09	0.02	0.09	0.08	1.0
1989	0.22	0.09	0.08	0.02	0.08	0.08	0.06	0.09	0.09	0.02	0.09	0.08	1.0
1990	0.22	0.09	0.09	0.02	0.08	0.09	0.06	0.09	0.09	0.02	0.09	0.08	1.0
1991	0.22	0.09	0.09	0.02	0.08	0.09	0.06	0.09	0.09	0.02	0.10	0.08	1.0
1992	0.23	0.09	0.09	0.02	0.08	0.09	0.06	0.09	0.10	0.02	0.10	0.09	1.1
1993	0.23	0.09	0.09	0.02	0.08	0.09	0.07	0.09	0.10	0.02	0.10	0.09	1.1
1994	0.24	0.09	0.09	0.02	0.09	0.09	0.07	0.09	0.10	0.02	0.10	0.09	1.1
1995	0.24	0.10	0.09	0.02	0.09	0.09	0.07	0.10	0.10	0.02	0.10	0.09	1.1
1996	0.25	0.10	0.10	0.02	0.09	0.10	0.07	0.10	0.10	0.02	0.11	0.09	1.2
1997	0.25	0.10	0.10	0.02	0.09	0.10	0.07	0.10	0.11	0.02	0.11	0.09	1.2
1998	0.25	0.10	0.10	0.02	0.09	0.10	0.07	0.10	0.11	0.02	0.11	0.10	1.2
1999	0.26	0.10	0.10	0.02	0.09	0.10	0.07	0.10	0.11	0.02	0.11	0.10	1.2
2000	0.26	0.10	0.10	0.02	0.10	0.10	0.07	0.11	0.11	0.02	0.11	0.10	1.2
2001	0.11	0.10	0.10	0.02	0.09	0.11	0.08	0.09	0.09	0.02	0.07	0.07	0.9
2002	0.89	0.09	0.09	0.02	0.08	0.09	0.08	0.10	0.11	0.02	0.14	0.12	1.8
2003	0.03	0.11	0.11	0.02	0.11	0.11	0.11	0.11	0.12	0.02	0.13	0.11	1.1
2004	0.02	0.12	0.11	0.02	0.09	0.10	0.02	0.11	0.13	0.02	0.11	0.10	1.0
AVE :	0.18	0.07	0.07	0.01	0.07	0.07	0.05	0.07	0.08	0.01	0.08	0.07	0.8
SD :	0.12	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.02	0.00	0.03	0.02	0.3

Return Flows from Stellenbosch Municipality

File : STEL.NSI
Units : Mm3
Descrip. : 1978-88 WCSA 1989-03 Interpolated 2004 Observed at WWTW for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.268	0.259	0.221	0.264	0.238	0.253	0.245	0.267	0.325	0.253	0.241	0.307	3.1
1979	0.352	0.358	0.283	0.318	0.316	0.343	0.322	0.361	0.373	0.401	0.402	0.353	4.1
1980	0.303	0.314	0.307	0.308	0.307	0.321	0.308	0.306	0.297	0.431	0.519	0.439	4.1
1981	0.261	0.297	0.264	0.266	0.267	0.308	0.297	0.300	0.307	0.326	0.395	0.302	3.5
1982	0.289	0.268	0.251	0.239	0.269	0.310	0.259	0.353	0.394	0.444	0.366	0.311	3.7
1983	0.274	0.246	0.219	0.237	0.253	0.288	0.259	0.396	0.293	0.383	0.422	0.374	3.6
1984	0.371	0.268	0.253	0.243	0.327	0.303	0.273	0.279	0.371	0.419	0.413	0.298	3.8
1985	0.274	0.273	0.242	0.246	0.258	0.291	0.282	0.299	0.272	0.300	0.566	0.430	3.7
1986	0.361	0.335	0.281	0.293	0.273	0.308	0.278	0.316	0.326	0.375	0.409	0.371	3.9
1987	0.307	0.287	0.252	0.213	0.222	0.310	0.270	0.278	0.294	0.385	0.357	0.436	3.6
1988	0.313	0.253	0.204	0.263	0.277	0.356	0.263	0.321	0.331	0.409	0.409	0.456	3.8
1989	0.324	0.237	0.194	0.273	0.289	0.363	0.275	0.326	0.329	0.406	0.404	0.452	3.8
1990	0.336	0.222	0.183	0.283	0.301	0.371	0.287	0.331	0.327	0.403	0.399	0.449	3.8
1991	0.347	0.206	0.173	0.292	0.313	0.378	0.300	0.336	0.325	0.400	0.394	0.445	3.9
1992	0.358	0.190	0.163	0.302	0.324	0.385	0.312	0.341	0.323	0.397	0.389	0.442	3.9
1993	0.370	0.174	0.153	0.312	0.336	0.393	0.324	0.346	0.321	0.394	0.384	0.438	3.9
1994	0.381	0.159	0.142	0.322	0.348	0.400	0.336	0.351	0.319	0.391	0.379	0.434	3.9
1995	0.393	0.143	0.132	0.332	0.360	0.407	0.348	0.356	0.317	0.389	0.374	0.431	3.9
1996	0.404	0.127	0.122	0.341	0.372	0.415	0.360	0.361	0.315	0.386	0.369	0.427	4.0
1997	0.415	0.112	0.112	0.351	0.384	0.422	0.373	0.366	0.313	0.383	0.364	0.423	4.0
1998	0.427	0.096	0.101	0.361	0.395	0.429	0.385	0.371	0.311	0.380	0.359	0.420	4.0
1999	0.438	0.080	0.091	0.371	0.407	0.436	0.397	0.376	0.308	0.377	0.354	0.416	4.0
2000	0.449	0.065	0.081	0.380	0.419	0.444	0.409	0.381	0.306	0.374	0.349	0.413	4.0
2001	0.461	0.049	0.070	0.390	0.431	0.451	0.421	0.386	0.304	0.371	0.343	0.409	4.1
2002	0.472	0.033	0.060	0.400	0.443	0.458	0.434	0.391	0.302	0.368	0.338	0.405	4.1
2003	0.483	0.017	0.050	0.410	0.455	0.466	0.446	0.396	0.300	0.365	0.333	0.402	4.1
2004	0.495	0.002	0.040	0.420	0.466	0.473	0.458	0.401	0.298	0.362	0.328	0.398	4.1
AVE :	0.36	0.18	0.17	0.31	0.33	0.37	0.33	0.34	0.31	0.38	0.38	0.40	3.9
SD :	0.07	0.10	0.08	0.06	0.07	0.06	0.06	0.04	0.03	0.04	0.06	0.05	0.2

B.10

G2H030: Canal from Eerste River

File : G2H030.NSI
Units : Mm3
Descrip. : From DWAF for 1976 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1976	0.062	0.138	0.081	0.011	0.087	0.230	0.108	0.012	0.021	0.021	0.016	0.022	0.8
1977	0.131	0.230	0.287	0.322	0.258	0.250	0.045	0.061	0.114	0.190	0.300	0.167	2.3
1978	0.217	0.219	0.228	0.265	0.215	0.261	0.213	0.083	0.185	0.253	0.362	0.292	2.7
1979	0.423	0.337	0.310	0.305	0.124	0.079	0.125	0.016	0.007	0.152	0.117	0.165	2.1
1980	0.160	0.258	0.117	0.056	0.151	0.117	0.111	0.031	0.078	0.017	0.034	0.072	1.2
1981	0.067	0.130	0.261	0.118	0.111	0.162	0.155	0.023	0.071	0.053	0.088	0.073	1.3
1982	0.210	0.365	0.319	0.260	0.242	0.193	0.199	0.071	0.121	0.029	0.039	0.060	2.1
1983	0.036	0.209	0.276	0.176	0.157	0.230	0.128	0.074	0.107	0.063	0.098	0.046	1.5
1984	0.038	0.183	0.235	0.244	0.242	0.230	0.128	0.013	0.068	0.065	0.133	0.101	1.6
1985	0.110	0.201	0.183	0.238	0.165	0.188	0.226	0.074	0.019	0.013	0.010	0.019	1.4
1986	0.075	0.121	0.183	0.279	0.316	0.237	0.164	0.019	0.094	0.011	0.008	0.009	1.5
1987	0.009	0.246	0.465	0.312	0.252	0.120	0.069	0.069	0.010	0.099	0.173	0.124	1.9
1988	0.374	0.371	0.405	0.267	0.517	0.339	0.019	0.078	0.010	0.013	0.016	0.014	2.4
1989	0.009	0.283	0.315	0.377	0.289	0.292	0.176	0.103	0.045	0.009	0.177	0.153	2.2
1990	0.282	0.318	0.558	0.569	0.472	0.422	0.249	0.188	0.083	0.035	0.105	0.113	3.3
1991	0.200	0.047	0.311	0.373	0.341	0.299	0.189	0.155	0.085	0.192	0.274	0.076	2.5
1992	0.119	0.202	0.353	0.462	0.338	0.230	0.119	0.018	0.068	0.065	0.015	0.108	2.0
1993	0.310	0.332	0.328	0.326	0.248	0.319	0.068	0.189	0.010	0.014	0.007	0.137	2.2
1994	0.059	0.258	0.349	0.429	0.345	0.240	0.118	0.087	0.058	0.018	0.158	0.274	2.3
1995	0.203	0.210	0.202	0.230	0.215	0.139	0.041	0.027	0.024	0.015	0.038	0.063	1.4
1996	0.051	0.106	0.070	0.165	0.146	0.173	0.081	0.030	0.086	0.024	0.057	0.098	1.0
1997	0.309	0.202	0.296	0.387	0.296	0.360	0.337	0.094	0.096	0.167	0.139	0.174	2.8
1998	0.228	0.186	0.175	0.337	0.197	0.224	0.208	0.215	0.193	0.159	0.106	0.034	2.2
1999	0.071	0.218	0.229	0.188	0.152	0.120	0.142	0.143	0.066	0.030	0.101	0.052	1.5
2000	0.073	0.135	0.188	0.288	0.260	0.357	0.096	0.091	0.073	0.015	0.012	0.022	1.6
2001	0.036	0.048	0.259	0.073	0.133	0.186	0.012	0.008	0.013	0.006	0.013	0.020	0.8
2002	0.019	0.045	0.228	0.229	0.112	0.179	0.009	0.116	0.013	0.104	0.033	0.068	1.1
2003	0.027	0.156	0.185	0.285	0.278	0.167	0.084	0.015	0.126	0.039	0.040	0.063	1.4
2004	0.051	0.105	0.166	0.170	0.266	0.326	0.082	0.037	0.018	0.009	0.045	0.006	1.2
AVE :	0.13	0.20	0.26	0.26	0.23	0.23	0.12	0.07	0.06	0.06	0.09	0.09	1.8
SD :	0.12	0.09	0.11	0.12	0.10	0.08	0.08	0.06	0.05	0.07	0.09	0.07	0.6

B.11.1

Grabouw abstraction from Palmiet River

File : GRABOUW.NSI
Units : Mm3
Descrip. : 1978-87 WCSA 1988-91 Linear interpolation 1992-04 for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.020	0.030	0.030	0.040	0.040	0.030	0.030	0.020	0.020	0.020	0.020	0.020	0.3
1979	0.020	0.030	0.030	0.040	0.040	0.040	0.030	0.030	0.020	0.020	0.020	0.020	0.3
1980	0.020	0.040	0.040	0.040	0.040	0.040	0.030	0.030	0.020	0.020	0.020	0.020	0.4
1981	0.030	0.040	0.040	0.040	0.050	0.040	0.030	0.030	0.020	0.020	0.020	0.020	0.4
1982	0.030	0.030	0.030	0.040	0.030	0.030	0.030	0.030	0.020	0.020	0.020	0.020	0.3
1983	0.030	0.050	0.030	0.050	0.060	0.060	0.050	0.030	0.030	0.040	0.040	0.040	0.5
1984	0.040	0.060	0.060	0.050	0.050	0.040	0.040	0.030	0.030	0.030	0.030	0.030	0.5
1985	0.030	0.050	0.050	0.080	0.060	0.070	0.060	0.040	0.040	0.040	0.040	0.040	0.6
1986	0.030	0.030	0.040	0.070	0.040	0.040	0.030	0.040	0.030	0.030	0.030	0.030	0.4
1987	0.030	0.040	0.040	0.050	0.060	0.050	0.040	0.040	0.030	0.020	0.020	0.020	0.4
1988	0.040	0.040	0.050	0.060	0.060	0.060	0.050	0.050	0.030	0.030	0.030	0.030	0.5
1989	0.050	0.050	0.060	0.070	0.070	0.070	0.050	0.050	0.040	0.040	0.040	0.050	0.6
1990	0.070	0.050	0.070	0.080	0.070	0.080	0.060	0.060	0.040	0.050	0.040	0.060	0.7
1991	0.080	0.050	0.080	0.090	0.080	0.090	0.060	0.060	0.040	0.060	0.050	0.080	0.8
1992	0.090	0.060	0.090	0.100	0.080	0.100	0.070	0.070	0.050	0.060	0.060	0.090	0.9
1993	0.090	0.080	0.090	0.100	0.100	0.100	0.090	0.070	0.000	0.000	0.050	0.070	0.8
1994	0.070	0.090	0.110	0.000	0.100	0.110	0.080	0.080	0.060	0.070	0.010	0.060	0.8
1995	0.070	0.090	0.100	0.100	0.090	0.110	0.090	0.080	0.080	0.060	0.080	0.060	1.0
1996	0.100	0.050	0.100	0.110	0.090	0.110	0.080	0.080	0.080	0.640	0.400	0.190	2.0
1997	0.200	0.020	0.060	0.100	0.120	0.110	0.120	0.090	0.070	0.080	0.070	0.090	1.1
1998	0.040	0.120	0.120	0.100	0.100	0.050	0.050	0.080	0.180	0.000	0.060	0.090	1.0
1999	0.060	0.080	0.180	0.140	0.140	0.140	0.110	0.120	0.090	0.090	0.090	0.090	1.3
2000	0.110	0.130	0.130	0.140	0.130	0.130	0.130	0.090	0.080	0.070	0.090	0.090	1.3
2001	0.090	0.080	0.080	0.110	0.080	0.160	0.130	0.080	0.100	0.160	0.120	0.120	1.3
2002	0.120	0.140	0.100	0.160	0.170	0.130	0.100	0.000	0.000	0.000	0.110	0.050	1.1
2003	0.040	0.040	0.090	0.090	0.070	0.120	0.120	0.050	0.050	0.050	0.040	0.050	0.8
2004	0.080	0.050	0.050	0.050	0.060	0.050	0.040	0.040	0.040	0.040	0.050	0.120	0.7
AVE :	0.06	0.06	0.07	0.08	0.08	0.08	0.07	0.05	0.05	0.07	0.06	0.06	0.8
SD :	0.04	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.12	0.07	0.04	0.4

B.11.2

Irrigation abstraction from Nuweberg Dam

File : NUWEBERG.NSI
Units : Mm3
Descrip. : 1978-87 WCSA 1988-04 Monthly average for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.000	0.480	0.810	1.040	0.790	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.6
1979	0.000	0.360	0.680	1.150	0.470	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.1
1980	0.000	0.520	0.630	1.040	0.790	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.4
1981	0.000	0.480	0.810	1.040	0.790	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.6
1982	0.000	0.540	0.560	0.660	0.630	0.280	0.000	0.000	0.000	0.000	0.000	0.000	2.7
1983	0.000	0.480	0.810	0.860	1.020	0.350	0.000	0.000	0.000	0.000	0.000	0.000	3.5
1984	0.000	0.520	0.600	0.660	0.470	0.410	0.000	0.000	0.000	0.000	0.000	0.000	2.7
1985	0.360	0.680	0.970	0.920	1.010	0.570	0.000	0.000	0.000	0.000	0.000	0.000	4.5
1986	0.000	0.480	0.810	1.040	0.790	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.6
1987	0.000	0.480	0.740	1.640	1.120	0.410	0.000	0.000	0.000	0.000	0.000	0.000	4.4
1988	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1989	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1990	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1991	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1992	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1993	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1994	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1995	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1996	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1997	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1998	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
1999	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
2000	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
2001	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
2002	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
2003	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
2004	0.070	0.530	0.790	1.020	0.880	0.430	0.000	0.000	0.000	0.000	0.000	0.000	3.7
AVE :	0.06	0.52	0.77	1.01	0.85	0.43	0.00	0.00	0.00	0.00	0.00	0.00	3.6
SD :	0.07	0.05	0.08	0.16	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.4

B.11.3

G4H027: Elfco Pipeline abstraction from Eikenhof Dam

File : ELFCO.NSI
Units : Mm3
Descrip. : From DWAF for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.010	0.010	0.030	0.020	0.010	0.010	0.010	0.010	0.010	0.000	0.010	0.010	0.1
1979	0.010	0.010	0.000	0.000	0.010	0.010	0.020	0.020	0.010	0.000	0.000	0.000	0.1
1980	0.000	0.010	0.010	0.010	0.010	0.020	0.020	0.020	0.010	0.010	0.010	0.010	0.1
1981	0.010	0.010	0.010	0.010	0.010	0.030	0.020	0.020	0.010	0.010	0.010	0.010	0.2
1982	0.010	0.010	0.010	0.010	0.010	0.020	0.020	0.010	0.010	0.010	0.010	0.010	0.1
1983	0.010	0.010	0.010	0.020	0.020	0.020	0.020	0.020	0.020	0.010	0.010	0.010	0.2
1984	0.010	0.010	0.010	0.010	0.010	0.020	0.020	0.000	0.020	0.020	0.020	0.020	0.2
1985	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.2
1986	0.030	0.010	0.010	0.010	0.030	0.020	0.020	0.010	0.010	0.010	0.010	0.010	0.2
1987	0.000	0.000	0.000	0.010	0.020	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.1
1988	0.010	0.010	0.010	0.000	0.000	0.010	0.010	0.010	0.010	0.000	0.010	0.010	0.1
1989	0.000	0.000	0.000	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.1
1990	0.010	0.010	0.000	0.010	0.000	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.1
1991	0.000	0.000	0.000	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.1
1992	0.010	0.010	0.000	0.000	0.000	0.010	0.010	0.010	0.010	0.000	0.010	0.010	0.1
1993	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.000	0.010	0.000	0.000	0.1
1994	0.010	0.010	0.010	0.000	0.010	0.020	0.010	0.010	0.010	0.000	0.000	0.000	0.1
1995	0.000	0.000	0.000	0.010	0.010	0.010	0.010	0.010	0.010	0.000	0.010	0.000	0.1
1996	0.010	0.000	0.010	0.010	0.010	0.020	0.010	0.020	0.010	0.000	0.010	0.000	0.1
1997	0.000	0.010	0.000	0.010	0.010	0.020	0.020	0.010	0.000	0.020	0.010	0.010	0.1
1998	0.000	0.010	0.010	0.010	0.010	0.030	0.020	0.010	0.020	0.010	0.010	0.010	0.2
1999	0.010	0.010	0.010	0.010	0.020	0.020	0.010	0.010	0.010	0.010	0.000	0.010	0.1
2000	0.010	0.010	0.010	0.010	0.020	0.020	0.020	0.010	0.020	0.010	0.010	0.010	0.2
2001	0.010	0.010	0.010	0.010	0.010	0.020	0.010	0.010	0.010	0.020	0.010	0.010	0.1
2002	0.010	0.010	0.010	0.010	0.010	0.020	0.020	0.010	0.010	0.020	0.010	0.010	0.2
2003	0.010	0.010	0.010	0.010	0.010	0.020	0.020	0.010	0.010	0.010	0.010	0.010	0.1
2004	0.010	0.010	0.010	0.010	0.010	0.020	0.010	0.010	0.010	0.010	0.010	0.010	0.1
AVE :	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.1
SD :	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.0

B.11.4

G4H026: Applegarth Pipeline abstraction from Eikenhof Dam

File : APPLEG.NSI
Units : Mm3
Descrip. : From DWAF for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.020	0.060	0.060	0.080	0.060	0.030	0.050	0.010	0.010	0.000	0.000	0.000	0.4
1979	0.010	0.080	0.080	0.110	0.060	0.080	0.010	0.010	0.010	0.010	0.010	0.020	0.5
1980	0.030	0.020	0.030	0.080	0.040	0.050	0.010	0.010	0.010	0.000	0.000	0.000	0.3
1981	0.030	0.100	0.070	0.100	0.070	0.060	0.020	0.000	0.000	0.010	0.010	0.010	0.5
1982	0.010	0.090	0.080	0.110	0.040	0.010	0.060	0.010	0.010	0.000	0.010	0.000	0.4
1983	0.020	0.090	0.090	0.110	0.090	0.020	0.050	0.000	0.000	0.000	0.010	0.010	0.5
1984	0.010	0.090	0.040	0.090	0.060	0.010	0.010	0.000	0.000	0.000	0.000	0.010	0.3
1985	0.010	0.060	0.050	0.020	0.060	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.3
1986	0.010	0.060	0.070	0.070	0.080	0.050	0.050	0.000	0.010	0.000	0.000	0.030	0.4
1987	0.010	0.100	0.110	0.130	0.150	0.660	0.010	0.010	0.000	0.000	0.000	0.000	1.2
1988	0.000	0.100	0.120	0.140	0.120	0.020	0.110	0.000	0.010	0.010	0.010	0.020	0.7
1989	0.010	0.020	0.130	0.140	0.100	0.080	0.050	0.010	0.010	0.000	0.010	0.010	0.6
1990	0.020	0.070	0.090	0.140	0.140	0.120	0.070	0.020	0.000	0.010	0.000	0.000	0.7
1991	0.010	0.070	0.100	0.170	0.150	0.140	0.030	0.010	0.000	0.000	0.030	0.010	0.7
1992	0.010	0.020	0.150	0.180	0.130	0.140	0.030	0.020	0.000	0.010	0.000	0.010	0.7
1993	0.020	0.050	0.070	0.150	0.130	0.110	0.060	0.000	0.000	0.000	0.000	0.000	0.6
1994	0.060	0.080	0.020	0.070	0.070	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.3
1995	0.000	0.020	0.020	0.030	0.030	0.060	0.040	0.000	0.000	0.000	0.000	0.000	0.2
1996	0.000	0.000	0.050	0.120	0.130	0.060	0.000	0.000	0.010	0.000	0.000	0.000	0.4
1997	0.000	0.030	0.020	0.040	0.040	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.2
1998	0.000	0.020	0.040	0.060	0.070	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.2
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2000	0.020	0.020	0.070	0.090	0.080	0.080	0.030	0.000	0.000	0.000	0.000	0.000	0.4
2001	0.020	0.050	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.1
2002	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2003	0.000	0.060	0.120	0.120	0.100	0.090	0.090	0.000	0.000	0.000	0.000	0.000	0.6
2004	0.090	0.080	0.130	0.130	0.120	0.110	0.020	0.010	0.000	0.000	0.000	0.000	0.7
AVE :	0.02	0.05	0.07	0.09	0.08	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.4
SD :	0.02	0.03	0.04	0.05	0.04	0.12	0.03	0.01	0.00	0.00	0.01	0.01	0.3

B.11.5

G4H024: Groenland Pipeline abstraction from Eikenhof Dam

File : GROENLD.NSI
Units : Mm3
Descrip. : From DWAF for 1978 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0.260	1.220	1.780	1.950	1.840	1.530	1.300	0.360	0.060	0.010	0.150	1.010	11.5
1979	1.130	1.440	1.940	2.220	2.000	2.110	0.890	0.260	0.090	0.030	0.190	1.170	13.5
1980	1.490	1.290	1.470	1.910	1.530	1.780	0.990	0.160	0.050	0.040	0.050	0.220	11.0
1981	0.710	1.880	2.140	2.160	1.970	2.060	0.820	0.190	0.350	0.320	1.010	1.620	15.2
1982	1.740	1.860	2.030	2.070	1.890	1.770	1.520	0.550	0.510	0.250	0.270	0.310	14.8
1983	0.630	1.830	2.230	2.260	2.270	2.140	0.180	0.110	0.150	0.530	0.720	0.800	13.8
1984	0.730	1.640	1.780	1.950	1.780	1.090	0.670	0.110	0.250	0.480	0.570	0.970	12.0
1985	1.310	1.500	1.970	1.940	1.810	1.860	0.910	0.630	0.730	0.740	0.800	0.790	15.0
1986	1.100	1.730	2.090	2.310	2.000	2.170	1.470	0.900	0.990	1.020	0.990	0.970	17.7
1987	0.220	1.720	2.230	2.240	2.200	2.160	1.380	0.250	0.840	0.700	0.930	0.900	15.8
1988	1.400	1.960	2.800	3.080	2.820	2.460	0.760	0.500	0.760	0.750	0.480	0.280	18.1
1989	0.390	1.800	2.770	3.020	2.620	2.730	1.700	0.280	0.140	0.130	0.340	0.450	16.4
1990	1.550	2.480	2.940	3.040	2.620	2.730	2.350	1.100	0.380	0.380	0.990	0.410	21.0
1991	0.910	0.980	2.740	2.850	2.610	3.000	1.530	0.260	0.130	0.350	0.790	0.910	17.1
1992	0.490	0.930	2.600	2.940	2.620	2.710	0.930	0.190	0.180	0.150	0.180	0.850	14.8
1993	0.980	1.620	2.860	2.790	2.650	2.600	1.970	0.560	0.830	0.510	0.800	0.850	19.0
1994	1.130	2.530	2.790	2.810	2.570	2.800	1.890	0.200	1.210	0.910	0.660	0.060	19.6
1995	0.050	0.150	2.740	2.470	2.470	2.730	2.160	0.780	0.290	0.550	0.800	0.420	15.6
1996	0.060	0.350	2.390	2.740	2.740	3.060	1.200	0.590	0.270	0.010	0.160	2.160	15.7
1997	1.940	1.780	2.630	2.670	2.540	2.650	1.690	0.260	0.020	1.110	0.060	2.720	20.1
1998	1.560	1.430	2.720	2.570	2.620	3.020	1.540	0.660	0.520	1.140	1.130	0.650	19.6
1999	0.870	2.320	3.220	2.680	2.700	2.420	1.780	1.170	0.730	0.760	0.990	0.560	20.2
2000	1.260	2.510	2.590	3.110	2.670	2.670	2.360	0.700	1.590	0.050	0.870	0.530	20.9
2001	1.210	1.010	0.310	5.120	2.550	2.950	1.440	0.990	0.790	1.200	0.480	0.670	18.7
2002	0.990	1.770	2.900	2.760	2.550	2.440	1.170	0.740	0.740	1.700	1.420	0.500	19.7
2003	0.950	2.090	2.490	2.460	2.550	2.730	1.270	0.970	0.180	1.130	1.030	1.820	19.7
2004	1.400	1.950	2.610	2.680	2.220	2.250	1.460	1.200	0.010	0.260	0.330	0.540	16.9
AVE :	0.98	1.62	2.36	2.62	2.35	2.39	1.38	0.54	0.47	0.56	0.64	0.86	16.8
SD :	0.51	0.59	0.59	0.63	0.36	0.49	0.52	0.35	0.41	0.45	0.38	0.61	2.9

B.11.6

G4H025: Highlands Pipeline abstraction from Eikenhof Dam

File : HIGHLDS.NSI
Units : Mm3
Descrip. : From DWAF for 1979 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979	0.000	0.000	0.030	0.030	0.020	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.1
1980	0.000	0.000	0.000	0.040	0.020	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.1
1981	0.000	0.020	0.030	0.030	0.030	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1982	0.000	0.030	0.030	0.030	0.030	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1983	0.000	0.030	0.040	0.040	0.040	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1984	0.000	0.020	0.030	0.030	0.020	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.1
1985	0.000	0.010	0.030	0.030	0.040	0.040	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1986	0.000	0.010	0.040	0.030	0.030	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1987	0.000	0.010	0.030	0.030	0.030	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1988	0.000	0.010	0.030	0.040	0.060	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.2
1989	0.000	0.000	0.060	0.050	0.040	0.040	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1990	0.000	0.030	0.030	0.030	0.030	0.040	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1991	0.000	0.000	0.060	0.060	0.060	0.040	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1992	0.000	0.000	0.050	0.040	0.040	0.050	0.010	0.000	0.000	0.000	0.000	0.000	0.2
1993	0.010	0.040	0.040	0.040	0.040	0.040	0.040	0.000	0.000	0.000	0.000	0.000	0.3
1994	0.000	0.040	0.050	0.040	0.040	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1995	0.000	0.020	0.030	0.050	0.050	0.040	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1996	0.000	0.020	0.010	0.050	0.010	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.1
1997	0.010	0.030	0.040	0.030	0.020	0.030	0.020	0.000	0.000	0.000	0.000	0.000	0.2
1998	0.000	0.000	0.030	0.020	0.010	0.040	0.010	0.000	0.000	0.000	0.000	0.000	0.1
1999	0.000	0.020	0.030	0.020	0.020	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.1
2000	0.000	0.030	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000	0.1
2001	0.000	0.010	0.030	0.020	0.180	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.3
2002	0.000	0.090	0.050	0.010	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.2
2003	0.000	0.040	0.040	0.030	0.030	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.2
2004	0.010	0.040	0.030	0.000	0.040	0.050	0.030	0.000	0.000	0.000	0.000	0.000	0.2
AVE :	0.00	0.02	0.03	0.03	0.04	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.2
SD :	0.00	0.02	0.01	0.01	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.1

B.11.7

Irrigation abstraction from Grootvlei Dam

File : GRTVLEI.NSI
Units : Mm3
Descrip. : Monthly record for 1970 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1970	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1971	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1972	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1973	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1974	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1975	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1976	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1977	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1978	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1979	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1980	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1981	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1982	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1983	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1984	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1985	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1986	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1987	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1988	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1989	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1990	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1991	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1992	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1993	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1994	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1995	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1996	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1997	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1998	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
1999	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
2000	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
2001	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
2002	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
2003	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
2004	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.250	1.8
AVE :	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.25	1.8
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

B.12.1

Ben Etive Irrigation Abstraction

File : BENETIRR.NSI
Units : Mm3
Descrip. : SOURCE: 1964-1990 (BRBS) 1991-2004 (monthly avg) for 1964 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1964	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.850	0.540	0.480	0.550	0.270	2.9
1965	0.000	0.000	0.000	0.000	0.000	0.000	0.110	0.150	0.550	1.460	0.940	0.630	3.8
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.510	1.220	0.710	0.690	0.380	3.5
1967	0.530	0.000	0.000	0.000	0.000	0.000	0.000	1.720	1.280	1.140	1.110	0.460	6.2
1968	1.400	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.150	0.180	0.470	0.460	2.7
1969	0.910	0.000	0.000	0.000	0.000	0.000	0.000	0.200	1.680	1.560	1.630	0.960	6.9
1970	0.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320	1.230	1.540	0.690	4.4
1971	0.350	0.000	0.000	0.000	0.010	0.010	0.020	0.520	0.660	0.520	0.720	0.930	3.7
1972	0.090	0.010	0.000	0.000	0.000	0.020	0.010	0.070	0.170	1.660	1.220	0.950	4.2
1973	0.190	0.010	0.000	0.000	0.000	0.000	0.010	0.270	1.500	0.850	1.950	1.050	5.8
1974	0.820	0.260	0.030	0.000	0.000	0.000	0.150	1.940	0.670	0.800	1.440	0.520	6.6
1975	0.840	0.090	0.000	0.000	0.000	0.000	0.050	0.140	1.950	1.170	0.930	0.520	5.7
1976	0.090	0.370	0.240	0.010	0.000	0.000	0.650	1.370	1.910	0.750	0.060	0.410	5.9
1977	0.470	0.000	0.000	0.000	0.000	0.010	0.040	0.200	0.220	0.060	1.560	0.500	3.1
1978	0.310	0.010	0.000	0.000	0.000	0.000	0.000	0.290	1.390	1.010	0.870	0.830	4.7
1979	0.550	0.070	0.000	0.000	0.000	0.000	0.050	0.500	0.720	0.440	0.950	0.500	3.8
1980	0.000	0.210	0.010	0.010	0.000	0.000	0.010	0.100	0.250	1.610	1.680	1.370	5.3
1981	0.700	0.010	0.000	0.000	0.000	0.000	1.330	0.400	0.700	0.750	0.590	0.310	4.8
1982	0.210	0.000	0.000	0.010	0.010	0.000	0.060	1.400	1.680	1.960	0.880	0.720	6.9
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.060	1.940	0.610	0.720	0.650	1.030	5.0
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.570	1.180	1.860	0.880	1.030	5.6
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.170	1.180	0.790	1.910	0.850	5.0
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.060	1.400	1.180	1.090	0.880	0.950	5.6
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.550	0.370	1.180	0.640	0.880	0.850	4.5
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.420	1.180	0.940	1.690	1.030	6.0
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.060	1.400	1.180	1.860	0.880	0.700	6.1
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.490	1.930	1.860	0.880	1.030	6.2
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.820	1.330	1.280	1.040	0.910	5.7
AVE :	0.20	0.03	0.01	0.00	0.00	0.00	0.20	0.71	1.12	1.12	1.05	0.80	5.2
SD :	0.34	0.08	0.04	0.00	0.00	0.00	0.25	0.50	0.48	0.45	0.38	0.24	1.0

B.12.2

Rooikloof Dam Irrigation Abstraction

File : ROOIKIRR.NSI
Units : Mm3
Descrip. : SOURCE: 1971-1990 (BRBS) 1991-2004 monthly avg for 1971 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1971	0.000	0.000	0.000	0.000	0.000	0.000	0.190	0.510	0.510	0.510	0.510	0.510	2.7
1972	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.090	0.130	0.930	0.930	0.930	3.1
1973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.730	0.510	0.510	0.510	0.510	2.8
1974	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1975	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.230	0.790	0.510	0.510	0.510	2.8
1976	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1977	0.000	0.000	0.000	0.000	0.000	0.000	0.150	0.230	0.280	0.230	1.250	0.630	2.8
1978	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.660	0.510	0.510	0.510	0.510	2.8
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.630	0.560	0.510	0.510	0.510	2.8
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.150	0.140	0.330	1.030	0.930	0.510	3.1
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.090	0.640	0.510	0.510	0.510	0.510	2.8
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.160	0.630	0.630	0.630	0.630	2.8
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.510	0.510	0.510	0.510	0.510	2.8
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.300	0.590	0.590	0.590	0.590	0.590	3.3
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.530	0.810	0.650	0.590	0.590	3.2
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.530	0.590	0.550	0.540	0.540	3.0
AVE :	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.49	0.54	0.56	0.58	0.55	2.9
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.14	0.12	0.13	0.15	0.07	0.1

Rietvlei Irrigation Abstraction

File : RIETVLEI.NSI
Units : Mm3
Descrip. : SOURCE: 1966-1990 (BRBS) 1991-2004 monthly avg for 1966 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1967	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1968	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.190	0.190	0.190	0.190	1.0
1970	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.140	0.240	0.200	0.190	0.190	1.0
1971	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1972	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.060	0.800	0.210	0.190	1.3
1973	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.250	0.190	0.190	0.190	0.190	1.0
1974	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1975	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1976	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1977	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1978	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.190	0.190	0.190	0.190	1.0
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.200	0.190	0.190	0.190	0.190	1.0
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.120	0.260	0.190	0.190	0.190	1.0
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.190	0.190	0.190	0.190	0.190	1.0
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.260	0.190	0.190	0.190	0.190	1.0
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.200	0.190	0.190	0.190	0.190	1.0
AVE :	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.19	0.19	0.21	0.19	0.19	1.0
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.03	0.10	0.00	0.00	0.0

H1H031: Pipeline to Worcester

File : H1H031.NSI
Units : Mm3
Descrip. : From DWAF for 1957 to 2005

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1957	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.157	0.150	0.162	0.179	0.177	0.8
1958	0.212	0.226	0.291	0.269	0.318	0.314	0.262	0.217	0.216	0.233	0.241	0.297	3.0
1959	0.288	0.339	0.365	0.399	0.426	0.398	0.314	0.256	0.232	0.240	0.250	0.253	3.7
1960	0.283	0.343	0.430	0.446	0.448	0.447	0.340	0.319	0.280	0.262	0.252	0.311	4.1
1961	0.337	0.409	0.428	0.434	0.407	0.365	0.280	0.284	0.235	0.232	0.240	0.258	3.8
1962	0.205	0.292	0.399	0.378	0.359	0.355	0.326	0.316	0.250	0.243	0.272	0.339	3.7
1963	0.403	0.433	0.444	0.499	0.489	0.448	0.353	0.307	0.283	0.291	0.294	0.336	4.5
1964	0.381	0.387	0.558	0.550	0.524	0.522	0.374	0.367	0.311	0.320	0.373	0.427	5.1
1965	0.434	0.483	0.552	0.590	0.584	0.604	0.451	0.415	0.345	0.337	0.359	0.395	5.5
1966	0.547	0.585	0.685	0.709	0.724	0.529	0.388	0.399	0.360	0.337	0.364	0.435	6.0
1967	0.474	0.551	0.626	0.671	0.647	0.584	0.484	0.342	0.267	0.293	0.308	0.447	5.6
1968	0.483	0.545	0.635	0.661	0.634	0.606	0.431	0.415	0.358	0.405	0.447	0.457	6.0
1969	0.499	0.575	0.677	0.741	0.615	0.653	0.527	0.346	0.316	0.323	0.321	0.338	5.9
1970	0.462	0.547	0.614	0.639	0.577	0.536	0.431	0.394	0.308	0.255	0.283	0.380	5.4
1971	0.515	0.550	0.617	0.652	0.601	0.599	0.462	0.315	0.298	0.367	0.327	0.428	5.7
1972	0.547	0.639	0.620	0.714	0.669	0.663	0.540	0.443	0.368	0.304	0.322	0.390	6.2
1973	0.588	0.652	0.595	0.763	0.702	0.687	0.577	0.411	0.367	0.336	0.367	0.436	6.4
1974	0.536	0.601	0.735	0.796	0.773	0.739	0.613	0.492	0.411	0.463	0.370	0.413	6.9
1975	0.587	0.684	0.766	0.838	0.762	0.737	0.600	0.467	0.383	0.461	0.502	0.578	7.3
1976	0.637	0.708	0.765	0.901	0.749	0.757	0.528	0.430	0.428	0.465	0.488	0.515	7.3
1977	0.683	0.795	0.793	0.870	0.864	0.690	0.508	0.563	0.522	0.497	0.401	0.514	7.7
1978	0.689	0.809	0.743	0.865	0.691	0.629	0.579	0.497	0.447	0.493	0.506	0.596	7.5
1979	0.655	0.807	0.846	0.897	0.777	0.803	0.692	0.534	0.505	0.499	0.497	0.618	8.1
1980	0.710	0.606	0.675	0.751	0.593	0.701	0.607	0.518	0.529	0.555	0.555	0.565	7.3
1981	0.724	0.742	0.889	0.919	0.834	0.866	0.678	0.567	0.487	0.311	0.423	0.456	7.8
1982	0.626	0.774	0.811	0.835	0.762	0.682	0.599	0.487	0.444	0.335	0.461	0.427	7.2
1983	0.627	0.752	0.917	0.980	1.010	0.770	0.562	0.469	0.540	0.546	0.518	0.403	8.1
1984	0.559	0.751	0.727	0.748	0.916	0.746	0.678	0.675	0.605	0.418	0.365	0.445	7.6
1985	0.548	0.690	0.636	0.794	0.921	0.654	0.544	0.525	0.297	0.329	0.259	0.366	6.5
1986	0.507	0.819	1.060	1.200	0.982	1.100	0.726	0.857	0.678	0.630	0.566	0.567	9.6
1987	0.991	1.070	1.200	1.100	0.983	0.820	0.483	0.483	0.478	0.436	0.675	0.692	9.4
1988	0.903	0.916	0.973	0.903	0.915	0.727	0.617	0.526	0.464	0.470	0.561	0.708	8.6
1989	0.814	0.929	0.913	0.963	0.835	0.784	0.703	0.473	0.487	0.461	0.629	0.742	8.7
1990	0.869	0.932	1.000	1.010	0.978	1.030	0.613	0.320	0.146	0.406	0.440	0.407	8.1
1991	0.223	0.278	0.122	0.193	0.028	0.200	0.219	0.167	0.426	0.567	0.599	0.566	3.5
1992	0.712	0.899	1.140	1.180	0.988	1.020	0.612	0.607	0.536	0.542	0.650	0.770	9.6
1993	0.996	1.100	1.030	1.210	1.130	1.000	0.775	0.738	0.699	0.645	0.653	0.760	10.7
1994	0.906	1.070	1.120	1.190	1.130	1.100	0.852	0.775	0.695	0.756	0.867	1.020	11.4
1995	0.940	1.120	0.952	1.140	1.140	1.110	0.920	0.886	0.668	0.649	0.662	0.709	10.9
1996	0.944	0.799	1.060	1.260	1.120	1.060	0.836	0.803	0.628	0.656	0.662	0.859	10.6
1997	1.100	1.070	1.120	1.090	1.070	1.070	0.862	0.700	0.687	0.677	0.709	0.854	11.0
1998	0.978	0.940	1.030	1.220	1.040	1.140	0.909	0.799	0.667	0.676	0.752	0.731	10.8
1999	0.953	1.080	1.290	1.180	1.100	0.969	0.939	0.846	0.737	0.815	0.744	0.753	11.4
2000	1.060	1.180	1.270	1.300	1.160	1.150	0.813	0.788	0.773	0.687	0.659	0.671	11.5
2001	0.933	1.080	1.270	1.250	1.150	1.360	0.947	0.779	0.692	0.682	0.669	0.795	11.6
2002	1.010	1.170	1.270	1.400	1.320	1.220	0.940	0.874	0.824	0.725	0.654	0.749	12.1
2003	0.911	1.130	1.140	1.300	1.300	1.350	0.860	1.010	0.747	0.718	0.762	0.861	12.1
2004	0.908	1.070	1.200	1.270	1.190	1.260	0.896	0.846	0.746	0.702	0.776	0.874	11.7
2005	1.070	1.100	1.290	1.430	1.320	1.270	1.030	0.825	0.778	0.783	0.805	0.839	12.5
AVE :	0.65	0.73	0.80	0.86	0.80	0.77	0.59	0.53	0.47	0.46	0.49	0.54	7.7
SD :	0.27	0.29	0.32	0.33	0.31	0.31	0.23	0.22	0.19	0.18	0.18	0.20	2.9

B.14.1

Domestic and Irrigation Demand from Ceres Dam

File : CERES.NSI
Units : Mm3
Descrip. : 1925-1990 (BRBS) 1991-2004 monthly avg for 1925 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1925	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1926	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1927	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1928	0.070	0.100	0.120	0.110	0.050	0.060	0.060	0.050	0.030	0.030	0.030	0.040	0.8
1929	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1930	0.070	0.100	0.120	0.120	0.080	0.040	0.060	0.050	0.030	0.030	0.030	0.040	0.8
1931	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1932	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1933	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1934	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1935	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1936	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1937	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1938	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1939	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1940	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1941	0.070	0.100	0.120	0.120	0.090	0.040	0.040	0.050	0.030	0.030	0.030	0.040	0.8
1942	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1943	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1944	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1945	0.070	0.100	0.120	0.120	0.070	0.060	0.060	0.050	0.030	0.030	0.030	0.040	0.8
1946	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1947	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1948	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1949	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1950	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1951	0.070	0.100	0.120	0.120	0.110	0.100	0.060	0.050	0.030	0.030	0.030	0.040	0.9
1952	0.070	0.100	0.120	0.390	0.260	0.100	0.410	0.610	0.700	1.200	1.220	1.370	6.6
1953	1.240	0.910	0.630	0.390	0.200	0.110	0.410	0.610	0.700	1.200	1.220	1.370	9.0
1954	1.320	0.910	0.630	0.390	0.260	0.300	0.340	0.250	0.700	1.200	1.220	1.370	8.9
1955	1.320	0.910	0.630	0.390	0.260	0.220	0.100	0.610	0.700	1.200	1.220	1.370	8.9
1956	1.320	0.900	0.500	0.130	0.260	0.300	0.410	0.610	0.700	1.200	1.220	1.370	8.9
1957	1.320	0.910	0.630	0.390	0.260	0.130	0.110	0.610	0.700	1.200	1.220	1.370	8.9
1958	1.320	0.910	0.620	0.210	0.140	0.040	0.410	0.610	0.700	1.200	1.220	1.370	8.8
1959	1.320	0.910	0.630	0.300	0.120	0.120	0.270	0.610	0.700	1.200	1.220	1.280	8.7
1960	1.060	0.690	0.380	0.380	0.140	0.020	0.170	0.620	0.700	1.200	1.220	1.380	8.0
1961	1.320	0.920	0.570	0.180	0.120	0.260	0.420	0.620	0.700	1.200	1.220	1.380	8.9
1962	1.330	0.920	0.640	0.300	0.120	0.060	0.050	0.060	0.700	1.200	1.220	1.380	8.0
1963	1.330	0.930	0.650	0.420	0.290	0.130	0.240	0.620	0.700	1.200	1.220	1.380	9.1
1964	1.330	0.940	0.660	0.420	0.290	0.330	0.430	0.630	0.700	1.200	1.220	1.390	9.5
1965	1.240	0.820	0.590	0.120	0.070	0.340	0.430	0.340	0.700	1.200	1.220	1.390	8.5
1966	1.340	0.750	0.240	0.090	0.020	0.010	0.430	0.630	0.710	1.210	1.230	1.390	8.1
1967	1.350	0.950	0.680	0.450	0.110	0.040	0.440	0.640	0.710	1.210	1.230	1.390	9.2
1968	1.350	0.960	0.690	0.450	0.160	0.040	0.390	0.130	0.590	0.740	1.230	1.400	8.1
1969	1.360	0.970	0.630	0.110	0.030	0.020	0.020	0.650	0.710	1.210	1.230	1.400	8.3
1970	1.360	0.980	0.620	0.110	0.030	0.130	0.090	0.060	0.710	1.210	1.230	1.400	7.9
1971	1.130	0.720	0.300	0.110	0.080	0.030	0.460	0.650	0.720	1.220	1.240	1.410	8.1
1972	1.370	0.980	0.610	0.190	0.070	0.110	0.110	0.200	0.200	1.220	1.240	1.410	7.7
1973	1.380	1.000	0.560	0.230	0.100	0.020	0.040	1.150	1.210	1.710	1.730	1.900	11.0
1974	1.380	1.000	0.740	0.500	0.300	0.040	0.250	1.440	1.500	2.000	2.020	2.190	13.4
1975	1.380	1.010	0.740	0.190	0.080	0.040	0.470	0.510	1.720	2.170	1.890	2.060	12.3
1976	1.320	1.010	0.750	0.510	0.380	0.400	0.470	1.070	1.130	1.630	1.650	1.830	12.1
1977	1.390	1.020	0.750	0.240	0.120	0.220	0.270	0.300	0.360	0.310	3.270	2.410	10.7
1978	1.380	0.860	0.400	0.280	0.380	0.350	0.170	0.670	2.040	2.540	2.120	2.300	13.5
1979	1.390	1.030	0.700	0.410	0.270	0.120	0.140	1.370	2.450	1.530	2.320	1.420	13.2
1980	1.400	1.030	0.770	0.530	0.400	0.430	0.340	0.150	0.450	2.810	2.830	2.210	13.4
1981	1.400	1.040	0.740	0.430	0.230	0.300	1.050	0.880	2.020	2.520	2.210	1.430	14.3
1982	1.400	1.040	0.740	0.480	0.410	0.360	0.130	1.380	1.430	1.930	1.950	2.130	13.4
1983	1.410	0.930	0.620	0.200	0.090	0.440	0.490	1.150	1.200	1.700	1.720	1.900	11.9
1984	1.410	1.050	0.790	0.600	0.450	0.480	0.510	1.150	1.190	1.690	1.710	1.900	12.9
1985	1.440	1.050	0.650	0.340	0.240	0.390	0.270	0.300	2.140	2.280	1.850	2.490	13.4
1986	1.320	0.920	0.630	0.300	0.180	0.130	0.090	1.450	1.250	1.530	2.180	2.080	12.1
1987	1.550	0.990	0.590	0.260	0.140	0.140	0.560	0.530	1.850	2.270	2.150	2.100	13.1
1988	1.360	1.000	0.640	0.230	0.200	0.230	0.150	1.420	1.120	1.920	1.640	2.310	12.2
1989	1.820	1.140	0.940	0.500	0.270	0.180	0.410	1.550	1.230	1.620	2.350	2.250	14.3
1990	0.930	0.770	0.570	0.430	0.150	0.120	0.070	0.660	1.410	1.740	1.870	1.560	10.3
1991	1.410	0.980	0.690	0.360	0.200	0.180	0.270	1.140	1.390	1.830	2.050	2.080	12.6
1992	1.410	0.980	0.690	0.360	0.200	0.180	0.270	1.140	1.390	1.830	2.050	2.080	12.6
1993	1.410	0.980	0.690	0.360	0.200	0.180	0.270	1.140	1.390	1.830	2.050	2.080	12.6
1994	1.420	0.990	0.700	0.370	0.210	0.190	0.280	1.150	1.400	1.840	2.060	2.090	12.7
1995	1.430	1.000	0.710	0.380	0.220	0.200	0.290	1.160	1.410	1.850	2.070	2.100	12.8
1996	1.440	1.010	0.720	0.390	0.230	0.210	0.300	1.170	1.420	1.860	2.080	2.110	12.9
1997	1.450	1.020	0.730	0.400	0.240	0.220	0.310	1.180	1.430	1.870	2.090	2.120	13.1
1998	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
1999	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
2000	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
2001	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
2002	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
2003	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
2004	1.450	1.020	0.730	0.400	0.250	0.220	0.310	1.180	1.430	1.870	2.100	2.120	13.1
AVE :	0.91	0.66	0.47	0.27	0.17	0.16	0.22	0.56	0.76	1.07	1.16	1.20	7.6
SD :	0.63	0.42	0.27	0.14	0.09	0.11	0.18	0.50	0.66	0.84	0.91	0.89	5.2

Ceres Power Station Releases from Koekoedouw Dam

File : PSTN.NSI
Units : Mm3
Descrip. : Monthly record for 1927 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1927	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1928	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1929	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1930	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1931	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1932	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1933	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1934	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1935	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1936	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1937	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1938	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1939	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1940	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1941	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1942	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1943	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1944	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1945	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1946	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1947	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1948	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1949	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1950	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1951	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1952	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1953	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1954	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1955	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1956	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1957	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1958	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1959	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1960	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1961	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1962	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1963	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1964	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1965	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1966	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1967	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1968	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1969	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1970	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1971	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1972	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1973	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1974	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1975	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1976	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1977	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1978	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1979	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1980	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1981	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1982	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1983	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1984	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1985	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1986	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1987	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1988	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1989	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1990	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1991	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1992	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1993	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1994	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1995	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1996	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1997	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1998	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
1999	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
2000	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
2001	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
2002	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
2003	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
2004	0.230	0.230	0.230	0.230	0.230	0.230	0.500	0.500	0.500	0.500	0.500	0.500	4.4
AVE :	0.23	0.23	0.23	0.23	0.23	0.23	0.50	0.50	0.50	0.50	0.50	0.50	4.4
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

APPENDIX C
GROUNDWATER USE

Calibration Subcatchment (DWAF Gauge No.)	Groundwater use (Mm^3/a)	
	GRA II	NGDB (WARMS)
G1H003	0.01	0.89
G1H004	0.01	1.07
G1H008	9.83	3.20
G1H011	0.73	0.24
G1H013	2.71	1.29
G1H019	0.04	0.19
G1H020	0.56	3.77
G1H021	0.52	0.17
G1H028	0.03	0.53
G1H029	0.28	0.02
G1H035	1.49	2.69
G1H036	1.27	2.95
G1H037	0.18	0.41
G1H038	0.00	0.25
G1H040	0.01	0.08
G1H041	0.31	0.71
G1H043	1.19	0.10
G1R002	0.01	0.18
G2H005	0.05	0.18
G2H008	0.12	0.41
G2H012	0.07	3.42
G2H013	1.19	3.46
G2H014	3.38	6.81
G2H015	0.13	0.88
G2H016	0.43	0.53
G2H020	0.28	1.68
G4H005	0.01	0.56
G4H007	0.01	0.35
G4R001	0.00	0.00
G4R002	0.01	0.43
H1H003	18.16	21.85
H1H006	0.00	0.30
H1H007	0.00	0.00
H1H012	0.19	0.31
H1H013	3.04	3.86
H1H018	0.25	0.76
H1R002	0.11	0.18
H4H006	19.81	26.33
H6H007	0.00	0.15
H6H008	0.00	0.20
H6R001	0.41	1.26
H6R002	0.13	0.18

APPENDIX D
INTER-BASIN TRANSFERS

REF	BERG WAAS CALIBRATION GAUGE	DESCRIPTION	GAUGE/ RECORDER	TYPE
D.1	G1H004	Transfer from Theewaterskloof Dam to upper Berg River	G1H044	Tunnel
D.2	H1H006/G1H008	White Bridge (Michells Pass) Diversion to Klein Berg River	H1H022	Canal
D.3.1	G1H013	Diversion from Klein Berg River to Voëlvlei Dam	G1H066	Canal
D.3.2		Diversion from Twenty Four Rivers and Leeu River to Voëlvlei Dam	G1H067	Canal
D.4	G1H019	Transfer from Banhoek River to Theewaterskloof Dam	G1H063	Tunnel
D.5	H1H007/G1H037	Wit River to Krom River Transfer (Gawie se Water)	N.A.	Canal/Pipe
D.6	G1H038	Transfer from Wolwekloof River to Theewaterskloof Dam	G1H061	Tunnel
D.7	G4R001	Palmiet to Steenbras Dam transfer	N.A.	Canal

D.1

G1H044 Transfer from Theewaterskloof Tunnel

File : G1H044.TRF
Units : Mm3
Descrip. : From DWAF Patched with monthly average for 1983 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1983	0.730	3.528	6.763	7.877	6.622	0.202	0.815	0.000	0.000	0.000	0.000	0.000	26.5
1984	0.000	0.097	2.350	2.320	0.000	2.970	0.927	0.000	0.000	0.000	0.432	0.000	9.1
1985	0.000	2.530	6.370	6.660	6.390	2.580	0.000	0.000	7.930	13.400	0.144	9.010	55.0
1986	0.000	2.840	6.640	6.290	1.510	1.730	0.000	0.000	0.000	3.230	3.190	0.000	25.4
1987	0.000	0.000	0.557	4.510	5.140	1.970	0.000	0.000	0.000	0.000	0.000	0.000	12.2
1988	0.000	0.045	7.220	7.350	5.730	2.290	0.000	0.000	0.000	0.000	0.000	0.000	22.6
1989	0.000	0.000	4.150	7.040	4.710	3.140	0.000	0.000	0.000	0.000	0.000	0.000	19.0
1990	0.000	3.920	5.820	6.310	4.730	4.630	0.000	0.000	0.000	0.000	0.000	0.000	25.4
1991	5.830	2.590	5.450	7.340	5.820	4.540	1.470	0.716	0.207	5.250	0.136	0.001	39.3
1992	0.002	0.148	2.160	9.330	6.450	6.780	0.007	0.242	10.100	3.800	0.002	0.010	39.0
1993	0.600	7.320	7.870	8.840	6.980	3.868	0.547	0.128	0.924	1.299	0.216	0.736	39.3
1994	0.730	3.528	6.763	7.877	6.622	3.868	0.547	0.128	0.924	1.299	0.216	0.736	33.2
1995	0.730	3.528	10.300	6.850	5.390	0.980	0.010	0.000	0.000	0.000	0.000	0.000	27.8
1996	0.000	1.670	4.850	7.790	6.300	0.332	0.003	0.000	0.000	0.000	0.000	3.100	24.0
1997	3.280	4.430	7.760	8.330	8.100	2.690	0.028	0.000	0.000	0.000	0.041	0.971	35.6
1998	0.766	5.790	10.100	10.500	8.860	3.700	0.427	1.430	0.015	0.000	0.000	0.000	41.6
1999	0.002	8.650	13.000	9.820	10.800	6.040	1.220	0.013	0.101	0.001	0.191	1.620	51.4
2000	3.330	10.300	10.600	8.450	8.060	3.290	0.035	0.000	0.009	0.009	0.009	0.000	44.1
2001	0.020	4.680	4.740	5.410	7.130	2.520	0.027	0.000	0.000	0.165	0.167	0.002	24.8
2002	0.000	4.750	10.000	11.800	10.300	8.100	1.860	0.020	0.094	0.099	0.001	0.000	47.0
2003	0.031	4.960	8.950	11.400	12.000	10.400	2.860	0.123	0.023	0.017	0.001	0.000	50.8
2004	0.000	2.320	9.910	11.200	8.390	8.470	1.250	0.019	0.000	0.000	0.000	0.000	41.6
AVE :	0.73	3.53	6.92	7.88	6.64	3.87	0.54	0.13	0.92	1.30	0.21	0.73	33.4
SD :	1.49	2.80	3.09	2.29	2.72	2.65	0.77	0.33	2.65	3.07	0.67	1.99	12.7

D.2

H1H022: White Bridge Diversion

File : H1H022.NSI
Units : Mm3
Descrip. : SOURCE: 1964-1990 (BRBS) 1991-2004 (DWAF) for 1957 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1957	1.690	2.150	2.280	2.060	1.820	1.580	0.700	0.720	0.700	0.720	0.980	2.060	17.5
1958	2.460	2.380	2.460	1.260	1.120	1.060	1.480	0.640	0.390	0.530	0.340	0.520	14.6
1959	1.100	1.810	2.400	1.170	0.870	1.280	1.180	1.330	0.450	0.260	0.650	1.480	14.0
1960	2.480	2.180	1.610	1.530	1.200	0.950	1.500	1.090	0.830	1.150	1.020	0.650	16.2
1961	1.340	2.330	1.390	0.650	1.340	1.550	1.500	1.330	0.920	0.960	0.990	1.260	15.6
1962	1.200	2.030	2.580	1.520	0.760	0.480	0.860	1.330	0.850	0.850	0.370	1.340	14.2
1963	1.870	2.620	2.680	1.670	1.530	1.710	1.230	1.280	1.870	0.830	1.220	0.930	19.4
1964	1.270	1.240	2.370	2.080	2.040	2.050	1.060	1.280	1.390	1.290	1.460	2.140	19.7
1965	2.910	2.790	2.670	1.800	1.160	1.750	1.280	1.370	1.080	0.720	1.360	2.070	21.0
1966	2.380	2.310	1.060	0.650	0.310	0.240	1.490	1.420	0.790	1.270	0.490	1.070	13.5
1967	2.400	2.300	2.280	2.210	1.460	0.470	1.500	0.450	0.880	1.050	0.770	1.240	17.0
1968	1.450	2.120	2.430	1.910	1.010	0.710	1.640	1.340	1.430	1.480	1.540	1.950	19.0
1969	1.500	2.400	2.260	1.590	1.090	1.090	0.620	1.830	1.440	1.340	1.380	1.330	17.9
1970	1.550	2.410	2.510	1.680	1.040	2.650	1.780	2.230	0.320	0.570	0.950	1.030	18.7
1971	2.340	2.440	1.850	1.520	1.060	0.920	1.990	1.550	1.450	1.070	0.980	1.620	18.8
1972	2.310	2.620	2.520	1.190	0.640	2.270	1.690	2.180	1.260	1.130	0.790	1.160	19.8
1973	1.840	2.570	2.500	1.160	0.660	0.700	0.790	1.640	0.580	1.340	1.510	0.430	15.7
1974	1.140	1.330	1.980	2.350	1.230	0.930	1.660	0.720	0.920	0.960	1.200	1.350	15.8
1975	1.420	1.950	2.470	1.410	0.930	1.000	1.850	1.090	0.920	0.810	0.890	1.120	15.9
1976	1.710	2.090	0.950	2.420	1.170	2.310	2.040	1.220	0.920	0.960	0.990	1.250	18.0
1977	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1978	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1979	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1980	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1981	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1982	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1983	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1984	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1985	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1986	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1987	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1988	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1989	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1990	1.690	2.150	2.280	2.170	1.820	1.900	1.650	1.330	0.920	0.960	0.990	1.250	19.1
1991	1.561	2.107	2.520	2.300	2.020	1.940	1.616	1.050	0.873	0.704	0.261	0.407	17.3
1992	1.561	2.110	2.620	2.560	2.220	2.110	1.100	0.518	0.626	0.353	0.098	0.551	16.4
1993	1.960	2.410	2.440	1.910	1.440	1.570	1.470	1.350	0.790	0.964	0.519	1.550	18.4
1994	1.730	2.350	2.330	1.830	1.570	1.630	1.650	1.590	1.450	0.101	1.170	1.490	18.9
1995	1.550	2.180	2.370	2.410	2.120	2.230	1.780	1.620	1.010	0.765	0.867	0.304	19.2
1996	0.319	2.107	2.310	2.070	2.180	2.390	1.880	1.378	0.901	0.417	0.679	1.380	18.0
1997	2.100	2.150	2.390	2.420	1.790	1.900	1.720	0.760	0.375	0.131	0.046	1.230	17.0
1998	2.000	1.940	2.370	2.190	1.890	1.990	1.790	1.720	1.470	1.440	1.360	1.260	21.4
1999	1.840	2.260	2.400	2.470	2.150	2.200	2.130	1.950	1.370	0.624	0.373	1.180	20.9
2000	1.561	2.107	2.343	2.196	1.894	1.940	1.616	1.320	0.775	0.046	1.260	0.770	17.8
2001	1.250	1.860	2.290	2.170	1.990	2.400	1.840	1.100	0.210	0.038	0.517	1.250	16.9
2002	1.410	1.920	2.270	2.360	2.110	2.360	2.030	1.850	1.600	0.555	1.320	0.934	20.7
2003	1.550	2.050	2.320	2.250	1.750	1.770	1.660	1.970	1.260	0.033	0.766	1.490	18.9
2004	1.670	1.980	1.830	1.610	1.390	1.410	1.470	1.440	0.599	0.076	0.889	1.280	15.6
AVE :	1.71	2.16	2.25	1.94	1.55	1.67	1.56	1.34	0.95	0.81	0.91	1.22	18.1
SD :	0.43	0.27	0.35	0.45	0.47	0.57	0.33	0.37	0.34	0.38	0.35	0.39	1.9

D.3.1

G1H066: Transfer to Voelvlei from Klein Berg at Nieuwkloof

File : G1H066.NSI
Units : Mm3
Descrip. : From DWAF for 1950 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1950	1.953	0.665	0.381	0.161	0.101	0.173	0.633	2.490	5.438	15.700	11.700	11.100	50.5
1951	5.960	1.790	0.891	0.000	0.077	0.082	0.006	0.000	0.968	7.800	18.100	12.100	47.8
1952	5.170	2.180	0.402	0.000	0.000	0.000	2.020	7.540	8.210	4.730	0.000	0.000	30.3
1953	0.000	0.000	0.000	0.000	0.000	0.000	1.560	7.000	8.770	6.150	0.000	0.000	23.5
1954	0.000	0.527	0.972	0.000	1.320	0.177	0.770	0.800	4.450	16.700	3.770	0.000	29.5
1955	0.000	0.000	0.768	0.209	0.000	0.000	0.474	0.350	0.000	0.000	13.600	8.260	23.6
1956	1.220	0.215	0.263	0.000	1.910	0.049	0.000	5.930	20.800	5.660	0.000	0.000	36.0
1957	0.000	0.254	0.149	0.000	0.143	0.507	0.362	2.130	4.430	2.100	3.740	5.360	19.2
1958	1.530	0.324	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.570	5.140	4.190	12.8
1959	3.810	1.990	0.158	0.000	0.000	0.000	0.399	9.280	9.070	4.130	3.430	2.220	34.5
1960	0.851	0.000	0.000	0.000	0.000	0.000	0.027	1.090	6.380	4.500	6.880	12.200	31.9
1961	3.460	0.107	0.000	0.000	0.000	0.352	0.976	0.431	12.100	10.300	0.921	1.350	30.0
1962	0.223	1.520	0.120	0.000	0.000	0.000	0.000	0.000	1.960	5.480	15.700	1.860	26.9
1963	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.097	7.300	6.780	8.470	2.340	25.0
1964	0.254	0.000	0.000	0.000	0.000	0.000	0.420	4.280	4.940	3.340	6.790	4.000	24.0
1965	1.720	0.180	0.000	0.000	0.000	0.699	1.440	0.840	2.200	17.000	8.190	0.756	33.0
1966	0.403	0.015	0.000	0.028	0.029	0.018	0.776	1.550	14.100	7.120	8.870	0.000	32.9
1967	0.000	0.680	0.000	0.000	0.000	0.000	0.000	0.000	7.360	6.170	11.400	0.024	25.6
1968	0.974	0.525	0.017	0.000	0.000	0.000	0.003	0.705	1.080	1.800	2.560	5.270	12.9
1969	6.000	0.942	0.052	0.000	0.062	0.014	0.000	1.690	9.340	13.000	15.000	11.800	57.9
1970	3.650	0.342	0.006	0.000	0.000	0.147	0.009	0.674	0.853	1.990	4.640	3.140	15.4
1971	0.173	0.010	0.000	0.000	0.000	0.000	0.165	6.610	6.350	4.620	7.740	4.540	30.2
1972	1.150	0.038	0.294	0.003	0.052	0.235	0.006	0.321	0.765	9.080	12.800	6.730	31.4
1973	4.120	0.445	0.344	0.000	0.000	0.012	0.072	2.220	11.100	4.860	29.400	7.170	59.7
1974	2.960	1.530	0.597	0.103	0.013	0.014	0.954	7.510	5.650	6.500	4.550	1.970	32.3
1975	2.290	0.751	0.056	0.005	0.022	0.035	0.723	0.770	13.400	5.250	0.484	2.160	25.9
1976	1.530	2.010	2.830	2.520	0.307	0.079	1.710	4.440	0.552	0.428	9.400	0.471	26.3
1977	2.030	0.195	0.797	0.067	0.058	0.044	0.292	0.896	0.308	0.072	3.510	6.610	14.8
1978	3.510	0.168	0.055	0.018	0.023	0.320	0.051	1.730	6.360	4.610	6.040	3.310	26.2
1979	9.350	0.972	0.013	0.350	0.016	0.000	0.400	2.190	4.690	2.520	3.470	1.840	25.8
1980	0.925	7.720	5.240	1.650	0.392	0.135	0.220	0.514	1.620	8.810	11.000	2.350	40.6
1981	4.060	0.388	0.022	0.338	0.000	0.133	3.230	2.540	4.960	7.040	5.870	1.510	30.1
1982	3.260	0.150	0.460	0.008	0.101	0.346	0.089	8.100	5.850	6.390	8.220	5.570	38.5
1983	2.220	0.405	0.027	0.000	0.000	0.597	0.466	10.300	3.360	10.800	2.340	4.540	35.0
1984	3.420	0.254	1.130	1.220	0.438	3.630	2.750	2.490	2.930	0.403	0.568	0.001	19.2
1985	1.040	0.667	0.426	0.020	0.025	0.167	1.820	3.790	5.750	8.040	0.421	3.080	25.2
1986	2.090	0.598	0.137	0.191	0.143	0.155	0.256	4.180	9.780	8.090	1.930	2.270	29.8
1987	1.190	0.545	0.411	0.030	0.004	0.019	1.360	2.190	9.830	2.770	0.665	1.490	20.5
1988	0.024	0.141	0.000	0.002	0.003	0.942	1.110	1.680	3.920	9.690	0.005	0.019	17.5
1989	0.000	0.633	0.050	0.005	0.073	0.129	1.970	7.180	8.300	0.898	0.056	1.270	20.5
1990	0.721	0.148	0.109	0.013	0.009	0.017	0.072	0.563	5.880	16.900	0.262	0.014	24.7
1991	2.080	1.320	0.178	0.096	0.018	0.179	1.680	3.160	4.230	0.078	1.400	0.006	14.4
1992	0.070	0.029	0.142	0.012	0.000	0.002	3.550	7.020	3.800	0.210	0.119	1.570	16.5
1993	0.897	0.031	0.078	0.017	0.002	0.002	0.151	0.303	7.810	10.600	5.430	6.130	31.4
1994	4.800	0.292	0.051	0.004	0.019	0.173	0.633	2.490	2.610	12.200	11.200	3.395	37.8
1995	7.290	0.711	1.980	0.101	0.003	0.004	0.173	0.276	10.500	8.730	4.850	0.004	34.6
1996	0.007	2.240	0.544	0.532	0.061	0.030	0.202	2.490	1.060	5.700	6.201	3.120	22.2
1997	0.699	0.692	0.381	0.161	0.000	0.000	0.061	2.490	4.960	6.660	5.650	2.420	24.2
1998	1.953	0.665	0.381	0.286	0.003	0.000	0.156	2.490	5.438	6.292	6.201	3.395	27.2
1999	1.953	0.006	0.009	0.006	0.005	0.015	0.066	0.421	0.866	4.920	2.910	9.650	20.8
2000	1.950	0.294	0.381	0.161	0.000	0.005	0.053	1.970	2.400	16.800	16.900	1.550	42.5
2001	0.106	0.067	0.026	0.833	0.121	0.026	0.090	3.490	5.970	7.950	0.162	0.079	18.9
2002	0.002	0.003	0.004	0.005	0.000	0.000	0.008	0.008	0.010	0.013	5.120	4.580	9.7
2003	2.580	0.418	0.076	0.001	0.000	0.000	0.633	0.106	2.040	1.320	8.100	1.790	17.0
2004	1.980	0.317	0.010	0.000	0.000	0.000	0.098	0.338	6.270	4.820	10.400	6.480	30.7
AVE :	1.99	0.67	0.39	0.16	0.10	0.17	0.64	2.62	5.44	6.29	6.22	3.40	28.1
SD :	2.05	1.14	0.84	0.44	0.32	0.51	0.85	2.72	4.16	4.65	5.78	3.36	10.5

D.3.2

G1H067: Transfer to Voelvlei from Twenty Four Rivers and Leeu River

File : G1H067.NSI
Units : Mm3
Descrip. : From DWAF for 1971 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1971	5.947	2.956	1.290	0.476	0.116	0.641	1.796	7.447	12.300	7.240	12.000	10.400	62.6
1972	3.270	0.236	3.670	0.117	0.000	0.623	0.134	1.290	2.050	23.100	21.200	13.300	69.0
1973	7.800	1.140	0.796	0.000	0.000	0.000	0.018	7.590	26.900	13.100	41.400	6.290	105.0
1974	4.530	3.000	1.720	0.865	0.140	0.083	0.984	15.300	11.900	7.210	1.920	2.560	50.2
1975	7.060	1.960	0.463	0.054	0.000	0.141	1.790	2.920	28.100	12.600	6.550	2.940	64.6
1976	4.550	5.200	5.260	4.390	0.318	0.047	1.730	4.680	2.950	3.610	16.200	1.960	50.9
1977	2.930	2.040	3.240	0.451	0.090	0.119	0.735	0.664	1.720	1.160	10.700	17.300	41.1
1978	9.680	1.730	0.502	0.260	0.117	0.923	0.244	5.320	16.800	11.300	14.100	8.600	69.6
1979	19.200	3.480	0.744	1.810	0.079	0.000	1.740	9.720	10.800	6.570	11.000	6.230	71.4
1980	4.290	19.300	7.650	1.830	0.555	0.000	0.168	1.000	6.960	23.200	17.900	4.780	87.6
1981	3.530	2.250	0.953	0.871	0.000	1.200	6.810	8.950	13.500	14.900	7.130	3.900	64.0
1982	9.380	2.030	2.340	0.437	0.753	0.972	0.167	21.700	13.600	2.880	3.950	7.640	65.8
1983	4.820	0.842	0.143	0.000	0.000	0.523	0.979	22.500	5.950	16.000	5.350	7.510	64.6
1984	8.070	1.480	4.200	3.120	0.499	8.700	5.770	9.850	11.300	10.300	7.220	8.980	79.5
1985	3.950	0.962	0.451	0.023	0.000	0.775	3.100	6.980	15.000	18.300	9.080	9.800	68.4
1986	3.830	1.040	0.101	0.318	0.001	0.000	0.837	13.000	18.900	13.700	4.130	6.010	61.9
1987	3.270	1.230	1.290	0.007	0.000	0.176	3.610	7.250	20.900	10.500	5.230	5.420	58.9
1988	4.150	1.650	0.019	0.029	0.096	5.560	4.320	6.740	10.200	19.800	12.300	13.200	78.0
1989	8.660	3.510	0.780	0.029	0.268	0.070	3.050	15.400	14.900	10.700	2.410	2.250	62.0
1990	0.331	0.272	0.466	0.001	0.001	0.013	0.331	3.960	16.700	30.800	12.300	12.100	77.3
1991	11.000	3.930	0.395	0.000	0.455	0.705	4.930	9.240	19.300	15.100	4.710	7.690	77.4
1992	7.190	3.940	1.080	0.000	0.028	0.000	8.540	16.100	18.300	11.900	7.770	3.940	78.8
1993	0.648	0.000	0.173	0.000	0.000	0.000	0.815	1.460	19.700	17.700	9.740	7.280	57.5
1994	7.440	0.117	0.000	0.000	0.000	0.013	0.001	3.740	10.300	31.300	23.400	7.430	83.7
1995	14.800	0.828	0.433	0.026	0.170	0.014	0.029	1.130	18.600	27.100	12.600	6.200	81.9
1996	1.630	12.600	1.550	0.101	0.014	0.144	1.560	3.590	21.100	10.500	20.700	8.900	82.4
1997	0.783	4.070	2.700	0.451	0.006	0.000	0.025	11.400	12.000	16.200	16.500	5.020	69.1
1998	3.860	11.100	0.527	0.037	0.000	0.000	1.980	7.550	13.900	20.700	24.500	27.100	111.2
1999	2.740	1.510	0.480	0.021	0.023	0.000	0.012	2.320	9.730	18.800	13.600	30.300	79.5
2000	4.500	1.180	0.020	0.001	0.185	0.001	0.251	8.890	9.760	40.800	34.300	19.900	119.8
2001	6.220	0.459	0.371	0.426	0.039	0.076	0.756	12.000	17.300	32.400	13.500	10.300	93.8
2002	8.120	2.670	0.115	0.002	0.000	0.262	0.353	0.463	0.927	1.640	21.100	17.200	52.8
2003	7.790	1.280	0.518	0.476	0.000	0.000	2.270	0.393	7.180	9.930	25.200	4.580	59.6
2004	6.230	0.514	0.000	0.000	0.000	0.000	1.240	2.670	22.100	12.400	29.300	11.100	85.6
AVE :	5.95	2.95	1.31	0.49	0.11	0.64	1.79	7.45	13.58	15.40	14.09	9.36	73.1
SD :	3.91	3.96	1.72	0.96	0.19	1.73	2.12	5.87	6.78	9.27	9.33	6.56	17.1

D.4

G1H063: Transfer from Banhoek River

File : G1H063.NSI
Units : Mm3
Descrip. : From DWAF for 1985 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1986	0.000	0.000	0.040	0.000	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.1
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.750	0.140	0.9
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.550	0.580	0.150	1.3
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.470	1.650	1.330	2.500	0.870	0.750	7.6
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.410	2.060	0.000	0.000	0.000	2.5
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.560	1.960	0.000	0.000	0.000	3.5
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1994	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
1995	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
1996	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
1997	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
1998	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
1999	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
2000	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
2001	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
2002	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
2003	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
2004	0.000	0.000	0.004	0.000	0.000	0.000	0.058	0.402	0.594	0.339	0.244	0.116	1.7
AVE :	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.40	0.59	0.33	0.24	0.11	1.7
SD :	0.00	0.00	0.01	0.00	0.00	0.00	0.10	0.45	0.59	0.54	0.24	0.16	1.6

D.5

Gawie-se-water: Transfer from Wit River

File : GAWIE2.NSI
Units : Mm3
Descrip. : SOURCE: Kromme River Irrigation Board for 1961 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1961	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1962	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1963	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1964	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1965	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1966	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1967	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1968	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1969	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1970	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1971	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1972	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1973	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1974	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1975	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1976	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1977	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1978	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1979	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1980	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1981	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1982	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1983	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1984	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1985	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1986	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1987	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1988	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1989	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1990	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1991	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1992	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1993	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1994	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1995	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1996	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1997	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1998	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
1999	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
2000	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
2001	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
2002	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
2003	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
2004	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	4.9
AVE :	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	4.9
SD :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

G1H061: Inlet To Mine Shaft@Wolwekloof River

File : G1H061.NSI
Units : Mm3
Descrip. : From DWAF for 1983 to 2004

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
1985	0.000	0.000	0.000	0.000	0.000	0.000	1.580	2.230	3.220	2.750	0.000	0.000	9.8
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.880	0.010	0.000	0.000	0.000	0.000	0.9
1987	0.000	0.000	0.000	0.000	0.000	0.000	1.280	0.000	1.780	0.000	0.000	0.000	3.1
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.260	0.000	0.3
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.390	0.500	0.290	1.2
1990	0.000	0.000	0.000	0.000	0.000	0.000	1.620	0.220	2.620	6.270	2.680	0.680	14.1
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.840	0.000	0.010	0.000	0.780	1.6
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.640	0.190	0.000	0.000	0.000	1.8
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.780	0.000	0.000	0.000	0.000	0.8
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	19.503	9.743	3.260	3.440	17.400	53.3
1995	1.559	0.941	6.032	1.451	1.335	0.673	3.114	7.937	0.000	0.000	0.000	0.000	23.0
1996	0.000	3.470	40.500	7.820	8.040	1.550	12.400	21.200	48.500	3.180	4.307	4.660	155.6
1997	1.559	0.941	6.032	1.451	1.335	0.673	3.114	7.937	9.743	3.260	4.307	4.660	45.0
1998	1.559	0.941	6.032	1.451	1.335	0.673	3.114	7.937	9.743	3.260	4.307	4.660	45.0
1999	1.559	0.941	6.032	1.451	1.335	0.673	3.114	7.937	3.450	4.470	3.810	7.690	42.4
2000	2.440	0.460	0.200	0.086	0.006	0.256	1.060	1.860	1.920	1.980	1.890	1.520	13.7
2001	1.240	0.881	0.675	0.952	0.472	0.348	2.020	4.920	7.680	4.600	0.003	0.003	23.8
2002	0.002	0.002	0.001	0.001	0.000	1.480	0.728	0.214	0.000	1.540	6.180	5.120	15.3
2003	3.490	0.778	0.000	0.000	0.000	0.554	3.730	1.440	8.410	6.870	9.720	2.270	37.3
2004	3.740	0.995	0.849	1.300	0.826	0.523	1.860	6.420	7.980	3.440	9.410	3.280	40.6
AVE :	0.78	0.47	3.02	0.72	0.67	0.34	1.80	4.23	5.23	2.06	2.31	2.41	24.0
SD :	1.19	0.80	8.69	1.70	1.73	0.47	2.69	6.05	10.39	2.21	3.06	4.05	34.6

D.7

Palmiet to Steenbras transfer

File : PALMIET.NSI
Units : Mm3
Descrip. : City of Cape Town Record

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1997	0.000	0.000	1.801	0.802	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.6
1998	0.000	2.501	0.202	0.000	0.000	0.104	0.000	0.000	5.103	0.000	4.001	0.107	12.0
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.705	7.900	14.704	26.3
2000	0.000	2.408	0.000	0.000	0.000	0.000	0.000	0.000	2.101	9.406	0.601	0.000	14.5
2001	0.000	0.000	0.000	1.403	0.000	0.000	3.101	1.308	4.800	1.805	0.000	0.000	12.4
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	17.106	12.603	29.7
2003	0.000	0.000	0.000	1.307	0.000	0.000	0.000	0.000	3.900	1.601	15.000	3.204	25.0
2004	7.700	0.000	0.000	0.000	0.000	0.000	4.307	5.304	10.506	9.405	5.500	6.607	49.3
AVE :	0.96	0.61	0.25	0.44	0.00	0.01	0.93	0.83	3.30	3.24	6.26	4.65	21.5
SD :	2.72	1.13	0.63	0.63	0.00	0.04	1.74	1.86	3.62	4.01	6.68	6.04	14.4