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DUNEVELD PV

Preliminary Water Consumption Study
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Prepared for:
Mr Mackay
Acting Technical Services
Kai !Garib Local Municipality
mackayj@kaigarib.gov.za

Contact Person:
Peter Smith
Atlantic Renewable Energy Partners
101, Block A, West Quay Building
7 West Quay Road, Waterfront
Cape Town, 8000
F: + 27 (0) 21 418 2596
M: + 27 (0) 82 300 6497
E: peter@atlanticep.com

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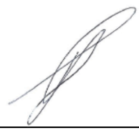
Name	Title	Signed
Anthony De Graaf	Director	

DISTRIBUTION

Name	Designation	Company
Anthony De Graaf	Director	AEP
Peter Smith	Project Manager	AEP

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LIST OF ACRONYMS

AC	Alternating Current
DC	Direct Current
kV	Kilovolt
MW	Megawatt
MWp	Megawatt Peak
PV	Photovoltaic
SEF	Solar Energy Facility
SWSA	Strategic Water Source Areas
UN	United Nations
Wp	Watt Peak
WUL	Water Use License

1. PURPOSE AND SCOPE

This document defines the scope of the study for the definition of water needs and consumption during the **Construction Phase** and in the **Operation Phase** for the Duneveld PV Project in the Northern Cape Province, South Africa.

2. LOCATION

Duneveld PV (Pty) Ltd is proposing the development of the Duneveld PV Facility as well as all associated infrastructure on a site to be located within Geel Kop Farm 456 RE . The proposed project development site is located approximately 30 km south west of Upington and 16 km north east of Keimoes in the Kai !Garib Local Municipality (ZF Mgcawu District Municipality) in the Northern Cape. Access to the site is provided directly from the N14 National Road that runs along the southern boundary of the site.

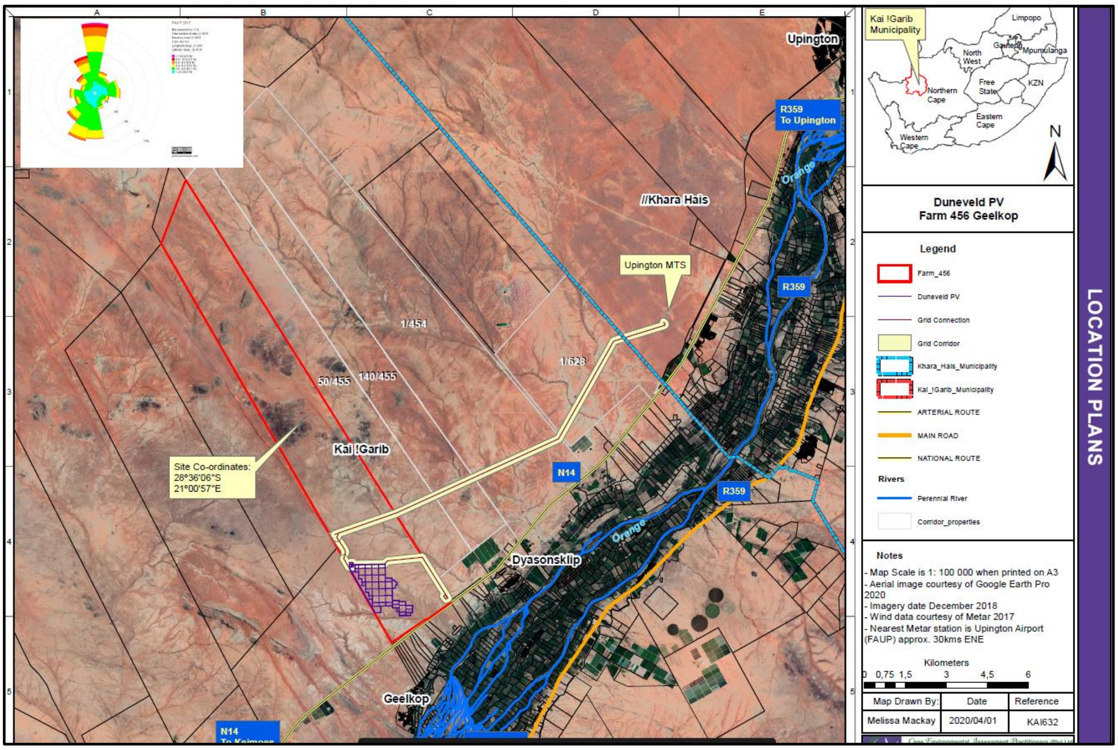

FIGURE 1: DUNEVELD PV PROJECT

3. BASIC DESCRIPTION OF THE FACILITIES

The solar photovoltaic (PV) plant will have a maximum installed capacity of 115 Megawatt (MW), with a net AC electrical generating capacity of 100 MW.

The main elements of theDuneveld PV Facility will be as follows:

- Modules (solar panels),
- Inverters,
- Transformers,
- Medium-voltage grid,
- Transformer Substation, and
- Internal and external roadways.

4. WATER NEEDS AND CONSUMPTIONS

4.1. INTRODUCTION

The estimates are based on two distinct phases, the first one being for the **construction** of the solar energy facility, and the second phase corresponding to the **operation & maintenance** of the installed energy-generating infrastructure.

4.2. CONSTRUCTION PHASE

The **Construction Phase** of the Duneveld PV is broken down into two categories of requirements, **Sanitation** (drinking, cooking and cleaning) and **Construction Processes**. The construction duration Duneveld PV is estimated to be 18 months.

4.2.1. SANITATION WATER REQUIREMENTS

It is estimated that there will be approximately 250 workers on site at the peak of the construction period. The average number of construction workers on site per day is estimated to be approximately 250. The United Nations (UN) suggests that a person needs in the region of 20 - 50 Litres of water a day to ensure their basic needs for drinking, cooking and cleaning (UN-Water, n.d.). The following calculations assume 50 Litres/worker/day with the assumption that **portable chemical toilets** will be used at the construction site.

TABLE 1: CONSTRUCTION SANITATION WATER REQUIREMENTS

Consumption (Litres/worker/day)	Construction Duration	Workers on site	Total Consumption (Litres)	Total Consumption (m^3)
50	540 days	250	6,750,000	**6,750**

4.2.2. CONSTRUCTION PROCESS WATER REQUIREMENTS

Water consumption during the construction process is associated primarily with the compaction of roads (including dust suppression) to meet minimum quality requirements. The requirement is estimated to be 150 Litres/m^3. A further 250 m^3 quantity has been allowed for other general uses such as concrete curing, road maintenance, terrain irrigation etc.

TABLE 2: CONSTRUCTION PROCESS WATER REQUIREMENTS

Construction Process	**Consumption** (Litres/m^3)	**Construction Quantities**	**Total Consumption** (Litres)	**Total Consumption** (m^3)
Compaction of roads	150 Litres/m^3	35,000 m3 of granular material	5,250000	**5,250**
Others	-	-	-	**250**
			TOTAL	**5,500 m3**

Note: Recycled water as opposed to potable water may be used for the above construction processes.

4.3. OPERATIONAL PHASE

The **Operational Phase** of the Duneveld PV is broken down into two categories of requirements, **Sanitation** (drinking, cooking and cleaning) and **Plant Maintenance** (module cleaning and road maintenance & irrigation). The operation duration of the solar PV facility is estimated to be 20 years.

4.3.1. SANITATION WATER REQUIREMENTS

Employment numbers at a Solar PV Facility depends largely on the extent to which operational processes are automated. For the purpose of these calculations, it is assumed that the Duneveld PV will employ a maximum of 60 workers at any given point in time during the 20-year operational lifespan of the Plant. The United Nations (UN) suggests that a person needs in the region of 20 - 50 Litres of water a day to ensure their basic needs for drinking, cooking and cleaning (UN-Water, n.d.). Assuming 50 Litres/worker/day, the total annual consumption during the operational phase of the facility is calculated to be **1,095 m^3**.

4.3.2. PLANT MAINTENANCE WATER REQUIREMENTS

<u>Module cleaning</u>

For this purpose it is assumed that the solar PV modules will be cleaned twice per annum. The maximum allowable DC/AC ratio is 1.15. Therefore a plant with a net generating capacity of 100 MW corresponds to a total peak installed capacity of 115 MWp. Assuming a module size of 330 Wp, the facility will see 348,485 units installed. The estimated water consumption is calculated in the following table.

TABLE 3: PLANT MAINTENANCE WATER REQUIREMENTS

Quantity (modules)	Area (m² per module)	Water Consumption (Litres/m²)	Consumption per Clean (Litres)	Cleans/year	Total Consumption (m³)
348,485	1.95	3	2,038,637	2	**4,077**

Road maintenance

It is assumed that 200 m^3/year will be required for road maintenance and irrigation purposes.

4.4. WATER STORAGE REQUIREMENTS

It is assumed that potable water will be stored in small water tanks on site. A typical example of such would be a standard JoJo 5,000 Litre water tank measuring 1,820 mm in diameter and 2,100 mm in height.

Grey water and sewerage will be discharged to an approved watertight conservancy tank system, for collection by authorized agents who will dispose the waste water at a registered waste water treatment works.

4.5. SUMMARY OF WATER CONSUMPTIONS

The total water consumption estimated for the **Construction Phase** is **12,250 m^3**, for the total **18-month construction period**.

The total water consumption estimated for the **Operational Phase** is **5,372 m^3 per annum**, for the **20-year operational lifespan** of the Solar PV Facility.

5. GROUNDWATER AND RAINWATER

5.1. INTRODUCTION

In order to reduce the demand placed on the municipality, the Project will look to use both rainwater and groundwater during the construction and operational phases.

5.2. GROUNDWATER

The proposed Duneveld PV will be located near Upington in the Northern Cape Province. According to Figure 2 below, the area may have a groundwater occurrence of between 0.1 and 2 Litres/second.

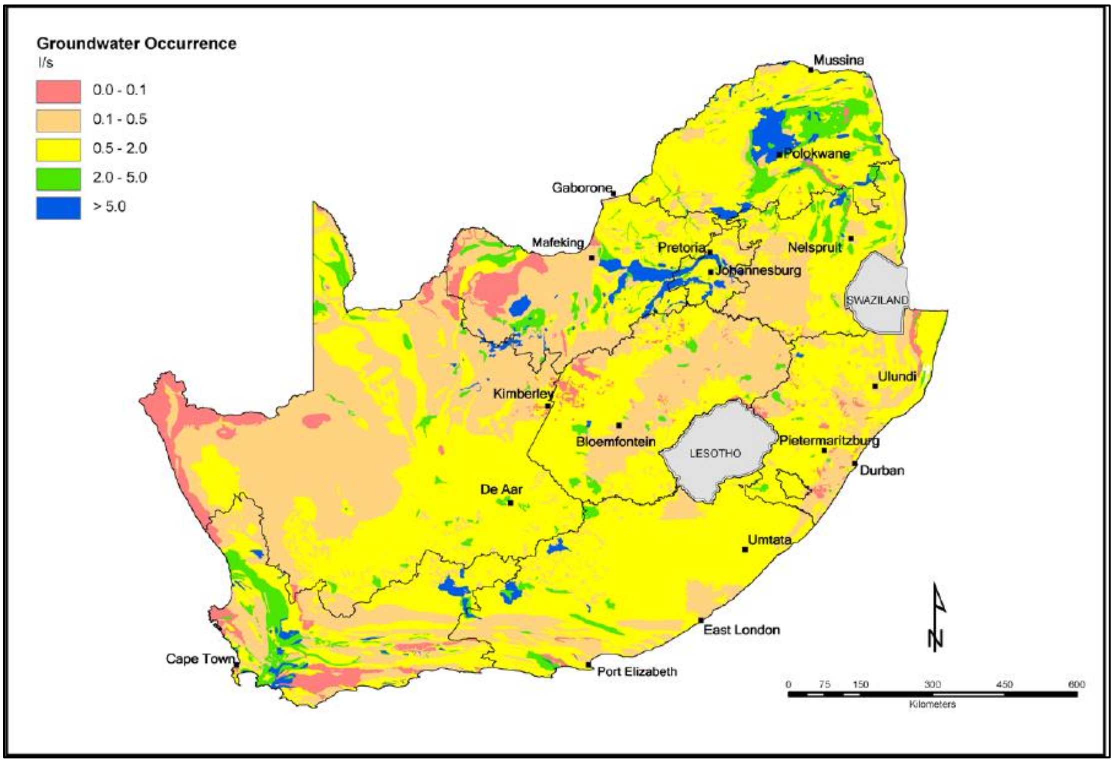

FIGURE 2: GROUNDWATER OCCURENCE IN SOUTH AFRICA (DEPARTMENT OF WATER AFFAIRS)

The Developer will solicit the services of a consultant to undertake an assessment of groundwater resources that will include hydrocensus and yield test studies. Should borehole extraction prove to be a feasible water supply option for the proposed Duneveld PV, then the formal processes will commence for registration of the necessary water use license (WUL) applications and the municipality notified accordingly.

5.3. RAINWATER

Figure 4 below (WORLD WEATHER ONLINE, n.d.) depicts the average rainfall amount for Upington over the most recent 12 month period. The average monthly rainfall is calculated to be 8.26 mm. Figure 5 below depicts a mean annual runoff map of South Africa (Biodiversity GIS, 2007) in which it is shown that Upington may experience anywhere between 0 – 60 mm/year runoff.

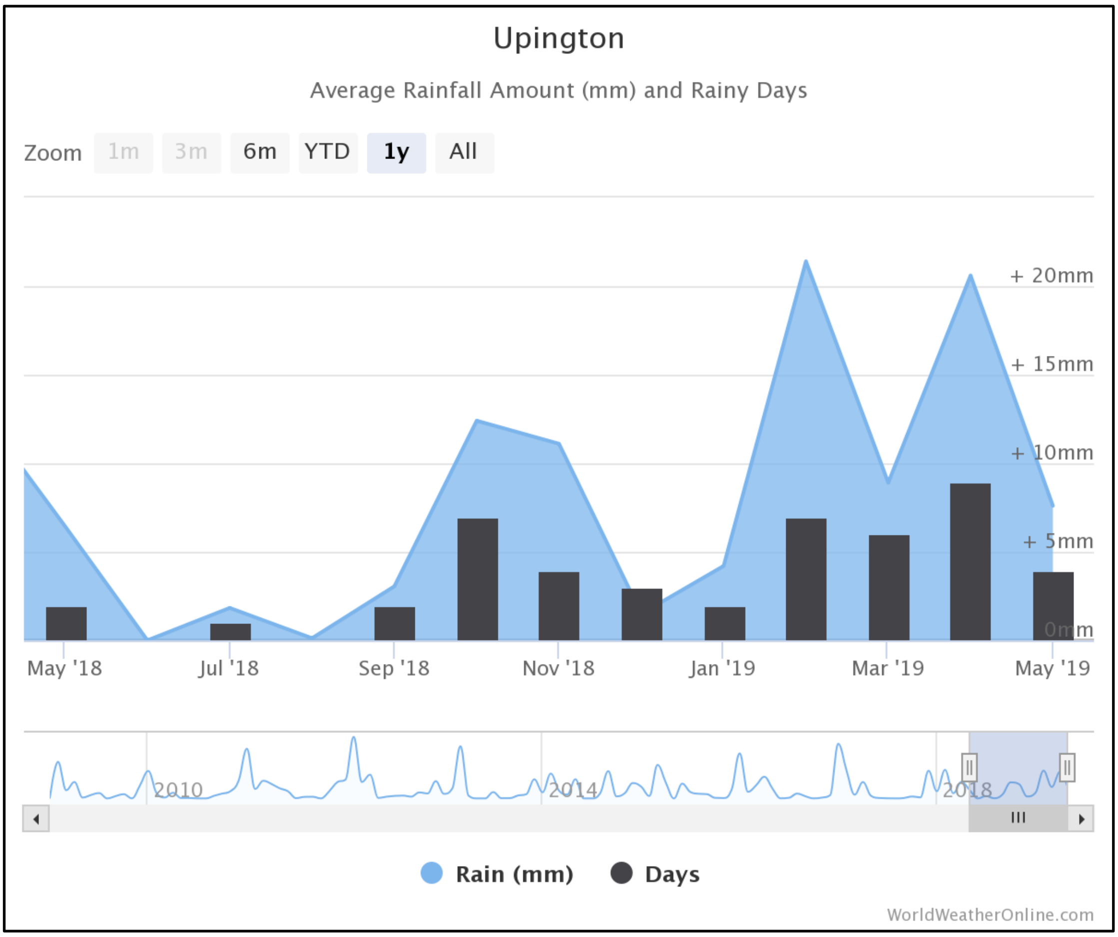

FIGURE 4: UPINGTON MONTHLY CLIMATE AVERAGE, SOUTH AFRICA (WORLD WEATHER ONLINE, 2000 - 2012).

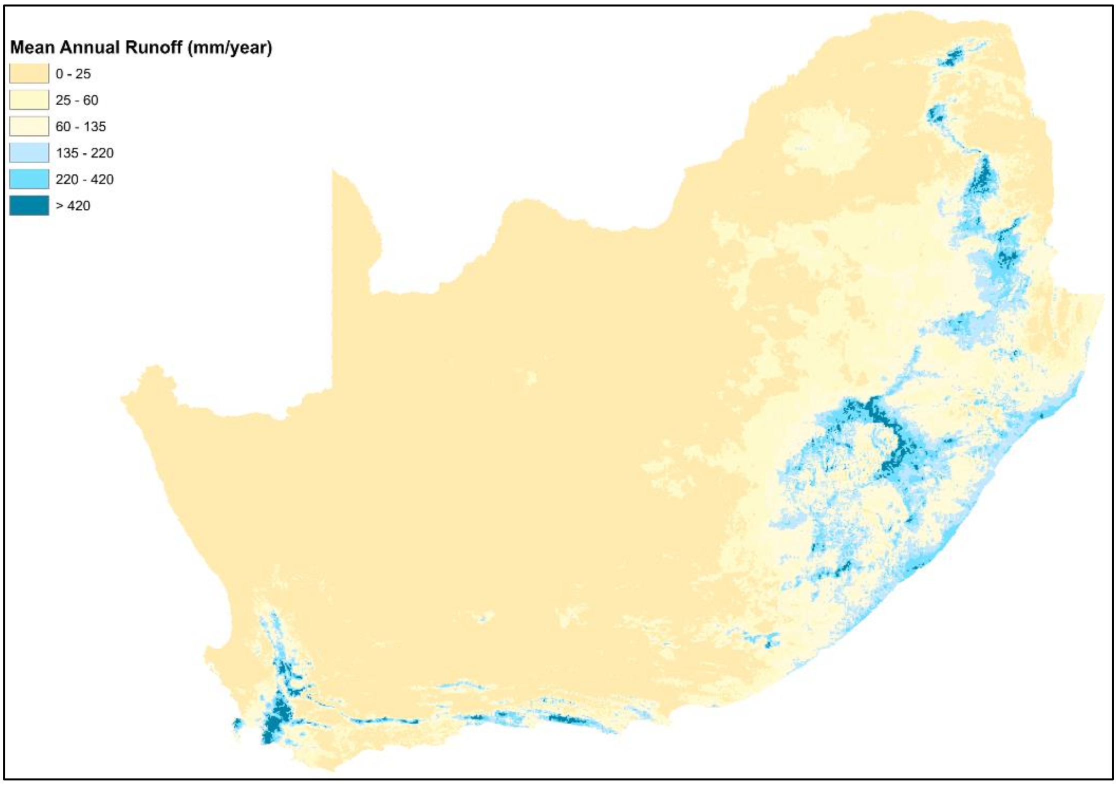

FIGURE 5: MEAN ANNUAL RUNOFF FOR SOUTH AFRICA (BIODIVERSITY GIS, 2007)

5.4. FLOW ESTIMATE

As a minimum it is intended to catch and store rainfall that falls on the roof of the substation building. These calculations are indicative, and are based on the monthly average rainfall of 8.26 mm.

The Rational Method is used to calculate the rain flow: **Q = C x I x A**

Where:	**Q**	is	**Flowrate**
	C	is	the **Coefficient of Runoff**
	I	is	the **Intensity of the storm**, and
	A	is	the **Catchment Area**

For the roof, the coefficient of runoff, **C**, is equal to **1**.

The Intensity of the storm, **I**, is equal to **0.011 mm/hr**.

The dimension of the roof is:

- b = 33 m; 2a = 8.55 m; d = 0.6 m, with a total area of 282.15 m^2.

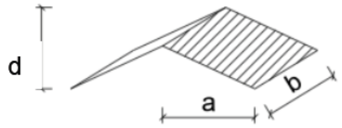	**Area considering wind effect** $A_c = \left(a + \frac{d}{2}\right) \cdot b$

FIGURE 6: WIND EFFECT FORMULA

Taking wind effect into consideration (see Figure 5), the rainfall catchment area, **A**, of the roof is reduced to **151 m^2**.

The total flowrate, **Q**, is equal to **0.002 m^3/hr**.

Therefore, for an average of 365 days it would be possible to accumulate 14.55 m^3 of rainfall, which meets only 0.27% of the annual sanitation water needs during operation of the solar energy facility, indicating that potable water will need to be trucked in to the facility.

6. LIST OF REFERENCES

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