# Technical Note: Hydrological Review of the Olifants River Catchment

## 1. Introduction

The Olifants Basin is a principal sub-catchment of the Limpopo River. It rises in the north of South Africa (in the province of Mpumalanga) and flows north-east (through Northern Province) into Mozambique (Figure 1). In South Africa, significant mining, industrial and agricultural activities (including intensive irrigation schemes) are concentrated within the catchment, so it is of considerable importance for the country's economy. In compliance with the National Water Act (1998) and National Water Resources Strategy (NWRS), it is planned to establish a Catchment Management Agency to manage the water (DWAF, 2002). This Agency will be responsible for managing water resources to the point where the Olifants river flows into Mozambique. DWAF and the Limpopo Permanent Technical Committee are currently involved in discussions to determine downstream flow requirements in Mozambique, but at the present time there is no accepted international agreement specifying trans-boundary flow requirements. The Letaba River, a major tributary that rises in South Africa but joins the Olifants in Mozambique, will not be included in the Olifants Water Management Area. For this reason, and because most previous studies have not included the Letaba River, the information presented in this technical note focuses only on the region (54,308 $km^2$) that will be incorporated in the Olifants Water Management Area, hereafter simply referred to as the Olifants catchment.

This note comprises a review of existing data and a brief discussion of the main hydrological issues pertaining to the Olifants catchment.

## 2. Catchment Description

A detailed description of the biophysical and demographic characteristics of the Olifants catchment is presented in de Lange *et al.* (2003). For the purposes of managing water in the catchment, it has been divided into five regions (Figure 1). Each of these regions comprises of a number of "quaternary cachments". Quaternary catchments are the principal water management unit in South Africa and were demarcated for the whole country as part of a comprehensive national water resource assessment, known as the WR90 study (Midgley *et al*., 1994). In the WR90 study, quaternary catchments were delineated to have similar runoff (i.e. the greater the runoff the smaller the catchment area and vice-versa). Quaternary catchments are nested within tertiary, secondary and primary drainage areas. There are 22 Primary Drainage Regions in South Africa, of which the Olifants is one. Within the Olifants there are seven secondary, 12 tertiary and 102 quaternary catchments (Table 1).

**Table 1:** *Secondary, Tertiary and Quaternary Catchments in the Olifants Basin (excluding the Letaba River)*

| Water Management Region | Secondary Catchment identifier | Tertiary Catchment identifier | Quaternary Catchments Identifier [1] | Description of Tertiary Catchment |
|---|---|---|---|---|
| Upper Olifants River | B1 | 1 | A to L (11) | Olifants upstream of Loskop Dam |
| | | 2 | A to E (5) | Klein Olifants |
| | B2 | 0 | A to G (7) | Wilge River |
| Upper Middle Olifants River | B3 | 1 | A to J (9) | Elands River |
| | | 2 | A to J (9) | Olifants from Loskop Dam to confluence with Elands |
| Mountain Region | B4 | 1 | A to K (10) | Steelport River |
| | | 2 | A to H (8) | Spekboom River to confluence with Steelport |
| Lower Middle Olifants Region | B5 | 1 | A to H (8) | Olifants from confluence with Elands to gauging station B5H002 |
| Lower Olifants Region | B6 | 0 | A to J (9) | Blyde River |
| | B7 | 1 | A to J (9) | Olifants from gauging station B5H002 to confluence with Blyde River |
| | | 2 | A to K (10) | Olifants to confluence with Selati River |
| | | 3 | A to H (8) | Olifants from confluence with Selati River to the Mozambique border |

[1] the letter I, is not used as a quaternary catchment identifier.

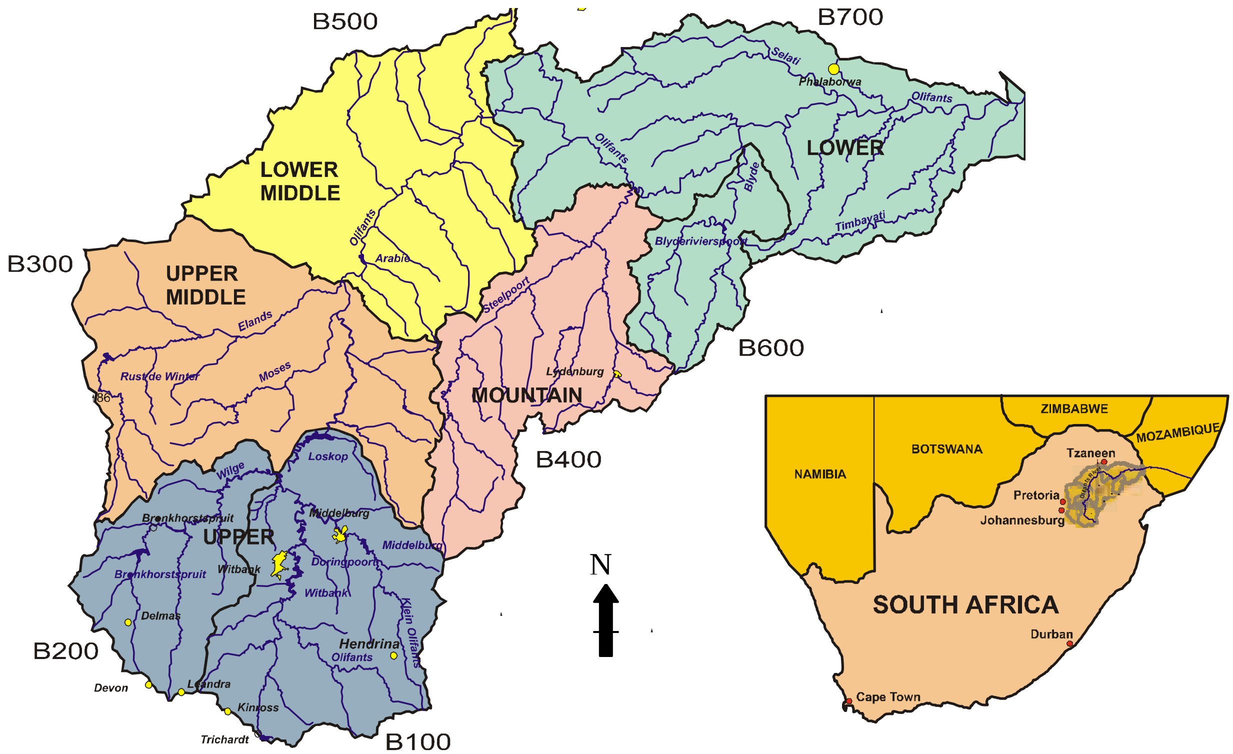



**Figure 1:** *Location of the Olifants River Water Management Area and the boundaries of the 5 water management regions* (after de Lange *et al., 2003* )

## 3. Data

In South Africa, the Department of Water Affairs and Forestry (DWAF) is responsible for managing water resources. To this end, extensive data collection networks have been established throughout the country and data storage and retrieval systems as well as sophisticated software have been developed. For the IWMI benchmark basin study (Molle, ????) comprehensive data sets, comprising both biophysical and socio-economic information, have been obtained from DWAF and a range of other sources.

Much of the baseline information presented in this report has been derived from an atlas of agrohydrology and climatology that has been developed for South Africa and the kingdoms of Lesotho and Swaziland (Schulze *et al*., 1997). This atlas comprises thematic agrohydrological and agroclimatic maps developed from specialized methods of spatial analysis. The basis for the climatic parameter mapping is a 1 minute of a degree latitude by longitude grid (raster) covering the region. Made up of 437,000 grid points, this 1' x 1' digital database serves as a basis for mapping physiographic and climatic (e.g. rainfall and potential evaporation) attributes. For climate variables, statistical goodness of fit was determined between observed and estimated values at points of measurement in order to obtain the level of confidence to which equations could be use to interpolate and extrapolate at grid points where no observations had been made. Once acceptable equations had been developed these were used to extrapolate to grid points where no observations had been made (Schulze *et al.*, 1997). An electronic version of the atlas provides coverages for use in ArcView (ESRI, 19??). These coverages were interrogated to provide data specific to the Olifants catchment.

Data have also been obtained from two important water resource studies that have been conducted for the whole of South Africa. The first was the previously mentioned WR90 study, which was a 5-year project undertaken “to provide a basis for preliminary planning of water resources development” and to make available “valuable data and information for water resources planning and development” (Midgeley *et al*., 1994). The second is a project to develop a Water Situation Assessment Model (WSAM) for rapid evaluation of the status of water resources anywhere in South Africa (Schultz and Watson, 2002). The latter has built on the work undertaken in the WR90 study. Data specific to the Olifants catchment have been obtained from databases developed for both studies and provided to IWMI by DWAF.

In addition, partly as a consequence of its important role in the economy of South Africa, numerous water resources studies have been undertaken in the Olifants catchment. These reports have provided additional information. Of particular value is the Olifants River Basin Study which collected and evaluated a lot of information necessary for addressing problems associated with human water utilisation The project comprised a comprehensive evaluation of the development potential and management of the water resources in the catchment and culminated in a main report, eight volumes of situation assessments and 28 supporting technical annexes (DWAF and Theron Prisloo Grimshel and Pullen, 1991).

As a result of the seasonality of rainfall and hence flow across much of South Africa (sections 4 and 6), DWAF use a hydrological year that extends from October 1$^{st}$ to September 30$^{th}$. For the purposes of consistency, throughout this technical note (unless stated otherwise) the hydrological year has been used when computing annual statistics. The standard convention of naming hydrological years after the year in which the month of October occurs has been adopted. Thus hydrological year 1956 (i.e. HY1956) extends from 01/10/56 to 30/09/57.

## 4. Rainfall

Mean annual precipitation characterises the long-term quantity of water available in the catchment for agriculture and other purposes. In the Olifants catchment precipitation data are available for 523 rainfall stations located within or very close to the catchment boundary. Of these 47 have more than 50 years of data and 73 have more than 40 years of data. The South African Weather Bureau (SAWB) and other organizations (e.g. Department of Agriculture, South Africa Sugar Association and forestry companies) are responsible for these stations.

The climate of the Olifants catchment is largely controlled by the movement of air-masses associated with the Inter-Tropical Convergence Zone (ICTZ). During the summer, high land temperatures produce low pressures and moisture is brought to the catchment through the inflow of maritime air masses from the Indian Ocean. During the winter, the sun moves north and the land cools, causing the development of a continental high pressure system. The descending and outflowing air produces the regional dry season. For this reason, rainfall is seasonal and largely occurs during the summer months, October to April. Mean annual precipitation for the whole catchment is 630 mm, but the rainfall pattern is irregular with coefficients of variation greater than 0.25 across most of the catchment (Table 2; Figure 2).

**Table 2:** *Mean annual rainfall and coefficient of variation for each of the secondary catchments*

| **Secondary catchment** | **Mean altitude (masl)** | **Mean annual precipitation mm)** | **CV** |
|---|---|---|---|
| B1 | 1588 | 689 | 0.29 |
| B2 | 1501 | 670 | 0.29 |
| B3 | 1174 | 617 | 0.24 |
| B4 | 1430 | 681 | 0.26 |
| B5 | 1097 | 551 | 0.28 |
| B6 | 1207 | 823 | 0.27 |
| B7 | 603 | 586 | 0.26 |
| **Total Catchment** | 1149 | 630 | 0.27 |

The catchment is divided into two by an escarpment, orientated approximately north-south. To the west of the escarpment is the highveld (altitude > 1000 m) and to the east, the lowveld (altitude < 800 m). The highest rainfall is in the region of the escarpment. Orographic rainfall in the vicinity of the escarpment (caused when air is forced to rise over the escarpment) results in mean annual precipitation that exceeds 1,000 mm in some places. However, to both the east and the west of the escarpment, mean annual precipitation is generally 600mm and less (Figure 2). Secondary catchment B6 lies on the escarpment and as a result experiences considerably higher rainfall than the other secondary catchments in the Olifants Basin. The lowest mean annual precipitation occurs in catchments B5 and B7 (Table 2). Time series of annual rainfall and departure from the mean annual rainfall at three representative rain stations, located on the highveld, lowveld and the escarpment, illustrates (Figure 3):

i. higher rainfall on the escarpment than either to east or west
ii. considerable inter-annual variability at all locations
iii. often several consecutive years with below average rainfall

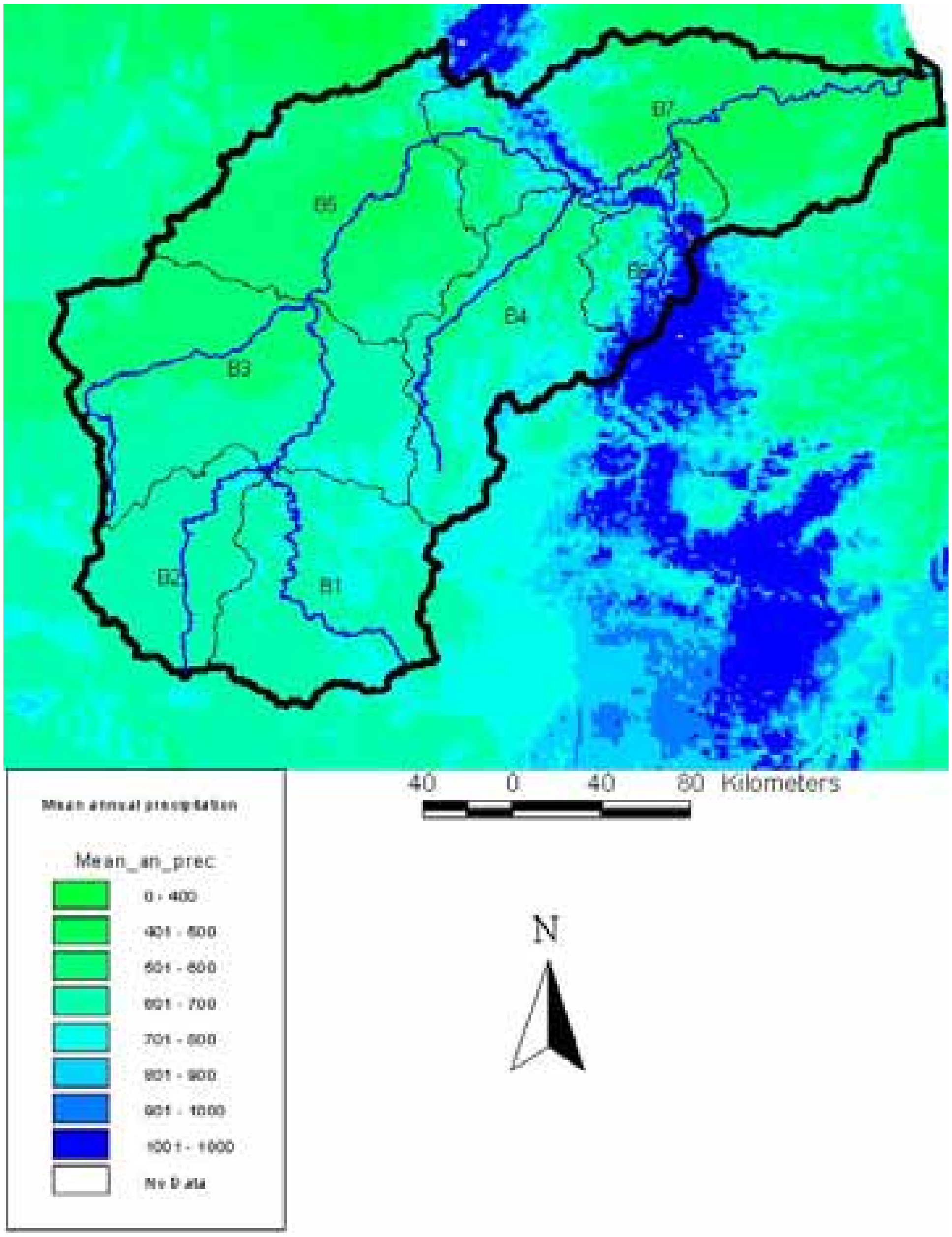



**Figure 2**: *Mean annual precipitation across the Olifants catchment* (developed from Schulze *et al*., 1997).

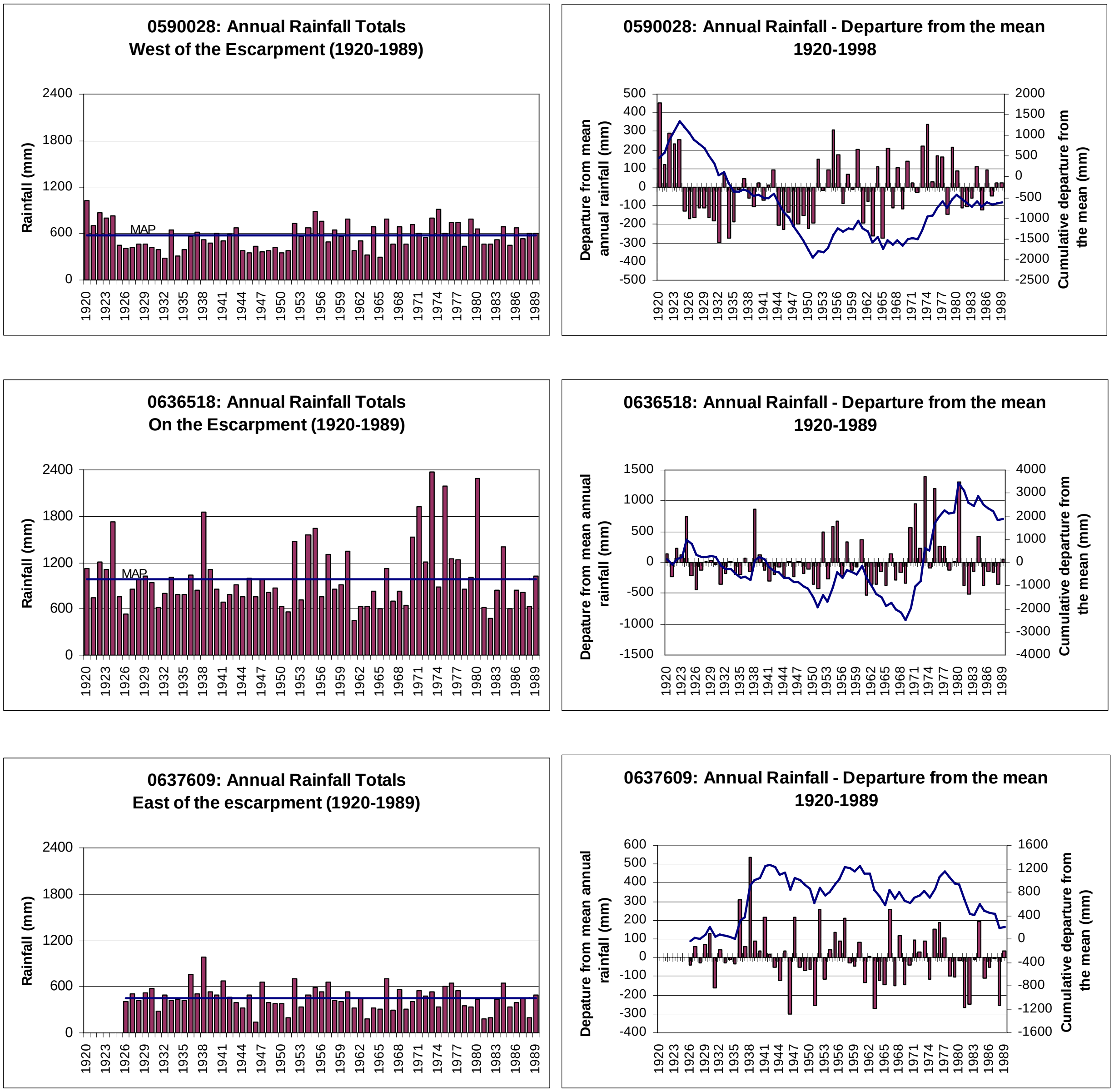



**Figure 3:** *Rainfall at three rain stations in the Olifants Catchment for the period HY1920-HY1989. Located: i) on the highveld (to the west of the escarpment) ii) on the escarpment, iii) on the lowveld (i.e. to the east of the escarpment).*

A plot of mean annual precipitation and altitude indicates that a different relationship exists between rainfall and altitude for sites in the vicinity of the escarpment than exists for locations elsewhere in the catchment, clearly illustrating the orographic influence of the escarpment (Figure 4).

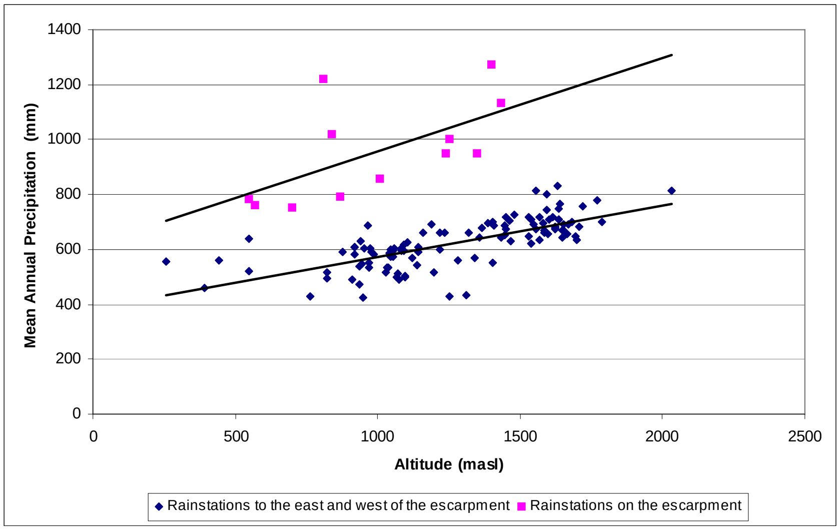



**Figure 4:** *Relationship between mean annual precipitation (for gauges with >30 years of data) in the vicinity of the escarpment and elsewhere in the Olifants catchment*

The intra-annual distribution of rainfall for each of the secondary catchments is presented in Table 3, with the median rainfall for each month. A graph of mean monthly precipitation for the three representative stations used previously demonstrates the strong seasonal nature of the rainfall (Figure 5).

**Table 3:** *Median monthly precipitation for each of the secondary catchments in the Olifants catchment* (derived from Schulze *et al*., 1997).

| Secondary Catchment | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1 | 63.1 | 111.2 | 106.3 | 114.6 | 83.0 | 70.2 | 35.1 | 9.8 | 0.1 | 0.0 | 0.5 | 14.9 |
| B2 | 57.2 | 102.9 | 103.6 | 112.9 | 83.0 | 72.4 | 32.7 | 9.2 | 0.1 | 0.0 | 0.1 | 12.7 |
| B3 | 47.3 | 98.9 | 97.6 | 101.8 | 79.1 | 63.7 | 31.0 | 6.8 | 0.0 | 0.0 | 0.0 | 10.2 |
| B4 | 52.8 | 107.1 | 110.6 | 110.9 | 85.9 | 70.1 | 37.3 | 8.6 | 0.3 | 0.1 | 0.3 | 13.4 |
| B5 | 37.1 | 82.1 | 88.7 | 89.9 | 71.4 | 53.0 | 27.5 | 5.1 | 0.1 | 0.1 | 0.1 | 8.5 |
| B6 | 50.4 | 105.7 | 122.0 | 127.3 | 114.8 | 89.1 | 44.5 | 12.4 | 1.8 | 2.4 | 2.5 | 14.8 |
| B7 | 30.7 | 68.3 | 92.4 | 91.8 | 76.0 | 56.1 | 30.2 | 6.2 | 0.4 | 1.0 | 0.6 | 7.2 |
| **Total Catchment** | 45.5 | 92.4 | 99.4 | 102.4 | 80.5 | 63.8 | 32.4 | 7.5 | 0.2 | 0.4 | 0.4 | 10.7 |

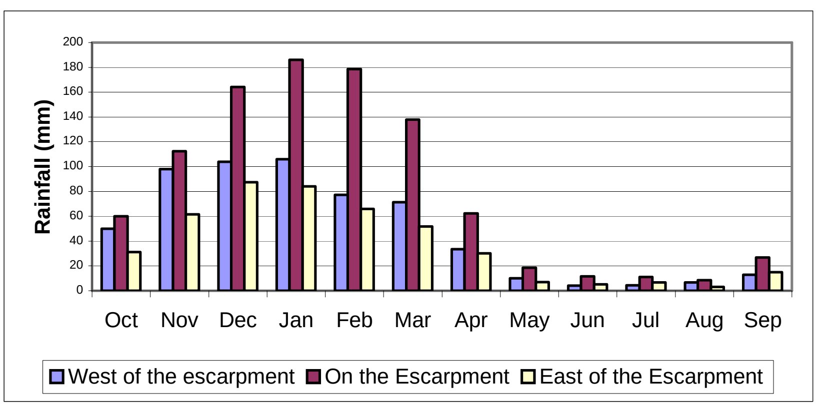



**Figure 5:** *Mean monthly precipitation for the same three rain stations as Figure 3.*

## 5. Evaporation

Potential evaporation (i.e. evaporation that is not constrained by moisture deficit and so fully meets atmospheric demand) can be estimated in a number of different ways. One approach is direct measurement of evaporation from the surface of an evaporation pan. In southern Africa there is a network of over 750 US Weather Bureau Class A pans. The A-pan provides an index of open water evaporation and many crop coefficients, which relate the consumptive water use of plants at different growth stages to a reference evaporation (Doorenbos and Pruitt, 1977), have been tried and tested against the A-pan (Schulze, 1995). Data are available for 56 evaporation pans located in or very close to the boundary of the Olifants catchment. Of these 19, have 40 or more years of data.

There are a number problems with extrapolating A-pan data from its measurement at a site to other locations (Smith, 1975). Consequently, for the South African Atlas of Agrohydrology and Climatology, simple climatic and physiographic variables (i.e. maximum daily temperature, extra-terrestrial radiation, altitude and median monthly rainfall) were used as surrogates to develop the grids of "A-pan equivalent" potential evaporation (Schulze *et al.*, 1997). The results for the Olifants catchment are shown in Figure 6 and summarized for each of the secondary catchments in Table 4.

**Table 4:** *Mean monthly and annual A-pan equivalent evaporation for each of the secondary catchments in the Olifants catchment* (derived from Schulze *et al*., 1997).

| Secondary Catchment | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1 | 210.8 | 205.6 | 215.1 | 204.8 | 170.5 | 173.0 | 141.0 | 125.0 | 102.8 | 115.0 | 156.1 | 188.5 | 2013.7 |
| B2 | 226.6 | 220.8 | 228.4 | 217.5 | 179.8 | 180.2 | 145.5 | 129.4 | 106.1 | 118.1 | 160.8 | 198.5 | 2117.0 |
| B3 | 230.8 | 226.1 | 233.3 | 228.6 | 189.7 | 187.3 | 149.0 | 133.2 | 110.2 | 122.0 | 163.6 | 200.1 | 2179.4 |
| B4 | 199.9 | 195.0 | 199.9 | 197.4 | 162.9 | 169.1 | 143.6 | 130.6 | 107.4 | 117.5 | 152.8 | 180.8 | 1962.2 |
| B5 | 221.2 | 220.7 | 221.6 | 222.5 | 181.4 | 181.9 | 148.7 | 133.0 | 110.8 | 121.2 | 159.2 | 193.4 | 2121.0 |
| B6 | 194.1 | 192.3 | 195.9 | 194.4 | 165.0 | 167.8 | 144.3 | 130.4 | 107.5 | 117.1 | 149.7 | 174.9 | 1939.5 |
| B7 | 201.3 | 209.4 | 214.6 | 217.3 | 183.1 | 178.6 | 143.2 | 125.7 | 105.8 | 117.5 | 150.0 | 179.2 | 2031.2 |
| **Total Catchment** | 213.7 | 212.6 | 218.1 | 215.2 | 178.7 | 178.6 | 145.4 | 129.6 | 107.5 | 118.8 | 156.5 | 188.8 | 2068.9 |

An alternative recommended reference for estimating irrigation water requirements of crops is the Penman-Montieth equation (FAO, 1992). This provides an estimate of potential evapotranspiration from a well watered vegetation surface rather than an open water body (Penman 1948, Monteith, 1981). Water movement in plants is passive (i.e. requires no input of biological energy), but even when the stomata of plants are fully open there is some resistance to the interchange of water between the plant and the atmosphere. Consequently, except in exceptional circumstances, evapotranspiration from a vegetated surface will always be less than that from open water. The FAO (1992) definition of potential evapotranspiration is:

> *The rate of evapotranspiration from a hypothetical crop with assumed crop height of 0.12m, a fixed canopy resistance of 70ms$^{-1}$ and albedo of 0.23, which could closely resemble evapotranspiration from an extensive surface of green grass cover of uniform height, actively growing, completely shading the ground and not short of water.*

For the South African Atlas of Agrohydrology and Climatology, because the gridded A-pan equivalent potential evaporation estimates had been based on readily mappable and physiographically related variables and because extensive verification tests had been performed on the equations used to extrapolate the data, it was decided to relate month-by-month ratios of Penman-Montieth to A-pan values (Schulze *et* *al*., 1997). The resultant estimates of Penman-Monteith potential evapotranspiration for each of the sub-catchments of the Olifants are presented in Table 5.

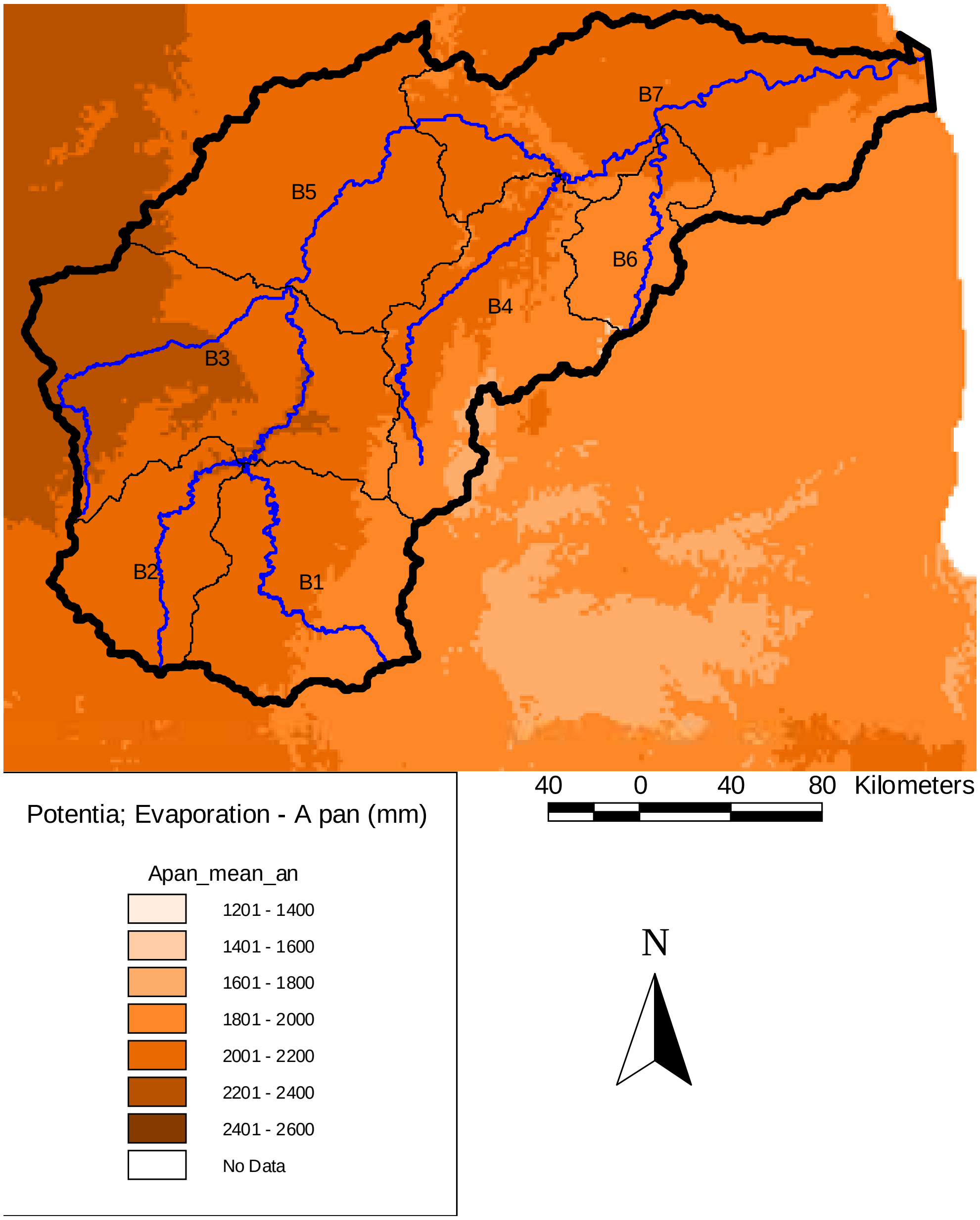



**Figure 6:** *Mean annual A-pan equivalent evaporation for the Olifants catchment* (derived from Schulze *et al*., 1997).

**Table 5:** *Mean monthly and annual potential evapotranspiration (Penman-Montieth) for each of the secondary catchments in the Olifants catchment* (derived from Schulze *et al*., 1997).

| Secondary Catchment | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1 | 149.5 | 150.0 | 156.9 | 149.4 | 124.4 | 122.8 | 95.8 | 77.4 | 60.5 | 67.7 | 96.6 | 126.2 | 1377.2 |
| B2 | 160.8 | 161.5 | 167.6 | 160.1 | 132.3 | 129.4 | 99.8 | 81.2 | 63.4 | 70.5 | 100.5 | 133.3 | 1460.4 |
| B3 | 163.8 | 165.9 | 172.1 | 169.6 | 140.7 | 135.8 | 102.9 | 84.6 | 66.6 | 73.8 | 103.2 | 134.7 | 1513.7 |
| B4 | 141.8 | 142.5 | 146.2 | 144.5 | 119.3 | 120.6 | 97.9 | 81.3 | 63.6 | 69.6 | 95.0 | 121.2 | 1343.5 |
| B5 | 156.9 | 163.0 | 165.8 | 168.5 | 137.3 | 135.7 | 105.1 | 87.2 | 69.3 | 75.9 | 103.0 | 118.9 | 1486.6 |
| B6 | 139.4 | 141.7 | 144.7 | 143.7 | 122.3 | 121.2 | 99.7 | 82.9 | 65.3 | 71.2 | 95.0 | 131.2 | 1358.3 |
| B7 | 149.4 | 158.8 | 164.9 | 167.5 | 142.4 | 137.0 | 105.1 | 87.4 | 71.0 | 78.9 | 102.9 | 127.5 | 1492.8 |
| **Total Catchment** | 153.2 | 157.1 | 162.3 | 160.9 | 133.9 | 131.1 | 101.8 | 83.9 | 66.5 | 73.5 | 100.5 | 128.7 | 1453.4 |

A comparison of the median monthly rainfall and the mean monthly Penman-Monteith potential evapotranspiration for the whole of the Olifants catchment shows that there are no months when rainfall exceeds potential evapotranspiration and typically it only exceeds 50% potential evapotranspiration in the months November to February (Figure 7). Consequently rainfall conditions are not ideal for the development of crops and irrigation is necessary to reduce the risk of water shortages. In relation to rainfall and potential evapotranspiration, the secondary catchment most suited for rain-fed agriculture is B6 (the Blyde River) in which rainfall typically exceeds 50% potential evapotranspiration from November to March and is close to full potential evapotranspiration from December to February.

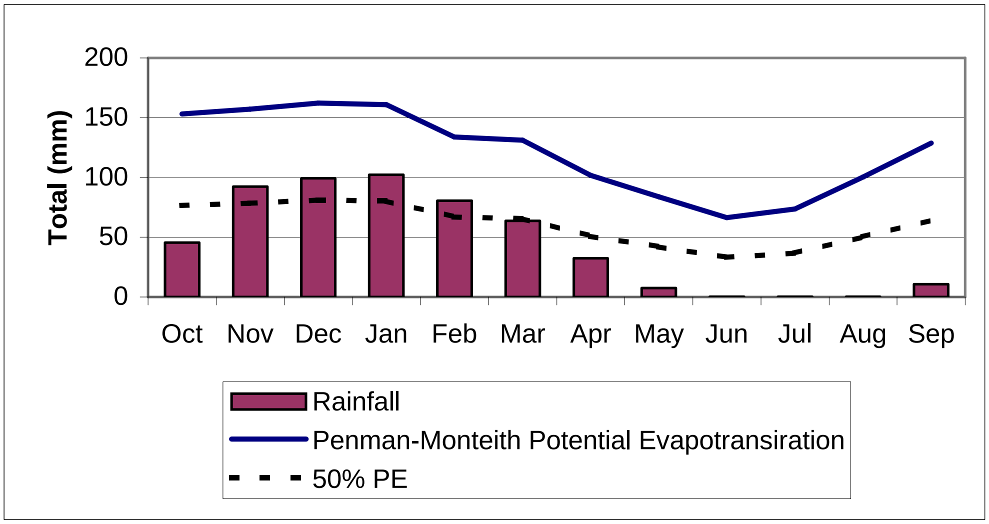



**Figure 7:** *Median monthly rainfall and mean monthly potential evapotranspiration for the whole of the Olifants catchment* (derived from Schulze *et al*., 1997).

## 6. Flow

### 6.1 Measured Flow

Nearly all the 1500 streamflow gauging stations in South Africa are maintained and the records processed by DWAF. There are 72 flow gauging stations within the Olifants catchment, with varying amounts of available data (Appendix 1). Flow is determined, or has been measured in the past, at seven locations on the main stem of the Olifants River (Figure 8). For the current study daily flow data, provided by DWAF, for all the Olifants stations have been loaded to a hydrological database (HYDATA, Renn *et al.*, 1999) and converted to mean monthly ($m^3s^{-1}$) and total monthly flows ($Mm^3$).

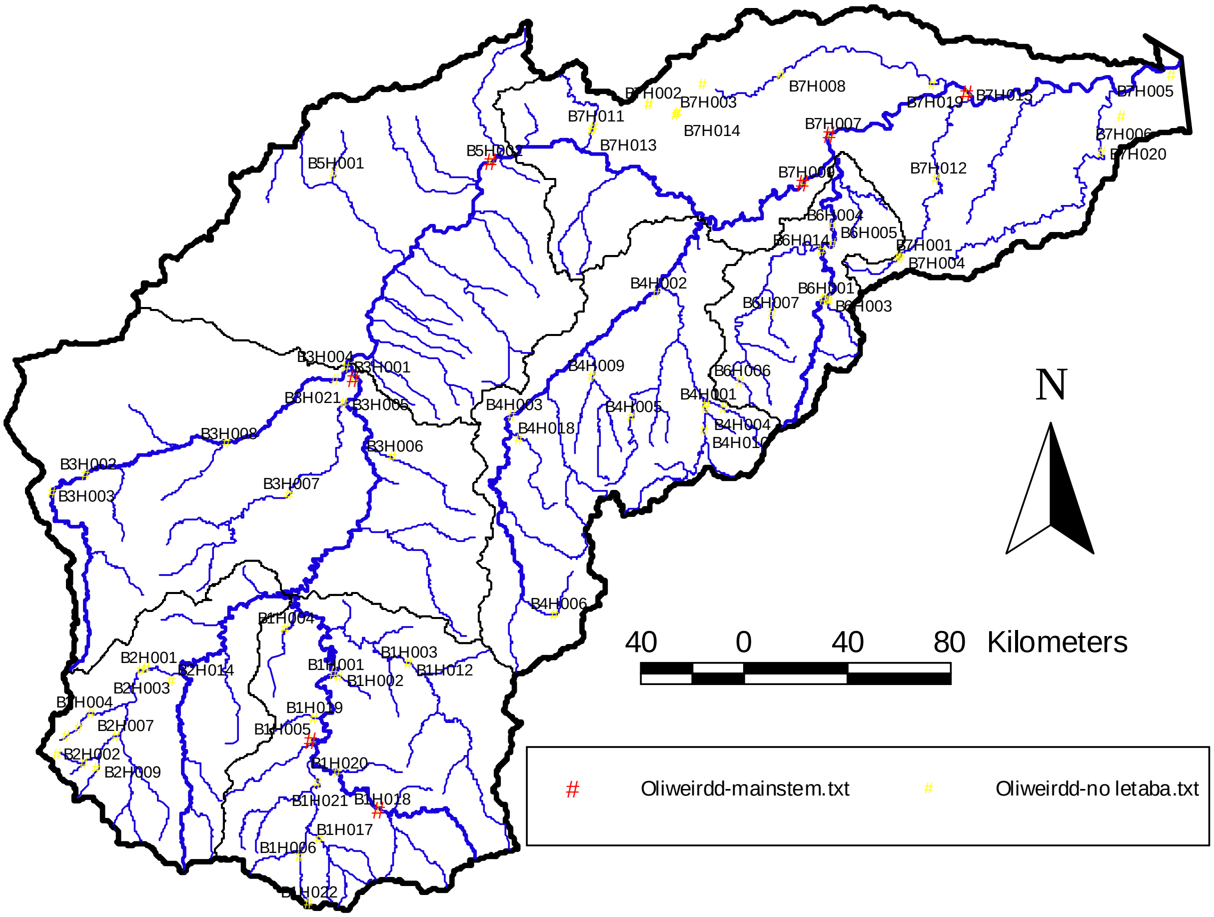



**Figure 8:** *Map showing location of flow gauging station locations in the Olifants catchment –* highlighting those on the main stem

Figure 9 shows graphs of time series of flow for three of the gauging stations on the Olifants main stem – B1H005, B5H002 and B7H009, with catchment areas of 3,256 $km^2$, 31,416 $km^2$ and 42,472 $km^2$ respectively. Although, as a consequence of different data availability, they cover different periods of time, the graphs illustrate:

i. the general increase in flow with distance downstream

ii. the considerable inter-annual variability at all points on the river (even allowing for the water storage within the catchment – section 7).
iii. the frequent occurrence of consecutive years in which flow is below the mean annual discharge (e.g. for much of the 1980s and 1990s).

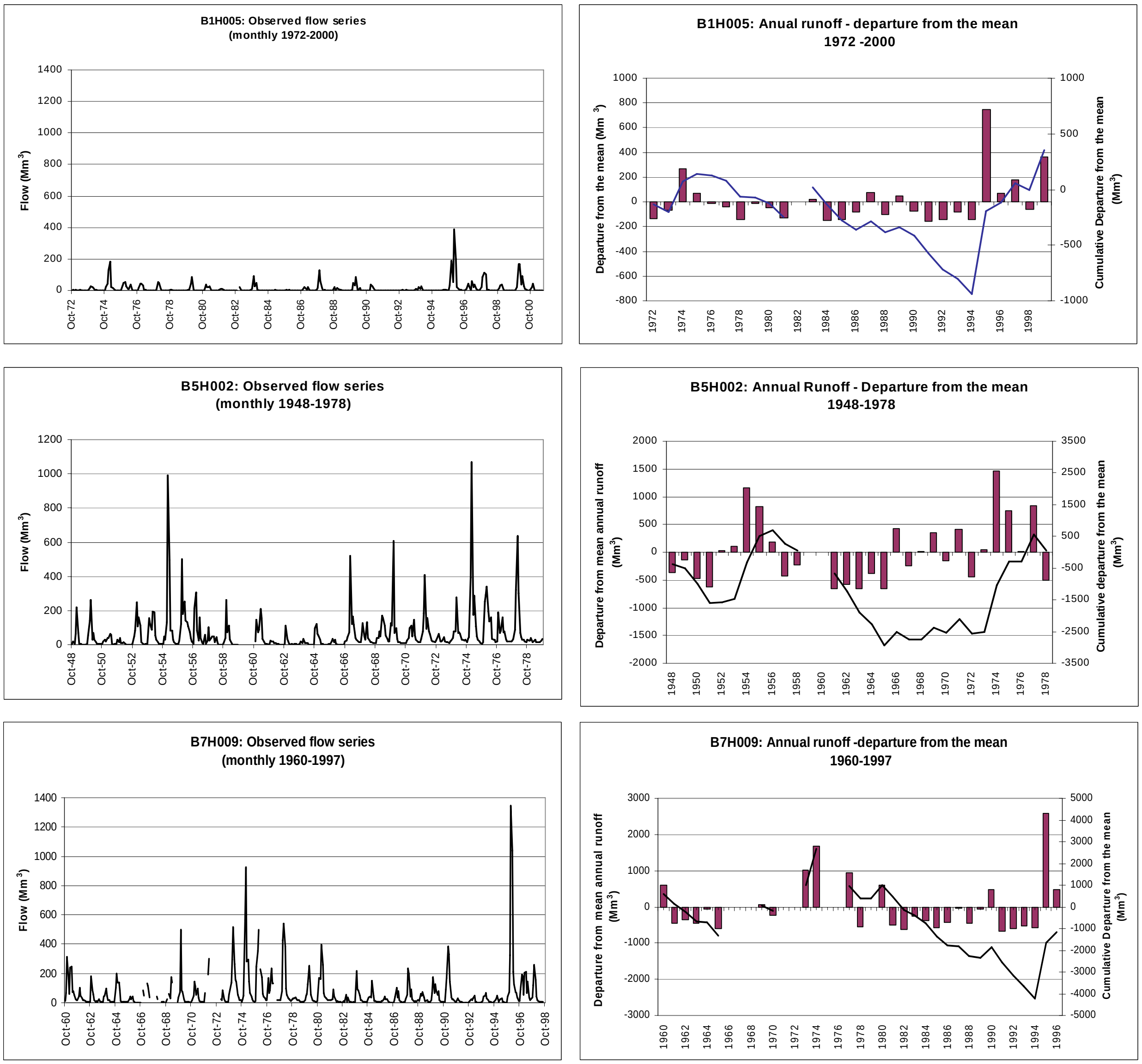



**Figure 9:** *Flow measured at three gauging stations on the Olifants River and departure from the mean annual runoff.*

Figure 10 shows the mean monthly runoff at each of these three gauging station.

## 6.2 Naturalised Flow

For the purpose of water resource assessment, it is necessary to have an understanding of flow conditions unaffected by human induced land cover and water use changes. In the WR90 study, considerable effort was made to calibrate and validate a deterministic model to synthesise natural flow conditions (Midgley *et al.*, 1994). The model used, WRMS90, is a version of the Pitman Model. This is a monthly time step rainfall-runoff model, developed specifically for use in South Africa (Pitman, 1973). The model can be used to take into account the hydrological impacts of irrigation, the planting of non-indigenous forests (i.e. eucalyptus and conifer plantations) and urbanization, as well as the impact of reservoirs and water transfers into and out of a catchment. The model was applied to estimate the "natural" hydrology at key gauging stations in the country (i.e. assuming no water resource development and "virgin" conditions for land cover). Naturalised flow was derived for 17 of the gauging stations in the Olifants catchment, but for different periods of time. Once calibrated, model parameters were regionalized and the model was used to generate 70-year sequences (HY1920-HY1989) of naturalized flow for each quaternary catchment in the country (Midgley *et al.*, 1994).

More recently, as part of the WSAM study (Schultz and Watson, 2002), the naturalized quaternary catchment flows have been updated to accommodate new developments in methods for estimating the effects of afforestation and alien vegetation (Scott and le Maitre, 1994; Le Maitre, 1999). However, this updating did not re-evaluate the naturalized flow at gauging stations and did not extend the naturalized flow series for the quaternary catchments beyond HY1989.

There is relatively little difference in the mean annual flow (MAF) of each of the water management regions of the Olifants catchment estimated from the naturalized quaternary flows derived in the WR90 and WSAM studies (Table 6). Overall, the most recent estimates provide a MAF for the whole catchment of 2040 $Mm^3$ compared to 1992 $Mm^3$ derived from the WR90 data. In both datasets, approximately 40% the MAF is generated in the Lower Olifants region. However, the WSAM derived estimates indicate even greater variability in runoff than was the case with the WR90 estimates. This emphasizes the need for storage to meet water demands in the catchment (section 7).

**Table 6:** *Naturalised mean annual runoff derived from the WR90 and WSAMs studies for the five water management regions of the Olifants catchment*

| **Water Management Region** | **WR90**[1] | | **WSAM** | |
|---|---|---|---|---|
| | MAF ($Mm^3$) | Range in MAF ($Mm^3$) | MAF ($Mm^3$) | Range in MAF ($Mm^3$) |
| Upper Olifants River | 466 | 134-1233 | 424 | 80-1365 |
| Upper Middle Olifants River | 200 | 86-538 | 249 | 42-897 |
| Mountain Region | 397 | 147-769 | 396 | 138-1509 |
| Lower Middle Olifants Region | 107 | 23-555 | 121 | 13-636 |
| Lower Olifants Region | 822 | 255-2351 | 849 | 259-4595 |
| Total Catchment | 1992 | no data | 2040 | 677-8020 |

[1] Data from DWAF, 2002

A graph showing the contribution to mean monthly naturalised flow (derived from the WSAM study) from each of the secondary catchments (Figure 11), illustrates:

i. the strongly seasonal nature of the naturalised flow regime of the river, reflecting the seasonal rainfall pattern.
ii. secondary catchments B4, B6 and B7 make the greatest contribution to the naturalised flow of the Olifants River (Table 7).

The comparatively large contributions to naturalised MAF from secondary catchments B4 and B7 occur because of their relatively large areas in comparison to the other catchments. The coefficient of runoff is an index of the proportion of rainfall that is converted to runoff (i.e. the proportion of mean annual runoff (mm) to mean annual rainfall (mm)). In all the secondary catchments, with the exception of B6, the coefficient of runoff is 0.08 or less (Table 8). The exceptionally low value (0.02) for B5 is a consequence of both the low rainfall in this area and the underlying geology/soils, which promote infiltration and reduce runoff from the catchment (Aston, 2000 ?). In catchment B6 the coefficient of runoff is 0.18 reflecting the much higher rainfall experienced over this cachment (i.e. Blyde River), which lies along the escarpment (section 4).

**Table 7:** *Mean monthly naturalised riverflow ($Mm^3$) from each secondary catchment in the Olifants basin*

| Secondary Catchment | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1 | 10.37 | 35.46 | 34.55 | 44.67 | 46.89 | 31.69 | 18.60 | 11.97 | 7.66 | 5.91 | 4.84 | 4.50 | 257.12. |
| B2 | 8.53 | 17.46 | 16.47 | 27.20 | 28.27 | 21.41 | 14.35 | 10.69 | 7.58 | 5.87 | 4.83 | 4.27 | 166.93 |
| B3 | 8.68 | 36.03 | 34.69 | 47.57 | 41.44 | 29.38 | 19.04 | 10.66 | 6.81 | 5.56 | 4.63 | 4.15 | 248.64 |
| B4 | 13.03 | 52.55 | 61.63 | 78.94 | 66.98 | 44.75 | 28.82 | 16.79 | 10.47 | 8.28 | 7.02 | 7.07 | 396.33 |
| B5 | 2.52 | 18.44 | 23.50 | 33.22 | 25.67 | 13.15 | 3.78 | 0.53 | 0.06 | 0.04 | 0.03 | 0.26 | 121.21 |
| B6 | 13.65 | 23.04 | 38.16 | 59.60 | 86.01 | 78.37 | 46.27 | 27.51 | 20.70 | 16.64 | 14.13 | 12.54 | 436.61 |
| B7 | 6.62 | 14.35 | 34.11 | 71.55 | 113.78 | 86.76 | 35.91 | 15.32 | 11.27 | 9.03 | 7.59 | 6.53 | 412.82 |
| **Total Catchment** | 63.39 | 197.34 | 243.11 | 362.76 | 409.03 | 305.51 | 166.79 | 93.47 | 64.56 | 51.32 | 43.07 | 39.31 | 2039.67 |

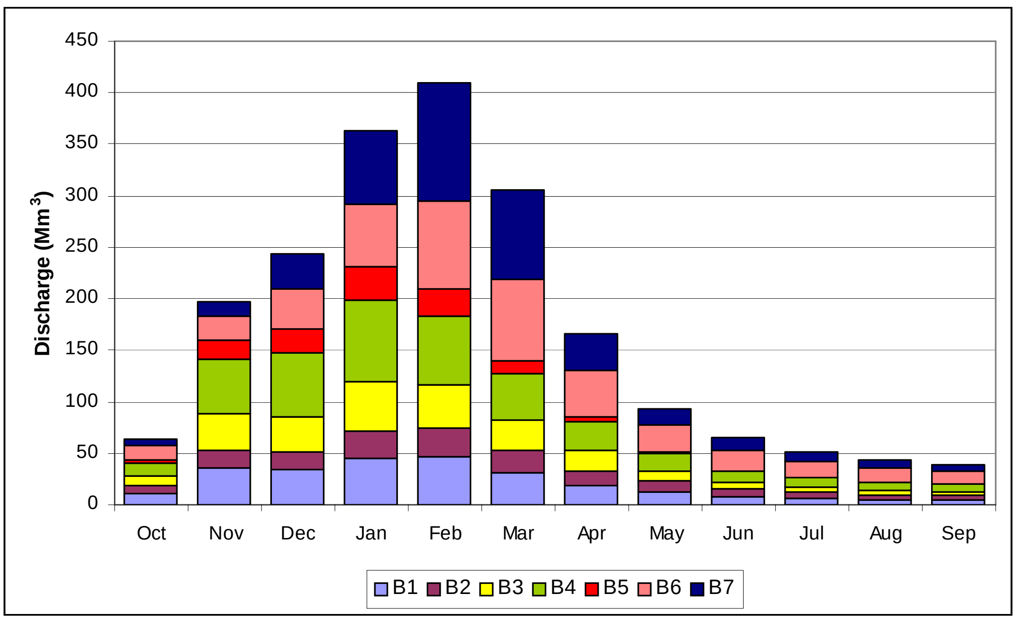



**Figure 11:** *Contribution to naturalized mean monthly river flow from each secondary catchment.*

**Table 8:** *Comparison of mean annual precipitation and mean annual runoff for each secondary catchment in the Olifants catchment*

| **Secondary Catchment** | **Area ($km^2$)** | **Mean annual precipitation (mm)** | **Mean annual runoff (mm)** | **Coefficient of runoff** |
|---|---|---|---|---|
| B1 | 7,105 | 689 | 36.2 | 0.05 |
| B2 | 4,356 | 670 | 38.3 | 0.06 |
| B3 | 11,242 | 617 | 22.1 | 0.04 |
| B4 | 7,136 | 681 | 55.5 | 0.08 |
| B5 | 9,728 | 551 | 12.5 | 0.02 |
| B6 | 2,842 | 823 | 153.6 | 0.19 |
| B7 | 11,899 | 586 | 34.7 | 0.06 |
| **Total catchment** | 54,308 | 630 | 37.6 | 0.06 |

The mean annual runoff contribution from each quaternary catchment is shown in Figure 12 (in mm).

The naturalised mean annual riverflow for the whole catchment is 2040 $Mm^3$ (Table 7). However, given the temporal variability in the rainfall (section 4), it is not surprising that the naturalized flow series for the catchment also shows considerable inter-annual variability (Figure 13). Wet years (i.e. naturalized flow exceeding 4,000 $Mm^3$) were HY1922, HY1924, HY1936, HY1938 and HY1954. HY1938 was exceptionally wet with naturalized flow exceeding 8,000 $Mm^3$. In addition to periods of high flow, drought is also a recurrent phenomenon. The naturalised flow record indicates the occurrence of twenty droughts (defined as periods with below average flow) between HY1920 and HY1989. Ranked in terms of severity (i.e. cumulative deficit over the period of the drought) this indicates that the two most severe droughts occurred between HY1961 and HY1965 and between HY1925 and HY1928 (Table 9). Total naturalised flow in these periods was just 53% and 59% of the long-term average respectively. The periods of the five most severe droughts are shown in Figure 13. Although not included in the naturalized flow record for the Olifants, regional analysis indicates that a severe drought was experienced across the whole of southern Africa in 1991 and 1992 and again between 1994 and 1995 (Houghton-Carr *et al.*, 2002). Both the rainfall records (section 4) and the measured flows (section 6.1) confirm that these droughts affected the Olifants catchment.

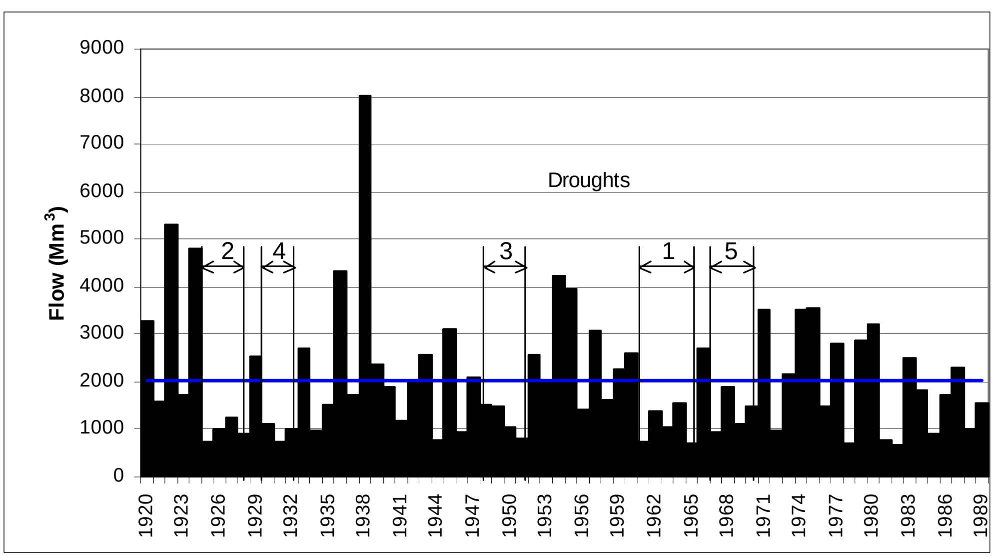



**Figure 13:** *Naturalised flow for the whole Olifants catchment (i.e. cumulative flow to quaternary catchmentB73H) for HY1920 to HY1989*

**Table 9:** *Droughts identified in the naturalised flow series in the period HY1920 to HY1989*

| Rank | First year | Last year | Duration (i.e. nos. of years) | Severity (i.e. cumulative deficit) $Mm^3$ | % of average flow over the same period |
|---|---|---|---|---|---|
| 1 | 1961 | 1965 | 5 | 4755 | 53 |
| 2 | 1925 | 1928 | 4 | 4216 | 59 |
| 3 | 1948 | 1951 | 4 | 3260 | 68 |
| 4 | 1930 | 1932 | 3 | 3245 | 68 |
| 5 | 1967 | 1970 | 4 | 2699 | 74 |
| 6 | 1981 | 1982 | 2 | 2638 | 74 |
| 7 | 1984 | 1986 | 3 | 1651 | 84 |
| 8 | 1934 | 1935 | 2 | 1605 | 84 |
| 9 | 1988 | 1989 | 2 | 1503 | 85 |
| 10 | 1978 | 1978 | 1 | 1331 | 87 |
| 11 | 1944 | 1944 | 1 | 1253 | 88 |
| 12 | 1946 | 1946 | 1 | 1109 | 89 |
| 13 | 1972 | 1972 | 1 | 1067 | 90 |
| 14 | 1940 | 1941 | 2 | 1011 | 90 |
| 15 | 1956 | 1956 | 1 | 629 | 94 |
| 16 | 1976 | 1976 | 1 | 539 | 95 |
| 17 | 1921 | 1921 | 1 | 437 | 96 |
| 18 | 1958 | 1958 | 1 | 431 | 96 |
| 19 | 1937 | 1937 | 1 | 312 | 97 |
| 20 | 1923 | 1923 | 1 | 301 | 97 |

## 6.3 Comparison of naturalised and measured flow

The difference between naturalised and measured flow provides an indication of water consumption within a catchment. Figure 14 compares the observed and naturalised flow at the three gauging stations (i.e. B1H005, B5H002 and B7H009) on the Olifants River. In each case the naturalised flow presented is that computed specifically for the station in the WR90 study. Although not taking into account the most recent methods for estimating the effects of afforestation and alien vegetation in computing the flow (section 6.2) these data were used in preference to those derived in the WSAMs study because:

- rather than regionalised values, in each case model parameters were derived specifically for the catchment in question
- some of the gauging stations are situated at the outlet of quaternary catchments, but this is not always the case. Consequently, using the WSAMs data, it is necessary to interpolate between quaternary catchments to estimate the naturalized flow at a specific gauging station
- the difference between the WSAMs and WR90 naturalised flow series are not large (section 6.2).

Also shown in Figure 14 is the mean monthly measured and naturalised flow series for each of the gauging stations. These graphs indicate that at gauging stations B5H002 and B7H009 the measured flows are, as would be expected in a catchment in which water resources are heavily utilized, significantly less than the naturalized flows. In contrast, at gauging station B1H005, the measured flows are in many months greater than the estimated naturalized flows. It is probable that the difference reflects uncertainty in both the measured and naturalized flow series. This uncertainty arises from gaps and measurement error in the observed flow series, as well as simulation errors and over or underestimation of land use effects in determining the naturalised flow series. For these reasons care should be taken in interpreting these results.

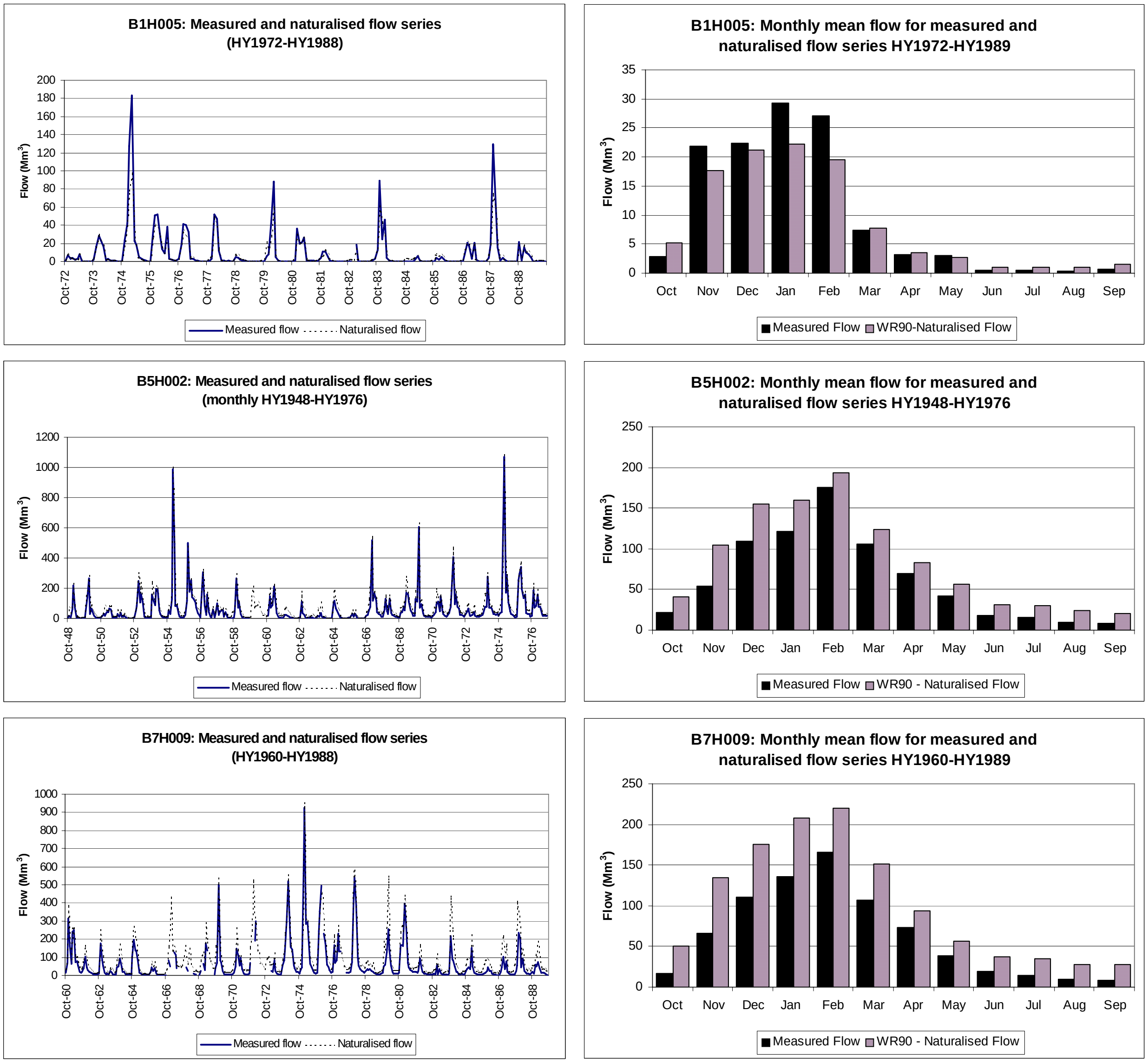
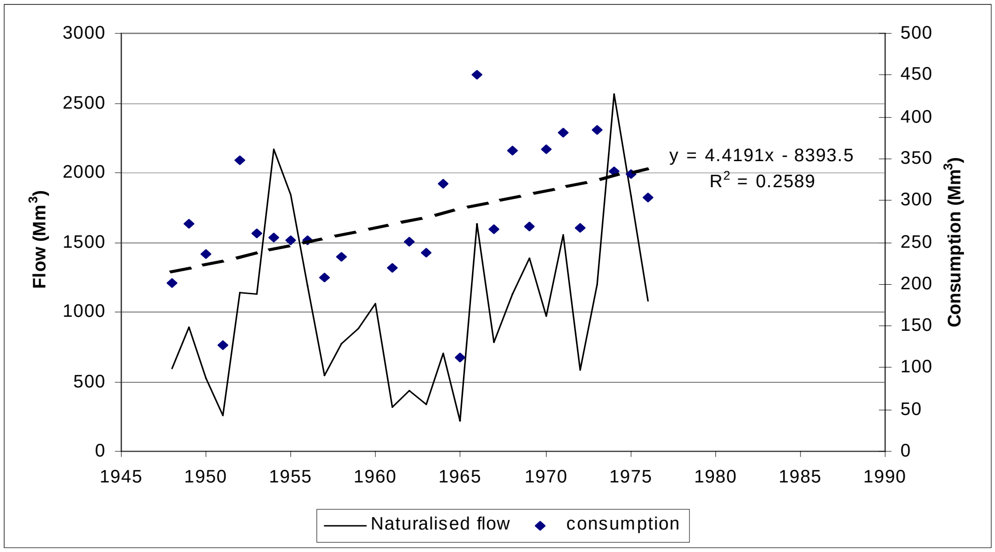



**Figure 14:** *Comparison of measured and naturalised flow series at three locations on the mainstem of the Olifants River*

Within a catchment, water consumption in any particular year depends on a large number of both biophysical and socio-economic factors. Although (as noted above) care must be taken in interpretation, the difference between measured and naturalized flow at gauging stations B5H002 and B7H009, are believed to be indicative of water consumption in the Olifants catchment. These data show considerable variation in consumption from year to year reflecting, amongst other things, the availability of water (Figure 15). Thus, the data from B7H009 show that consumption was severely constrained in the drought years of HY1965, HY1978 and HY1981-HY1982. Conversely, water consumption was also reduced in years of high flows, such as HY1973-HY1974, presumably because irrigation requirements were reduced. For both B5H002 and B7H009, the data indicate a trend of increasing water consumption over time. Although not statistically significant (because of the considerable inter-annual variability), nevertheless this trend is consistent with the widely perceived increase in water demand, driven by growing population and rising levels of economic activity (e.g. mining) within the catchment.

a)




b)

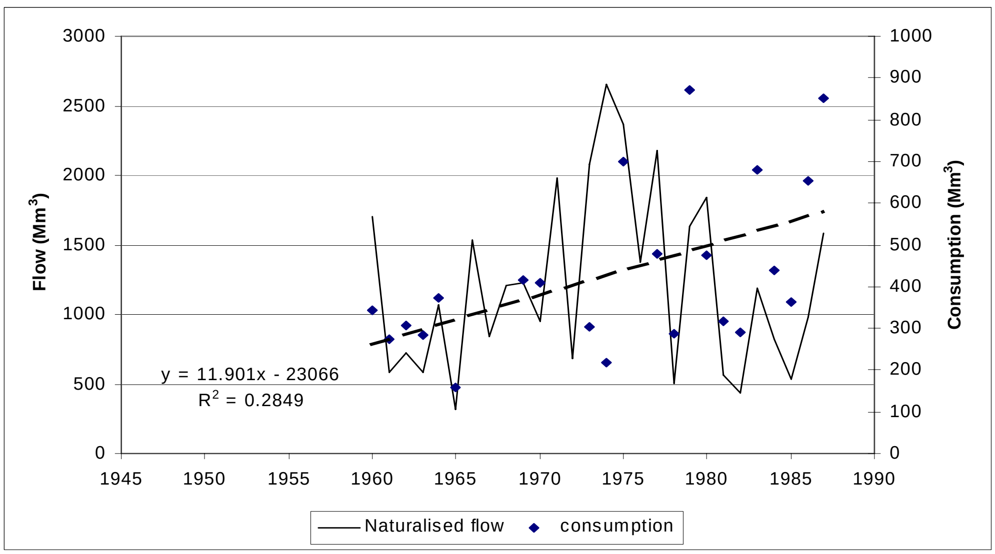



**Figure 15:** *Annual variation in naturalized flow at gauging stations and estimated "consumption" derived for two gauging stations on the Olifants mainstem: a) B5H002 and b) B7H009.*

Comparison of mean annual measured and mean annual naturalized flow at different locations on the main stem of the Olifants river indicates increasing consumption with distance downstream (Figure 16). Again caution must be exercised in interpreting these data because they have been derived from a variety of sources and represent mean annual flows determined for a wide range of different years. Nonetheless, the data indicate that a considerable proportion of the renewable water resource is being utilized. By gauging station B7H015 the ratio of water consumption (on average 865 $Mm^3$) to renewable resource (1964 $Mm^3$) is approximately 44%. If this ratio is assumed to hold to the catchment outlet then total consumption is 898 $Mm^3$ (i.e. 44% of 2040 $Mm^3$). Given the high variability in the natural flow regime and even allowing for the large amount of storage within the catchment (section 7) this is indicative of a catchment likely to experience periods of high water stress (Raskin *et al*., 1995).

The value of consumption estimated here compares reasonably well with total "demand" estimated through analysis of sectoral water requirements (Table 10). However, it is important to note that the demand for water from the power generation sector is met largely by water imported from outside the catchment (section 7.2) and furrthermore it is not clear if the "demand" presented is an estimate of consumption or water withdrawals (i.e. whether or not there is allowance for water returns).

**Table 10:** *Total annual water demand in the Olifants River Catchment in 1995* (source, DWAF, 2002)

| **Sector** | **Water demand (Mm3)** | |
|---|---|---|
| | **Mm3** | **% of total** |
| Irrigation | 540.3 | 54 |
| Power Generation | 160.2+ | 16 |
| Urban water supply | 117.8 | 12 |
| Mining/Industrial | 94.3 | 9 |
| Afforestation | 55.4 | 6 |
| Stock watering | 27.8 | 3 |
| **Total** | **995.8** | |

+ Supplied by water transfers into the Olifants Catchment (section 7.2).

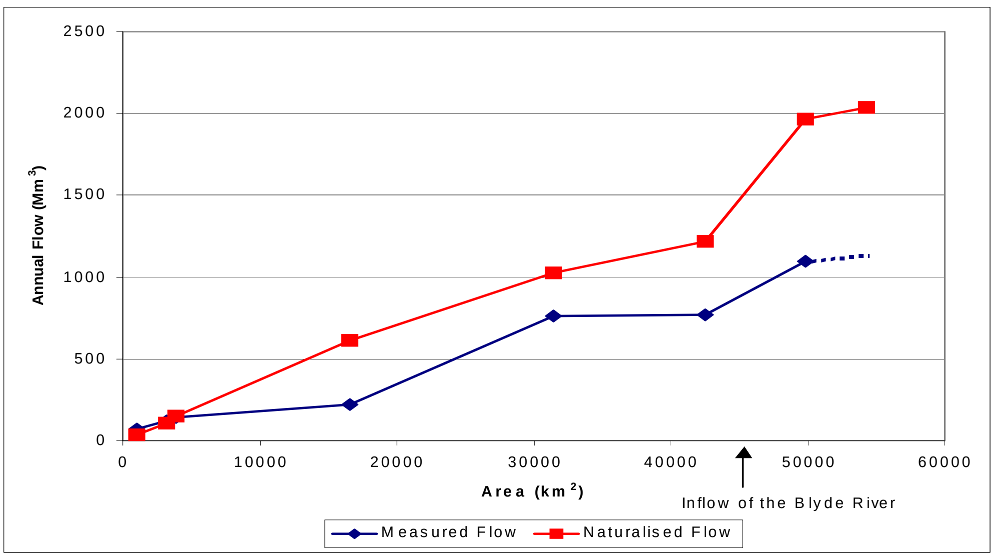



**Figure 16:** *Comparison of measured and naturalized mean annual flow with increasing distance downstream in the Olifants catchment*

## 7. Water Resource Development

### 7.1 Dams

On average more than 900 $Mm^3$ of water is consumed annually within the Olifants catchment (section 6). This equates to an average annual consumption in excess of 255,000 litres per person living in the catchment. The principal water consumers are irrigation, thermal power production (i.e. cooling water) and urban water supply (Table 10). Most of the water for power production is imported into the catchment (section 7.2) and because it is subsequently lost through evaporation has little impact on the overall hydrology of the catchment (DWAF, 1991).

Water resource development has played a prominent role in the expansion of agriculture and industry in the Olifants catchment. Substantial state investment over the last century has financed the transformation of the Olifants river and its tributaries into a complex system for harvesting, storing, transporting and controlling water resources. The dams safety register, maintained by DWAF, is a national database with information on more than 4,000 dams for which there is a potential safety risk (i.e. where a breach of the dam will endanger life and/or cause significant economic loss). The register includes data on 210 dams located in the Olifants catchment (Appendix B). The cumulative storage of these dams is 1262 $Mm^3$.

In most cases, the dams included on the dam safety register are the largest dams in a catchment. For the Olifants catchment, 37 dams on the register are classified as "major" dams (i.e. reservoir capacity in excess of 2 $Mm^3$) and 134 are classified as "minor" dams (i.e. reservoir capacity between 0.1 and 2 $Mm^3$). The remainder of the dams on the register, are classified as "small" dams (i.e. reservoir capacity less than 0.1 $Mm^3$). However, the vast majority of small dams, are deemed not to pose a safety risk and so are excluded from the register. There is considerable uncertainty about the number of minor and small dams in the Olifants catchment and over the years DWAF have published different estimates of the total number of dams and the capacity of the small and minor reservoirs (Table 11). What is certain is that the number of minor dams is approximately 300 and the number of small dams is in excess of 3,000 and may exceed 4,000. On the WSAM database the cumulative storage of non-major dams in the Olifants catchment is estimated to be 210 $Mm^3$.

**Table 11:** *Estimates of the number of minor and small dams in the Olifants catchment and the capacity of the reservoirs they impound*

| **Water Management Region** | **DWAF, 1991** | | | **DWAF, 2002** | | |
|---|---|---|---|---|---|---|
| | **Nos of minor dams** | **Nos. of small dams** | **Capacity ($Mm^3$)** | **Nos of minor dams** | **Nos. of small dams** | **Capacity ($Mm^3$)** |
| Upper Olifants River | 142 | 1,800 | 83.9 | 99 | 1,100 | 114 |
| Upper Middle Olifants River | 86 | 990 | 57.8 | 88 | 950 | 40.3 |
| Mountain Region | 35 | 261 | 16.5 | 42 | 0 | 15.4 |
| Lower Middle Olifants Region | 7 | 411 | 11.3 | 7 | 411 | 18.5 |
| Lower Olifants Region | 37 | 578 | 24.4 | 37 | 578 | 29.0 |
| **TOTAL** | 307 | 4040 | 193.9 | 273 | 3039 | 217.2 |

Within the Olifants catchment the total storage (i.e. impounded by major, minor and small dams) is approximately 1410 $Mm^3$. This equates to 69% of the average annual naturalized flow (section 6.2). Of this total 1200 $Mm^3$ (85%) is impounded behind the 37 major dams (Dam safety register, 2003). These large dams were built for a variety of reasons. Information on the original reason for construction was obtained from a variety of sources (e.g. DWAF, 1991; Turton and Meissner, 2003) for 25 of the major dams. Using this information the following can be determined (Figure 17):

- the majority of dams (56%) were constructed as multipurpose dams (i.e. they fulfil a number of functions)
- 28% of the dams (equating to 38% of the total storage) were built solely for irrigation
- 46% of the multipurpose dams contribute to irrigation, so in total 52% of the major dams in the Olifants support irrigation
- no dams have been built solely for industrial purposes, but 62% of the multipurpose dams include an industrial water supply function (including water supply to the mines)
- 85% of the multipurpose dams have a domestic water supply function.

a) b)

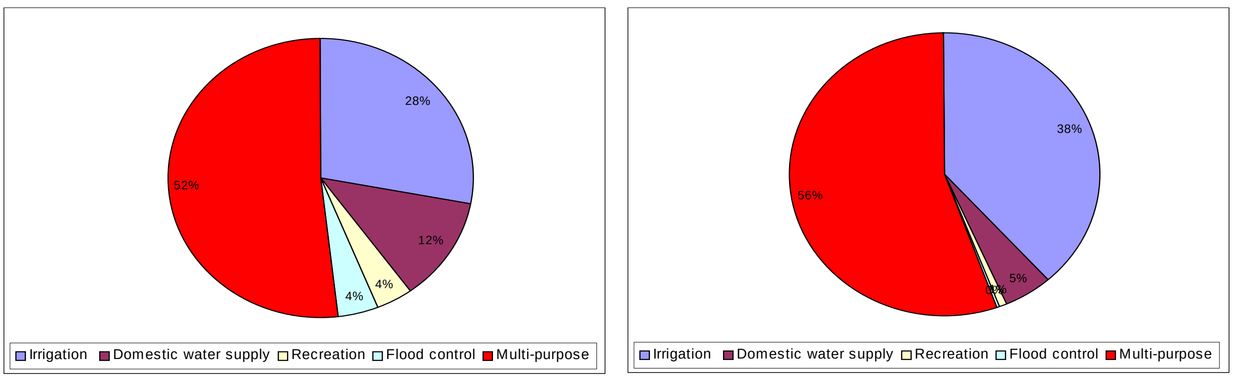



**Figure 17:** *Function of major dams (storage > 2Mm$^3$) constructed in the Olifants catchment: a) number of dams; b) storage of dams* (based on 25 large dams for which information on original purpose is available).

Over the last century, as the demand for water increased within the catchment, the number of dams built also increased (Figure 18a). There was rapid rise in the rate of dam construction in the 1960s and this rise continued well into the 1980s. Only in the 1990s was there a slight decline in the rate of dam construction. This pattern in the rate of dam construction lags the global trend (i.e. rapid rise following the second world war, which peaked in the 1970s and then declined) by approximately a decade (WCD, 2000). However, in terms of storage the picture is more complex because more than 30% of the total storage in the catchment was constructed in the 1930s (Figure 18b). This large increase was almost wholly attributable to the construction of a single dam, the Loskop dam (capacity 374 Mm$^3$). The only decade comparable to the 1930s, was the 1980s, but in this instance the increase in storage is attributable to the construction of more than 50 dams, the largest of which, Rhenosterkop, impounds 206 Mm$^3$.

White farmers moved into the Olifants catchment in the mid-1880s. The potential for irrigation was realized when a reconnaissance survey was undertaken between 1905 and 1907. However, it was the negative socio-economic consequences of the severe droughts of the mid-1920s and early 1930s (section 6.2), which caused great hardship to many farmers, which were a primary motivating factor in the government's decision to build dams. Moreover, many irrigation projects during the early 1930s were implemented not only to develop irrigation, but also to alleviate (white) unemployment (Turton and Meissner, 2003). The Loskop dam, which impounds the largest reservoir in the Olifants catchment, is one such scheme.

Following petitions from farmers in the area, planning for the Loskop dam was initiated in April 1929 (i.e. in the final year of the one of the worst droughts experienced in the area – section 6.2) when the Irrigation Commission (*is this the same as the Department of Irrigation ??*) recommended that the Loskop Irrigation project on the Olifants should be investigated. Work on the scheme commenced in 1934. Only white married men were employed in the construction. The work was funded by a loan from the Land Bank under the supervision of the Department of Irrigation. The reservoir filled and spilled during the high rains of December 1937 and January 1938 and the dam was completed at the end of 1938.

Following construction of the Loskop dam, there was relatively little increase in dam storage within the Olifants catchment until the 1970s (Figure 18b). By 1971, the Loskop reservoir served a system of canals commanding an area of 25,600 ha, of which approximately 16,624 ha were irrigated. In the same year, the annual demand for water from Loskop reservoir was estimated to be 144 $Mm^3$. This included not only irrigation water, but also water to the municipality of Middelburg and Groblersdal. To meet this demand and ensure supply after anticipated future development, DWAF proposed that the dam should be raised. In 1977, the dam was raised by 9.1 m (by the installation of crest gates) to provide its present storage capacity of 374 $Mm^3$. This provides a firm yield of 145.2 $Mm^3$ a year, when operated in tandem with the upstream dams of Witbank (built 1971, capacity 104 $Mm^3$) and Middelburg (built 1978, capacity, 48.4 $Mm^3$) (DWAF, 1991).

In 1973, the catchment area of the Loskop dam was proclaimed a Government Water Control Area (GWCA) under provision of the Water Act of 1956. This prohibited the private construction of dams on the Olifants and its main tributaries upstream of the Loskop reservoir. Off-river reservoirs could be constructed providing that the total storage of dams did not exceed 0.1 $Mm^3$, on any property (DWAF, 1991). However, dams could be constructed if a government permit was obtained and designation of the GWCA provided farmers' with direct access to loans and subsidies for the construction of dams, canals and other irrigation infrastructure (Deacon, 1997 – cited in Bate and Tren, 2002).

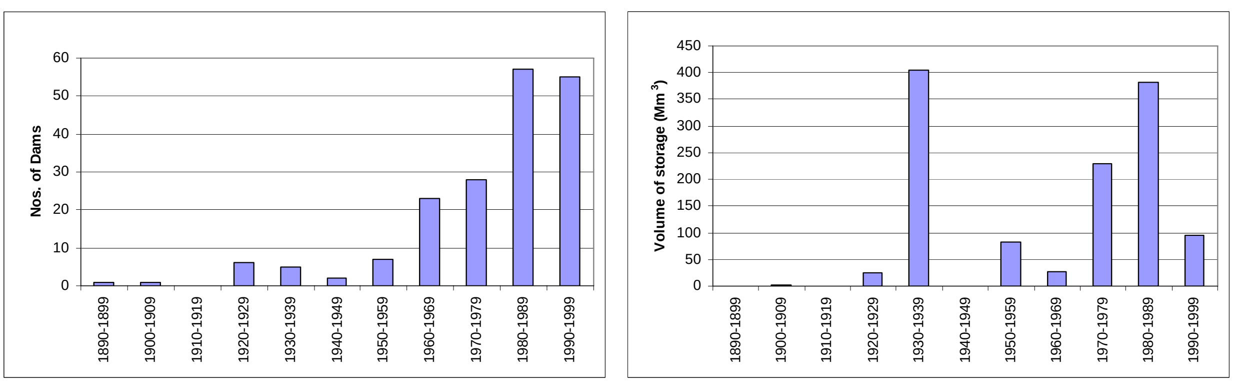



**Figure 18:** *The number of dams (a) and the capacity of storage built (b) in the Olifants catchment in each decade from 1890 to 1999* (source: DWAF dams safety register).

Prior to the 1980s, all major dam construction in South Africa was targeted at benefiting the white community. Consequently, there was negligible dam development in the so called homelands, which were nominally "self governing" regions, established under the apartheid regime. Within the Olifants catchment the homelands were Bophuthatswana, Lebowa, Gazankulu and KwaNdebele. Figure 19, illustrates the difference in the historical development of storage in the former homelands and what was the Republic of South Africa. The location of the dams built in each decade are shown on the maps presented in Figure 20.

In the 1980s, in what was a clear change in the policy of DWAF, two major dams were constructed in the homelands. It is possible that at this time the most technically attractive sites elsewhere in the catchment had already been developed. However, the motivation for the change in policy is not clear, although it is interesting that, as was the case with the 1930s construction, both dams were built following a period of severe drought (i.e. 1980 and 1981 - section 6.2).

The two major dams built in the 1980s were the Rhenosterkop dam (capacity 206 $Mm^3$) and the Flag Boshielo dam (capacity 105 $Mm^3$ and formerly known as Arabie Dam). Both dams were built downstream of the Loskop dam. The Rhensoterkop Dam was built on the Elands River in what was at the time the KwaNdebele homeland. The Flag Bosheilo dam was built on the main stem of the Olifants in what was then the Lebowa homeland. Both are multipurpose dams and both were financed and constructed by DWAF. The Rhenosterkop Dam was built to provide domestic and industrial water supplies in the KwaNdebele homeland. The Flag Bosheilo dam was built to provide water for irrigation, for domestic and industrial supply and also for recreation.

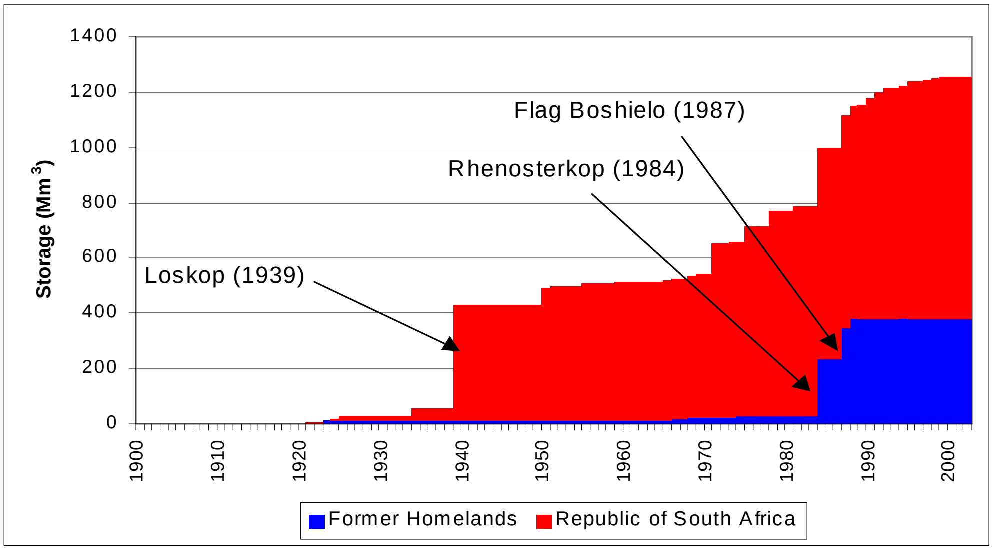



**Figure 19:** *Development of large dam storage in the Olifants Catchment (source dam safety register, 2003).*

The majority of small and minor dams are built to provide water for agriculture (i.e. irrigation and livestock watering). However, they are used for a variety of other purposes including aquaculture and the mines). The small dams will have some impact on the flows into and the yields from the major reservoirs. Research in Botswana has shown that as the total capacity of small reservoirs within a catchment increases there is a decline in yield from major reservoirs. However, the decline is affected by secondary factors such as the relative location of the small reservoirs and the way the water stored is utilized (Meigh, 1995). At the present time the magnitude of the impact of small dams in the Olifants catchment is unknown, but in terms of resource planning DWAF assumes it is negligible (DWAF, 1991).

Most small dams are privately financed and constructed and most comprise simple earth embankments. It is believed that most small dams were constructed after 1960, possibly when the technology to build them easily became readily available. The most significant increase in small dams occurred between 1970 and 1980, particularly following years of low rainfall (DWAF, 1991).

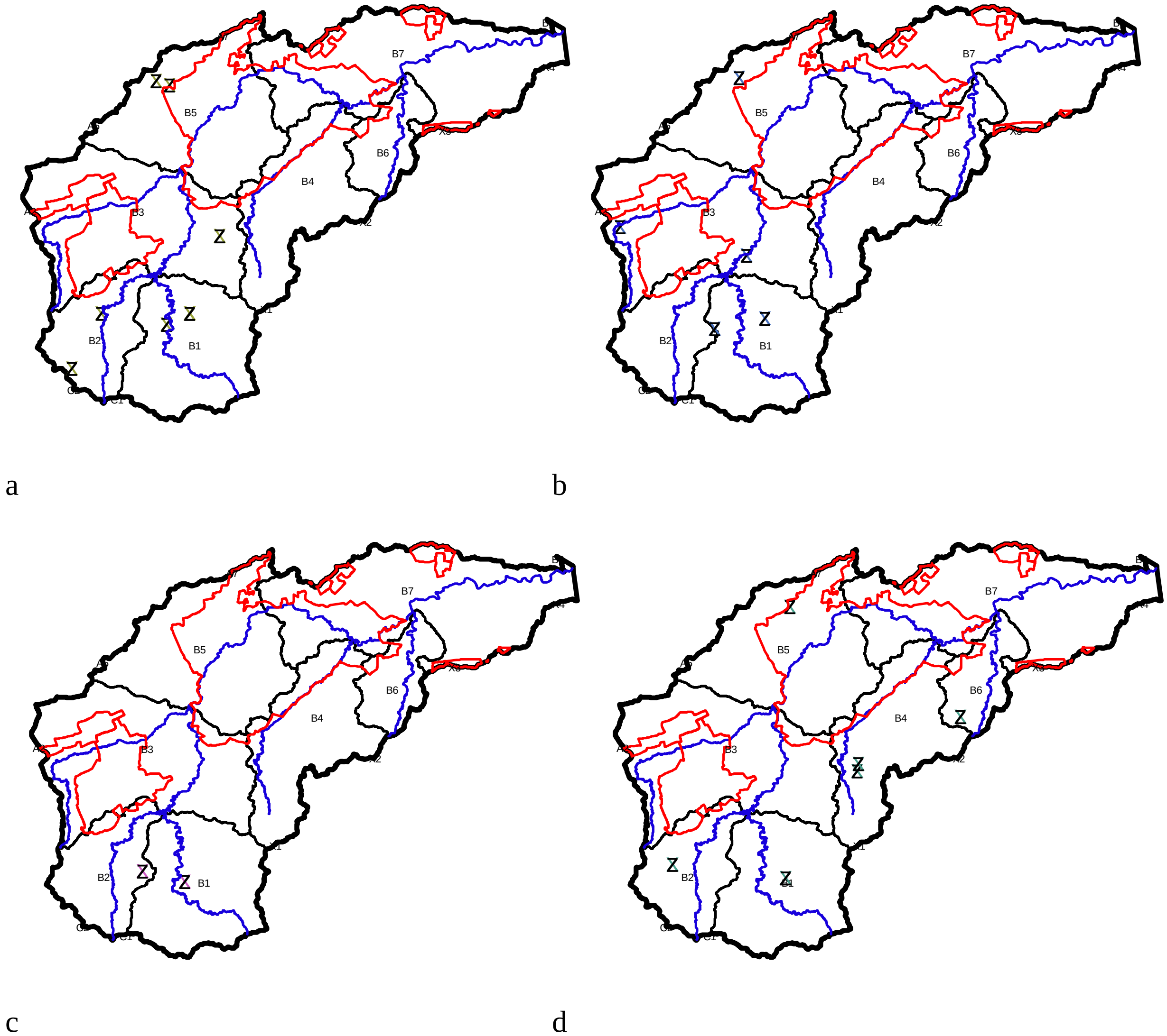



**Figure 20:** *Development of large dams in the Olifants catchment: a) Pre-1930; b) 1930-1939 c) 1940-1949 and d) 1950-1959*

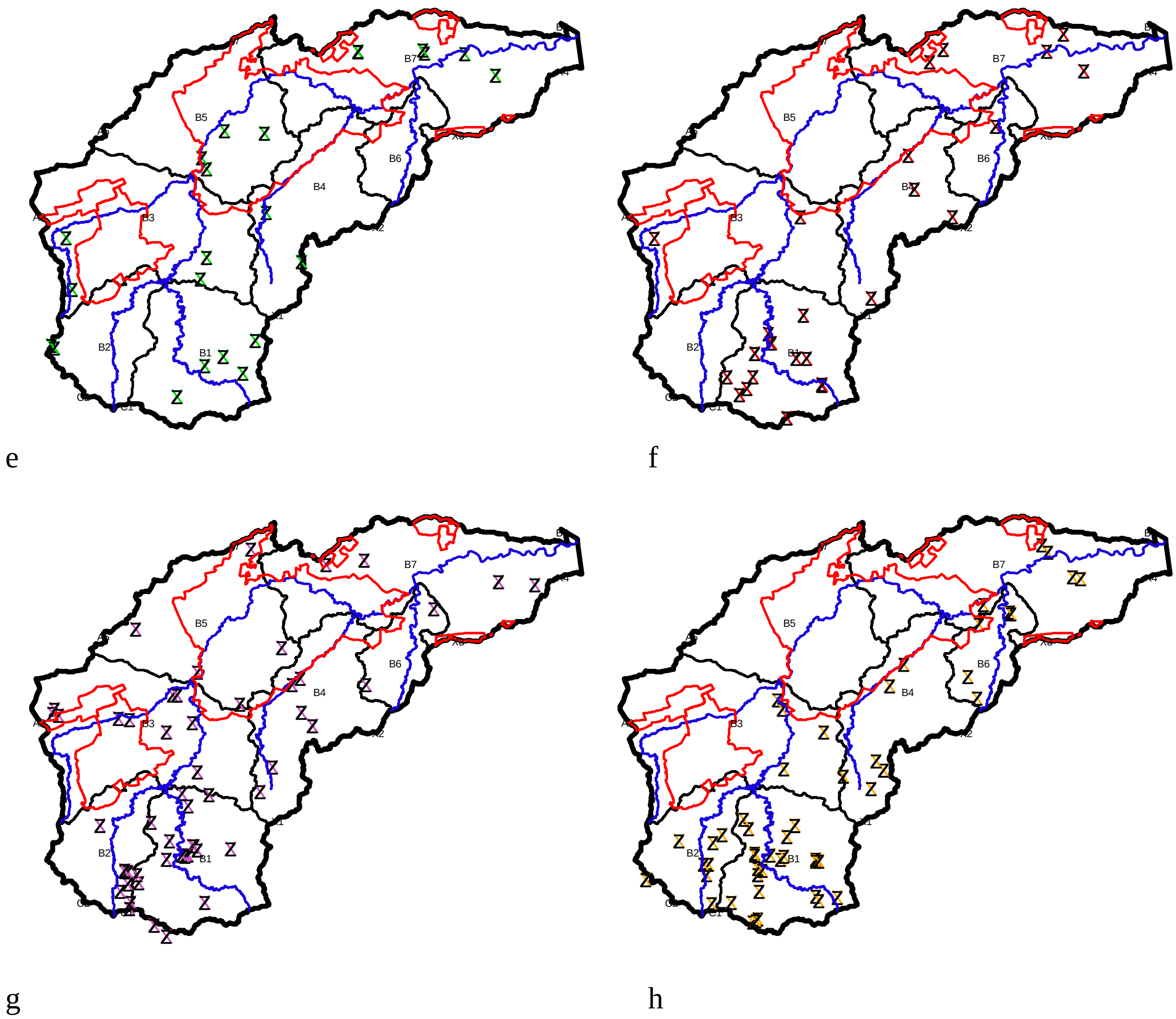



**Figure 20 (cont):** *Development of large dams in the Olifants catchment: e) 1960-1969; f: 1970-1979; g) 1980-1989; h) 1990-1999*

## 7.2 Interbasin transfers

Water resources within the Olifants catchment are augmented by transfers from the Vaal, Komati, Usutu and Great Letaba Rivers (Table ??). Most of the water transferred (i.e. from the Vaal, Kamati and Usutu rivers) is utilized as cooling water in the power stations located in the headwaters of the Olifants catchment and so leaves the catchment as evaporation.

**Table 12:** *Average annual water transfers ($Mm^3$) into the Olifants Catchment (source DWAF, 1991)*

| Source | Power Stations | Other uses* | Total |
|---|---|---|---|
| Vaal River | 21.8 | 5.0 | 26.8 |
| Usutu River | 64.0 | 0.0 | 64.0 |
| Komati River | 103.0 | 1.0 | 104.0 |
| Groot Letaba River | 0.0 | 1.3 | 1.3 |
| | | | |
| **Total** | 188.8 | 7.3 | 196.1 |

* domestic water supply, mines and fish farming

Note – total supplied to power stations is inconsistent with that presented in Table 10.

There is a single scheme that transfers water out of the Olifants catchment. This pumps approximately 4.0 $Mm^3$ a year from a dam on the Wilge River to meet industrial requirements in the adjacent catchment of the Crocodile River (DWAF, 1991).

### 7.3 Irrigation Development

The primary consumer of water in the Olifants catchment is irrigation. Since the 1950s the area of the catchment under irrigation has increased steadily from approximately 34,000 ha to 110,000 ha ((Table 13; Figure 21). The greatest proportion of the irrigation has always been in secondary catchment B3, largely in the vicinity of the Loskop Dam. A breakdown of the crops irrigated in 1988 indicates that most irrigation is of maize and wheat (Figure 22).

**Table 13:** *Estimated area under irrigation in the subcatchments of the Olifants catchment* (source DWAF, 1991 and WSAMs 1995).

| Secondary Catchment | Area (km$^2$) | Area irrigated (ha) | | | |
|---|---|---|---|---|---|
| | | **1950-1960** | **1965-1973** | **1988** | **1995** |
| B1 | 7,105 | 625 | 920 | 4,760 | 6,560 |
| B2 | 4,356 | 1,280 | 2,040 | 5,580 | 5,589 |
| B3 | 11,242 | 13,170 | 38,975 | 49,295 | 51,621 |
| B4 | 7,136 | 4,203 | 7,654 | 12,118 | 13,104 |
| B5 | 9,728 | 7,700 | 9,338 | 6,455 | 15,850 |
| B6 | 2,842 | 3,875 | 9,400 | 11,297 | 8,291 |
| B7 | 11,899 | 2,933 | 5,311 | 9,410 | 9,230 |
| **Total catchment** | 54,308 | 33,786 | 73,638 | 98,915 | 110,245 |

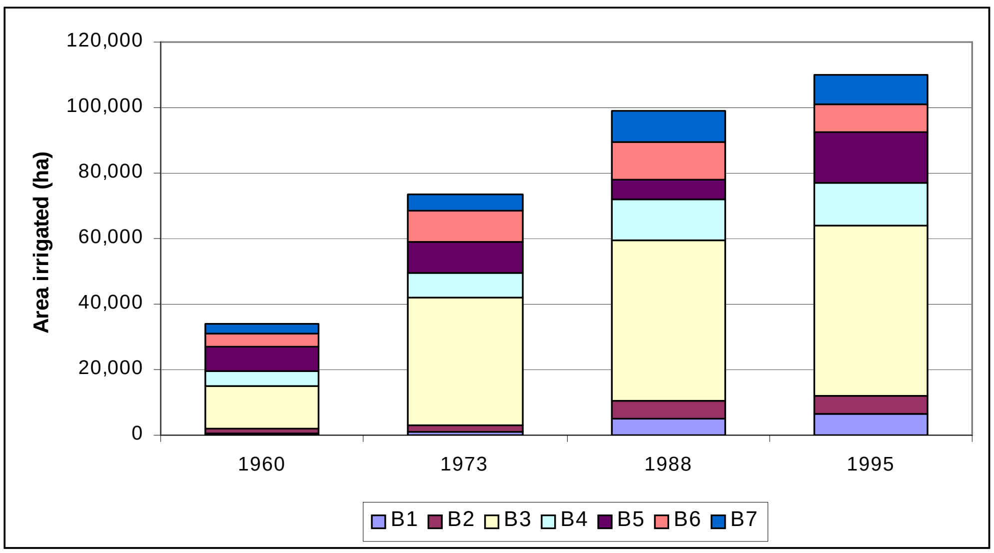



**Figure 21:** *Estimated area under irrigation in each of the subcatchments of the Olifants* (source DWAF, 1991 and WSAM).

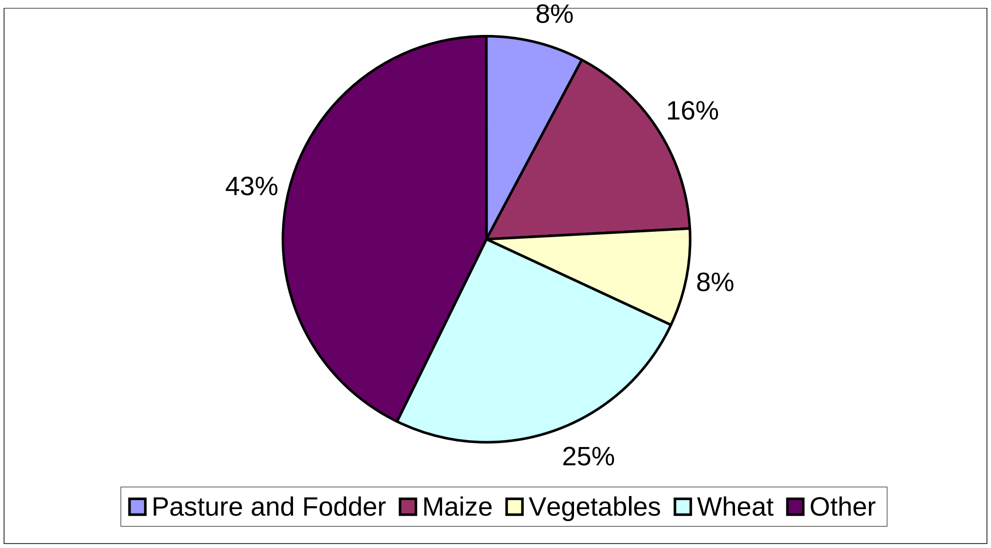



**Figure 22:** *Percentage of area irrigated under different crops in the whole of the Olifants catchment in 1988* (source DWAF, 1991).

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## Appendix A:

*Flow gauging stations in the Olifants catchment*

| Gauge number | Start of record | End of record | River | Description | Catchment area (km$^2$) | Location | |
|---|---|---|---|---|---|---|---|
| | | | | | | Latitude | Longitude |
| B1H001 | 1904 | 1951 | OLIFANTS RIVER | GAUGING WEIR | 3904.4 | -25.8093 | 29.3197 |
| B1H002 | 1956 | still open | SPOOKSPRUIT | GAUGING WEIR | 252.0 | -25.8190 | 29.3378 |
| B1H003 | 1957 | 1966 | KLEIN-OLIFANTS RIVER | GAUGING WEIR | 1576.0 | -25.7740 | 29.5428 |
| B1H004 | 1959 | still open | KLIPSPRUIT | GAUGING WEIR | 376.0 | -25.6740 | 29.1711 |
| B1H005 | 1972 | still open | OLIFANTS RIVER | GAUGING WEIR | 3256.0 | -26.0070 | 29.2539 |
| B1H006 | 1982 | still open | TRICHARDSPRUIT | GAUGING WEIR | 107.0 | -26.3590 | 29.2167 |
| B1H012 | 1978 | still open | LITTLE OLIFANTS RIVER | GAUGING WEIR | 1577.0 | -25.7756 | 29.5458 |
| B1H017 | 1989 | still open | STEENKOOLSPRUIT | GAUGING WEIR | 387.0 | -26.3062 | 29.2742 |
| B1H018 | 1989 | still open | OLIFANTS RIVER | GAUGING WEIR | 985.0 | -26.2173 | 29.4592 |
| B1H019 | 1990 | still open | NOUPOORTSPRUIT | GAUGING WEIR | 88.1 | -25.9404 | 29.2575 |
| B1H020 | 1990 | still open | KORINGSPRUIT | GAUGING WEIR | 133.0 | -26.1065 | 29.3308 |
| B1H021 | 1990 | still open | STEENKOOLSPRUIT | GAUGING WEIR | 1356.3 | -26.1368 | 29.2700 |
| B1H022 | 1991 | still open | TRICHARDTSPRUIT | GAUGING WEIR | 0.0 | -26.4957 | 29.2411 |
| B2H001 | 1904 | 1951 | BRONKHORSTSPRUIT | GAUGING WEIR | 1594.0 | -25.7926 | 28.7556 |
| B2H002 | 1917 | 1931 | RIETFONTEIN EYE | GAUGING FLUME | 0.0 | -26.0506 | 28.4833 |
| B2H003 | 1982 | still open | BRONKHORSTSPRUIT | DIVERSION WEIR | 1574.0 | -25.7995 | 28.7358 |
| B2H004 | 1984 | still open | OSSPRUIT | GAUGING WEIR | 123.0 | -25.9254 | 28.5856 |
| B2H005 | 1984 | still open | OSSPRUIT | GAUGING FLUME | 16.0 | -25.9943 | 28.5125 |
| B2H006 | 1984 | still open | OSSPRUIT | GAUGING WEIR | 54.0 | -25.9673 | 28.5508 |
| B2H007 | 1985 | still open | KOFFIESPRUIT | GAUGING WEIR | 317.0 | -25.9954 | 28.6628 |
| B2H008 | 1985 | still open | KOFFIESPRUIT TRIB. | GAUGING WEIR | 100.0 | -26.0795 | 28.5628 |
| B2H009 | 1985 | still open | KOFFIESPRUIT | GAUGING WEIR | 86.0 | -26.0923 | 28.6036 |
| B2H013 | 1907 | 1949 | BRONKHORSTSPRUIT | FLOOD SECTION | 1594.0 | -25.7926 | 28.7556 |
| B2H014 | 1990 | still open | WILGE RIVER | GAUGING WEIR | 1086.3 | -25.8273 | 28.8303 |
| B3H001 | 1966 | still open | OLIFANTS RIVER | GAUGING WEIR | 16553.0 | -24.9173 | 29.3842 |
| B3H002 | 1929 | 1933 | ELANDS RIVER | GAUGE PLATES | 1206.0 | -25.2095 | 28.5692 |
| B3H003 | 1965 | still open | ELANDS RIVER | GAUGING WEIR | 1050.0 | -25.2629 | 28.4675 |
| B3H004 | 1966 | still open | ELANDS RIVER | GAUGING WEIR | 6133.0 | -24.8853 | 29.3575 |
| B3H005 | 1969 | still open | MOSES RIVER | GAUGING WEIR | 1673.0 | -24.9912 | 29.3514 |
| B3H006 | 1970 | 1988 | DIEPKLOOFSPRUIT | GAUGING WEIR | 244.0 | -25.1542 | 29.4975 |
| B3H007 | 1980 | still open | MOSES RIVER | GAUGING WEIR | 971.0 | -25.2701 | 29.1847 |
| B3H008 | 1979 | still open | ELANDS RIVER | STORAGE WEIR | 4083.0 | -25.1151 | 28.9975 |
| B3H021 | 1989 | still open | ELANDS RIVER | GAUGING WEIR | 6119.0 | -24.9259 | 29.3244 |
| B4H001 | 1921 | 1921 | DORPS RIVER | GAUGING NOTCH | 707.0 | -25.0006 | 30.4467 |
| B4H002 | 1931 | 1937 | STEELPOORT RIVER | GAUGE PLATES | 4411.0 | -24.6659 | 30.2939 |
| B4H003 | 1955 | still open | STEELPOORT RIVER | GAUGING WEIR | 2240.0 | -25.0295 | 29.8567 |
| B4H004 | 1960 | still open | DORPS RIVER | DIVERSION WEIR | 701.0 | -25.0095 | 30.4450 |
| B4H005 | 1960 | still open | WATERVAL RIVER | GAUGING WEIR | 188.0 | -25.0384 | 30.2192 |
| B4H006 | 1954 | 1979 | LANGSPRUIT | GAUGING WEIR | 198.0 | -25.6290 | 29.9900 |
| B4H007 | 1963 | still open | KLEIN-SPEKBOOM RIVER | GAUGING WEIR | 151.0 | -25.0087 | 30.4994 |
| B4H009 | 1966 | still open | DWARS RIVER | GAUGING WEIR | 448.0 | -24.9131 | 30.1033 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B4H010 | 1979 | still open | DORPS RIVER | GAUGING WEIR | 526.0 | -25.0759 | 30.4389 |
| B4H018 | 1968 | 1968 | MALANSLAERLOOP | GAUGING WEIR | 0.0 | -25.1006 | 29.8792 |
| B5H001 | 1919 | 1932 | GOMPIES RIVER | GAUGING WEIR | 396.0 | -24.3034 | 29.3192 |
| B5H002 | 1948 | 1988 | OLIFANTS RIVER | GAUGE PLATES | 31416.0 | -24.2673 | 29.8008 |
| B6H001 | 1909 | still open | BLYDE RIVER | GAUGING WEIR | 518.0 | -24.6798 | 30.8025 |
| B6H002 | 1909 | 1939 | TREUR RIVER | GAUGING WEIR | 97.0 | -24.6823 | 30.8147 |
| B6H003 | 1959 | still open | TREUR RIVER | GAUGING WEIR | 92.0 | -24.6867 | 30.8150 |
| B6H004 | 1950 | still open | BLYDE RIVER | GAUGING WEIR | 2241.0 | -24.4592 | 30.8275 |
| B6H005 | 1958 | still open | BLYDE RIVER | GAUGING WEIR | 2204.0 | -24.5145 | 30.8289 |
| B6H006 | 1963 | still open | KRANSKLOOFSPRUIT | GAUGING WEIR | 43.0 | -24.9281 | 30.5461 |
| B6H007 | 1971 | still open | VYEHOEK RIVER | GAUGING WEIR | 86.0 | -24.7248 | 30.6439 |
| B6H014 | 1989 | still open | BLYDE RIVER | CURRENT METERING | 2176.0 | -24.5381 | 30.7958 |
| B6H016 | 1910 | 1925 | BLYDE RIVER | FLOOD SECTION | 518.0 | -24.6798 | 30.8025 |
| B7H001 | 1938 | 1950 | KLASERIE RIVER | GAUGE PLATES | 137.0 | -24.5506 | 31.0267 |
| B7H002 | 1948 | still open | NGWABITSI RIVER | GAUGING FLUME | 58.0 | -24.0926 | 30.2753 |
| B7H003 | 1948 | still open | SELATI RIVER | GAUGING WEIR | 84.0 | -24.1226 | 30.3586 |
| B7H004 | 1950 | still open | KLASERIE RIVER | GAUGING WEIR | 136.0 | -24.5559 | 31.0322 |
| B7H005 | 1952 | 1961 | BANGU RIVER | STORAGE WEIR | 202.0 | -24.0050 | 31.8500 |
| B7H006 | 1952 | 1961 | NGOTSO RIVER | STORAGE WEIR | 41.0 | -24.1339 | 31.7000 |
| B7H007 | 1955 | still open | OLIFANTS RIVER | GAUGING WEIR – no data available | 46583.0 | -24.1839 | 30.8222 |
| B7H008 | 1956 | still open | SELATI RIVER | STORAGE WEIR | 832.0 | -24.0098 | 30.6728 |
| B7H009 | 1960 | still open | OLIFANTS RIVER | GAUGING WEIR | 42472.0 | -24.3312 | 30.7408 |
| B7H010 | 1960 | still open | NGWABITSI RIVER | GAUGING WEIR | 318.0 | -24.0356 | 30.4333 |
| B7H011 | 1963 | still open | MOHLAPITSE RIVER | GAUGE PLATES | 262.0 | -24.1642 | 30.1058 |
| B7H012 | 1965 | 1975 | KLASERIE RIVER | GAUGING WEIR | 444.0 | -24.3223 | 31.1411 |
| B7H013 | 1970 | still open | MOHLAPITSE RIVER | GAUGING WEIR | 263.0 | -24.1731 | 30.1031 |
| B7H014 | 1973 | still open | SELATI RIVER | GAUGING WEIR | 83.0 | -24.1245 | 30.3536 |
| B7H015 | 1983 | still open | OLIFANTS RIVER | GAUGING WEIR | 49826.0 | -24.0595 | 31.2372 |
| B7H019 | 1961 | still open | GA-SELATI RIVER | GAUGING WEIR | 2268.0 | -24.0362 | 31.1289 |
| B7H020 | 1988 | 1991 | TIMBAVATI RIVER | STORAGE WEIR | 935.5 | -24.2378 | 31.6403 |
| B7H023 | 1948 | 1960 | NGWABITSI RIVER | FLOOD SECTION | 58.0 | -24.0926 | 30.2753 |

Appendix B:

*Dams in the Olifants catchment that are included on the DWAF safety register*

| Completion Date | Name | Long. °E | Lat. °S | River | Height (m) | Capacity ($Mm^3$) |
|---|---|---|---|---|---|---|
| 1939 | LOSKOP DAM | 29.36 | 25.42 | OLIFANTS RIVER/RIVIER | 53 | 374.31 |
| 1984 | RHENOSTERKOP DAM 4 | 28.92 | 25.10 | ELANDS RIVER/RIVIER | 35 | 205.80 |
| 1987 | FLAG BOSHIELO DAM - WAS ARABIE DAM (MOKGOMO MATLALA) | 29.43 | 24.80 | OLIFANTS RIVER/RIVIER | 36 | 105.00 |
| 1971 | WITBANK DAM | 29.32 | 25.89 | OLIFANTS RIVER/RIVIER | 42 | 104.02 |
| 1950 | BRONKHORSTSPRUIT DAM | 28.73 | 25.89 | BRONKHORST SPRUIT | 32 | 57.91 |
| 1975 | BLYDERIVIERSPOORT DAM | 30.80 | 24.54 | BLYDE RIVER/RIVIER | 71 | 54.05 |
| 1978 | MIDDELBURG DAM | 29.55 | 25.77 | LIT/KLN OLIFANTS RIVER/RIVIER | 36 | 48.43 |
| 1988 | KENNEDYS VALE DAM | 30.10 | 24.84 | DWARS RIVER/RIVIER | 43 | 28.00 |
| 1934 | RUST DE WINTER DAM | 28.53 | 25.23 | ELANDS RIVER/RIVIER | 31 | 27.21 |
| 1990 | KROMFONTEIN MIDDLE COFFER DAM | 29.25 | 26.12 | STEENKOOL SPRUIT | 14 | 18.00 |
| 1991 | TWEEDRAAI DAM | 29.22 | 26.43 | TRICHARDSPRUIT | 21 | 18.00 |
| 1981 | TRICHARDTSFONTEIN DAM | 29.23 | 26.52 | TRICHARDTSPRUIT | 26 | 14.70 |
| 1955 | OHRIGSTAD DAM | 30.62 | 24.92 | OHRIGSTAD RIVER/RIVIER | 52 | 14.44 |
| 1995 | BOSCHMANSKOP NO 1 DAM | 29.63 | 26.02 | WOES-ALLEEN SPRUIT | 22 | 14.40 |
| 1992 | KROMFONTEIN LOWER (WILGE) COFFER DAM | 29.25 | 26.08 | STEENKOOL SPRUIT | 15 | 13.00 |
| 1925 | DOORNPOORT DAM | 29.30 | 25.87 | OLIFANTS RIVER/RIVIER | 16 | 9.18 |
| 1923 | ONDER-COMPIES DAM | 29.32 | 24.30 | COMPIES RIVER/RIVIER (NKUMPI) | 25 | 9.13 |
| 1989 | DER BROCHEN DAM | 30.11 | 25.06 | GRT. DWARS RIVER/RIVIER | 31 | 7.30 |
| 1968 | PIET GOUWS DAM - LEBOWA | 29.61 | 24.57 | NGWARITSI RIVER/RIVIER | 21 | 6.50 |
| 1992 | KROMFONTEIN UPPER (MIDDLEDRIFT) COFFER DAM | 29.25 | 26.12 | STEENKOOL SPRUIT | 20 | 6.00 |
| 1966 | PHALABORWA BARRAGE | 31.17 | 24.07 | OLIFANTS RIVER/RIVIER | 21 | 5.65 |
| 1959 | KLASERIE DAM (JAN WASSENAAR) | 31.07 | 24.53 | KLASERIE RIVER/RIVIER | 20 | 5.61 |
| 1987 | TOURS | | | | | 5.50 |
| 1971 | BUFFELSKLOOF DAM | 30.27 | 24.95 | WATERVALS RIVER/RIVIER | 39 | 5.38 |
| 1978 | RIETSPRUIT DAM | 29.22 | 26.17 | RIET SPRUIT | 20 | 4.64 |
| 1987 | MOLEPO DAM | 29.78 | 24.00 | MOHOGODIMA RIVER/RIVIER | 20 | 4.52 |
| 1995 | BOSCHMANSKOP NO 3 DAM | 29.63 | 26.02 | WOES-ALLEEN SPRUIT | 20 | 4.50 |
| 1973 | BELFAST DAM (WELTEVREDE 386 JS) | 29.99 | 25.66 | DORPSPRUIT | 13 | 4.39 |
| 1997 | PULLENS HOPE WPC DAM | 29.65 | 26.03 | UNNAMED | 9 | 4.10 |
| 1999 | UPPER VLEI SHAFT DAM | 29.23 | 25.99 | OLIFANTS RIVER/RIVIER TR. | 19 | 3.88 |
| 1969 | BUFFELSDOORN DAM - LEBOWA | 29.46 | 24.75 | MAKOTSWANE RIVER/RIVIER | 21 | 3.40 |
| 1991 | KRAPFONTEIN DAM | 29.24 | 26.42 | KRAPFONTEINSPRUIT | 20 | 3.38 |
| 1951 | CHUNIESPOORT DAM | 29.50 | 24.20 | CHUNIES RIVER/RIVIER | 15 | 3.37 |
| 1924 | MOGOTO DAM - NUWE DREINERINGSGEBIED | 29.23 | 24.27 | MOGOTO RIVER/RIVIER | 34 | 2.93 |
| 1988 | NKADIMENG DAM - LEBOWA | 29.98 | 24.64 | PSHIRWARI RIVER/RIVIER | 19 | 2.80 |
| 1972 | KROMDRAAI FLOOD DEVERSION DAM | 28.58 | 25.27 | ELANDS RIVER/RIVIER TR. | 21 | 2.25 |
| 1921 | ROOIKRAAL DAM | 29.65 | 25.29 | BLOED RIVER/RIVIER | 15 | 2.10 |
| 1936 | BO-COMPIES DAM | 29.31 | 24.25 | COMPIES RIVER/RIVIER (NKUMPI) | 15 | 2.09 |
| 1968 | ROODEPOORT DAM | 29.49 | 25.39 | SELONS RIVER/RIVIER | 17 | 1.80 |
| 1984 | SPECULATIE DAM | 29.65 | 25.95 | - | 6 | 1.75 |
| 1909 | WILGE RIVER DAM (PREMIER MINE) | 28.87 | 25.80 | WILGE RIVER/RIVIER | 11 | 1.69 |
| | VERGELEGEN DAM - WAS LEHLAGARE MATLALA DAM - LEBOWA | 29.84 | 24.81 | NGWANTSI RIVER/RIVIER | 17 | 1.55 |
| 1966 | LOLA MONTES DAM - LEBOWA | 29.49 | 24.82 | MOTSEPHIRI RIVER/RIVIER | 21 | 1.40 |
| 1965 | LEPELLANE DAM-NUWE NR. OU NR. WAS B500-06 | 29.87 | 24.58 | SEBELWANE RIVER/RIVIER | 28 | 1.30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | DR EISELEN DAM | 29.98 | 24.87 | SHAKWANENG RIVER/RIVIER | 23 | 1.17 |
| 1964 | KROMDRAAI INDUSTRIAL WATER DAM | 28.58 | 25.27 | ELANDS RIVER/RIVIER TR. | 16 | 1.14 |
| 1977 | LYDENBURG TOWN DAM | 30.52 | 25.13 | STERK RIVER/RIVIER | 27 | 1.10 |
| 1999 | DRIEFONTEIN DAM | 29.33 | 25.99 | BOESMANSKRANSSPRUIT | 9 | 1.05 |
| 1950 | BANKFONTEIN DAM | 29.47 | 25.98 | SPOOK SPRUIT | 12 | 1.00 |
| 1930 | PIENAARS DAM | 29.48 | 25.83 | VAALBANK SPRUIT | 9 | 1.00 |
| 1998 | BOSCHMANSKRANSSPRUIT DAM 1 | 29.42 | 26.00 | BOSCHMANSKRANSSPRUIT | 14 | 0.94 |
| 1979 | MATLA POWER STATION TERMINAL RESERVOIR 1 & 2 | 29.13 | 26.29 | - | 9 | 0.89 |
| 1979 | DUVHA POWER STATION TERMINAL RESERVOIRS NO. 1 & 2 | 29.33 | 25.95 | - | 11 | 0.89 |
| 1980 | MAHLANGU DAM | 29.71 | 25.01 | MOTSEPHIRI SPRUIT | 15 | 0.88 |
| 2000 | KLIPFONTEIN DAM | 29.53 | 25.94 | VAALBANKSPRUIT TR. | 9 | 0.78 |
| | SPITSKOP DAM | 29.80 | 24.98 | TSHWENENG RIVER/RIVIER | 12 | 0.75 |
| | GESLUIT-WAS SPITSKOP DAM-NOU B401-56 | 29.80 | 24.92 | TSHWENENG RIVER/RIVIER | 12 | 0.75 |
| 1996 | GOEDEHOOP DAM | 29.38 | 24.98 | OLIFANTS RIVER/RIVIER | 11.9 | 0.75 |
| 1966 | GOOSEN DAM | 30.48 | 24.06 | GA-SELATI RIVER/RIVIER | 9 | 0.73 |
| 1984 | SELATI DAM | 30.52 | 24.07 | GA-SELATI RIVER/RIVIER | 8 | 0.72 |
| 1988 | PIET GROBLER DAM | 31.63 | 24.23 | TIMBAVATI | 0 | 0.70 |
| 1976 | KRIEL TERMINAL RESERVOIRS NO. 1 & 2 (RAW WATER) | 29.18 | 26.25 | - | 9.2 | 0.68 |
| 1968 | HARMONIE DAM | 30.48 | 24.05 | GA-SELATI RIVER/RIVIER | 8 | 0.66 |
| 1969 | MAPOCH'S DAM | 29.88 | 25.10 | MAPOCHS RIVER/RIVIER | 25 | 0.64 |
| 1954 | TONTELDOOS DAM | 29.94 | 25.28 | TONTELDOOS RIVER/RIVIER | 17 | 0.63 |
| | RIETFONTEIN WEIR/STUDAM | 29.22 | 21.28 | TRICHARD SPRUIT | 9 | 0.61 |
| 1991 | SYFERFONTEIN DAM | 29.25 | 26.41 | KRAPFONTEINSPRUIT | 12 | 0.60 |
| 2002 | HAVERCROFT DAM | 30.18 | 24.30 | OLIFANTS RIVER/RIVIER | 10 | 0.59 |
| 1982 | N0. 5 POLLUTION CONTROL DAM | 29.41 | 25.93 | SPOOKSPRUIT TR. | 5 | 0.58 |
| 1985 | LEEUWKLIP DAM | 29.84 | 25.58 | STEELPOORT RIVER/RIVIER TR. | 19 | 0.53 |
| | JOUNIE DAM | 30.09 | 24.96 | KLEIN DWARS RIVIER/RIVER | 7 | 0.50 |
| 1988 | BLESBOKSPRUIT NO.1- DAM | 28.99 | 26.34 | BLESBOK SPRUIT | 7 | 0.50 |
| 1946 | DOUGLAS COLLIERY DAM | 29.36 | 26.00 | BOESMANKRANS SPRUIT TR. | 8 | 0.49 |
| | FEDMIS GYPSUM DAM B | 31.09 | 23.98 | SELATI RIVER/RIVIER TR. | 70 | 0.48 |
| 1989 | DOUGLAS WATERS DAM | 29.33 | 25.99 | BOESMANSKRANS RIVER/RIVIER | 6 | 0.46 |
| 1986 | DE KAFFERSKRAAL DAM H | 30.18 | 25.15 | KAFFERSKRAAL SPRUIT | 13 | 0.45 |
| 1959 | VLUGKRAAL DAM | 29.95 | 25.23 | VLUGKRAAL RIVER/RIVIER | 26 | 0.44 |
| 1960 | HENDRINA-DORPS DAM | 29.73 | 26.15 | KLEIN-OLIFANTS RIVER/RIVIER TR. | 7 | 0.43 |
| 1996 | RUBICON DAM | 29.41 | 25.04 | OLIFANTS RIVER/RIVIER | 11 | 0.43 |
| | FEDMIS GYPSUM DAM A | 31.09 | 23.97 | SELATI RIVER/RIVIER TR. | 68 | 0.42 |
| 1986 | KENDAL POWER STATION TERMINAL RESERVOIRS 1 & 2 | 28.98 | 26.10 | - | 9 | 0.41 |
| 1890 | KRUGER DAM | 29.45 | 25.80 | DU TOIT SPRUIT | 7 | 0.41 |
| 1967 | HENDRINA POWER STATION RAW WATER TERMINAL | 29.60 | 26.04 | - | 7 | 0.41 |
| 1998 | TUBATSE DAM | 30.20 | 24.75 | STEELPOORT RIVER/RIVIER TR. | 25 | 0.40 |
| 1999 | WITBOOI DAM | 29.81 | 25.48 | STEELPOORT RIVER/RIVIER TR. | 15 | 0.40 |
| 1990 | LAKE MILLSTREAM | 30.67 | 25.44 | WITPOORT RIVER/RIVIER TR. | 15 | 0.38 |
| 2002 | WELVERDIEND DAM 2 | 29.40 | 26.03 | BOESMANSKRANSSPRUIT TR. | 8 | 0.36 |
| 1982 | N0. 2 POLLUTION CONTROL DAM | 29.40 | 25.93 | SPOOKSPRUIT | 10 | 0.35 |
| 1994 | MANTSIBI SPRUIT | 30.62 | 24.83 | MANTSIBI SPRUIT | 15 | 0.34 |
| 1973 | BOGART DAM | 30.46 | 24.04 | NGWABITSI RIVER/RIVIER | 8 | 0.31 |
| 1981 | WELTEVREDEN WEIR | 28.99 | 25.11 | ELANDS RIVER/RIVIER | 11 | 0.30 |
| 1984 | UYSKRAAL-MIDDEL DAM | 29.30 | 24.95 | ELANDS RIVER/RIVIER TR. | 7 | 0.30 |
| 1985 | WELVERDIEND DAM | 30.97 | 24.39 | SAND SPRUIT | 9 | 0.29 |
| 1940 | CLEWER DAM | 29.08 | 25.93 | GROOT SPRUIT TR. | 10 | 0.29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | RHENOSTERFONTEIN DAM | 28.54 | 25.83 | | 7 | 0.28 |
| 1920 | ATHLONE DAM | 29.45 | 25.80 | DU TOIT SPRUIT | 8 | 0.27 |
| 1968 | VICTOR WILKENS DAM (PERU DAM) | 31.37 | 24.21 | NHLARALUMI RIVER/RIVIER | 7 | 0.27 |
| 1987 | SOBELI DAM | 31.39 | 24.21 | GA-SEKGOBELA RIVER/RIVIER | 7 | 0.26 |
| 1968 | ARNOT POWER STATION TERMINAL RESERVOIRS NO. 1 & 2 | 29.81 | 25.94 | NATURAL PAN | 6 | 0.25 |
| 1976 | BRAMLEIGH DAM | 30.37 | 24.12 | GA-SELATI RIVER/RIVIER | 14 | 0.25 |
| 1983 | VLAKFONTEIN DAM | 30.53 | 24.88 | OHRIGSTAD RIVER/RIVIER TR. | 8 | 0.25 |
| 1986 | MOOIGELEGEN DAM | 29.03 | 24.52 | - | 12 | 0.25 |
| 1994 | GROBLERSHOOP DAM | 29.77 | 26.27 | LTL/KLN OLIFANTS RIVER/RIVIER | 10 | 0.25 |
| 1995 | TOLLIE DAM NO. 1 | 29.63 | 26.03 | WOES-ALLEEN SPRUIT TR. | 10 | 0.25 |
| 1969 | AANGEWYS DAM | 29.30 | 26.30 | STEENKOOL SPRUIT TR. | 7 | 0.24 |
| 1978 | FRISCHGEWAAGD DAM | 29.67 | 26.22 | OLIFANTS RIVER/RIVIER TR. | 7 | 0.24 |
| 1997 | BOSCHMANSKRANSSPRUIT DAM 2 | 29.40 | 26.02 | BOSCHMANSKRANS SPRUIT | 7 | 0.24 |
| 1988 | HARTBEESTSPRUIT DAM | 29.13 | 25.78 | KLIP SPRUIT TR. | 6 | 0.24 |
| 1925 | WITKLIP BOTTOM DAM | 28.68 | 26.16 | BRONKHORSTSPRUIT | 4 | 0.23 |
| 1983 | BOMBARDIE FARM DAM NO.2 | 29.05 | 26.17 | - | 5 | 0.23 |
| 1995 | CALIFORNIA DAM - LEBOWA | 30.69 | 24.49 | PHIRING RIVER/RIVIER | 22 | 0.23 |
| 1986 | KENDAL POWER STATION: DIRTY WATER DAM | 28.96 | 26.10 | WILGE RIVER/RIVIER TR. | 11 | 0.23 |
| 1988 | N0. 7 ALLEN'S DAM | 29.43 | 25.96 | SPOOKSPRUIT | 9 | 0.23 |
| 1996 | LOOLE DAM | 31.14 | 24.02 | GA-SELATI RIVER/RIVIER TR. | 8 | 0.23 |
| 2001 | NORTH DAM | 29.64 | 26.03 | WOEST-ALLEEN TR. | 7.7 | 0.23 |
| 1972 | SABLE DAM | 31.24 | 23.94 | TSHTSHI RIVER/RIVIER | 8 | 0.22 |
| 1978 | ARGYLE DAM | 31.37 | 24.18 | GA-SEKGOBELA RIVER/RIVIER | 9 | 0.22 |
| 1985 | KROMDRAAI DAM | 29.37 | 25.67 | OLIFANTS RIVER/RIVIER TR. | 5 | 0.22 |
| 1984 | KHUTALA MINE: POLLUTION WATER DAM | 29.04 | 26.12 | KLIPPOORTJIES SPRUIT | 8 | 0.22 |
| 1986 | BLOEMPOORT DAM | 29.23 | 25.19 | MOSES RIVER/RIVIER TR. | 13 | 0.21 |
| 1965 | KOMATI-KRAGSENTRALE ROUWATERRESERVOIRS 1, 2, 3 & 4 | 29.48 | 26.10 | KORING SPRUIT TR. | 7 | 0.21 |
| 2001 | JAYDEE-STUWAL | 31.32 | 24.24 | NHLARALUMI RIVER/RIVIER | 7 | 0.20 |
| 1998 | NAVIGATION DAM | 29.16 | 25.76 | SCHOONGEZICHT SPRUIT | 7 | 0.20 |
| 1992 | HEUVELFONTEIN DAM | 28.90 | 26.05 | WILGE RIVER/RIVIER TR. | 5 | 0.20 |
| 1968 | MOOIPLAAS DAM | 29.45 | 25.53 | MOOIPLAAS SPRUIT | 6 | 0.20 |
| 1978 | BOMBARDIE FARM DAM NO.1 | 29.05 | 26.17 | - | 5 | 0.20 |
| 1985 | DE KUIL NO.2- DAM | 28.53 | 25.08 | ELANDS RIVER/RIVIER TR. | 5 | 0.20 |
| 1986 | ZONDAGSFONTEIN DAM | 28.98 | 26.18 | KLIPPIESPOORTJIE SPRUIT TR. | 8.5 | 0.20 |
| 1987 | KALKFONTEIN DAM | 30.05 | 24.88 | STEELPOORT RIVER/RIVIER TR. | 7 | 0.20 |
| 1995 | WELTEVREDEN DAM | 28.95 | 26.31 | KROMDRAAI SPRUIT | 8 | 0.20 |
| 1966 | HOPE DAM NO. 2 | 30.90 | 24.05 | RAM SPRUIT | 8 | 0.19 |
| 1993 | GOEDEHOOP NORTH POLLUTED WATER DAM | 29.44 | 25.87 | SPOOK SPRUIT TR. | 11 | 0.19 |
| 1964 | ONVERWACHT NO.1- DAM | 28.62 | 25.60 | MALAN SPRUIT | 8 | 0.19 |
| 1980 | UYSKRAAL-ONDER DAM | 29.27 | 24.95 | - | 7 | 0.18 |
| 1991 | VLAKLAAGTE DAM | 29.63 | 26.26 | BANK SPRUIT | 6 | 0.18 |
| 1992 | BAVARIA-LEI DAM | 30.89 | 24.41 | STORMWATERSLOOT | 8 | 0.18 |
| 1997 | DOORNRUG DAM | 29.02 | 25.86 | SAALKLAPS RIVIER/RIVER TR. | 7 | 0.17 |
| 1983 | DE KAFFERSKRAAL DAM D | 30.18 | 25.15 | KAFFERSKRAAL SPRUIT | 11 | 0.17 |
| 1990 | CUTWATER DAM | 30.02 | 25.38 | WITPOORT RIVER/RIVIER TR. | 8 | 0.17 |
| 1992 | ARGYLE NO.2- STUWAL | 31.35 | 24.19 | NHLARALUMI RIVER/RIVIER | 5 | 0.17 |
| 1995 | FEDMIS DETENTION DAM | 31.10 | 23.97 | GA-SELATI RIVER/RIVIER TR. | 5 | 0.17 |
| 1987 | KLIPBANK-OPGAAR DAM | 29.40 | 25.13 | OLIFANTS RIVER/RIVIER | 9 | 0.16 |
| | SPITSKOP DAM | 29.90 | 25.62 | DORSPRUIT TR. | 7 | 0.15 |
| 1966 | CLOSED - WAS INGIFELL DAM | 30.11 | 25.42 | CROCODILE RIVER/RIVIER | 10 | 0.15 |

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| 1984 | BUCKER DAM | 28.80 | 25.80 | BRONKHORSTSPRUIT TR. | 9 | 0.15 |
| 2000 | NOOITGEDACHT NR 2 DAM | 30.56 | 25.05 | SPEKBOOMRIVIER/RIVER | 12 | 0.15 |
| 1991 | LAKESIDE DAM NO. 1 | 28.92 | 26.12 | WILGE RIVER/RIVIER TR. | 6 | 0.14 |
| 1998 | KLEINBUB DAM | 29.68 | 25.19 | BUFFELSVLEI SPRUIT | 11 | 0.13 |
| 1984 | 120 ML DAM | 29.36 | 25.99 | BOESMANKRANS SPRUIT TR. | 6 | 0.13 |
| | WACHTEENBIETJIESKOP | 28.80 | 25.80 | | 15 | 0.13 |
| 1989 | MOEDVERLOREN DAM | 29.00 | 26.30 | BLESBOKSPRUIT TR. | 5 | 0.13 |
| 1977 | SOUTH AFRICAN COAL ESTATES STORAGE DAM | 29.23 | 26.02 | - | 7 | 0.13 |
| 1978 | RUSTFONTEIN-MIDDEL DAM | 29.44 | 26.44 | NATUURLIKE LOOP | 8 | 0.12 |
| | ONS EIE DAM | 30.08 | 25.42 | BOLOOP STEELPOORT RIVER | 10 | 0.12 |
| 1987 | WONDERBOOM DAM | 29.33 | 25.59 | OLIFANTS RIVER/RIVIER TR. | 8 | 0.12 |
| 1988 | LOCH MACDONALD DAM | 29.37 | 25.99 | BOESMANSKRANS RIVER/RIVIER | 5 | 0.11 |
| 1992 | R.C. DAM | 29.08 | 26.30 | RIETSPRUIT | 6 | 0.11 |
| 1993 | BAVARIA NO.2- DAM | 30.90 | 24.42 | RIET SPRUIT TR. | 7 | 0.11 |
| 1993 | LEEUWPOORT DAM NO. 2 | 29.19 | 25.82 | BLESBOKSPRUIT TR. | 7 | 0.11 |
| 1991 | RIETKUIL DAM | 29.65 | 26.29 | BANK SPRUIT TR. | 5 | 0.11 |
| 1996 | NDLOPFU STUWAL | 31.30 | 24.18 | TSIRI RIVER/RIVIER | 7 | 0.11 |
| 2002 | ESCOM MATURATION DAM | 29.21 | 26.28 | | 5 | 0.10 |
| 1979 | DUVHA ASH RETURN WATER DAM | 29.34 | 25.95 | - | 8 | 0.10 |
| 1961 | OSSPRUIT NO. 2- DAM | 28.48 | 25.97 | OS SPRUIT TR. | 8 | 0.10 |
| 1976 | ROODEPOORT NO. 2- DAM | 29.50 | 26.05 | WOES-ALLEEN SPRUIT | 6 | 0.10 |
| 1982 | UYSKRAAL-BO DAM | 29.30 | 24.95 | ELANDS RIVER/RIVIER TR. | 5 | 0.10 |
| 1985 | BALA DAM | 28.50 | 25.04 | GOTWANE RIVER/RIVIER TR. | 5 | 0.10 |
| 1985 | DE KUIL NO.1- DAM | 28.49 | 25.07 | GOTWANE RIVER/RIVIER TR. | 5 | 0.10 |
| 1987 | CHRIS BOSHOFF DAM | 28.93 | 26.23 | KROMDRAAISPRUIT TR. | 6 | 0.10 |
| 1990 | VAN DYKSPUT DAM | 28.93 | 26.05 | WILGE RIVER/RIVIER TR. | 5 | 0.10 |
| 1966 | HOPE DAM NO. 1 | 30.91 | 24.07 | RAM SPRUIT | 6 | 0.10 |
| 1990 | JUNIOR BOERDERY DAM | 29.26 | 26.23 | STEENKOOL SPRUIT TR. | 7 | 0.10 |
| 1986 | WASSERMAN DAM | 29.48 | 26.30 | JOUBER SPRUIT TR. | 5 | 0.09 |
| 1976 | ROODEPOORT NO. 8- DAM | 29.57 | 26.05 | WOES-ALLEEN SPRUIT | 5 | 0.09 |
| 1986 | KENDAL POWER STATION: CLEAN WATER DAM | 28.96 | 26.09 | WILGE RIVER/RIVIER TR. | 11 | 0.09 |
| 1993 | PAARDEKRAAL DAM NO. 1 | 30.68 | 24.97 | - | 10 | 0.09 |
| 1993 | PORTSGATE CITRUS DAM A | 30.72 | 24.36 | OLIFANTS RIVER/RIVIER TR. | 9 | 0.09 |
| 1989 | BRODERICK'S DAM | 29.35 | 26.00 | BOESMANKRANS SPRUIT TR. | 5 | 0.09 |
| 1978 | SELATI TAILINGS RETURN WATER DAM | 31.13 | 24.05 | SELATI RIVER/RIVIER | 11.9 | 0.08 |
| 1987 | SOUTH AFRICAN COAL ESTATES VLEI SHAFT DAM | 29.23 | 26.02 | - | 5 | 0.08 |
| 1990 | KRANSPOORT DAM | 29.42 | 25.43 | KRANSPOORT SPRUIT | 10 | 0.08 |
| 1989 | MAC'S CREEK DAM | 29.33 | 25.99 | BOESMANKRANS SPRUIT | 11 | 0.08 |
| 1975 | AUTHER HENRY PILLMAN DAM | 29.53 | 25.13 | DIEPKLOOF RIVER/RIVIER | 15 | 0.08 |
| 1992 | GOEDEHOOP NORTH FRESHWATER DAM | 29.44 | 25.87 | SPOOK SPRUIT TR. | 8 | 0.08 |
| 1998 | HOLFONTEIN LEACHATE STORAGE DAM | 28.52 | 26.15 | | 7 | 0.08 |
| | NOOITGEDINK DAM | 28.77 | 25.87 | | 8 | 0.08 |
| 1985 | DE VOETPADKLOOF DAM | 29.43 | 25.45 | KRANSPOORT SPRUIT TR. | 11 | 0.08 |
| 1992 | VLAKPLAAS DAM | 29.99 | 25.56 | KLEIN SPRUIT TR. | 8 | 0.08 |
| 1991 | TWEEFONTEIN MINE RETURN WATER DAM | 30.11 | 24.89 | DWARS RIVER/RIVIER TR. | 7 | 0.08 |
| | DOORNRUG-OPGAARDAM | 29.08 | 25.92 | SAALKLAP SPRUIT TR. | 6 | 0.07 |
| 1977 | SOUTH AFRICAN COAL ESTATES SETTLING DAM | 29.23 | 26.02 | - | 7 | 0.07 |
| 1986 | TWEEFONTEIN | 29.51 | 25.60 | KLIP RIVER/RIVIER TR. | 8 | 0.07 |
| 1974 | OLIFANTSPOORTJE DAM | 30.23 | 24.73 | STERKFONTEIN RIVER/RIVIER | 10 | 0.07 |
| 1968 | OSSPRUIT NO.1- DAM | 28.50 | 25.98 | OS SPRUIT TR. | 7 | 0.07 |

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| 1998 | A.M. VAN ROOYEN DAM | 28.96 | 25.91 | SAALBOOM SPRUIT TR. | 6 | 0.06 |
| | BLINKWATER DAM 1 | 29.83 | 25.42 | STEELPOORT RIVER/RIVIER TR. | 9 | 0.06 |
| 1979 | KAFFERSTAD DAM | 29.67 | 26.23 | OLIFANTS RIVER/RIVIER TR. | 8 | 0.06 |
| 1984 | WATERKLIP PUNT C VARSWATER DAM | 29.25 | 25.90 | MUNISIPALE WATERNETWERK | 9 | 0.06 |
| 1986 | CORNELIUS DAM | 29.92 | 25.42 | WELGEVONDEN SPRUIT | 7 | 0.06 |
| 1995 | BRINE STORAGE SOUTH DAM | 29.49 | 25.80 | | 6 | 0.06 |
| 1995 | BRINE STORAGE SOUTH DAM | 29.49 | 25.80 | | 6 | 0.06 |
| 1993 | GROENFONTEIN DAM | 28.74 | 25.90 | - | 7 | 0.06 |
| 1986 | KENDAL POWER STATION: EMERGENCY DAM | 28.96 | 26.09 | WILGE RIVER/RIVIER TR. | 9 | 0.06 |
| 1930 | SCHOONGEZICHT DAM | 29.15 | 25.90 | BRUG SPRUIT & KLIP SPRUIT TR. | 5 | 0.05 |
| 1976 | RUSTFONTEIN-ONDERSTE DAM | 29.44 | 26.44 | NATUURLIKE LOOP | 7 | 0.05 |
| | HENDRINA ASH RETURN WATER RESERVOIR | 29.60 | 26.07 | - | 10 | 0.05 |
| 1985 | WILDEBEESTFONTEIN NO 3 RESERVOIR | 29.15 | 26.45 | - | 14 | 0.05 |
| 1993 | KLEINKOPJE-KLIPPAN DAM | 29.23 | 25.98 | OLIFANTS RIVER/RIVIER TR. | 5 | 0.05 |
| | MABALINGWE SPA DAM | 29.02 | 25.60 | | 7 | 0.03 |
| 1997 | OXBOW 8 PLUG WALLS DAM | 29.28 | 26.09 | OLIFANTS RIVER/RIVIER | 6 | 0.00 |