# 8. SURFACE WATER ASSESSMENT

During the Environmental Scoping Study two options existed with regards to water supply. The two possible options included the abstraction of water from the Orange River or the supply of water from the local municipality. Due to the fact that the latter option had not yet been confirmed it was recommended that a study be done on the impact of possible water abstraction from the Orange River for the CSP Plant.

***Recently it has been confirmed that the Local municipality will be supplying water to the CSP Plant and, therefore, no abstraction from the Orange River will be necessary***. A Letter from Eskom to the Municipality in this regard has been attached in Appendix O.

Even though, the impact of the CSP Plant’s water requirements will have no impact on the Orange River, the following study has been included for completeness and compliance with that set out in the Plan of Study for EIA (approved by DEAT on 24 October 2006). The chapter gives outlines the potential impacts that the CSP Plant could have had if it did indeed abstract water from the Orange River.

## 8.1. Introduction

Eskom is considering building a concentrating solar thermal plant (CSP) in the Northern Cape. Three sites were assessed through a scoping review and the site at the farm Olyvenhout, about 10 km north-west of Upington (also known as the Tungsten site after an old tungsten mine prospect), was selected for further study through an environmental impact assessment. The site requires water for cleaning and occasional cooling purposes, and also be close to existing Eskom transmission infrastructure so as to minimize development costs and environmental impacts.

The proposed CSP is modelled on one developed by Sandia National Laboratories at Barstow in California and now also being built by ENER in Spain. The essence of the design is a field of heliostats concentrating sunlight onto a receiver located at the top of a tower. The concentrated sunlight heats the receiver, which in turn heats a molten salt flowing in a primary circuit. This heats a secondary circuit of water in a heat exchanger, the resulting steam driving a turbine and generator. The steam cycle will use mostly dry cooling, although the design is not yet fixed. Occasional mist-spray cooling might be required when ambient air temperatures become too high for efficient and effective cooling of the steam circuit.

The total capacity of the plant will be around 400 MW. About 100 MW will be transmitted from the CSP while the other 300 MW will go into storage. This energy reserve is used to maintain continuous generating capacity during the night and parts of the day when the incident sunlight is not strong enough for electricity generation. Energy storage will be accomplished by maintaining tanks of molten salt at high temperature.

The site required for the installation will be a square about 4 km on each side. Within this, the field of about 6 000 heliostats of 130 $m^2$ each will be somewhat elliptical, with a median diameter of about 2 km. The 200 m receiving tower will be located near the locus of the ellipse, with the bulk of the heliostats on the southern side, facing north). The site should be flat, but better still it would be slightly concave, giving distal heliostats a better, more unobstructed view of the receiver because they will be slightly higher than the more proximal ones. When the heliostats are not functioning (night time), they will be inverted, a position in which they can be cleaned. Dust adhering to the reflecting surfaces will significantly reduce reflectivity and hence power output of the CSP plant, if not controlled. The heliostat surfaces will be cleaned regularly by a high pressure spray of demineralised water from a vehicle moving under them.

The area in the immediate vicinity of the receiving tower will be paved, as will the area around other supporting infrastructure (salt storage tanks, buildings, roads and some of the electricity distribution infrastructure). The area under the heliostats will be natural veld with short shrubby vegetation.

The scoping review for the Tungsten site on the Farm Olyvenhouts Drift indicated that the proposed CSP would have minimal impact on local and regional hydrology and water resources. In that review, the impacts of the proposed CSP on local and regional rainfall (through possible local heating of the air and reduction of rainfall development processes), water infiltration into the soil, surface runoff and streamflow, were addressed. Nevertheless, an EIA on hydrology and water resources was requested. This document informs that part of the process.

## 8.2. Environmental Description

### *8.2.1. Site Description*

The Tungsten site on the farm Olyvenhouts Drift is about 10 km north-west of Upington. It has a slightly concave topography, ideal for the proposed CSP design. An ephemeral drainage line called "Helbrandleegte" on the 1: 250 000 and 1: 50 000 topographic map sheets traverses the site. This drainage feature appears to be a response to the slightly higher and more impervious ground further to the north-west and does not seem to indicate the runoff-generating potential of the Tungsten CSP site itself. Vegetation is sparse karroid shrubs and grasses. The drainage feature itself has poorly defined edges and is better located through the line of denser vegetation that exists on it. It is possible that this line more strongly represents a palaeo-channel or fracture that provides a preferential line of transmission for groundwater, or is a linear feature of longer-persisting wetness after rainfall. Soils are typically aeolian red sands overlying a calcrete hardpan typical of this area of the southern Kalahari. Stabilised dunes exist in the area (to the north and east) but are not a feature of the site.

### *8.2.2. Climate and Landscape*

The region is hot and dry. Temperatures can reach 42°C and Upington has a mean annual rainfall of about 170 mm (South African Weather Service). The January (14:00) atmospheric saturation deficit averages about 40 mb (Tyson, 1986). The humidity mixing ratio (a measure of moisture content independent of temperature) for January is about 7 $g.kg^{-1}$, compared to 15 $g.kg^{-1}$ in more humid parts of the country (Preston-Whyte and Tyson, 1988). The atmosphere here is the driest in South Africa, which is one reason why the Upington region is so favourable as a site for the CSP. Optical clarity of the atmosphere is very good when compared with other parts of the world where CSPs have been considered. This advantage results in an insolation of 3 000 $kWh.m^{-2}.yr^{-1}$ when only 1 800 $kWh.m^{-2}.yr^{-1}$ is the minimum required to operate this type of CSP (ESKOM data).

Most of the rainfall received in the area is of convective origin and occurs in summer (Preston-Whyte and Tyson, 1988). Storms are relatively brief, but peak rainfall intensities over 5, 10 and 15 minutes differ little from other parts of South Africa which receive much heavier rainfalls in total, for example the Gauteng region and on the eastern Limpopo escarpment, which receive some of the heaviest short-duration convective rainfalls (Smithers and Schulze, 2002). The difference in the Upington region is that the duration of rainfall events is shorter than those parts which receive higher summer rainfalls.

Evidence of overland flow and runoff is not common in places where the ground is flat and soils are mostly aeolian-derived red sands deposited on a calcrete hardpan. They have a particle size of about 0.1 to 0.5 mm and can be termed fine to medium-grade sands. Few streamlines exist because of the general aridity and high infiltration rates evident in the sandy soils.

The Southern African Kalahari basin (and its dune system) has its southern boundary along the Orange River. Standing dunes, which mostly begin north of the river, trend north-west south-east and indicate a more xeric (dryer) past with higher wind energies (Partridge, 1997). They have become immobilised by a vegetation cover of about 14% by area, mostly grasses and xerophytic dwarf shrubs (vegetation tolerant of dry conditions) but with some thornveld (Thomas *et al.* 2005; Scott *et al*. 1997). The vegetation is a transition between Orange

River Nama-Karoo and Karroid Kalahari Bushveld (Low and Rebelo, 1996; Palmer and Hoffman, 1997). This arid shrubland grassland is used for extensive, low intensity grazing.

## 8.3. Methods

The scoping review assessed the possible impacts of the proposed development on 1) rainfall, 2) infiltration, 3) runoff and 4) streamflow. Nothing changes with regard to that assessment and these issues are not addressed further here. This impact assessment addresses the requirement for water by the proposed CSP and rates the impact it may have on the water source, with due consideration given to other current users of that water (social, economic and environmental). Data on the local and regional availability of water is presented and the water requirement of the proposed development is compared and assessed in that context.

### *8.3.1. Criteria used to Rank Impacts*

This impact assessment addresses the possible impacts of the proposed development on available water resources using the following criteria: 1) temporal impacts, 2) spatial impacts 3) severity of the impact, 4) significance of the impact, 5) risk or likelihood of the impact, and 6) the confidence level or rating given to the assessments of the previous five impacts.

## 8.4. Water Requirements of the CSP

Approximately 200 000 m $^{3}$ per year of water will be required by the CSP, primarily for the purpose of cleaning the reflecting surfaces of the heliostats. The Orange River is about five km away from the Tungsten site (it should be noted that the Local Municipality will be supplying the CSP Plant with water, therefore, no water will be abstracted from the Orange River)

## 8.5. Flow in the Orange River

Water flows in the Orange River are measured at Upington (Longitude: 21° 14’ 21.2”, Latitude: 28° 27’ 28.5”). The Department of Water Affairs measuring device number is D7H005.

Median annual flows at this gauging station are 7 148 million m $^{3}$ per year. It is highly variable, with a range from 1 413 million m $^{3}$ per year minimum to 28 947 million m $^{3}$ per year maximum (see Figure 8.1). Monthly median flows range from a low of 140 million m $^{3}$ in September to more than 700 million m $^{3}$ in March (it takes several weeks for the peak rainfall period in the upper catchment to manifest as increased river flows at Upington (see Figure 8.2). The median value is used because it is not skewed by the occasional extreme river flow events, and is more representative of the usual condition.

The lowest flows in the Orange River at Upington occur in September (mostly). The flow regime for this month is illustrated in Figure 8.3. Flows in this month range from zero (once in the year 2000), to more than 2 300 million m $^3$ in 1957.

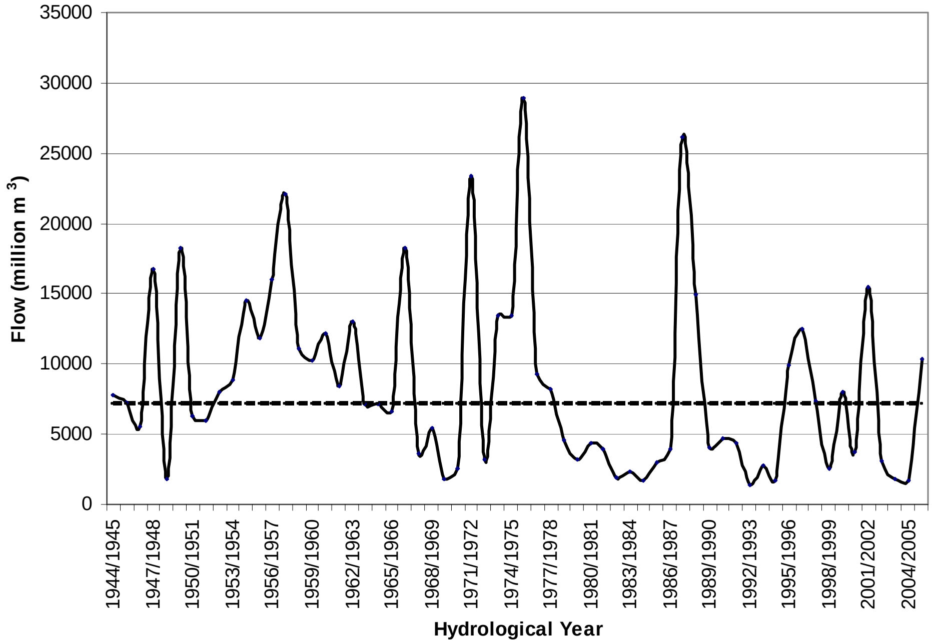


**Figure 8.1:** Annual flow at the measuring point D7H005 in the Orange River at Upington, for the period 1945 to 2006, in millions of cubic metres of water. The dotted line is median flow. Source – Department of Water Affairs and Forestry.

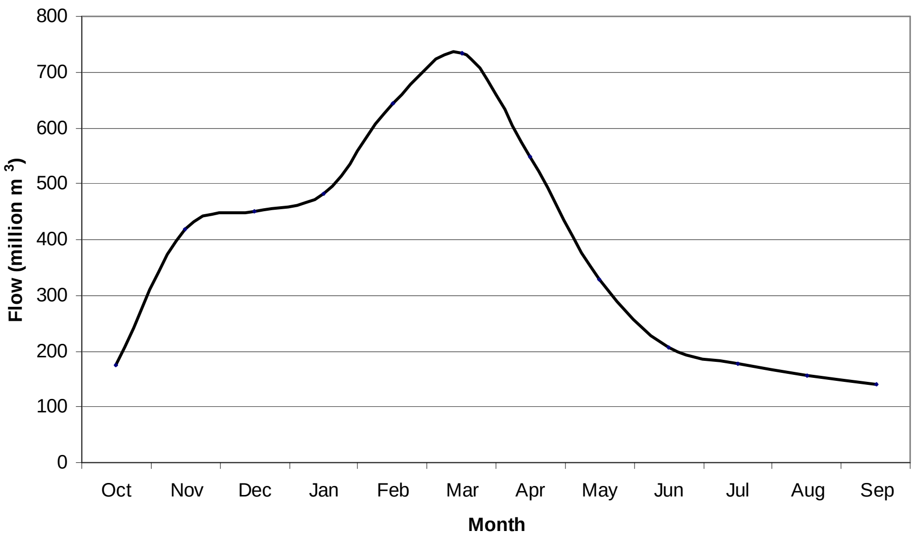

**Figure 8.2:** Monthly median flows, in millions of cubic metres of water, at the gauging point D7H005 in the Orange River at Upington. Source - Department of Water Affairs and Forestry**.**

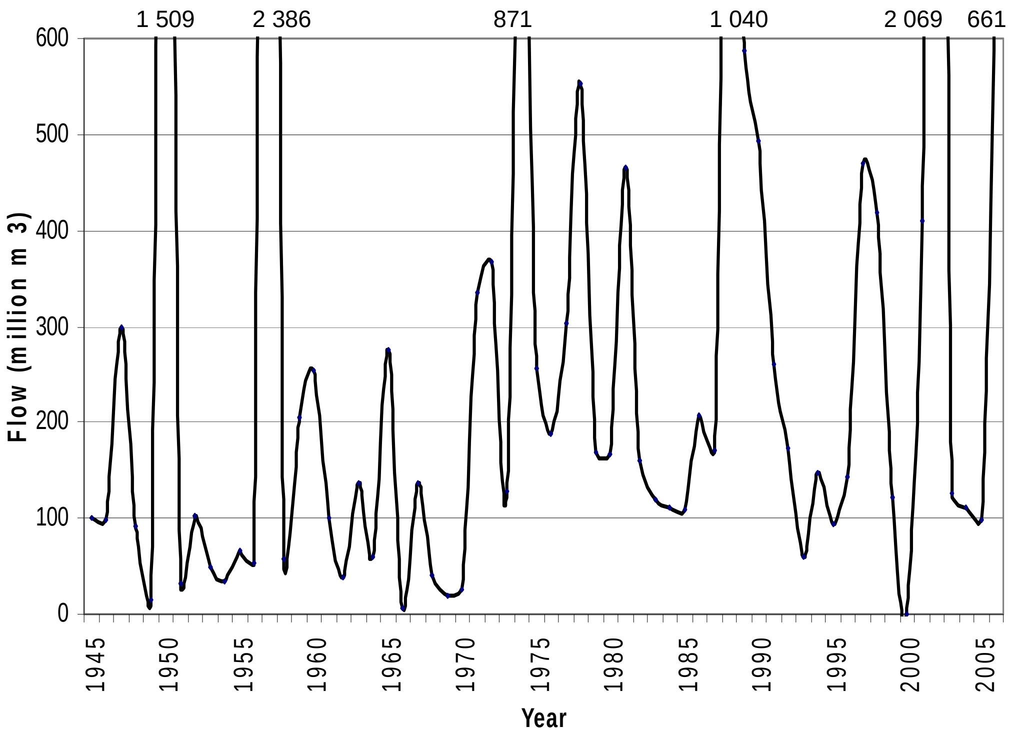


**Figure 8.3:** Flows in the Orange River at Upington, gauging station D7H005, for the month of September over the period 1945 to 2006. Source – Department of Water Affairs and Forestry**.**

## 8.6. Assessment

In the event that water is abstracted from the Orange River, the water demand by the proposed CSP (200 000 $m^3$ per year) would be 0.0079% (less than one hundredth of a percent, or 0.0000279 as a proportion) of median annual flow. In the driest month of September, water demand would be 0.0119% (just over one hundredth of a percent or 0.000119 as a proportion) of the monthly median flow), taking into account average water demand by the CSP would be roughly 16 670 $m^3$ for an individual month.

As a general rule, this water demand by the proposed CSP is a very small fraction of the flow in the Orange River at Upington and it would have no noticeable effect on river flow. This is about the same as an additional water use created by adding 13 ha of land near the Orange River with an irrigation duty of 1 500 mm per year.

However, the Orange River has also experienced a zero flow condition - in September, October and November of the year 2000, when flows were less than 1 000 $m^3$ per month and therefore unregistered. This has happened only once in the historical record from 1945 onwards, and so could be called a 1:50 year drought condition. Such a river flow condition will occur again at some stage in the future, in all likelihood. If the proposed CSP is built and requires water from the river, then it is also likely that it would have priority demands on available water when such an event again occurred, along with other high priority requirement of meeting basic human needs. This prioritisation will happen because the regional economy will be dependent to a significant extent on the electricity generated by the CSP.

The flow conditions and demands are assessed against the impact criteria in Table 8.1 below:

**Table 8.1:** Assessment of significance of impact ratings for the effects of water demand by the CSP on local and regional water resources in the event that it was necessary**.**

| **Scales** | **Significance of Impact** |
|---|---|
| Temporal | Long. The CSP will operate *in situ* for 20 – 30 years, if not longer. Water demand will remain about constant for the duration of its operational life. |
| Spatial | Regional. The CSP could add an additional water abstraction and consumption to the Orange River at Upington, which has an effect from there to the Orange River estuary and the marine environment. |
| Severity rating | Slight. For 98% of the time there will be no effect because the water demand by the CSP in relation to river flow is so small. For a 2% chance (1 year in 50) there may be some competition for scarce water resources during drought conditions. Users who pay low rates for water, such as farmers, have a lower assurance of supply, and will receive reduced supplies during a drought condition while priority users will continue to receive their allocations where possible (basic human needs). |
| Significance rating | Not significant. For 49 years out of 50, water use by the proposed CSP will have no significance to the region, including other social (water for basic human needs), economic (farming and industrial users), and environmental requirements. |
| Risk or likelihood of impact | Unlikely to occur. Because of the small proportion of total river flow planned to be utilised by the CSP, there is little risk |

| | |
|---|---|
| | of impact, or an impact is unlikely. |
| Confidence rating | Definite. The confidence in the ratings supplied above is greater than 90%. |

## 8.7. Conclusions

In the event that the CSP Plant abstracted water from the Orange River it is anticipated that the water abstraction would have an insignificant impact on the local and regional water resources.

**However, due to the fact that the Local municipality will be supply water to the CSP Plant, no direct abstraction from the Orange River will be necessary. Therefore, the impacts associated with this issue are not relevant.**