<u>Water Resources Assessment</u>:

Paulputs Concentrated Solar Plan,

Northern Cape Province

Prepared for:

Savannah Environmental (Pty) Ltd
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SPECIALIST STATEMENT DETAIL

This statement has been prepared with the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant other National and / or Provincial Policies related to biodiversity assessments in mind.

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Expertise / Field of Study: BSc (Hons) Zoology, MSc Botany (Rivers), Ph.D Botany Conservation Importance rating (Estuaries) and interior wetland / riverine assessment consultant from 1996 to present.

I, **Dr. Brian Michael Colloty** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs

Signed:… ………………. Date:…17 June 2016…………

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1 - Introduction

Scherman Colloty & Associates (SC&A) was appointed by Savannah Environmental to conduct an aquatic delineation and water resource impact assessment for the proposed Paulputs Concentrated Solar Plant (CSP) near Pofadder in the Northern Cape (Figure 1), located within the D81E Quaternary Catchments, while the project spans an unknown tributary of the Gariep River (Figure 2).

This study includes a delineation of any natural waterbodies remaining on the affected property in question. This was based on information collected in 2010/11 for the same farm portion as wells as along the proposed pipelines and roads alignments within the region.

The Present Ecological State status of the observed waterbodies together with an analysis of the potential impact of the proposed facility on the aquatic environment was also determined as part of the study. A detailed description of the methods used in this assessment is included in Appendix 1.

Assumptions and limitations

In order to obtain a comprehensive understanding of the dynamics of the aquatic systems, as well as the status of endemic, rare or threatened species in any given area, assessments should always consider temporal and spatial scales within the study. However, due to time and budget constraints, long-term studies are rarely feasible, resulting in most EIA specialist assessments being once off surveys.

It should be emphasised that information, as presented in this document, only has reference to the study area(s) as indicated on the accompanying maps. Therefore, this information cannot be applied to any other area without detailed investigation.

Furthermore, additional information may come to light during the next phase of the project, which will require detailed surveys to complete the required documentation for example the Water Use Licenses that may be required.

2 - Project description

The applicant, Paulputs CSP (Pty) Ltd, proposes to construct a 200 MW Concentrated Solar Power Tower facility with the associated infrastructure. This is located within the farm Scuit-klip 92 portion 4, near Pofadder in the Northern Cape. The farm is situated in the Northern Cape Province approximately 30 km North East of Pofadder and 34 km South East of Onseepkans, with the shortest distance to the Gariep River from the middle of the proposed site, being 24 km to the North East. The proposed facility is also located directly adjacent to several other projects and includes the KaXu Solar 1 CSP and Xina Solar 1 CSP within the same farm portion which are either already operational or under construction (Figure 1)

The CSP Tower facility is proposed to make use of **molten salt technology** and include the following infrastructure:

- Molten salt tower up to 300m in height with surrounding heliostat field
- Power island including salt storage tanks, steam turbine generator, heat exchangers, and dry cooled condenser
- On-site project substation, and short 132 kV power line to Eskom's existing Paulputs Transmission Substation
- Water supply abstraction point located at the Gariep River close to Onseepkans
- Filter and booster station at abstraction point
- Water supply pipeline along R357 Onseepkans Road to the site
- On-site lined ground water storage reservoir and various steel water tanks
- Lined evaporation ponds
- Packaged water treatment plant and associated chemical store
- Auxiliary wet cooled chiller plant
- Control room and office building
- Heliostat assembly building and workshop

From a water resource management point of view, suitable water resources are required for the steam production that will drive the turbines. Water is to be abstracted from the Gariep River.

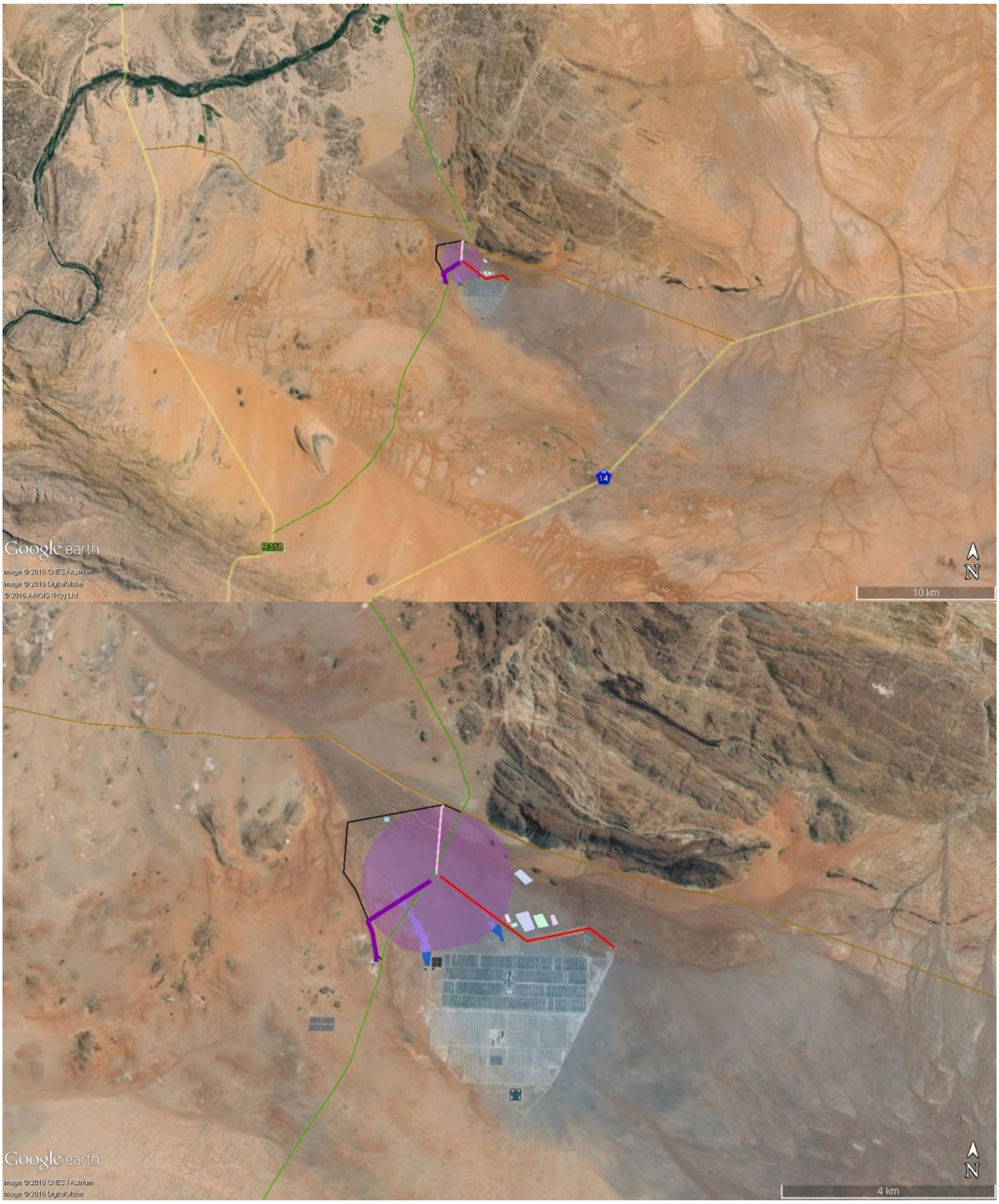

Figure 1: Study area locality indicating the project footprint and associated access roads / pipeline alignments (Above), while below is zoomed in on the proposed project components and the adjacent existing projects.

3 – Study Area Description

The study area is situated within quaternary catchment D81E (Figure 2) and is dominated by highly ephemeral river systems (DWAF, 2004). Potential runoff would flow in a North Westerly direction towards the Gariep River, while runoff from the elevated portions of the Skuitklip ridges flows in a Northerly direction towards the Kaboep River, which then flows into the Gariep River.

Several potential wetlands, other than the riparian systems found along the Gariep River are shown on the SANBI National Wetlands Map v4 (SANBI, 2015) (Figure 3). These were visited during the specialist site visit, i.e. no natural wetlands were observed within 500m of the proposed CSP site, i.e. more than 3km away, while wetlands / reedbeds (*Phragmites australis*) were observed near the proposed abstraction point along the Gariep River floodplain (Plate 1).

The region is however dominated by several dry alluvial water courses (Plate 2), which only flow during high rainfall events. Such an event was observed during the 2011 surveys, which only resulted in flows within the larger water courses associated with the proposed road / pipeline area to the west of the CSP facility near the Gariep River (Plate 3). The proposed CSP site itself is mostly dry, although a large number of drainage lines were observed and will thus be impacted upon by the proposed layout (Figure 4). These systems were highly fragmented by the roads and farming practices in the past while the adjacent projects have now disrupted any flows within these systems. The significance of this impact at the time of assessing the adjacent projects was low, due to the impacts and high degree of fragmentation coupled to the general lack of any important / visible aquatic habitat.

4. Potential Water Abstractions Resources – Background Information

The non-perennial Mean Annual Rainfall (MAR) for the D81E quaternary catchment has been estimated by Middleton & Bailey (2008) as low as 0 – 200 mm/a, while A-pan evaporation can exceed 2600 mm/a, as compared to the MAR 0-2.5 mm/a. A-pan evaporation is standardised measurement, which integrates several climate variables, namely; temperature, humidity, solar radiation, and wind. Evaporation, is greatest on hot, windy, dry days as opposed to times when the air is cool, calm, and humid. A Pan evaporation measurements, which is measured using the water filled pan of a prescribed size, are used to determine the irrigation requirements of cultivated areas.

Surface water runoff would therefore not meet the water demands of the proposed project (2.5 million m3/a) and water would have to be sourced from the Gariep River.

4.1. Surface water quantity

As no available surface water flows within the study site, water will thus have to be sourced from the Gariep River. Currently water demand is dominated by use for irrigation along the river at various points and small quantities for urban use and stock watering within the Onseepkans / Pofadder region (ORASECOM, 2007). More recently several other CSP projects have also been commissioned and make use of water from the Gariep River.

Most of the flow in the Gariep River originates from the Gariep Water Management Area (WMA) (and Lesotho). The Vaal River only contributes small quantities of high salinity irrigation return flows and flood spillage/releases from the Bloemhof Dam to the Lower Gariep River system.

The natural runoff of the entire Gariep River catchment is estimated at 11 490 million m^3/a, with approximately 4 000 million m^3/a originating from the Lesotho Highlands while 900 million m^3/a from the contributing catchment downstream of the Gariep/Vaal confluence, which includes part of Namibia and a small portion in Botswana feeding the Nossob and Molopo rivers. The current phase of the ORASECOM project will attempt to address the issue of whether or not these two rivers directly contribute to the Gariep River. The remaining 6 700 million m^3/a originates from the areas contributing to the Vaal, Caledon, Kraai and Middle Gariep rivers.

Most of the documents assessed for this report have noted that runoff originating from the Gariep River downstream of the Gariep/Vaal confluence is highly erratic and cannot be relied upon to support the various downstream demands unless further storage is provided (ORASECOM, 2007). It is also important to note that any releases from the Vanderkloof Dam take approximately 3 – 4 weeks to reach the mouth, a distance of 1400 km. The Vanderkloof Dam is situated near the town of Petrusville, approximately 170 km South West of Bloemfontein.

Latest data indicates that only 5 500 million m^3/a of the natural flow actually reaches the mouth as opposed to the expected estimate of 11 490 million m^3/a. The difference is possibly as a result of the extensive water utilisation in the Vaal River basin for domestic and industrial use. Irrigation accounts for a further 1 800 million m^3/a) while mining activities require 40 million m^3/annum, occurring along the Gariep River downstream of the Gariep/Vaal confluence. Additional water demands also include the Fish River transfer scheme via the Gariep/Fish Canal, which in periods of drought, is the only source of water for certain hinterland regions (e.g. Cookhouse, Cradock and Grahamstown) of the Eastern Cape. Evaporative losses from the Gariep River and the associated riparian vegetation account for between 500 million m^3/a and 1 000 million m^3/a depending upon the flow of water (and consequently the surface area) in the river (Mckenzie *et al*, 1993, 1994 and 1995, cited in ORASECOM, 2007). An approximate

water balance for the Gariep River is provided in Table 1 to provide perspective on the various demands supported from the river.
Future demand is mainly limited to mining activities found in Namibia, below the town of Noordoewer post while in Botswana the developments that may influence the lower Gariep River are restricted mainly to groundwater abstraction. The Pofadder region has not been earmarked as a future economic development centre or growth point, other than the increase in the development of local farming activities (DWA, 2009) and at the time excluded the projected demand from the renewables sector within the Province. and is currently being determined by the DWS in association with various stake holders in this industry.

Table 1: Gariep River water balance as of 2005 (ORASECOM 2007)

Water Balance component	Volume (million m^3/a)
Environmental requirement	900 (Incl of natural evaporative losses from Gariep River
Namibia	120 (Incl water use from Gariep & Fish Rivers)
Lesotho & transfers to South Africa	820 (With full LHWP Phase 1 active)
South Africa Gariep River demand	2560 (Includes transfers to the Eastern Cape)
South Africa Vaal River demand	1560 (Vaal demand supplied from locally generated runoff)
Evaporation & losses	1750 (Evaporation not accounted for in the Environmental Requirement)
Spillage	3780
TOTAL	**11490**
Spillage under natural conditions	10900

It should be noted that when the available documentation was reassessed for this report, a number of discrepancies were still evident in the reported values even within reports. Modelling versus observed flows, coupled to the lack of suitable measuring stations in the lower Gariep systems could account for the variability. However, during the Water Use licensing process that will be required for this project, a detailed assessment of the available water supply will have to be made. This must be done in light of the current studies still being conducted by the DWS to determine the available water, water requirements and flow patterns. The flow patterns are important with regard releases made from dams such as Van der Kloof Dam to support the natural fish and invertebrate requirements in the future.

4.2. Surface water quality

Although the inflows from the Vaal River systems are low, the poor water quality from this system would seem to have a significant impact on the sub-basin and the Lower Gariep WMA. The Vaal River receives high salinity irrigation return flows and flood spillage/releases from Bloemhof Dam. The Lower Gariep is also characterised by high turbidity waters during flood flows; in its natural state, water in the Gariep River is of good quality (ORASECOM, 2007).

The ORASECOM (2007) study indicated that the salinity in this sub-basin deteriorates downstream of the confluence of the Vaal and Gariep rivers, but remains acceptable for human use. There is an increase in Electrical Conductivity (EC) from the Prieska station to Vioolsdrift along the reaches of the Lower Gariep River. This is again due to irrigation return flows and losses from evaporation along the river.

4.3. Local water resources and social needs

Three major areas within the vicinity of the study area receive water directly from the Gariep River, namely Pofadder, Witbank and Onseepkans managed via water supply schemes as follows:

The Pelladrift Water Supply scheme of the Pelladrift Water Board supplies both Pofadder and Aggeneys. The Black Mountain Mine and Pella Mission also benefit from this scheme. Water is abstracted from the Gariep River through an abstraction works at Pella Mission, consisting of a 1.88 million m^3/a water treatment works and bulk water supply lines to the respective towns. Pofadder's current water requirements are estimated at 200 000 kl per annum(0.548 Ml/day) and is projected to increase to 280 000 kl per annum by the year 2030 (DWA, 2009). The combined projected water requirements for Aggeneys, Pella and Pofadder for the year 2030 is 5 640 000 kl per year, which is less than the Allocation of 16 060 000 m^3/annum (DWA Registration Number: 25035649) for which Pelladrift Water Board are authorised to abstract from the Gariep River (DWA, 2009).

Witbank is supplied with raw water, which is abstracted from the Gariep River using submersible pumps and then purified using a solar/diesel powered package water treatment plant. However due to the high sediment loads, pumps require on-going maintenance and have an expected lifespan of between 4 to 5 months (DWA, 2009).

The Onseepkans irrigation area is supplied through a canal on the left bank of the Gariep River. The capacity of this canal is unknown, but is used to irrigate 314 ha of land (DWA, 2009).

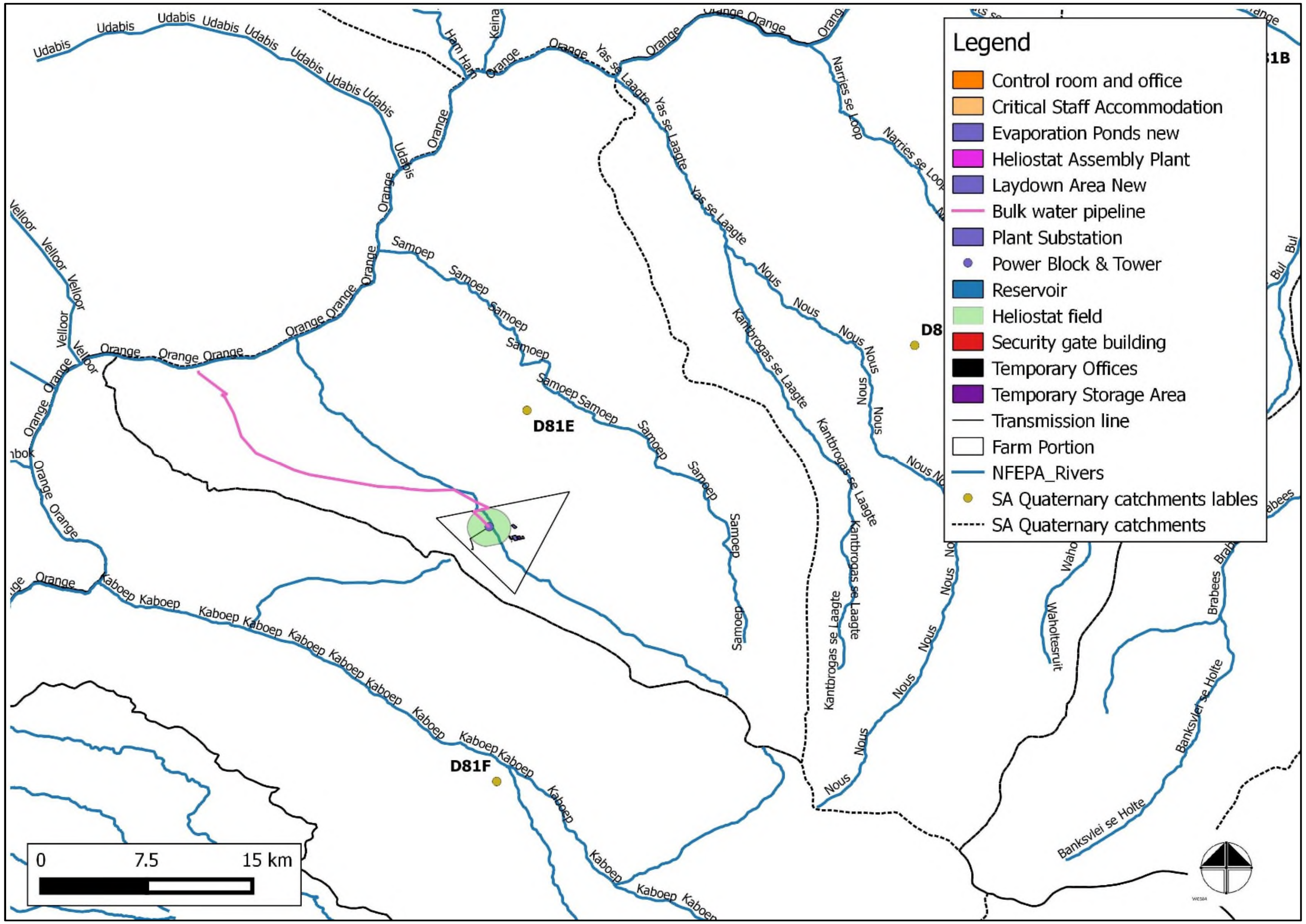

Figure 2: Project locality map indicating various quaternary catchments within the region (NFEPA & DWS)

5 - Waterbody delineation & classification

The water body delineation and classification was conducted using the standards and guidelines based on the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods used in this desktop assessment are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance and Present Ecological State (PES) assessment methods used in this report. Reference is also included with regard relevant legislation related to the protection of waterbodies and the minimum requirements in terms of prescribed buffers.

For reference the following definitions are as follows:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).
- **Water course**: as per the National Water Act means -

    (a) a river or spring;

    (b) a natural channel in which water flows regularly or intermittently;

    (c) a wetland, lake or dam into which, or from which, water flows; and

    (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

According to the National Freshwater Ecosystems Priority Area (NFEPA) wetland data, only two natural wetlands occur within the study area. The remaining waterbodies are artificial or man-made systems as shown in Figure 3. mostly associated with the low lying river valleys and their floodplains. This was confirmed during the site visits conducted in the faunal and floral surveys conducted for this project.

Figure 4 indicates significant watercourses observed within the site. Any activities within 32m of the centreline (or the 1:100 floodline, whichever is the greatest) will require a Water Use license.

The exact extent and the number of water use licenses will be determined during the final design phase of the project in association with the EMPr walk down surveys.

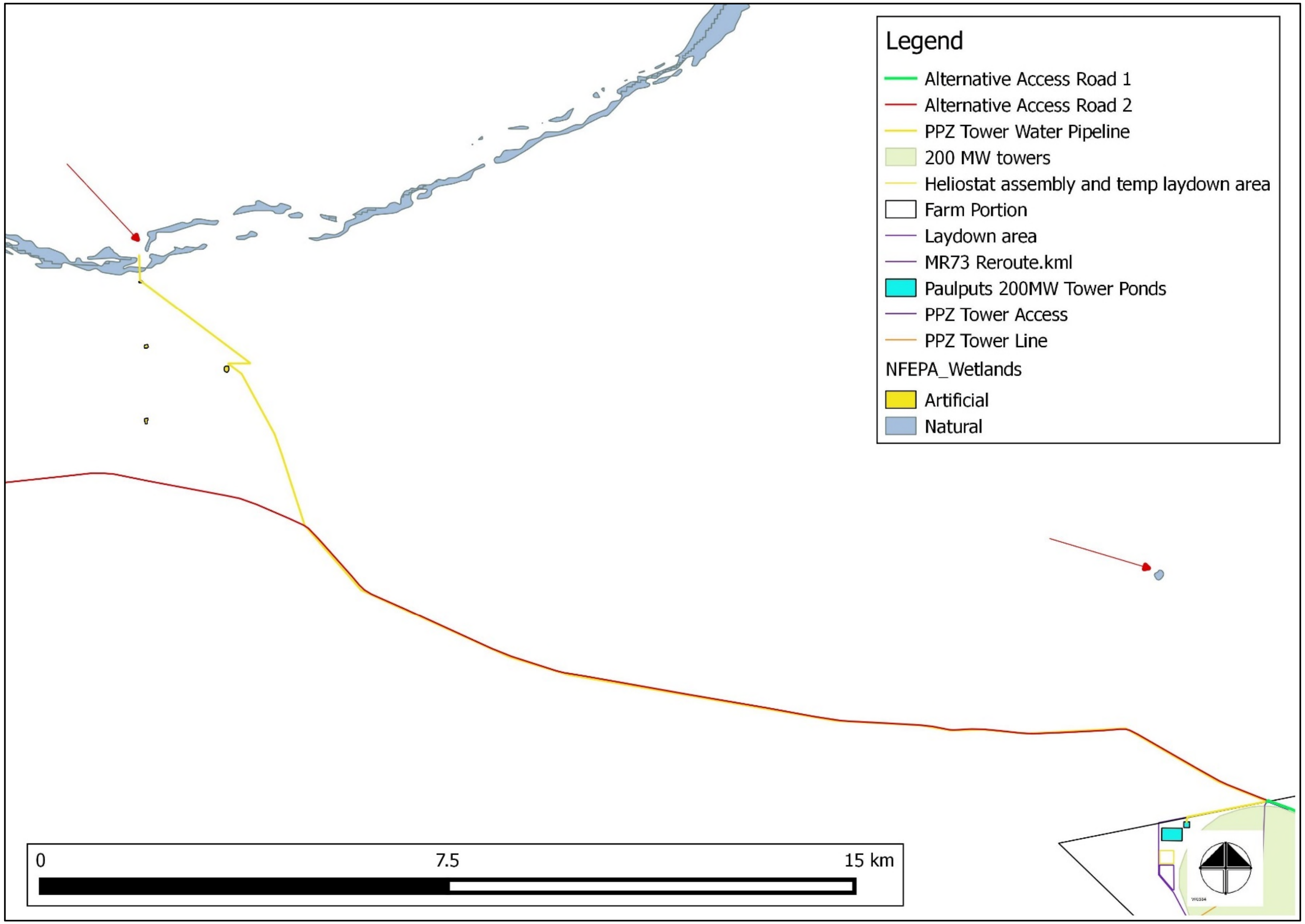

Figure 3: Potential wetlands according to the National Wetland Inventory (SANBI, 2015 ver 4) in relation to the proposed layout with the only natural wetlands indicated by the red arrows

6 - Present Ecological State and conservation importance

The Present Ecological State of a river represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habit and biota, as well as ecosystem functioning (Category E).

The national Present Ecological Score or PES scores have been revised for the country and based on the new models aspects of functional importance as well as direct and indirect impacts have been included. The new PES system also incorporates EI (Ecological Importance) and ES (Ecological Sensitivity) separately as opposed to EIS (Ecological Importance and Sensitivity) in the old model. Although the new model is still heavily centered on rating rivers using broad fish, invertebrate, riparian vegetation and water quality indicators. The Recommended Ecological Category (REC) is still contained within the new models, with the default REC being B, when little or no information is available to assess the system or when only one of the above mentioned parameters is assessed or the overall PES is rated between a C or D.

The Present Ecological State scores (PES) for the drainage lines and the rivers in the study area were rated as follows (DWS, 2014 – where C = Moderately Modified):

Subquaternary Catchment Number	Present Ecological State	Ecological Importance	Ecological Sensitivity
3349	C	High	High

It is thus evident that systems are largely functional. These systems although dry then support the downstream areas and the respective Ecological Importance and Ecological Sensitivity Scores were rated as HIGH.

However, the DWS, 2014 results would seem to be an over estimation when considering the degree of habitat fragmentation that has already occurred on the site and in the surrounding area. Thus the EI & ES would be rated as moderate within the study area.

Plate 1: A view of the reed (*Phragmites australis*) lined banks of the Gariep River near the proposed abstraction point

Plate 2: A view of a dry alluvial water course within the proposed CSP site

Plate 3: One of the larger alluvial water courses that will be crossed by the proposed pipeline and Access road option 2

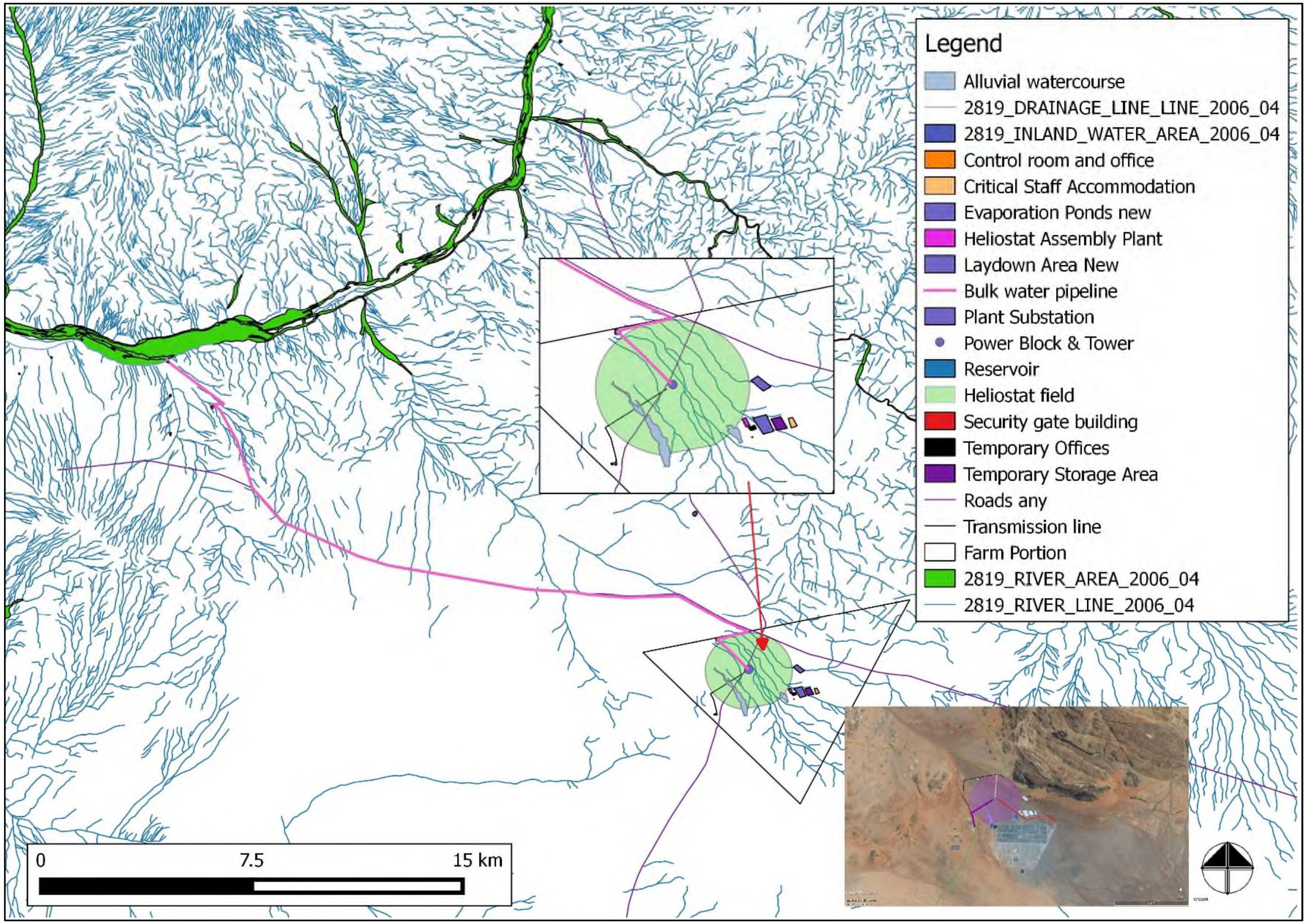

Figure 4: Delineated water courses in relation to the study area, CSP site (inset above) and present day impacts posed by the adjacent sites (inset below)

8 – Potential impacts and risk assessment

During the impact assessment study a number of potential key issues / impacts were identified and these were assessed based on the methodology supplied by Savannah Environmental (Pty) Ltd.

As no permanent surface water or associated aquatic habitats occur within the study site, and the abstraction of water is of key importance it is thus needed to briefly describe the greater regional aquatic environment. The ecology in the Lower Gariep sub-basin is dominated by the presence of dams and irrigation water use along most sections of the Gariep River. Increased populations of invasive alien plant species contribute significantly to land degradation in the sub-basin (ORASECOM, 2007). Growing numbers of Mesquite (*Prosopis spp*.) are also affecting the more arid part of the Lower Gariep River and the prevalence of dense stands of alien species on river banks and floodplains have reduced basal vegetation cover, causing erosion of the top clayey soil layers (ORASECOM, 2007). However certain unique features such as the Onseepkans Falls and three fish species with conservation concern are found in close proximity to the proposed site in the Gariep River.

The invertebrate populations appear to be rather homogenous throughout the entire length of the Gariep River and are described as mostly unpredictable, due to the erratic nature of the system (LORMS, 2005).

The occurrence of freshwater fish being infested by parasites, as well as an increase in fish parasite diversity in the study area had been observed during fish surveys between 1985 and 1989 (Benade, unpublished data, cited in LORMS, 2005). This phenomenon is indicative of water quality deterioration. The Gariep River system as a whole is relatively poor in indigenous freshwater fish species diversity. Presently, eight fish families are represented by 22 species.

Five of the six endemic Gariep River fish species occur in this lower river section, of which one, Namaqu Barb (*Barbus hospes*), is unique to the Gariep River section between Augrabies Falls and the Gariep River Mouth. Three of the five endemic species, *B. hospes*, Largemouth yellowfish (*Labeobarbus kimberleyensis*) and Rock catfish (*Austroglanis sclateri*) are Red Data listed. Although the other two endemics, Smallmouth Yellowfish (*Labeobarbus aeneus*) and Gariep River mudfish (*Labeo capensis*), are fairly abundant and thus appear not to be threatened, they remain of concern because of their endemic status (LORMS, 2005). It should also be remembered that Gariep River mouth is a Ramsar site, being a wetland of international importance, managed in partnership with Namibia (LORMS, 2005).

In summary the following key issues and related impacts will be assessed:

Issue - Physical environment

- Impact on water quality of the region
- Impact on water quantity of the region (see note below)
- Impact on dry riverbeds and localised drainage systems
- Impact on riparian and instream systems on form and function

Issue – Biological environment (e.g. vegetation, macro-invertebrates & fish)

- Impact on water quality of the region
- Impact on water quantity of the region (see note below)
- Impact on riparian systems (conservation & biodiversity)
- Impact on fish biodiversity & species of conservation concern

Issue – Social environment (human needs)

- Impact on water quality of the region
- Impact on water quantity of the region (See note below)

Note: Cumulative Impacts – Impact 5

Water quantity issues need to be addressed on a regional basis, especially considering that there is no available surface water within the study area. This will be conducted in detail as part of the Water Use License process, but an indicative assessment is presented below. The WULA process will also largely address the cumulative impact of the project, both considering the needs of the adjacent projects, downstream social, agricultural and the environmental needs. Thus this level of cumulative assessment is beyond the scope of this study as the WULA process is driven by the DWS at this given point. Although based on the available information (low confidence), the cumulative impact of water use (ecological and social) is anticipated to be low – See Impact 5 assessment table.

Issue – Physical Environment

Nature: Impact 1 – Impact on water quality region Any surface water run-off from the site has the potential to impact on the water quality of the region, particularly during flood conditions or via groundwater infiltration. However, in assessing annual records from the adjacent facility (Kaxu) limited amounts of effluent were produced (ca. 65 000cm^3 per annum). These volumes, which would be similar to the proposed project, are contained in lined ponds which are then allowed to evaporate, minimising the potential need to discharge and or seep into the environment.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (55)**	**Medium (45)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: The most significant form of mitigation would be to select a development area, which contained no drainage lines. This is not feasible considering the terrain and the high number of watercourses found present thus the following must occur: • Site clearing and preparation for the construction of the solar facility should take steps to avoid surface run-off and storm-water erosion of cleared areas where practicable. • A comprehensive Storm Water Management Plan (SWMP) incorporating anti-erosion measures on site should be put in place. • All surface run-off should be discharged via detention dams to allow sediment to settle out before leaving the site • Wastewater from the power generation process must be contained within appropriately lined evaporation and these should be located outside of any drainage lines or water courses.		
Cumulative impacts: The potential for any water quality changes is unlikely to occur, considering that the site is not near the main drainage channel and the annual rainfall figures are low.		
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site is unlikely to occur, considering that the site is not near the main drainage channels and the annual rainfall figures are low.		

Nature: Impact 2 - Abstraction of water from the Gariep River: timing and volume, i.e. impact on water quantity on the region The proposed abstraction of volumes of water from the Gariep River (ca 230 000 m^3/a based on Kaxu raw water use volumes) and may reduce present day flows and impact negatively on available habitat within the river. This impact would then impact on the regional biota.		
	Without mitigation	**With mitigation**

Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (55)**	**Medium (45)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Mitigation measures may be difficult and expensive, however, the possible measures to reduce volumes of water abstracted from the Gariep River could include the following: » Optimise the design or technology of the solar power facility to reduce consumptive water requirements as far as possible. » Adapt the abstraction regime to meet the EWR and requirements of other users where required.		
Cumulative impacts: Cumulative impacts due to water abstraction in the Lower Gariep River are already considered to be high and could be exacerbated by the abstractions for this project. Note that the water use required by this project is relatively small in a regional context.		
Residual impacts: No residual impacts expected if mitigation is implemented.		

Nature: Impact 3 - Impact on dry riverbeds and localised drainage systems The physical removal of narrow strips of woody riparian zones being replaced by hard engineered surfaces will alter the hydrological nature of the area, by increasing the surface run-off velocities, while reducing the potential for any run-off to infiltrate the soils. This impact would however be localised, as a large portion of the remaining farm and the downstream catchment would remain intact.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium (45)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: The most significant form of mitigation would be to select a development area which contained no drainage lines. However due to the nature of the site, this was not possible. Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant, and install stilling basins to capture large volumes of run-off, trap sediments and reduce flow velocities.		
Cumulative impacts: The increase in surface run-off velocities and the reduction in the potential for groundwater infiltration is unlikely to occur, considering that the site is not near the main drainage channel and the annual rainfall figures are low.		
Residual impacts: Diversion of run-off away from downstream systems is unlikely to occur as the site is not near the main drainage channel and the annual rainfall figures are low.		

Nature: Impact 4 - Impact on riparian systems through the possible increase in surface water runoff on riparian zone form and function as well as instream habitats		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (2)	Low (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (35)**	**Low (19)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant. It is also recommended that stilling basins to capture large volumes of run-off, trap sediments, and reduce flow velocities (e.g. water used when washing the mirrors) are installed. The project should also try to capture and recycle any form of run-off created by the daily operations. This would minimise the amount of water required by the project, but also serve to limit the downstream impacts on the riparian systems through an increase in run-off, a situation that these systems are currently unaccustomed to.		
Cumulative impacts: Downstream alteration of hydrological regimes due to the increased run-off from the area.		
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site assuming the predevelopment ground levels are reinstated.		

Issue – Biological Environment

Nature: Impact 1 – Impact on water quality of the region Any surface water run-off from the site has the potential to impact on the water quality of the region further reducing the quality of the water column impacting on the biota. However, in assessing annual records from the adjacent facility (KaXu) limited amounts of effluent were produced (ca. 65 000cm^3 per annum). These volumes, which would be similar to the proposed project are contained in lined ponds and are allowed to evaporate, minimising the potential need to discharge to the environment.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (55)**	**Medium (45)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation:		

The most significant form of mitigation would be to select a development area, which contained no drainage lines. This is not feasible considering the terrain and the high number of watercourses found present thus the following must occur: • Site clearing and preparation for the construction of the solar facility should take steps to avoid surface run-off and storm-water erosion of cleared areas where practicable. • A comprehensive Storm Water Management Plan (SWMP) incorporating anti-erosion measures on site should be put in place. • All surface run-off should be discharged via detention dams to allow sediment to settle out before leaving the site. • Wastewater from the power generation process must be contained within appropriately lined evaporation ponds.
Cumulative impacts: The potential for any water quality changes is unlikely to occur, considering that the site is not near the main drainage channel and the annual rainfall figures are low.
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site is unlikely to occur, considering that the site is not near the main drainage channels and the annual rainfall figures are low.

Nature: Impact 2 - Abstraction of water from the Gariep River: timing and volume, i.e. impact on water quantity on the regional biota The proposed abstraction of volumes of water from the Gariep River (ca 250 000 m^3/a based on Kaxu raw water use volumes) and may reduce present day flows and impact negatively on available habitat within the river. This impact would then impact on the regional biota. This impact would be particularly evident in summer when high river flows are required for fish spawning migrations and egg incubation. Several of the known fish species that occur near the abstraction site are protected (Threatened or Endangered). However, without detailed data on present-day flows, volumes abstracted by other users or Ecological Water Requirements, this impact is difficult to quantify. The system is also highly regulated (i.e. many dams upstream in the system), making an assessment more difficult. However, it is anticipated that constant pumping during droughts may impact on drought flow requirements needed to meet the EWR. Cognisance will have to be taken of other user requirement and will form part of the Water Use License process when evaluated by DWS.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (55)**	**Medium (45)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	
Mitigation: Mitigation measures may be difficult and expensive, however, the possible measures to reduce volumes of water abstracted from the Gariep River could include the following: » Optimise the design or technology of the solar power facility to reduce consumptive water requirements as possible. » Adapt the abstraction regime to meet the EWR and requirements of other users where required.		
Cumulative impacts: Cumulative impacts due to water abstraction in the Lower Gariep River are already considered to be high and could be exacerbated by the abstractions for this project. Note that the water use required by this project is relatively small in a regional		

context.
Residual impacts: No residual impacts expected if mitigation possible.

Nature: Impact 3 - Impact on dry riverbeds and localised drainage systems

The physical removal of narrow strips of woody riparian zones being replaced by hard engineered surfaces will alter the hydrological nature of the area, by increasing the surface run-off velocities, while reducing the potential for any run-off to infiltrate the soils. This impact would however be localised, as a large portion of the remaining farm and the downstream catchment would remain intact.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium (45)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	

Mitigation:
The most significant form of mitigation would be to select a development area which contained no drainage lines. However due to the nature of the site, this was not possible. Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant, and install stilling basins to capture large volumes of run-off, trap sediments and reduce flow velocities.

Cumulative impacts:
The increase in surface run-off velocities and the reduction in the potential for groundwater infiltration is unlikely to occur, considering that the site is not near the main drainage channel and the annual rainfall figures are low.

Residual impacts:
Diversion of run-off away from downstream systems is unlikely to occur as the site is not near the main drainage channel and the annual rainfall figures are low.

Nature: Impact 4 - Impact on riparian systems through the possible increase in surface water runoff on riparian zone form and function as well as instream habitats

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (2)	Low (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (35)**	**Low (19)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	

Mitigation:
Any stormwater within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant. It is also recommended that stilling basins to capture large volumes of run-off, trap sediments, and reduce flow velocities

(e.g. water used when washing the mirrors) are installed. The project should also try to capture and recycle any form of run-off created by the daily operations. This would minimise the amount of water required by the project, but also serve to limit the downstream impacts on the riparian systems through an increase in run-off, a situation that these systems are currently unaccustomed too.
Cumulative impacts: Downstream alteration of hydrological regimes due to the increased run-off from the area.
Residual impacts: Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

<u>Issue – Social Environment</u>

As discussed above these are largely cumulative impacts (See Impact 5) associated with water quantity and quality issues. Based on the available information, the additional water needs of the project would not result in any significant impacts on the social environment (human use and agricultural), however this can only be confirmed on a strategic regional basis by DWS through the Water Use License Application Process and is beyond the scope of this study, as we are unware of the exact current needs as well as other renewable project's needs at this time. Based on the water use requirement of Kaxu CSP (an operational facility on the same site as the proposed peoject), the overall impact has been assessed. It should be noted that the measured water use at Kaxu CSP is well below their water use allocation (i.e. optimised water use efficiency) and at no point was there no water available for abstraction in the Gariep River for that project.

Nature: Impact 5 – Cumulative impact on aquatic biology of the Gariep River as well as social needs of downstream users below the proposed abstraction point (Mines, agriculture and community / town supply). .		
	Overall impact of the proposed project considered in isolation	**Cumulative Impact of the project and other projects in the area**
Extent	Low (1)	Low (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Improbable (2)	Probable (3)
Significance	**Low (14)**	**Low (21)**
Status (positive/negative)	Negative	Negative
Reversibility	High	Low
Loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		
Mitigation: Optimise the design or technology of the solar power facility to reduce consumptive water requirements as far as possible. Adapt the abstraction regime to meet the EWR and requirements of other users where required which will be determined during the Water Use License Process. This is particularly true during times of excessive water use by upstream users (drought periods) and it is probable water could become unavailable		

Measures for inclusion into the Draft Environmental Management Plan

OBJECTIVE: Soil erosion control, water quality management

Project component/s	Project components affecting the objective: » All infrastructure connecting the site which may need to cross water courses or where the development may occur on dry drainage lines
Potential Impact	» Erosion and soil loss within **watercourses** » Negative impacts on **watercourses** » Disturbance to or loss of **watercourses** » Sedimentation of **watercourse areas** » A loss of indigenous vegetation cover, particularly in **watercourse areas** » Increased runoff into drainage lines can potentially be associated with accelerated erosion in **watercourses**
▪ **Activities/risk sources**	» Rainfall and wind erosion of disturbed areas » Excavation, stockpiling and compaction of soil » Concentrated discharge of water from construction activity » Storm water run-off from hard surfaces » Mobile construction equipment movement on site » Power line construction activities » Drainage line road crossings » Roadside drainage ditches » Project related infrastructure, such as buildings, turbines and fences
▪ **Mitigation: Target/Objective**	» To minimise erosion of soil from site during construction » To minimise deposition of soil into drainage lines » To minimise damage to vegetation by erosion or deposition » To minimise damage to soil and vegetation by construction activity » No accelerated overland flow related surface erosion as a result of a loss of vegetation cover » No reduction in the surface area of drainage lines as a result of the establishment of infrastructure » Minimal loss of vegetation cover due to construction related activities » No increase in runoff into drainage lines as a result of construction of project related infrastructure » No increase in runoff into drainage lines as a result of road construction

▪ **Mitigation: Action/control**	▪ **Responsibility**	▪ **Timeframe**
Identify and demarcate construction areas for general construction work and restrict construction activity to these areas. Prevent	▪ Contractor	▪ Before and during construction

▪ Mitigation: Action/control	▪ Responsibility	▪ Timeframe
unnecessary destructive activity within construction areas (prevent over-excavations and double handling)		
▪ Stockpile topsoil for re-use in rehabilitation phase. Maintain stockpile shape and protect from erosion. All stockpiles must be positioned at least 50 m away from drainage lines. Limit the height of stockpiles as far as possible in order to reduce compaction.	▪ Contractor	▪ During site establishment and any activity related to earthworks as well as the duration of construction
▪ Any excavation, must be supervised by the Environmental Officer.	▪ Contractor	▪ Duration of construction
▪ Disturbance of vegetation and topsoil must be kept to a practical minimum.	▪ Contractor	▪ Duration of contract
▪ Rehabilitate disturbance areas as soon as construction in an area is completed.	▪ Contractor	▪ During and after construction
▪ Compile a comprehensive storm water management plan as part of the final design of the project and implement during construction and operation.	▪ Construction team, management, environmental control officer	▪ Construction & operation

▪ **Performance Indicator**	» No activity in identified no-go areas » Acceptable level of activity within disturbance areas » Acceptable level of soil erosion around site » Acceptable level of increased siltation in drainage lines » Acceptable level of soil degradation » Acceptable state of excavations, as determined by Resident Engineer
▪ **Monitoring**	» Fortnightly inspections of the site by ECO » Fortnightly inspections of sediment control devices by ECO » Fortnightly inspections of surroundings, including drainage lines by ECO » Immediate reporting of ineffective sediment control systems » An incident reporting system must record non-conformances to the EMP/IWWMP. » Public complaints register must be developed and maintained on site.

OBJECTIVE: Limit Damage to water courses within the region

Construction within drainage lines must be minimised as far as possible. Where impacts are unavoidable, mitigation measures are required to minimise impacts on these systems.

Project component/s	List of project components affecting the objective: » access roads, pipelines and cabling » power line and associated access roads and hard surface areas
Potential Impact	» **Damage to water course areas** by any means that will result in hydrological changes (includes erosion, siltation, dust, direct removal of soil of vegetation, dumping of material).
▪ **Activity/risk source**	» Construction and operation of facility » Construction of access roads
▪ **Mitigation: Target/Objective**	» Minimise damage to watercourse areas where crossings are built or upgraded.

▪ **Mitigation: Action/control**	▪ **Responsibility**	▪ **Timeframe**
▪ Rehabilitate any disturbed areas as soon as possible once construction is completed in an area.	▪ Contractor,	▪ Construction & Operation
▪ Control storm water and runoff water through the implementation of a storm water management plan for the site.	▪ Contractor,	▪ Construction & Operation
▪ Obtain a permit as required in terms of the National Water Act from DWS to impact on any water resource.	▪ Project company, Contractor,	▪ Construction & Operation

▪ **Performance Indicator**	» No impacts on water quality, water quantity, natural status of watercourses.
▪ **Monitoring**	» Habitat loss in watercourses should be monitored before and after construction. » The presence and development of erosion features downstream of any construction must be monitored. » An incident reporting system must be used to record non-conformances to the EMP. » Public complaints register must be developed and maintained on site.

OBJECTIVE: Appropriate handling and storage of chemicals, hazardous substances and waste

The construction phase of the facility may involve the storage and handling of a variety of chemicals including adhesives, abrasives, oils and lubricants, paints and solvents although in small amounts. The main wastes expected to be generated by the construction of the facility will include **general solid waste, hazardous waste and liquid waste**.

Project component/s	List of project components affecting the objective: » power line » roads » CSP facility and substations » Ponds
Potential Impact	▪ **The watercourse areas could be impacted via:** » Release of contaminated water from contact with spilled chemicals could impact the surrounding water courses. » Generation of contaminated wastes from used chemical containers » Inefficient use of resources resulting in excessive waste generation » Litter or contamination of the site or water through poor waste management practices
▪ **Activity/risk source**	» Vehicles associated with site preparation and earthworks » Power line construction activities » Packaging and other construction wastes » Hydrocarbon use and storage » Spoil material from excavation, earthworks and site preparation » Brine handling
▪ **Mitigation: Target/Objective**	» To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons » To ensure that the storage and maintenance of machinery on-site does not cause pollution of the environment or harm to persons » To comply with waste management legislation » To minimise production of waste » To ensure appropriate waste storage and disposal » To avoid environmental harm from waste disposal

▪ **Mitigation: Action/control**	▪ **Responsibility**	▪ **Timeframe**
Storage areas must be located more than 50 m away from the watercourse.	▪ Contractor	▪ Before and during construction
▪ The storage of flammable and combustible liquids such as oils must be in designated areas which are appropriately bunded, and stored in compliance with MSDS files, as defined by the SHE Representative	▪ Contractor	▪ Duration of contract
▪ Any spills must receive the necessary clean-up action. If required, bioremediation kits are to be kept on-site and used to remediate any	▪ Contractor	▪ Duration of contract

▪ Mitigation: Action/control	▪ Responsibility	▪ Timeframe
spills that may occur. Appropriate arrangements to be made for appropriate collection and disposal of all cleaning materials, absorbents and contaminated soils (in accordance with a waste management plan).		
▪ Any storage and disposal permits/approvals which may be required must be obtained, and the conditions attached to such permits and approvals must be complied with.	▪ Contractor	▪ Duration of contract
▪ Routine servicing and maintenance of vehicles is not to take place on-site (except for emergency situations or large cranes which cannot be moved off-site). If repairs of vehicles must take place on site, an appropriate drip tray must be used to contain any fuel or oils.	▪ Contractor	▪ Duration of contract
▪ Transport of all hazardous substances must be in accordance with the relevant legislation and regulations.	▪ Contractor	▪ Duration of contract
▪ Waste disposal records must be available for review at any time.	▪ Contractor	▪ Duration of contract
▪ Construction contractors must provide specific detailed waste management plans to deal with all waste streams.	▪ Contractor	▪ Duration of contract
▪ Specific areas must be designated on-site for the temporary management of various waste streams, i.e. general refuse, construction waste (wood and metal scrap) and contaminated waste. Location of such areas must seek to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage and vermin control.	▪ EO/Contractor	▪ Duration of contract
▪ Where possible, construction and general wastes on-site must be reused or recycled. Bins and skips must be available on-site for collection, separation and storage of waste streams (such as wood, metals, general refuse etc.).	▪ Contractor	▪ Duration of contract
▪ Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed contractors.	▪ Contractor	▪ Duration of contract

▪ Mitigation: Action/control	▪ Responsibility	▪ Timeframe
▪ Hydrocarbon waste must be contained and stored in sealed containers within an appropriately bunded area.	▪ Contractor	▪ Duration of contract
▪ Waste and surplus dangerous goods must be kept to a minimum and must be transported by approved waste transporters to sites designated for their disposal.	▪ Contractor	▪ Duration of contract
▪ Documentation (waste manifest) must be maintained detailing the quantity, nature and fate of any hazardous waste.	▪ Contractor	▪ Duration of contract
▪ An incident/complaints register must be established and maintained on-site.	▪ Contractor	▪ Duration of contract
▪ Hazardous and non-hazardous waste must be separated at source. Separate waste collection bins must be provided for this purpose. These bins must be clearly marked and appropriately covered.	▪ Contractors	▪ Erection: during site establishmen t Maintenance: for duration of Contract within a particular area
▪ All solid waste collected must be disposed of at a registered waste disposal site. A certificate of disposal must be obtained and kept on file. The disposal of waste must be in accordance with all relevant legislation. Under no circumstances may solid waste be burnt or buried on site.	▪ Contractors	▪ Erection: during site establishmen t Maintenance: for duration of Contract within a particular area
▪ Supply waste collection bins at construction equipment and construction crew camps.	▪ Contractors	▪ Erection: during site establishmen t Maintenance: for duration of Contract within a particular area
▪ Construction equipment must be refuelled	▪ Contractor	▪ Duration of

Mitigation: Action/control	Responsibility	Timeframe
within designated refuelling locations, or where remote refuelling is required, appropriate drip trays must be utilised.		contract
▪ All stored fuels to be maintained within a bund and on a sealed surface.	▪ Contractor	▪ Duration of contract
▪ Fuel storage areas must be inspected regularly to ensure bund stability, integrity and function.	▪ Contractor	▪ Duration of contract
▪ Construction machinery must be stored in an appropriately sealed area.	▪ Contractor	▪ Duration of contract
▪ Oily water from bunds at the substation must be removed from site by licensed contractors.	▪ Contractor	▪ Duration of contract
▪ Spilled cement or concrete must be cleaned up as soon as possible and disposed of at a suitably licensed waste disposal site.	▪ Contractor	▪ Duration of contract
▪ Corrective action must be undertaken immediately if a complaint is received, or potential/actual leak or spill of polluting substance identified. This includes stopping the contaminant from further escaping, cleaning up the affected environment as much as practically possible and implementing preventive measures.	▪ Contractor	▪ Duration of contract
▪ In the event of a major spill or leak of contaminants, the relevant administering authority must be immediately notified as per the notification of emergencies/incidents.	▪ Contractor	▪ Duration of contract
▪ Any contaminated/polluted soil removed from the site must be disposed of at a licensed hazardous waste disposal facility.	▪ Contractor	▪ Duration of contract
▪ Upon the completion of construction, the area will be cleared of potentially polluting materials.	▪ Contractor	▪ Completion of construction

▪ Performance Indicator	» No chemical spills outside of designated storage areas » No water or soil contamination by chemical spills » No complaints received regarding waste on site or indiscriminate dumping » Internal site audits ensuring that waste segregation, recycling and reuse is occurring appropriately » Provision of all appropriate waste manifests for all waste streams » Designated areas for fires identified on site at the outset of the construction phase

	» Firefighting equipment and training provided before the construction phase commences
▪ Monitoring	» Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout construction phase » A complaints register must be maintained, in which any complaints from the community will be logged. Complaints must be investigated and, if appropriate, acted upon » Observation and supervision of waste management practices throughout construction phase » Waste collection to be monitored on a regular basis » Waste documentation completed » An incident reporting system must be used to record non-conformances to the EMP/IWWMP » An appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase. » Public complaints register must be developed and maintained on site.

10 – Conclusion and recommendations

With the implementation of suitable mitigation and of the proposed layout, the development should have limited impact on the overall status of the site specific riparian systems. This desktop assessment of the potential impacts of the proposed CSP on the fish biota of Gariep River also did not reveal any significant impacts on the fish fauna and associated aquatic habitats, provided the appropriate mitigation measures are implemented. All impacts that were assessed be reduced to medium or low significance with appropriate mitigation, apart from the moderate impact of water abstraction from the Gariep River. However, in this case the precautionary principle was applied due the lack of data on the Ecological Water Requirements of the Gariep River for this locality.

Impacts on the Gariep River system due to water abstraction, and site-specific impacts on instream biota are difficult to quantify due to the number of unknowns and the highly regulated nature of the system. Releases from Vanderkloof Dam would affect the site, although release patterns are re-evaluated every year to provide for irrigators and is therefore well known. Eskom requirements also play a role in release strategies. A 280 million m^3/a release for the estuary is also made as variable base flows over 12 months, although it is unknown as to whether this water actually reaches the estuary. Operating losses and requirements (such as to top up the upstream Boegoeberg Dam after draining it for cleaning) are also included in this allocation. Note that Boegoeberg Dam (upstream of Upington) is not used to operate flows into the river, but rather as a diversion weir for the canal systems. The only flows from this dam into the Gariep River are spills and when bottom releases are made (approximately once a year) to clean the dam (WRP Consulting, pers. comm., September 2010, for the ORASECOM EFR study).

Figure 4 indicates aquatic features, that would trigger the need for a Water Use License application in terms of Section 21 c and i of the National Water Act, should any construction take place within these areas, i.e. impeding and diversion of flows or alteration of bed and banks. It is also pointed out that the alluvial water courses that remain within the area (located within the heliostat field) should be considered as having a moderate sensitivity, but due to the surrounding impacts (existing roads in particular), these would seem to have little function or connectivity with the surrounding region. Thus when compared to the remaining natural alluvial systems within the region (Figure 1 & 4), the sensitivity to further development within the alluvial systems would be LOW.

In conclusion therefore, the facility is deemed to have a limited direct potential impact on the aquatic environment, considering the number of unknowns and the highly regulated nature of the Gariep River system. It is however assumed that any such changes would be detrimental to the various projects owners, i.e. reduce water availability for all projects. Therefore, based on this assessment the significance of the impacts assessed for the aquatic systems after mitigation would be Medium - Low. All of the proposed alternatives would have a similar impact on the aquatic environment.

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11 – Appendix 1: Aquatic Habitat Assessment Methods

Survey methods

The assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

A one day site visit was then conducted to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts and delineating the wetland areas.

Wetland and riparian areas were then assessed on the following basis:

- Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database.
- Plant species were further categorised as follows:
    - Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall
    - Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non wetland) (DWAF, 2005)
    - Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005)
- Assessment of the wetland type based on the NWCS method discussed below and the required buffers
- Mitigation or recommendations required

National Wetland classification System (NWCS 2010)

Since the late 1960's, wetland classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith *et al*., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with a number of specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS 2010). This system comprises a hierarchical classification process of defining a wetland based on the principles of the Hydrogeomorphic (HGM) approach at higher levels, with including structural features at the finer or lower levels of classification (SANBI 2009).

Wetlands develop in a response to elevated water tables, linked either to rivers, groundwater flows or seepage from aquifers (Parsons, 2004). These water levels or flows then interact with localised geology and soil forms, which then determines the form and function of the respective wetlands. Water is thus the common driving force, in the formation of wetlands (DWAF, 2005). It is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs. The Ecological Reserve of a wetland or river is used by DWS to assess the water resource allocations when assessing water use license applications (WULA).

The NWCS process is provided in more detail in the methods section of the report, but some of the terms and definitions used in this document are present below:

Definition Box

Present Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State. Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES is determined per component - for rivers and wetlands this would be for the drivers: flow, water quality and geomorphology; and the biotic response indicators: fish, macroinvertebrates, riparian vegetation and diatoms. PES categories for every component would be integrated into an overall PES for the river reach or wetland being investigated. This integrated PES is called the EcoStatus of the reach or wetland.

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).

Reserve: The quantity and quality of water needed to sustain basic *human needs* and *ecosystems* (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The *Ecological Reserve* pertains specifically to aquatic ecosystems.

Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements).

Ecological Reserve determination study: The study undertaken to determine Ecological Reserve requirements.

Licensing applications: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment.

Ecological Water Requirements: This **is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the Reserve Template**

Water allocation process (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements.

Ecoregions are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans *et al.* 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form), but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as **"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"** (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard *et al*., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are defined as "land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a water course (SANBI, 2009). The DWS is however reconsidering this position with regard the management of estuaries due to the ecological needs of these systems with regard to water allocation. Table 1 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open waterbodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands in order to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must therefore have one or more of the following attributes to meet the above definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 1: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	▪ YES	▪ NO	▪ NO
▪ Estuarine	▪ YES	▪ NO	▪ NO
▪ Waterbodies deeper than 2 m (i.e. limnetic habitats often describes as lakes or dams)	▪ YES	▪ NO	▪ NO
▪ Rivers, channels and canals	▪ YES	▪ NO[1]	▪ NO
▪ Inland aquatic ecosystems that are not river channels and are less than 2 m deep	▪ YES	▪ YES	▪ YES
▪ Riparian[2] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	▪ YES	▪ YES	▪ YES[3]
▪ Riparian[2] areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	▪ NO	▪ NO	▪ YES[3]

Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources they could provide. Wetland conservation is now driven by the South African National

[1] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act

[2] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[3] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

Wetlands are among the most valuable and productive ecosystems on earth, providing important opportunities for sustainable development (Davies and Day, 1998). However wetlands in South Africa are still rapidly being lost or degraded through direct human induced pressures (Nel *et al.,* 2004).

The most common attributes or goods and services provided by wetlands include:

- Improve water quality;
- Impede flow and reduce the occurrence of floods;
- Reeds and sedges used in construction and traditional crafts;
- Bulbs and tubers, a source of food and natural medicine;
- Store water and maintain base flow of rivers;
- Trap sediments; and
- Reduce the number of water borne diseases.

In the past wetland conservation has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Table 2 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze *et al*., 2008). One such example is emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 2: Summary of direct and indirect ecoservices provided by wetlands from Kotze *et al.*, 2008.

Ecosystem services supplied by wetlands	Indirect benefits	Hydro-geochemical benefits		Flood attenuation
				▪ Stream flow regulation
			Water quality enhancement benefits	▪ Sediment trapping
				▪ Phosphate assimilation
				▪ Nitrate assimilation
				▪ Toxicant assimilation
				▪ Erosion control
				▪ Carbon storage
				▪ Biodiversity maintenance
	Direct benefits			▪ *Provision of water for human use*
				▪ *Provision of harvestable resources*[2]
				▪ *Provision of cultivated foods*
				▪ *Cultural significance*
				▪ *Tourism and recreation*
				▪ *Education and research*

Relevant wetland legislation and policy

Locally the South African Constitution, seven (7) Acts and two (2) international treaties allow for the protection of wetlands and rivers. These systems are protected from the destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act, 1998 (Act No. 36 of 1998);
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983); and
- Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
- Nature and Environmental Conservation Ordinance (No. 19 of 1974)
- National Forest Act (No. 84 of 1998)
- National Heritage Resources Act (No. 25 of 1999)

Apart from NEMA, the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) will also apply to this project. The CARA has categorised a large number of invasive plants together with associated obligations of the land owner. A number of Category 1 & 2 plants were found at all of the sites investigated, thus the contractors must take extreme care further spread of these plants doesn't occur. This should be done through proper stockpile management (topsoil) and suitable rehabilitation of disturbed areas after construction.

An amendment of the National Environmental Management was promulgated late December 2011, namely the Biodiversity Act or NEM:BA (Act No 10 of 2004), which lists 225 threatened ecosystems based on vegetation type (Vegmap, 2006 as amended). Should a vegetation type or ecosystem be listed, actions in terms of NEM:BA are triggered.

Provincial legislation and policy

Various provincial guidelines on buffers have been issued within the province. These are stated below so that the engineers and contractors are aware of these buffers during the planning phase. Associated batch plants, stockpiles, lay down areas and construction camps should avoid these buffer areas.

Until national guidelines for riverine and wetland buffers are established, the guidelines set out in the Eastern Cape Biodiversity Conservation Plan documentation should be applied (Berliner & Desmet, 2007). Table 3 recommends buffers for rivers.

Table 3: Recommended buffers for rivers, with the applicable buffer related to this study shaded in grey

River criterion used	Buffer width (m)	Rationale
Mountain streams and upper foothills of all 1:500 000 rivers	▪ 50	▪ These longitudinal zones generally have more confined riparian zones than lower foothills and lowland rivers and are generally less threatened by agricultural practices.
▪ Lower foothills and lowland rivers of all 1:500 000 rivers	▪ 100	▪ These longitudinal zones generally have less confined riparian zones than mountain streams and upper foothills and are generally more threatened by agricultural practices. These larger buffers are particularly important to lower the amount of crop-spray reaching the river.
▪ All remaining 1:50 000 streams	▪ 32	▪ Generally smaller upland streams corresponding to mountain streams and upper foothills, smaller than those designated in the 1:500 000 rivers layer. They are assigned the riparian buffer required under South African legislation.

Currently there is no accepted priority ranking system for wetlands. Until such a system is developed, it is recommended that a **50m buffer be set for all wetlands**.

Other policies that are relevant include:

- Provincial Nature Conservation Ordinance (PNCO) – Protected Flora. Any plants found within the sites are described in the ecological assessment.
- National Freshwater Ecosystems Priority Areas – CSIR 2011 draft. This mapping product highlights potential rivers and wetlands that should be earmarked for conservation on a national basis.

National Wetland Classification System method

During this study due to the nature of the wetlands and watercourses observed, it was decided that the newly accepted National Wetlands Classification System (NWCS) be adopted. This classification approach has integrated aspects of the HGM approached used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (SANBI, 2009) as stated previously, uses hydrological and geomorphological traits to distinguish the primary wetland units, i.e. direct factors that influence wetland function. Other wetland assessment techniques, such as the DWAF (2005) delineation method, only infer wetland function based on abiotic and biotic descriptors (size, soils & vegetation) stemming from the Cowardin approach (SANBI, 2009).

The classification system used in this study is thus based on SANBI (2009) and is summarised below:

The NWCS has a six tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 4). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). Level 2 then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

- Inshore bioregions (marine)
- Biogeographic zones (estuaries)
- Ecoregions (Inland)

Level 3 of the NWCS assess the topographical position of inland wetlands as this factor broadly defines certain hydrological characteristics of the inland systems. Four landscape units based on topographical position are used in distinguishing between Inland systems at this level. No subsystems are recognised for Marine systems, but estuaries are grouped according to their periodicity of connection with the marine environment, as this would affect the biotic characteristics of the estuary.

Level 4 classifies the hydrogeomorphic (HGM) units discussed earlier. The HGM units are defined as follows:

(i) Landform – shape and localised setting of wetland
(ii) Hydrological characteristics – nature of water movement into, through and out of the wetland
(iii) Hydrodynamics – the direction and strength of flow through the wetland

These factors characterise the geomorphological processes within the wetland, such as erosion and deposition, as well as the biogeochemical processes.

Level 5 of the assessment pertains to the classification of the tidal regime within the marine and estuarine environments, while the hydrological and inundation depth classes are determined for the inland wetlands. Classes are based on frequency and depth of inundation, which are used to determine the functional unit of the wetlands and are considered secondary discriminators within the NWCS.

Level 6 uses of six descriptors to characterise the wetland types on the basis of biophysical features. As with Level 5, these are non hierarchal in relation to each other and are applied in any order, dependent on the availability of information. The descriptors include:

- (i) Geology;
- (ii) Natural vs. Artificial;
- (iii) Vegetation cover type;
- (iv) Substratum;
- (v) Salinity; and
- (vi) Acidity or Alkalinity.

It should be noted that where sub-categories exist within the above descriptors, hierarchical systems are employed, thus are nested in relation to each other.

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 5 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.

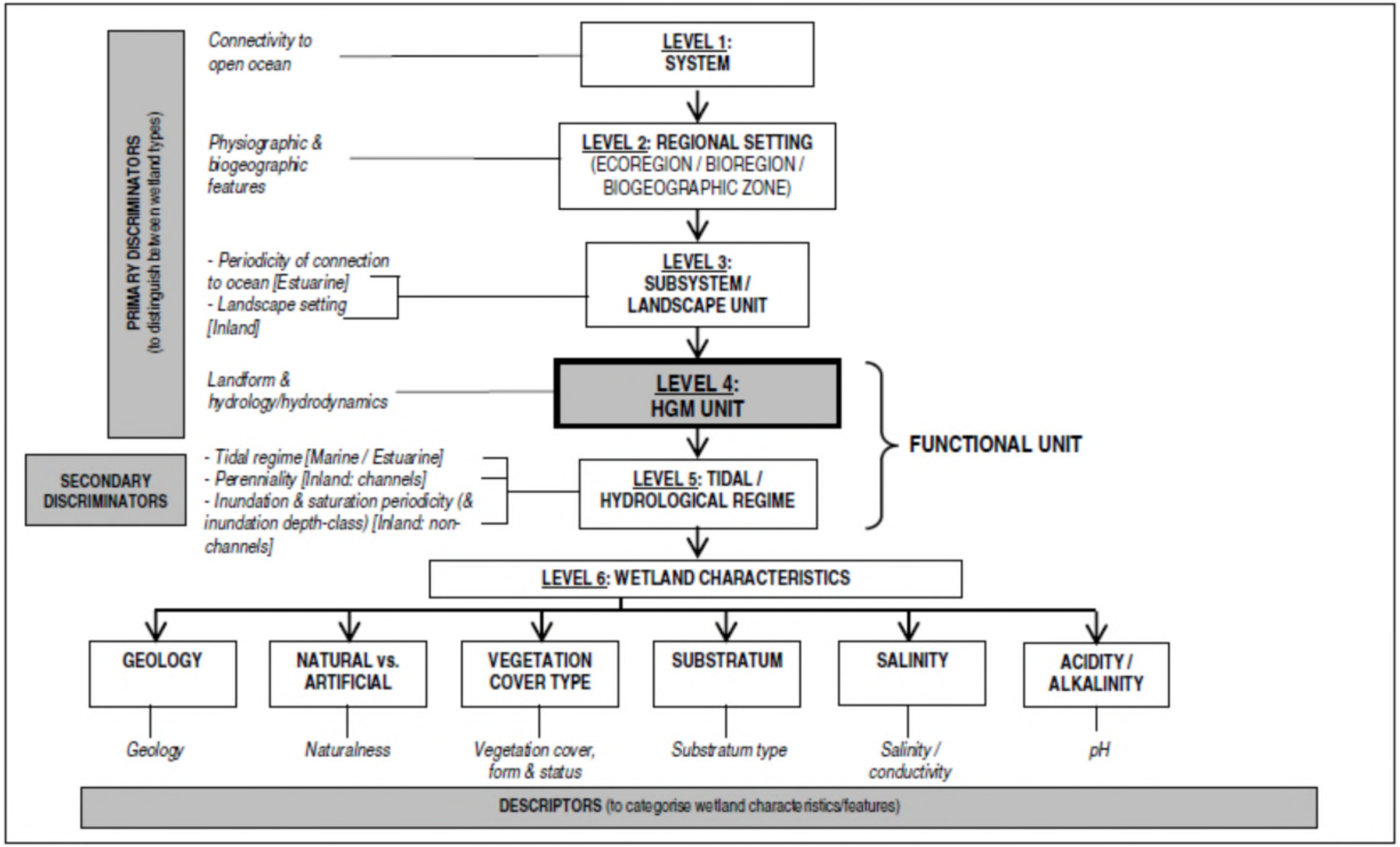


Figure 4: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the tidal/hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

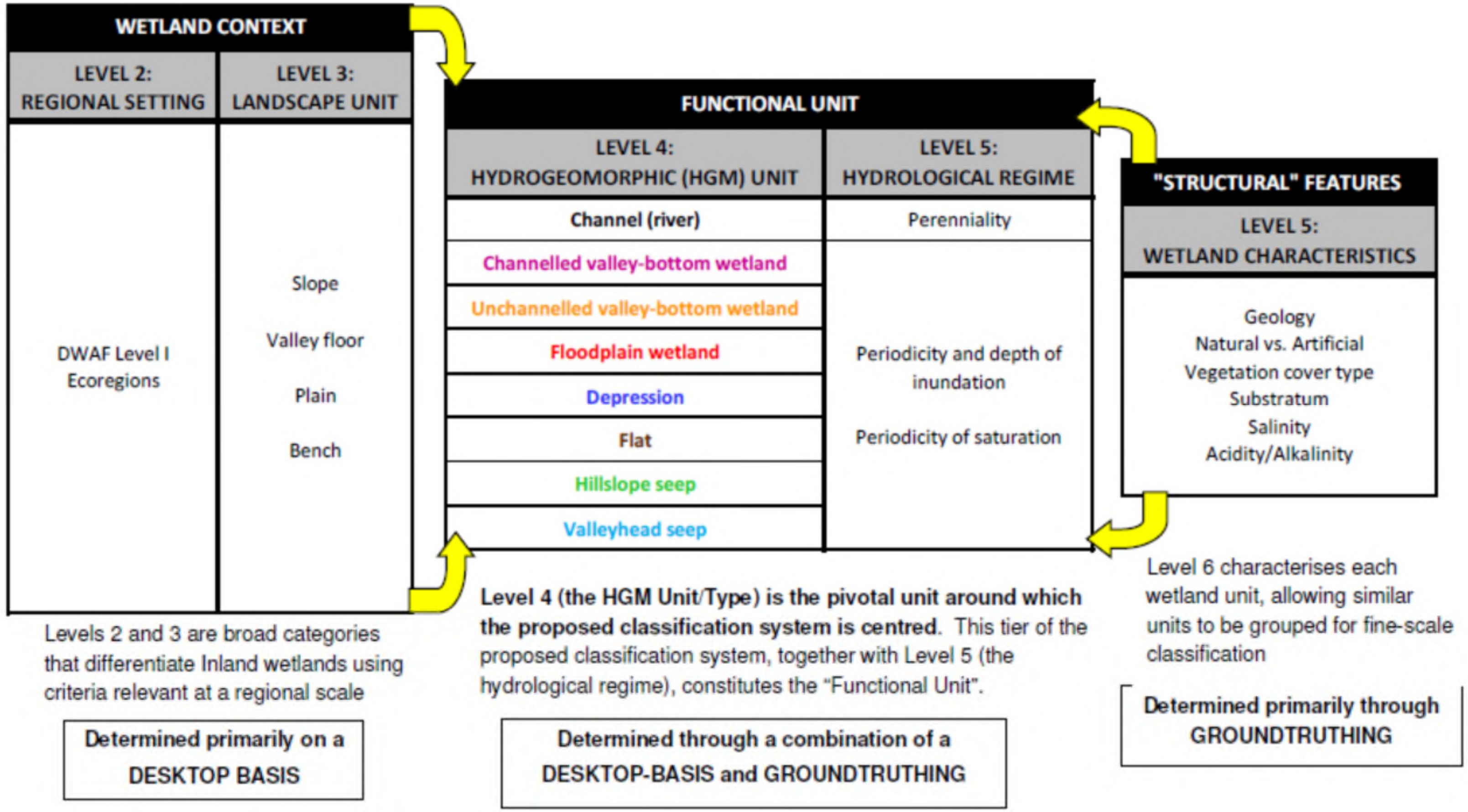


Figure 5 Illustration of the conceptual relationship of HGM Units (at Level 4) with higher and lower levels (relative sizes of the boxes show the increasing spatial resolution and level of detail from the higher to the lower levels) for Inland Systems (from SANBI, 2009).

Wetland condition and conservation importance assessment

To assess the Present Ecological State (PES) or condition of the observed wetlands, a modified Wetland Index of Habitat Integrity (DWAF, 2007) was used. The Wetland Index of Habitat Integrity (WETLAND-IHI) is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The output scores from the WETLAND-IHI model are presented in the standard DWAF A-F ecological categories (Table 4), and provide a score of the Present Ecological State of the habitat integrity of the wetland system being examined. The author has included additional criteria into the model based system to include additional wetland types. This system is preferred when compared to systems such as WET-Health – wetland management series (WRC 2009), as WET-Health (Level 1) was developed with wetland rehabilitation in mind, and is not always suitable for impact assessments. This coupled to degraded state of the wetlands in the study area, a complex study approach was not warranted, i.e. conduct a Wet-Health Level 2 and WET-Ecosystems Services study required for an impact assessment.

Table 4: Description of A – F ecological categories based on Kleynhans *et al*., (2005).

ECOLOGICAL CATEGORY	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A	▪ Unmodified, natural.	▪ Protected systems; relatively untouched by human hands; no discharges or impoundments allowed
B	▪ Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	▪ Some human-related disturbance, but mostly of low impact potential
C	▪ Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	▪ **Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation**
D	▪ Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	
E	▪ Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	▪ **Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality**
▪ F	▪ Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	

The WETLAND-IHI model is composed of four modules. The "Hydrology", "Geomorphology" and "Water Quality" modules all assess the contemporary ***driving processes*** behind wetland formation and maintenance. The last module, "Vegetation Alteration", provides an indication of the intensity of human landuse activities on the wetland surface itself and how these may have ***modified*** the condition of the wetland. The integration of the scores from these 4 modules provides an overall Present

Ecological State (PES) score for the wetland system being examined. The WETLAND-IHI model is an MS Excel-based model, and the data required for the assessment are generated during a rapid site visit.

Additional data may be obtained from remotely sensed imagery (aerial photos; maps and/or satellite imagery) to assist with the assessment. The interface of the WETLAND-IHI has been developed in a format which is similar to DWAF's River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Conservation importance of the individual wetlands was based on the following criteria:

- Habitat uniqueness
- Species of conservation concern
- Habitat fragmentation with regard ecological corridors
- Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a Species of conservation concern was observed (HIGH). Any systems that was highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating. Wetlands with HIGH and MEDIUM ratings should thus be excluded from development with incorporation into a suitable open space system, with the maximum possible buffer being applied. Wetlands which receive a LOW conservation importance rating could be included into stormwater management features, but should not be developed so as to retain the function of any ecological corridors.

Scherman Colloty and Associates

Environmental and Aquatic Management Consulting (CK 2009/112403/23)

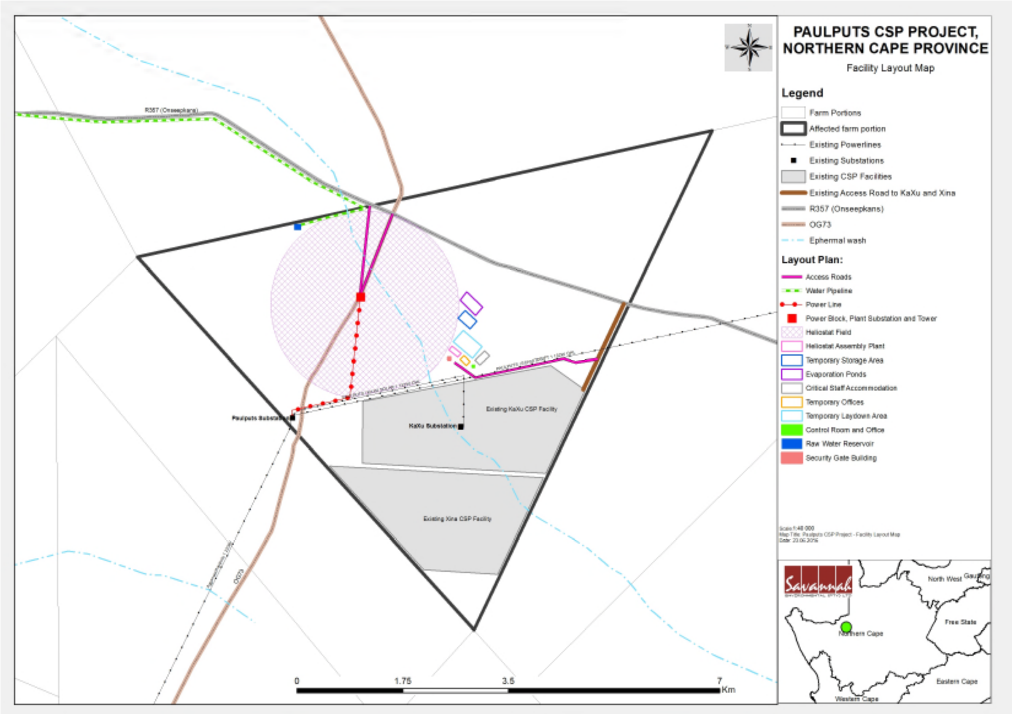
27June 2016

To whom it may concern

AQUATIC OPINION – LAYOUT AMENDMENTS TO PAULPITS CSP FACILITY NEAR POFADDER, NORTHERN CAPE

Scherman Colloty and Associates (SC&A) was approached by Savannah Environmental on behalf of ABENGOA to assess the potential impact of the layout amendment against the previous aquatic assessment submitted 17 June 2016.

Based then on the proposed layout supplied on 23 June 2016, the developer has taken cognisance of several of the other environmental and engineering constraints as shown in the Figure below:



However, based on the amended layout, this will have no new or additional impacts on the aquatic environment as highlighted in the specialist study submitted. Therefore, the impact ratings will remain unchanged, while no new mitigations or recommendations will be required

Please don't hesitate to contact me directly should you have any further queries.

Yours Sincerely

Dr Brian Colloty
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