National Research Foundation | SARAO South African Radio Astronomy Observatory

Freshwater Report

for the proposed

Square Kilometre Array Information Centre
Carnavon, Northern Cape.

April 2024

EnviroAfrica
Environmental Management and Impact Assessment
Omgewingsbestuur en Impakbeoordeling

WATSAN Africa

Executive Summary

The SKA radio telescope for the observation of and the research into the galaxies of the milky way is planning an information centre on the outskirts of Carnavon in the Northern Cape. This information aims to bring the science of Astronomy to the people of Carnavon, as well is to tourists and the public.

The proposed information centre will consist of two buildings, two vehicle parking areas and outdoor stalls for the sale of merchandise.

The centre will be constructed next to a mostly dry dam adjacent and the west of Carnavon. The ecological behaviour of this dam resembles that of the region's many mostly dry salt pans. These salt pan shave a very peculiar and distinct aquatic organism community.

This dam is one of a series that were constructed to arrest runoff. This would allow stormwater to penetrate the soil and to augment groundwater. Carnavon is deeply dependant on groundwater for household use.

Moreover, even dry, these salt pans are legitimate water resources, according to legislation. The construction of operation of the proposed information centre triggers Section 21(c) and Section 21 (i) of the National Water Act. This means that a water use license must be applied for through the official channels. A Freshwater Report must support this application. The report must be compiled according to a set format and contain adequate information for government officials to make an informed decision.

The dam is of a low ecological value. The impacts were found to be insignificant. Control measures are readily implementable. It is therefore recommended that this proposed development can be allowed. There won't be deleterious aquatic ecological consequences. A General Authorisation is the indicated level of authorisation.

If there were Schedule 1 water use assignments for low significance impacts as per current legislation available for Section 21(c) and Section 21(i) water use license applications, the proposed development next to Carnavon would certainly qualify. Schedule 1 water uses do not need to be generally authorised or licensed and are not subject to water use license applications.

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Abbreviations

Critical Biodiversity Area	CBA
Department of Fisheries, Forestry and the Environment	DFFE
Department of Water and Sanitation	DWS
Ecological Importance	EI
Ecological Importance and Sensitivity Class	EISC
Ecological Sensitivity	ES
Ecological Support Area	ESA
Environmental Impact Assessment	EIA
Electronic Water Use License Application (on-line)	eWULAAS
Government Notice	GN
Metres Above Sea Level	masl
National Environmental Management Act (107 of 1998)	NEMA
National Freshwater Environment Priority Area	NFEPA
National Water Act (36 of 1998)	NWA
Present Ecological State	PES
Section of an Act of Parliament	S
South Africa National Biodiversity Institute	SANBI
Water Use License Application	WULA

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1 Introduction

The Square Kilometre Array near the small town of Carnavon in the Northern Cape is designed to observe and research the skies above, the galaxies of the milky way. This is cutting edge science and technology in the field of astronomy. It exemplifies the boundless human spirit, its perpetual urge to explore, its unsatiable quest for knowledge. It was planned, organised, financed and maintained by a consortium of 14 nations of the world. Carnavon was selected out on a number of possible sites around the globe. The geographical attributes of the dessolated and arid expanse of the Bushmanland was scientifically the most ideal location to construct the SKA.

The SKA now is planning an information centre at the town of Carnavon. The aim is to inform residents what the SKA is all about, to establish an interest in science and the universe. The information centre is designed to draw tourist, both local and from abroad. The information centre would put the SKA in the middle of the local and a wider community.

The information centre is planned on a site on the outskirts of but adjacent to the town, on a proclaimed municipal plot. The centre consists of two buildings, two vehicle parking areas and stalls for selling merchandise. The aim is, apart from awareness and education, to provide opportunities for local people to improve their circumstances in an isolated area where livelihoods are hard to come by.

The proposed centre is planned next to a mostly dry dam adjacent and to the west of town. This dam is open, flat, mostly dusty, sparsely vegetated with grassed and scrub. It was designed to hold and allow the very occasional stormwater to penetrate the gound and to augment the groundwater. Carnavon is very much dependant on this groundwater for its household water provisioning. The DWS regard this dam, albeit mostly dry, as a legitimate water resource. Since the centre is going to be right next to the dam, a water use license application (WULA) is required.

Likewise, an EIA is required in terms of the NEMA. Enviro Africa of Somerset West was appointed to undertake the EIA.

Dr Dirk van Driel of WATSAN Africa in Knysna was appointed to deal with the WULA.

The Freshwater Report to support the WULA must contain adequate information to allow for informed decision-making. These decision-makers essentially are the DWS officials. The Freshwater report has developed in a set format and must contain specific information.

Moreover, it must contain a Risk Matrix as published on the DWS webpage and as specified in gazetted government notices. This Risk Matrix is the official mechanism that aids the decision if a letter of consent, a General Authorization or a License is required. The Risk Matrix must be compiled and signed by a registered specialist scientist.

The Freshwater Report must contain adequate information for the EIA as well. Hence, several specified evaluations have been included.

2 Legal Framework

The proposed development "triggers" sections of the National Water Act. These are the following:

S21 (c) *Impeding or diverting the flow of a water course.*

The proposed site is adjacent to an alleged wetland that is identified in the NWA and its regulations as a legitimate water resource. The wetland could possibly be altered, should the development go ahead.

S21 (i) *Altering the bed, bank, course of characteristics of a water course.*

The proposed site may alter the characteristics of an alleged wetland.

Government Notice 267 of 24 March 2017

Government Notice 1180 of 2002. *Risk Matrix.*

The Risk Matrix as published on the DWS official webpage must be completed and submitted along with the Water Use Licence Application (WULA). The outcome of this risk assessment determines if a letter of consent, a General Authorization or a License is required.

Government Notice 509 of 26 August 2016

An extensive set of regulations that apply to any development in a water course is listed in this government notice in terms of Section 24 of the NWA. No development take place within the 1:100 year-flood line without the consent of the DWS. If the 1:100-year flood line flood line is not known, no development may take place within a 100m from a water course without the consent of the DWS. Likewise, no development may take place within 500m of a wetland without the consent of the DWS.

National Environmental Management Act (107of 1998)

NEMA and regulations promulgated in terms of NEMA determines that no development without the consent and permission of the DFFE and its regional agencies may take place within 32m of a water course. The alleged wetland is perceived to be a legitimate water course.

3 Locality

Figure 1 Locality

Carnavon is in the Northern Cape halfway between Williston and Britstown. It is 290km south of Upington, measured in straight line.

The site's coordinates are as follows:

30°58'01.26"S and 22°07'24.33E.

It is on an elevation of 1250masl.

4 Quaternary Catchment

Carnavon is in the D54b quaternary catchment

5 The Project

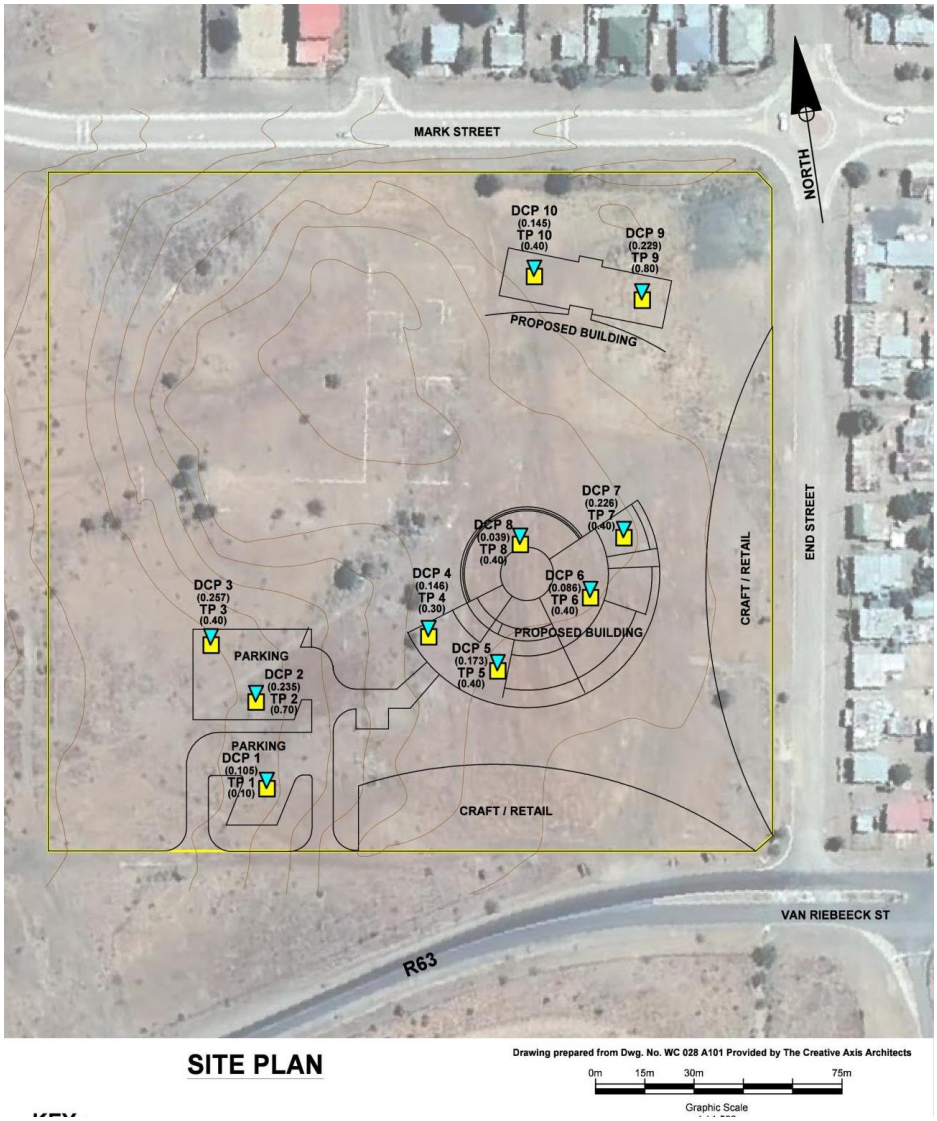

Figure 2 Lay-out (Gondwana Geosolutions)

The lay-out is shown in Figure 2. It entails two buildings, parking areas and craft stalls.

The current status of the site is shown in Figure 3.

Figure 3 The site

6 Conservation Status

6.1 NFEPA

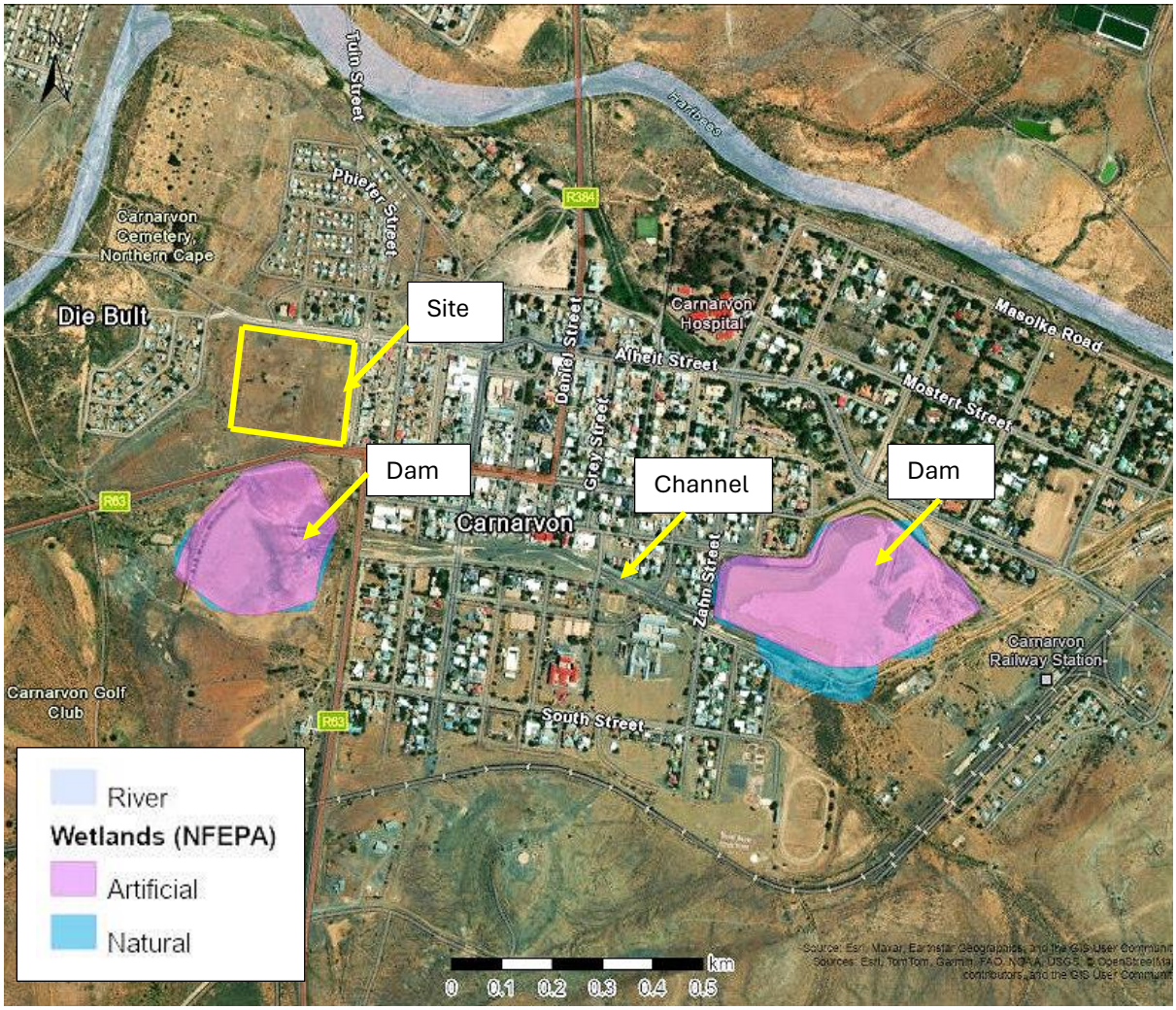

Figure 4 NFEPA (Cape Farm Mapper)

The site is within the 500m controlled zone of a NFEPA listed wetland (Figure 4). This triggered the need for a WULA and the supporting Freshwater Report. This is despite the situation that the dam is entirely artificial.

6.2 Vegetation

Carnavon's vegetation type is listed as Nama Karoo in the Western Upper Karoo. It is not endangered in any sense.

6.3 DFFE Screening Tool

Table 1 Screening Tool Results

Theme	Rating
Animal species Aquatic biodiversity Avian Plant species. Terrestrial biodiversity	Low Low Not listed Medium Very High

Even though aquatic biodiversity is low, a WULA and Freshwater Report is still required because the alleged wetland is withing 500m away from the proposed SKA information centre.

Terrestrial Biodiversity Theme

The plot earmarked for the information centre is listed as a CBA. It is included in the National Protected Area Expansion Strategy. However, it is in a proclaimed municipal area, a regular street block, even though on the verge of town.

7 Carnavon Rainfall

https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/carnarvon_south-africa_1014034

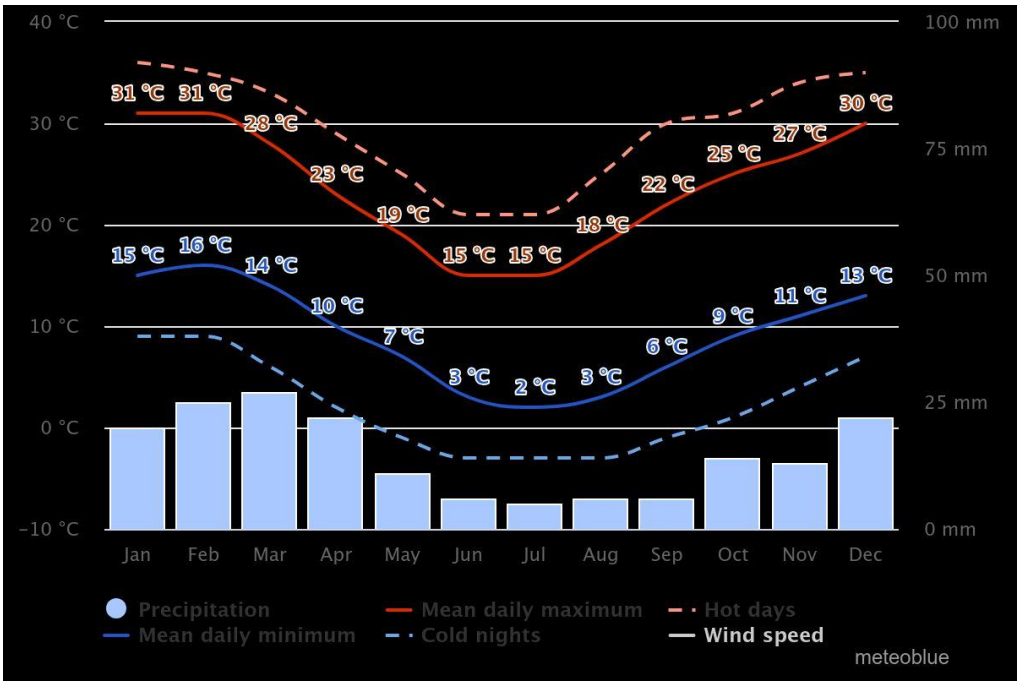

Figure 5 Carnavon Climate

This is an arid region with desert-like conditions. It rains more in summer than in winter, hardly more than 25mm a month. The average annual rainfall is only 187mm.

https://www.google.com/search?q=carnavon+annual+rainfall&rlz=1C1GCEA_enZA1031ZA1031&oq=carnavon+annual+rainfall&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIJCAEQABgNGIAEMg0IAhAAGIYDGIAEGIoF0gEJMTEzMjhqMGo3qAIIsAIB&sourceid=chrome&ie=UTF-8

Rainfall is variable, with sudden afternoon electric storms. High rainfall events may send a torrent down the mostly dry drainage lines.

Droughts can last for several years. According to residents a recent drought lasted for 8 years.

The summers are hot, with midday temperatures often rising above 40°C. Overnight temperatures in winter can be below freezing.

Carnavon is dependent on ground water. Boreholes do run dry, leaving people in dire straits.

8 Drainage lines and Sub-Catchment

Residents do not seem to recall the name of the large drainage line that skirts Carnavon's northern boundary (Figure 6 and 7). One travel directory named it as the *Carnavonleegte*. It is listed as the Hartbees River on the Cape Farm Mapper. It swings to the north to fade into a delta obscured by a dense stand of invasive *Prosopis* trees in the vast expanse of salt pans some 15km to the north, as the crow flies. These pans are a prominent feature on the Northern Cape landscape.

When the pans overflows during very scarce events, once in several years, from winter rainfall far to the south, water emerges as the Hartbees River. Perhaps this name was meant to refer to the same river that runs past Carnavon, after it morphed into a series of pans and regrouped as a river, or more as a mostly dry drainage line. This river flows to the north to its confluence with the Orange River near Keimoes. This river rises on an elevation of over 1600masl approximately 35km to the southeast of Carnavon, measured in a straight line.

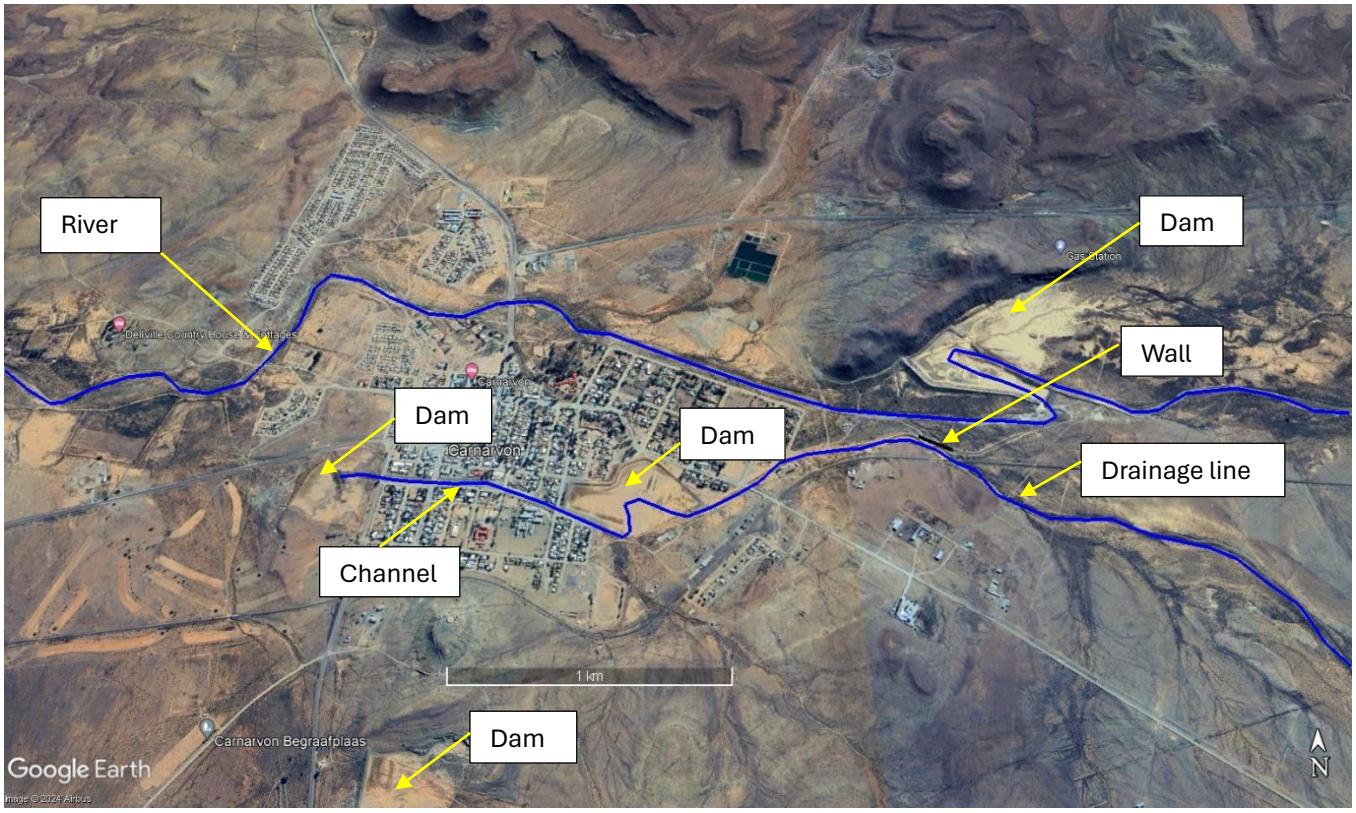

Figure 6 Carnavon Dams

Figure 7 River north of town

Figure 8 Dam in the middle of town

Figure 9 Spillway

Figure 10 Channel

Figure 11 Dam on western outskirts of Carnavon

Figure 12 Western dam wall

Figure 13 R63 culvert

The dams were constructed to replenish ground water.

Boreholes were sunk right in the dams, particularly in the larger dam to the northeast of the town, for the town's potable water supply. Walls were constructed to divert the river into the dam.

The tributary of the river (Figure 6), a mostly dry drainage line, is of more concern to this project, as it has been cut off from the river with a wall (Figure 6). From here the drainage line was diverted into a dam in the middle of town (Figure 8).

Again, the idea with the dam was to let water in the dam penetrate the ground to replenish ground water for the many boreholes in Carnavon. These boreholes were equipped with windmills to irrigate gardens. Since then, many of the windmills fell out of use and were removed. There are still some left.

The dam in town is flat, wide, with a large surface area compared to its holding capacity. Evaporation is high. The dam holds water for a limited time, days, weeks, but not months. The dam's wall is a prominent and rather dominant feature in Carnavon. When the dam overflows, water passes over a spillway (Figure 9) and down an excavated channel (Figure 10) to the next dam to the west on the outskirts of town (Figure 11).

The dam to the west does not look like much, just a flat, open pan, dry and with a vast surface area in relation to its holding capacity. To the contrary, the dam wall is quite a formidable structure (Figure 12).

The spillway of this dam is on the dam wall's southern end. From there spilled water runs downhill into a drainage line that runs to the north underneath the R63 trunk road through a set of culverts (Figure 13) to connect to the river.

The relatively large size of Carnavon's stormwater management infrastructure indicates that the town is water stressed and that no effort was spared to collect as much runoff as possible. It indicates that stormwater can be a threat because of sudden large rainfall events, even in these arid parts.

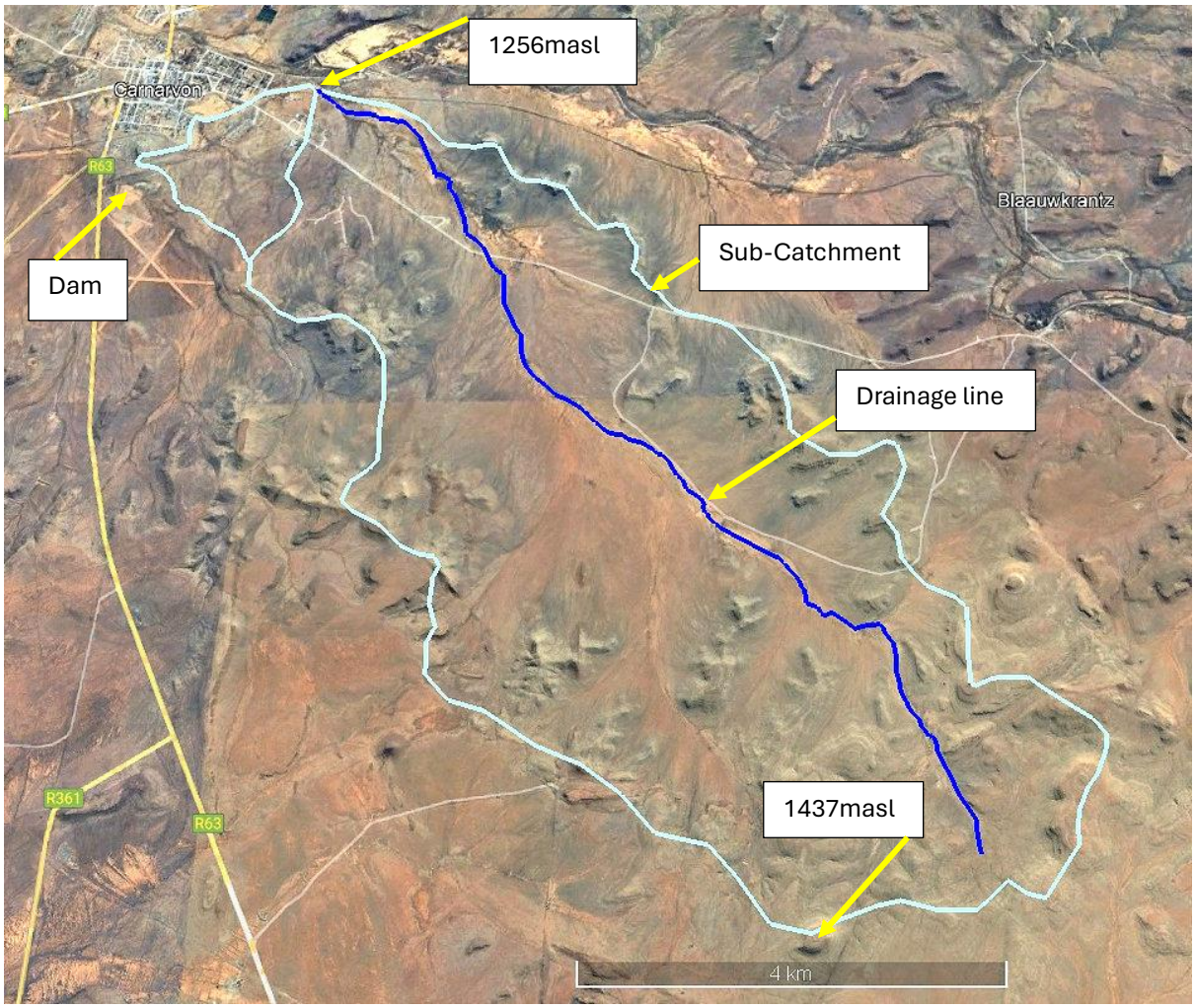

Figure 14 Sub-Catchment

As indicated before, it is the tributary and its sub-catchment (Figure 14) that is of interest to this project as the water from here feeds into the dam in town and ultimately into the westside dam next to the proposed SKA information centre.

This drainage line is only 12.3km long, following the curve of the drainage line. Its sub-catchment covers an area of 3722ha. The highest point is at 1437masl. The wall

at the point of discharge is at 1256masl. The distance in a straight line from the highest to the point of discharge is 11km. This translates into an average slope of less than 0.2 vertical metres in every 100 horizontal metres. This is flat country with low runoff velocities and with high volume losses. Still, residents saw open their way to construct dams in drainage lines to catch the little available runoff.

A smaller adjacent sub-catchment of 223ha feeds into the channel next to the dam in the middle of the town.

Next to this drainage line, to the southwest, is yet another similar dammed drainage line. This dam is one kilometre to the south of the centre of town adjacent and to the east of the southbound R63. This drainage line has no bearing on the proposed SKA information centre.

Runoff from the proposed SKA information centre site moves to the south downhill through a pipe culvert (Figure 15) onto the western dam. This is a small volume of runoff but nevertheless important because it may contain litter and pollutants from activities on the site, once operational.

Figure 15 Pipe culvert

9 The Hartbees River, Vis River and the Pans

It is always difficult for practitioners to make a call on entirely artificial habitats because they are essentially established because of human impact, essentially the very same aspect that must be assessed for natural sites. Therefore, it is assumed that a new ecology was established, like that of the existing Bushmanland salt pans in the district, following the construction of the diversions and the dams. This assessment is about impacts on this new ecology, as if it existed long before, not because of previous human impact.

The westward dam that must be assessed behaves very much the same as these salt pans. The dam fills up during heavy rain, occasionally, with an hydroperiod ecology that may resemble that of salt pans. Likewise, when the pan dries out, the aquatic organisms may go into dormancy, retreat into the sediments, until the next wet cycle. Therefore, the Bushmanland pans, what so far has scientifically been established, must be drawn into the assessment of the Carnavon westward dam.

The assessment of the westward dam it Carnavon may benefit from first interrogating what knowledge has been gathered up to now. An overall and concise view of the Boesmanland pans is called for.

Several projects have been completed in the area and the next paragraphs were taken out of previous reports (Van Driel, 2021).

The Hartbees River rises as the Vis River on the highlands to the south of Sutherland more than 450km to the south (Figure 16).

The catchment area of this river system is large and covers a sizable chunk of the Bushmanland and the western Karoo.

A series of pans separate the Vis River from the Hartbees River. Verneukpan is perhaps the one that is better known because the historical land speed record was set there. The Hartbees River only flows when these pans overflow. This happened in 1999 and in 2010. During a site visit in 2021, the pans along the R27 trunk road were under water. It is expected that these overflows will occur less often in future as water abstraction from the Vis River for agriculture increases.

It is however important to note that the Vis River do not contribute towards the Mean Annual Runoff (MAR) of the Orange River. This is an arid region and its contribution is negligible. The flow of the Orange River is mainly because of the contribution of the Lesotho Highlands.

The banks of the Hartbees River have been impacted since historical times, with agriculture leaving its mark. Currently there are several active agricultural concerns. In addition, there are several sand mines, some in the bed of the river, which are reportedly legally licenced entities.

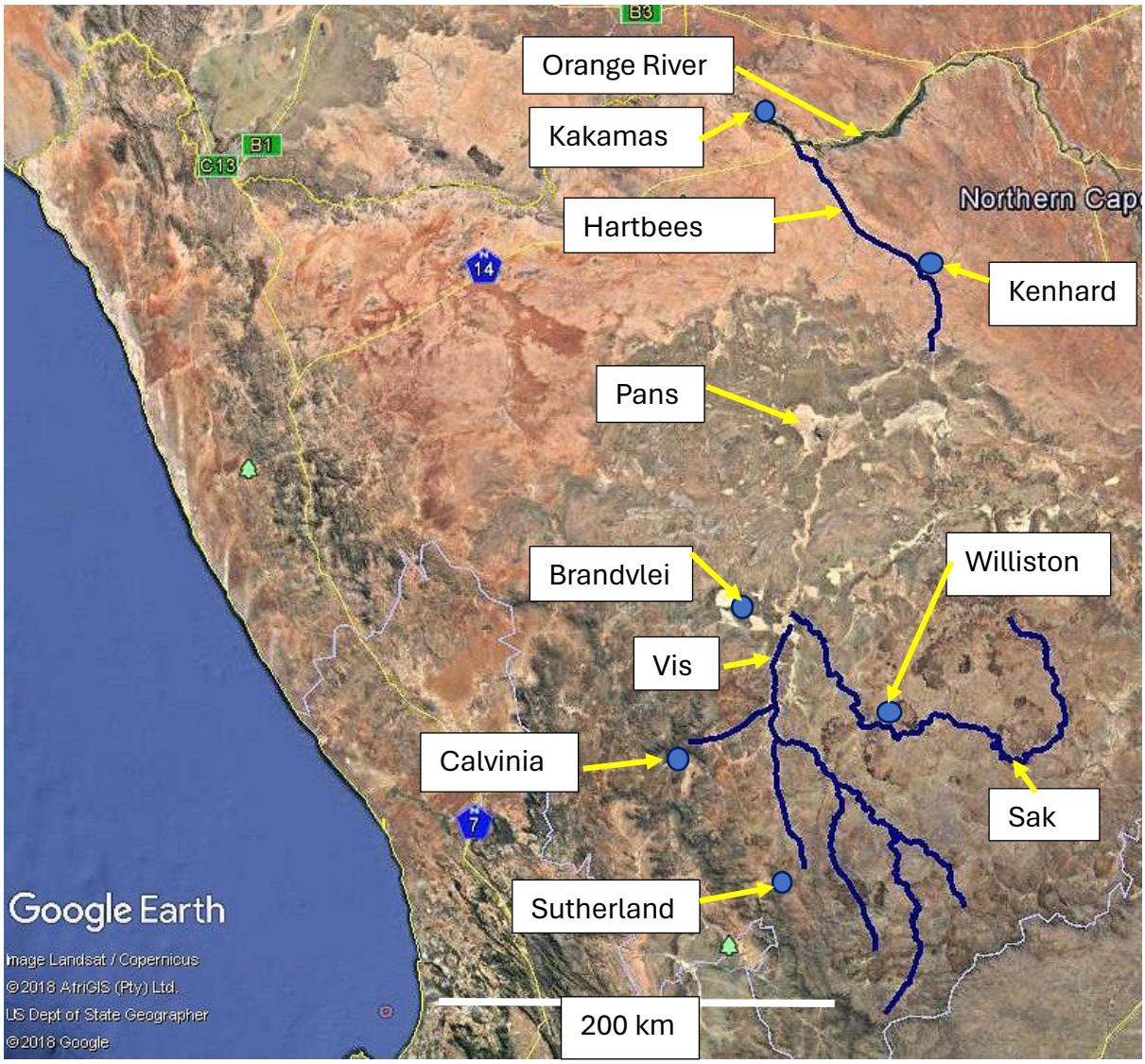

Figure 16 Vis / Hartbees River system

10 Current Limnological Knowledge

The question is often asked if South African pans in arid landscapes qualify as valid wetlands, considering that it is devoid of any water or moist most of the time, that the submerged period is brief and that aquatic life forms bear little resemblance to that of regular freshwater habitats. In many ways science still must find a spot as to where to position these pans and the like in the array of aquatic habitats that occur on the planet.

National Research Foundation (NRF) is an agency of the South African national government Department of Science and Technology. It was advertised on-line

(http://www.saeon.ac.za/2016%20Postdoc%20Ad%20SAEON%20-%20Landscape%20Ecology%20of%20Pans.pdf)

for a post-doctoral position. This was to study the ecology of ephemeral pans of the Northern Cape.

"The SAEON Arid Lands node offers opportunities for detecting changes in ephemeral pans across the Northern Cape Province. Though usually dry and only briefly wet from time to time, these pans are possibly the most sensitive ecosystems in this area, potentially supporting many species of conservation significance, and probably acting as key ecosystem structures for numerous species. Despite this, the pans of the Karoo (Bushmanland) and southern Kalahari (Hakskeenpan Complex; Ghaap Plateau; Kimberley) have received little attention in terms of research. By comparison, the geomorphology and biodiversity of ephemeral pans in less arid regions of South Africa are better studied and serve as good comparison. This postdoc project sets out to characterize pans, including the use of maps and remote sensing, and gather historic data on wetting. Samples of pans will be selected for more detailed data collection, which will then feed into a model incorporating abiotic (geomorphological, climatic, hydrological) and biotic (biodiversity, life histories, metapopulation dynamics, food-webs and community ecology) features and processes in their landscape context. This will include both aquatic and alternating dormant phases, as well as the interrelationship between pans to adjacent terrestrial ecosystems. The model should incorporate drivers and indicators of environmental changes of pans and make management recommendations for pans in their landscapes context in view of potential anthropogenic developments and in relation to global change."

The closing date was 30 June 2016.

From this advertisement it was evident that there was very little known about the ecology of these pans. This very much complicates the drafting of a Freshwater Report, for which a whole lot of knowledge is required.

Nevertheless, it can be deducted from the advertisement that the pans are mostly dry. When it rains the pans suddenly floods, which only happens occasionally.

When flooded, so is surmised, an entire ecology springs to life. Micro-algae (primary producers) reproduce rapidly in the nutrient-laden water to form a source of food for the microbial grazers (secondary producers) and a complicated chain of microbial predators, with macro-invertebrates at the top of the food chain. These may be dense clouds of swimming fairy shrimps (Crustacea, Anacostraca).

The pans dry up as suddenly as it flooded. As the last of the moist evaporates, the planktonic organisms perish, but leaving behind a wealth of spores and eggs. These sink into the red soil, in among the cracks that typically develop in these drying pans,

to sub-terraneously withstand the scorching temperatures of the harsh Bushmanland sun and the sub-zero temperatures of winter nights for months and even years on end.

These are very special organisms with highly adapted life cycles. They successfully survive in their dormant state under extreme conditions on the floor of the pans, ready to explode into life at the next flood event.

If one reads through the advertisement, it is evident that birds are important. These birds feed on the macro-invertebrates and include flamingos and Palearctic waders.

Much of the above is mere speculation, based on research in ephemeral pans in other parts of the world. On the other hand, much of the above description of this ecological marvel is probably quite true must be confirmed by meticulous scientific research. This process has already started, with several scientific accounts that have been published out of the SAEON initiative (Meyer-Milne *et al*, 2019, 2020 & 2021).

The Northern Cape pans are indeed a legitimate water resources that answer to the definition of the National Water Act, even though the only acknowledged user of the resource is nature. Because of the dormant but very much alive biota in the bone-dry soil, it is indeed a water resource, even though there is no water during the dry part of the cycle.

10.1 Salt Pans Concise Knowledge Overview

How credible will an impact assessment and a risk assessment be based on the current limited knowledge of South African pans? A better picture emerges as relevant research that has been done for comparable habitats. This will have to be very much limited to fit the scope and nature of this WULA Technical Report elsewhere, away from the Bushmanland pans, in South Africa but mostly outside of the country's boundaries.

10.2 Geomorphology

Thomas & Shaw (2012) described the geomorphology of numerous South African pans on a continuum from permanently flooded to mostly dry. These pans are termed terminal basins as they all lack an outflow.

These wetlands in arid regions are known as *playas* or salt pans.

The ground water table is mostly deep down, surface water is from a small catchment area, the bottom sediments are mostly alkaline clay with surface efflorescence.

This efflorescence happens when salts are brought up through the soil with capillary action to form a crystalline crust of the surface.

A depression associated with a series of longitudinal and parallel dunes are often associated with pans in arid areas. These dunes may not be active anymore, which means that they are not being moved about by strong desert winds as during geological times.

10.3 Sua Pan

The comprehensive work of McCulloch (2008) and his co-workers on Sua Pan in Botswana sets the standard for the scope and depth of the biological research that is needed for the facilitation of informed decision-making. It links the fluctuations of aquatic invertebrates in this saline pan to the change in salinity as the pan floods and subsequently dries out, as these pans do in arid regions.

It can be expected that the aquatic fauna in the Bushmanland pans follows a similar pattern.

This base-line information is required to assess environmental impacts on the Bushmanland pans because of future development.

There are only 16 taxa of aquatic invertebrates present in Sua Pan. This relatively small number illustrates that ephemeral saline pans are harsh environments in which only organisms adapted to these circumstances can survive.

The scientific paper on Sua Pan contains a most comprehensive literature list that could be regarded as an inventory of significant research that has been done on African saline pans up to 2008.

10.4 Etosha Pan

Etosha in northern Namibia forms part of a system known as the Cuvelai Pans with its catchment area on the Angolan highlands on an altitude of 1450m and more than 400 km to the north.

Rainfall on the highlands exceed 1000mm per year, which feeds a system of pans and rivulets known as *oshanas* or *omarumbas* in an area that is acknowledged as an ecoregion on its own.

This gives rise to an annual fish migration, which is harvested by the local population. The bulk of the biomass of these pans is replenished by migration from higher ground, while the Bushmanland pan's replenishment can be expected to be derived from only the dormant life forms in the sediments below.

The saline Etosha spans an incredibly large surface area of 7000km^2.

As it is located at the very end of the Cuvelai, it is covered with water only once in 7 years.

The bottom is mainly of lime as opposed to tillite and shale of the Bushmanland pans. It could therefore be expected that the water quality constituents and properties is quite different of that of the Bushmenland pans, with differently adapted aquatic organisms.

No less than 40 crustacean species have been identified from the Cuvelai (Lucy Scott, http://www.feow.org/ecoregions/details/etosha). Fairy shrimp is one of them.

Etosha Pan is one of two regular breeding sites in southern Africa for lesser and greater flamingos, *Phoenicopterus minor* and *P. ruber*.

Community structures are yet to be investigated.

The riparian vegetation at Etosha includes the sedge *Cyperus marginatus*, several species of the grass *Sporobolus* and several other genera of plants

Salt pans in the western Free State were studied by Janecke *et al* (2003), but information about the riparian vegetation and specifically indicator species were not given.

Perhaps some of the cyanobacteria and some other cosmopolitan aquatic microbes may be the same in both pans. It has been reported that Etosha is covered with a layer of blue green algae when it floods.

10.5 Eastern Highveld Pans

There are a large number of ephemeral pans on the Mpumalanga Highveld, some of which are still near-pristine and not impacted by coal mining and large-scale farming such as dairies and maize.

The community structures of these pans have been studied by Ferreira *et al* (2012). It was indicated that community structures are complex with a large number of species and that each of these pans is to a variable degree different from one another. It can be postulated that the Bushmanland pans would prove to be unique as well, given its location in the arid Northern Cape and its isolation from other comparable habitats. This could emphasize its conservation value.

Ferreira *et al* (2012) indicated that human activities indeed have a deleterious effect on the macroinvertebrates of these pans. Moreover, the company JG Africa with funding from the CSIR found that brachiopods in the Highveld pans utilised an “escape in time” survival strategy according to which life cycles are rapidly completed and eggs produced before the onset of the forthcoming arid period. These eggs are the survival stages and occur as egg banks in the sediments. However, the hatching of the eggs is severely curtailed by acid mine drainage, which then as a result has a profound effect on the community structure during the next wet phase.

It can be surmised that if acid mine drainage from the coal mines has such a marked effect on the hatching of branchiopod eggs, a fuel spill or sewage spill would result in

mortality of macroinvertebrate survival stages in Bushmanland as well. It should be very clear that acid mine drainage perpetually floods and covers an entire Highveld pan, while an unfortunate and accidental fuel or perhaps a sewage spill would be a once off event on a localised area of a very large pan. This nevertheless raises attention to the necessity to prevent spills and to clean them up, should they happen.

10.6 Australia

Australians have collected much more information on their ephemeral pans. As long ago as 1983 De Decker published an account on the vast body of basic research on Australia's saline pans.

(http://people.rses.anu.edu.au/dedeckker_p/pubs/120.pdf).

The driver that sets the food web going when flooded is phytoplankton. This is followed by microbial grazers and planktonic predatory organisms on various trophic levels.

From then research developed into population dynamics. They determined that the number of predatory invertebrate species increases as flood water recedes and that more trophic levels are introduced into the food web. The food web becomes more complicated as the hydroperiod nears its end. Community structure is determined by the frequency of flooding and the depth of the pan.

There is no reason to believe that the population dynamics of the Bushmanland pans is any different from that of the Australian situation.

10.7 Classification of Pans

Geldenhuys (1982) classified the Free State pans

Bare pans
Sedge pans
Scrub pans.
Mixed grass pans
Closed *Diplachne* pans
Open *Diplachne* pans

Geldenhuys' classification is useful for this Freshwater Report.

Bare pans can regress into sedge pans, then into scrub pans and from there into grass pans. Eventually these pans become grasslands that can hardly be distinguished from the surrounding areas.

Pans can evolve in both directions, from grassland into a bare pan and back from a bare pan into grassland. This can be because of long-term natural tendencies or because of human impact.

11 Classification of the Carnavon Dam

The dam was classified as a mixed grass pan.

It may well become a bare pan altogether towards the end of very long droughts that last for several years.

12 Present Ecological State

This westward dam at Carnavon is assessed very much in the same way the Bushmanland salt pans were assessed for previous WULA's (Van Driel, 2024). The assessment could be seen as a comparison to some of the pans, natural of artificial, in the Boesmanland pan district. One such pan is the bare pan along the R27 at Rooiputs (Van Driel, 2024). The human alteration of the landscape to create the Carnavon dam was ignored.

The assessment resulted in a mean score of 4 (Class B), which indicates that the aquatic habitat at the site of the proposed charging station is largely natural with little loss of ecological functioning. The level of confidence for this assessment is rated a 3 (High).

If these human impacts were to be taken into consideration, the score would have been low, less than 1 and the habitat would have been assessed as critically modified. Moreover, it would have been terrestrial habitat for which this assessment methodology could not have been applied.

The construction an operation of the proposed SKA information centre is not expected to change the score or the classification of the aquatic habitat.

Table 2 Habitat integrity assessment criteria for palustrine wetlands (DWAF,1999)

Criteria and attributes	Relevance	Score
Hydrology		
Flow modification.	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	**4**
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	**5**
Water Quality		
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	**3**
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	**3**
Hydraulic/ Geomorphic		
Canalization	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage	**4**
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activity which reduces or changes wetland habitat directly or through changes in inundation patterns.	**4**
Biota		
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	**4**
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	**4**
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	**5**
Alien fauna	Presence of alien fauna affecting faunal community structure.	**4**
Over utilisation of biota	Overgrazing, Over-fishing, etc.	**4**

Table 3 Scoring guidelines for the habitat integrity assessment for palustrine wetlands (DWAF, 1999).

Guideline	**Score**
Natural, unmodified Largely natural Moderately modified Largely modified Seriously modified Critically Modified	5 4 3 2 1 0
Confidence	
Very high confidence High confidence Moderate confidence Low confidence	4 3 2 1

Table 4 Category's assigned to the scores for wetland habitat assessment (Kleynhans, 1999; DWAF, 1999).

Category	Score	Description
A	>4	Unmodified or approximated natural condition.
B	>4 and ≤3	Largely natural with few modifications, but with some loss of natural habitats.
C	>2 and ≤3	Moderately modified, but with some loss of natural habitats.
D	2	Largely modified with a large loss of natural habitat and ecosystem function
E	>0 and ≤2	Seriously modified with extensive loss of habitat and ecosystem function
F	0	Critically modified with a near-complete loss of natural habitat

13 Ecological Importance

The Ecological Importance (EI) is based on the presence of especially fish species that are endangered on a local, regional or national level (Table 5).

Table 5 Ecological Importance according to endangered organisms (Kleynhans,1999).

Category	Description
1	One species or taxon are endangered on a local scale
2	More than one species or taxon are rare or endangered on a local scale
3	More than one species or taxon are rare or endangered on a provincial or regional scale
4	One or more species or taxa are rare or endangered on a national scale (Red Data)

There is no permanent water in the pan and no fish. According to this assessment, the pan is ecologically unimportant.

However, this is entirely not valid. When the pan floods with the occasional rain, a fascinating ecology springs to life, as has been described previously. It is not known if any species are endemic to the pan or if there are new species or if the planktonic community is unique. There are other dams in proximity with the same characteristics and probably with a similar benthic aquatic community. Eggs and spores are wind-driven and spread over the landscape along with the wind.

There are many salt pans in the district, mostly natural pans. Carnavon dam in only one of many. If Carnavon dam was to be lost due to development, it would not represent a significant loss. From this angle, the ecological importance of can only be rated as low.

14 Ecological Sensitivity

Ecological Sensitivity (ES) is often described as the ability of aquatic habitat to assimilate impacts. It is not sensitive if it remains the same despite of the onslaught of impacts. Put differently, sensitive habitat changes substantially, even under the pressure of slight impacts.

The Ecological Sensitivity also refers to the potential of aquatic habitat to bounce back to an ecological condition closer to the situation prior to human impact. If it recovers, it is not regarded as sensitive.

The pans are extremely sensitive as well. If the bottom of a pan is disturbed, there is no telling if the succession of organisms is going to happen anymore. Research is lacking to predict the consequences, but according to general ecological principles, it seems obvious that once destroyed, the system won't be able to resurrect itself.

15 EISC

Table 6 EISC

	Score
Rare and endangered species	3
Populations of unique species	3
Species / Taxon richness	2
Diversity of habitat	1
Migration Route/ Breeding and feeding site for wetland species.	1
Sensitivity to water quality changes	4
Flood storage, energy dissipation, particulate / element removal.	2
Protection status	1
Ecological integrity	4
Average	2.3
Score	Moderate

Score guideline:
Very High 4, High 3, Moderate 2, Low 1, None 0
Confidence Rating
Very High 4, High 3, Moderate 2, Low 1

The DWS demand that the pan be placed in a category according to the EISC methodology (Table 6). The EISC is one of the essential items that is required for the Risk Matrix.

The EISC is rated as Moderate, with a Low level of confidence, because science still must determine the value of the organisms inhabiting the pan.

16 Numerical Significance

Decision-makers often press on a numerical score for Significance**.** The score takes into consideration both the environmental value of the site and the degree of impact.

Table 33.4, p114, Appendix provides a system for allocation values for each of the parameters Conservation Value, Extent, Duration, Severity and Likelihood about possible impacts These values are then entered into the equation on p115 to derive at a value for Significance. The value for Significance can subsequently be evaluated according to Table 33.4.2.

Table 33.4.2 provides a yardstick for decision-making to allow or disallow a development with its concomitant impact on the environment.

The scores that were given are entirely those of the specialist (Table 15), based on his or her knowledge and experience. These scores form a bases for debate and consensus, should contemporaries and decision-makers wish to add to the process.

The scores apply under the assumption that mitigation measures will be in place.

Table 7 Significance Score

Parameter	Scofre
Conservation value Likelihood Duration Extent Severity	1 5 5 1 1
Significance	12 Insignificant

There will be a runoff from the site during rainfall events during construction and operation of the proposed SKA information centre.

The EISC was Low, insignificant, as the conservation value was deemed to be low. This was the same as for the bare pan along the R27 (Van Driel, 2024). Again, the confidence level of this assessment was Low, as science yet must determine if there are any unique aquatic microorganisms in the pan.

17 Possible Impacts and Mitigating Measures

Dickens *et al* (2003) lists several possible impacts on wetlands. This outline serves as a template for the discussion of the mitigating measures.

Flow modification.

The Carnavon westward pan exists because of the gross flow modification. The pan ecologically functions as a typical Bushmanland pan because of this modification. The addition runoff from the proposed site, once developed, will be miniscule and would not materially change the flow regime.

Permanent inundation

The proposed development will not materially change the inundation regime.

Water quality modification

The soil will be loosened during the construction phase. digging, with a possibility of the sediments washing into the pan along with storm water. This must be prevented, as it will greatly upset the natural properties of the pan. It is best to complete the construction during the dry season.

Sediment load modification

Soil will be disturbed during the construction phase. It is possible that storm water can wash sand and mud into the pan. This must be prevented at all costs.

Canalization

For the stormwater from the site the existing trench must be cleaned and maintained. At the moment the pipe culvert is partly blocked.

Topographic alteration

The envisaged construction is not about to alter the topography of the landscape in any way.

Terrestrial encroachment

The construction and operation of the information centre will not be the cause of vegetation encroaching onto the pan.

Indigenous vegetation removal

No indigenous vegetation of special note was noted on the pan. The existing vegetation must rather be protected by not allowing roaming farm animals to graze there at will.

Invasive vegetation encroachment

There was no invasive vegetation in and around the pan at the time of the site visit. It is not foreseen that the construction will alter in any way the vegetation regime.

Alien fauna

The farm is used for grazing sheep that occur in low numbers on the wide expanse of the Bushmanland. Sheep do not have a material impact on the pan. If sheep and goat numbers increase, it must be regulated.

Over-utilization

The pan is currently utilized as sheep grazing but does not seem to be overly grazed. The vegetation was sparse and dry but in a good condition during the site visit.

Isolation / Migration

The pan is part of a much larger system of pans (Figure 1). Recent research indicated that wind is important to distribute planktonic spores and eggs and to ecologically connect the various parts of the system. The proposed construction will obviously not alter any of this.

Ground water table.

The dams were constructed specifically to retain runoff for enhancing groundwater replenishment. The question remains if this practice is effective in any way. The geohydrology report (GCS, 2018) does not shed light on this aspect.

Waste

Portable toilets will be serviced by a reputable company and wastewater will be discharged in the municipal wastewater treatment works.

Litter must be collected in household wheelie bins and it will be disposed of on the municipal waste disposal site. Litter washing down the trench from the site during the operational phase must be collected and removed to the local landfill site. Now this trench is filled with litter.

18 Impact Assessment

Some of the authorities, such as the DFFE and its provincial offices prescribe an impact assessment according to a premeditated methodology.

The main benefit of this exercise is that it allows for the evaluation of mitigation measures. Later follows a Risk Assessment. This is different from the Impact Assessment as it does not attempt to weigh the success of mitigation measures.

The methodology is set out in the Appendix.

The impact assessment follows the stages in the life cycle of a project. These stages include planning, construction, operation, decommissioning and rehabilitation.

The impact assessment follows the stages in the life cycle of a project. These stages include planning, construction, operation, decommissioning and rehabilitation.

The planning phase does not have any impact for which a Risk Matrix can be completed, as during this phase nothing is happening on the ground. It is nevertheless worth mentioning, regarding the aquatic environment, that plans must be drafted to:

- Keep debris and sediment out of the trench from the site and out of the dam during construction.
- Keep litter and rubbish out of the dam during operation.
- To maintain stormwater management infrastructure.

These aspects must be kept onto the budget for as long as the information centre is in existence.

No provision is made for the closure and rehabilitation of the site because it is expected that the information centre will prevail in the foreseeable future and beyond.

Table 7 Impact Assessment

Description of impact: Construction Phase Levelling the ground Construction of information centre Digging of trenches for foundations. Storing of building material Construction of parking areas Installation of water provision and sewerage Installation of stormwater management infrastructure Cleaning up, rehabilitation, landscaping after construction. **Mitigation measures** Prevent loose soil and sediments from moving past the alleged wetland and further down the drainage line along with stormwater.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Indirect	Local	Medium	Short term	Medium	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Short term	Low	Definite	Sure	Reversible	Replaceable

Description of impact: Operational Phase Runoff from the parking area Litter, rubbish and wastewater down the trench and into the dam. **Mitigation measures** Prevent litter, rubbish and wastewater entering the alleged wetland.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Local	Medium	Permanent	Medium	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Permanent	Low	Definite	Sure	Reversible	Replaceable

The mitigating measures can easily and readily be implemented. The chances of successful implementation are excellent. The impacts assessment does not indicate any prohibition. The project should go ahead.

19 Risk Matrix

The purpose of the Risk Matrix is to determine if a General Authorisation of a License is applicable.

This assessment is based on the new version of the Risk Matrix that was published in February 2024.

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 9 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report. The numbers in Table 9 (continued) represent the same activities as in the Impact Assessment, with sub-activities added.

The methodology as published on the DWS webpage is duplicated in the Appendix.

Table 9 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1	**Construction** Levelling the ground Construction of information centre Digging of trenches for foundations. Storing of building material Construction of parking areas Installation of water provision and sewerage Installation of stormwater management infrastructure Cleaning up, rehabilitation, landscaping after construction.	Mobilisation of soil	Soil washing into the dam, alteration of aquatic habitat.	1.6	Low
2	**Operation** Runoff from the parking and stalls area.	Litter and rubbish in the dam.	Pollution of the dam	3.2	Low

Table 9 Continued Risk Matrix

No	Hydrology	Water Quality	Geomorphology	Biota	Vegetation	Fauna	Overall intensity
1 2	1 1	1 1	1 1	1 1	1 1	1 1	2 2

No	Spatial scale	Duration	Severity	Importance	Consequence	Likelihood %	Significance	Risk Rating
1 2	1 1	1 5	4 8	2 2	8 16	20 20	1.6 3.2	Low Low

The proposed SKA information centre is by its nature, a small building, parking area and trade stalls are of little consequence to the ecological well-being of the mostly dry municipal dam of limited ecological value across the street. It is not surprising that the Risk Matrix indicates that a General Authorisation is the correct level of authorisation. A License is not called for.

20 Resource Economics

The goods and services delivered by the environment, in this case the Carnavon westward dam, is a Resource Economics concept as adapted by Kotze *et al* (2009).

The diagram (Figure 17) is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 10.

Table 10. Goods and Services

Goods & Services	Score
Flood attenuation.	5
Stream flow regulation	5
Sediment trapping	3
Phosphate trapping	1
Nitrate removal.	1
Toxicant removal	1
Erosion control	5
Carbon storage	1
Biodiversity maintenance	4
Water supply for human use	4
Natural resources	0
Cultivated food.	1
Cultural significance	0
Tourism and recreation	0
Education and research	1

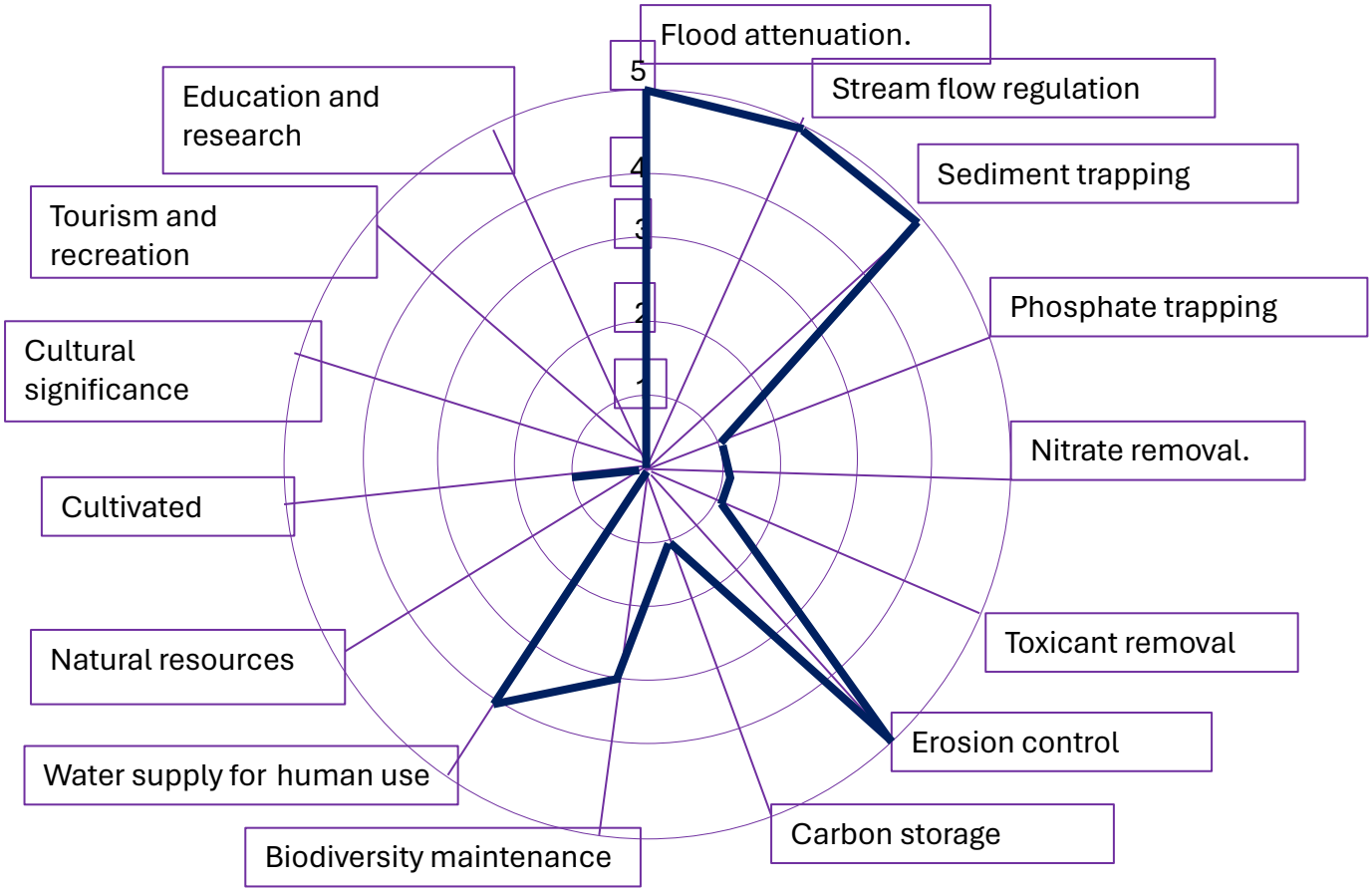

Figure 17. Resource Economics Footprint of the dam

The Resource Economics footprint spider diagram of the dam is spikey, with some parameters very important and other entirely absent. The pan is important for stream flow regulation and erosion control, but with the sparse vegetation not important for carbon storage.

The proposed SKA information centre is not about the change the resource economic footprint.

21 Summary

Table 11 Summary of evaluations

Aspect	Status
DFFE Screening Tool Property Wetland Vegetation PES Ecological Importance Ecological Sensitivity EISC Impact assessment Risk Matrix Resource Economics	Sensitivity Low, Medium, Very High CBA NFEPA Least concern B Not important Sensitive Low Impacts can be mitigated. General Authorization Scattered footprint.

Table 11 gives an overall and much condensed view of the assessments and the methodologies.

22 Discussion and Conclusions

'An anthropogenic activity can impact on any of the ecosystem drivers or responses and this can have a knock-on effect on all the other drivers and responses. This, in turn, will predictably impact on the ecosystem services (Figure 18). The WULA and the EAI must provide mitigation measured for these impacts.'

Figure 18 has been adapted from DWS policy documents.

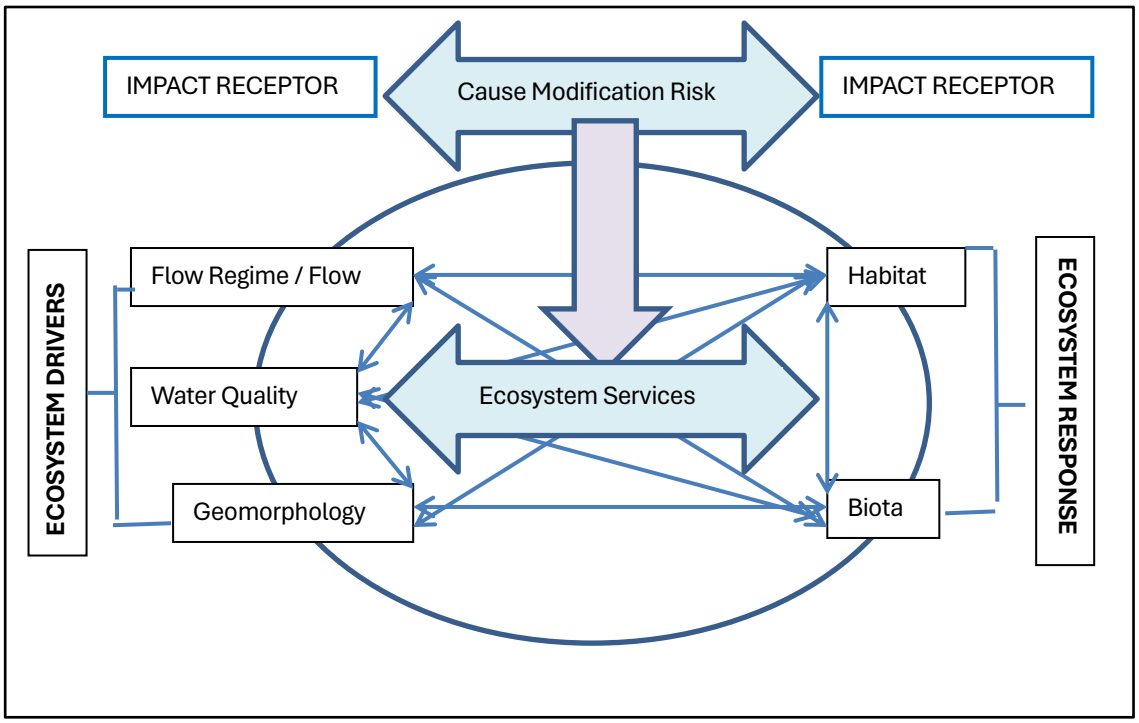

Figure 18 Minimum Requirements for a S21(c) and (i) Application.

The occasional, scarce but heavy downpour of rain is this arid land is the single most obvious driver of these mostly dry, flat and featureless dry pans of the Bushmanland. Once the pans fill up a most peculiar ecology springs to life, from organisms that outlived the second most obvious driver, the prolonged and intense droughts. The soils, the expanse of the pans and the gales over the plains all are necessary to maintain this unique community of fleeting aquatic organisms that retracts into the soil as water evaporates and completely dries up.

These pans are sensitive. Human disturbance can and will erase these life forms from the pans if allowed overstep the boundaries of ecological tolerance.

The dam next to Carnavon behaves as such a pan, even though it was entirely artificially brought into being.

The proposed SKA information right next to the dam, across the street, is not about to pose a threat to its delicate ecology. The possible impacts are small and can easily be ameliorated.

Current legislation makes provision for Schedule 1 water uses, for which GA's, Licenses and even WULA's are not required. For instances where the aquatic habitat is of a low value and where the impacts are insignificant, such as at the Carnavon site, a Schedule 1 assignment seems to be appropriate. A S21 (c) and S21(i) WULA seems to be an administrative overkill.

The Risk Matrix indicates that a General Authorisation is the appropriate level of official authorisation. A License is not called for.

23 References

De Decker, P. 1983. *Australian Salt Lakes, Their History, Chemistry and Biota. A Review.* Hydrobiologia 105(231 – 233).

De Klerk, A.R., LP De Klerk, PJ Oberholster, PJ Ashton, JA Dini & SD Holness. 2016. *A review of depressional wetlands (pans) in South Africa, including a water quality classification system.* CSIR, Pretoria.

Dickens, CWS D Kotze, S Mashigo, H MacKay, M Graham. 2003. *Guidelines for integrating the protection, conservation and management of wetlands into catchment management planning.* Water Research Commission, Pretoria

Ferreira, M., V Wepener, & JHJ van Vuren. 2012. Aquatic invertebrate communities of perennial pans in Mpumalanga, South Africa: A diversity and functional approach. Open Access.

Janecke,B.B. , P.J. du Preez, & H.J.T. Venter. 2003. *Vegetation ecology of the pans (playas) of Soetdoring Nature Reserve, Free State Province.* South African Journal of Botany Volume 69, Issue 3, October 2003, Pages 401-409

Kleynhans, C.J. 1999. *Assessment of Ecological Importance and Sensitivity*. Department of Water Affairs and Forestry. Pretoria.

Kotze, G., G. Marneweck, A. Batchelor, D. Lindley & Nacelle Collins. 2009. *A technique for rapidly assessing ecosystem services supplied by wetlands.* Water Research Commission, Pretoria.

Kruger, Marietjie & J. Beranek. 2018. *Hydrogeological investigation – Square Kilometre Array South Africa, Northern Cape.* GCS, Rivonia.

Thomas, D.S.G. & P. A. 2012. Shaw. *Terminal Basins: Lacustrine and Pan Systems*. In: *South African Geomorphology: Recent Trends and New Directions*. Ed.: P. Holmes & M. Meadows, pp 167 – 186. Sun Press. Bloemfontein.

Mcculloch, G.P. 2008. *The hydrochemistry of a semi-arid pan basin case study: Sua Pan, Makgadikgadi, Botswana*. Applied Geochemistry 23(6): 1563 – 1580.

Meyer-Milne, E., Brendock, L., & Pinceel, T. (2021). *Egg morphology may underpin the successful distribution of large branchiopods in temporary waters.* Aquatic Ecology, 16. https://doi.org/10.1007/s10452-020-09826-1

Elizabeth Meyer-Milne, Musa C. Mlambo, & D. Christopher Rogers. (2020). *Distribution of Clam Shrimps (Crustacea: Laevicaudata and Spinicaudata) in South Africa, with New Records from the Northern Cape Province*. Zoological Studies, (59). https://doi.org/10.6620/ZS.2020.59-39

Van Driel, D. 2024. *Freshwater Report for the construction of a water provision pipeline from the Orange River at Keimoes to the Gannakom Farm near Kenhardt, Northern Cape.* WATSAN Africa, Knysna.

Van Driel, D. 2021. *Calvinia bulk water supply. Water use license application for the construction of new pipelines. Freshwater Report.* WATSAN Africa, Cape Town.

24 Declaration of Independence

I, Dirk van Driel, as the appointed independent specialist hereby declare that I:

- Act/ed as the independent specialist in this application.
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct and;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management act;
- Have and will not have vested interest in the proposed activity;
- Have disclosed to the applicant, EAP and competent authority any material information have or may have to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the environmental Impact Assessment Regulations, 2010 and any specific environmental management act.
- Am fully aware and meet the responsibilities in terms of the NEMA, the Environmental Impacts Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R543) and any specific environmental management act and that failure to comply with these requirements may constitute and result in disqualification;
- Have ensured that information containing all relevant facts on respect of the specialist input / study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties facilitated in such a manner that all interested and affected parties were provided with reasonable opportunity to participate and to provide comments on the specialist input / study;
- Have ensured that all the comments of all the interested and affected parties on the specialist input were considered, recorded and submitted to the competent authority in respect of the application;
- Have ensured that the names of all the interested and affected parties that participated in terms of the specialist input / study were recorded in the register of interested and affected parties who participated in the public participation process;
- Have provided the competent authority with access to all information at my disposal regarding the application, weather such information is favourable or not and;
- Am aware that a false declaration is an offence in terms of regulation 71 of GN No. R543.

Signature of the specialist: D van Driel 1 April 2024

25 Résumé

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Experience

USAID/RTI, ICMA & Chemonics. Iraq & Afghanistan **2007 -2011**
Program manager.

City of Cape Town **1999-2007**
Acting Head: Scientific Services, Manager: Hydrobiology.

Department of Water & Sanitation, South Africa **1989 – 1999**
Senior Scientist

Tshwane University of Technology, Pretoria **1979 – 1998**
Head of Department

University of Western Cape and Stellenbosch University 1994 - 1998 part-time
- Lectured post-graduate courses in Water Management and Environmental Management to under-graduate civil engineering students
- Served as external dissertation and thesis examiner

Service Positions
- Project Leader, initiator, member and participator: Water Research Commission (WRC), Pretoria.
- Director: UNESCO West Coast Biosphere, South Africa
- Director (Past Deputy Chairperson): Grotto Bay Homeowner's Association
- Past Member Dassen Island Protected Area Association (PAAC)

Membership of Professional Societies
- South African Council for Scientific Professions. Registered Scientist No. 400041/96
- Water Institute of South Africa. Member

Reports

- Process Review Kathu Wastewater Treatment Works
- Effluent Irrigation Report Tydstroom Abattoir Durbanville
- River Rehabilitation Report Slangkop Farm, Yzerfontein
- Fresh Water and Estuary Report Erf 77 Elands Bay
- Ground Water Revision, Moorreesburg Cemetery
- Fresh Water Report Delaire Graff Estate, Stellenbosch
- Fresh Water Report Quantum Foods (Pty) Ltd. Moredou Poultry Farm, Tulbagh
- Fresh Water Report Revision, De Hoop Development, Malmesbury
- Fresh Water Report, Idas Valley Development Erf 10866, Stellenbosch
- Wetland Delineation Idas Valley Development Erf 10866, Stellenbosch
- Fresh Water Report, Idas Valley Development Erf 11330, Stellenbosch
- Fresh Water Report, La Motte Development, Franschhoek
- Ground Water Peer Review, Elandsfontein Exploration & Mining
- Fresh Water Report Woodlands Sand Mine Malmesbury
- Fresh Water Report Brakke Kuyl Sand Mine, Cape Town
- Wetland Delineation, Ingwe Housing Development, Somerset West
- Fresh Water Report, Suurbraak Wastewater Treatment Works, Swellendam
- Wetland Delineation, Zandbergfontein Sand Mine, Robertson
- Storm Water Management Plan, Smalblaar Quarry, Rawsonville
- Storm Water Management Plan, Riverside Quarry
- Water Quality Irrigation Dams Report, Langebaan Country Estate
- Wetland Delineation Farm Eenzaamheid, Langebaan
- Wetland Delineation Erf 599, Betty's Bay
- Technical Report Bloodhound Land Speed Record, Hakskeenpan
- Technical Report Harkerville Sand Mine, Plettenberg Bay
- Technical Report Doring Rivier Sand Mine, Vanrhynsdorp
- Rehabilitation Plan Roodefontein Dam, Plettenberg Bay
- Technical Report Groenvlei Crusher, Worcester
- Technical Report Wiedouw Sand Mine, Vanrhynsdorp
- Technical Report Lair Trust Farm, Augrabies
- Technical Report Schouwtoneel Sand Mine, Vredenburg
- Technical Report Waboomsrivier Weir Wolseley
- Technical Report Doornkraal Sand Mine Malmesbury
- Technical Report Berg-en-Dal Sand Mine Malmesbury
- Wetland Demarcation, Osdrif Farm, Worcester
- Technical Report Driefontein Dam, Farm Agterfontein, Ceres
- Technical Report Oewerzicht Farm Dam, Greyton
- Technical Report Glen Lossie Sand Mine, Malmesbury
- Preliminary Report Stellenbosch Cemeteries
- Technical Report Toeka & Harmony Dams, Houdenbek Farm, Koue Bokkeveld
- Technical Report Kluitjieskraal Sand & Gravel Mine, Swellendam
- Fresh Water Report Urban Development Witteklip Vredenburg
- Fresh Water Report Groblershoop Resort, Northern Cape
- Fresh Water Report CA Bruwer Quarry Kakamas, Northern Cape
- Fresh Water Report, CA Bruwer Sand Mine, Kakamas, Northern Cape
- Fresh Water Report, Triple D Farms, Agri Development, Kakamas
- Fresh Water Report, Keren Energy Photovoltaic Plant Kakamas
- Fresh Water Report, Keren Energy Photovoltaic Plant Hopetown
- Fresh Water Report Hopetown Sewer
- Fresh Water Report Hoogland Farm Agricultural Development, Touws River
- Fresh Water Report Klaarstroom Wastewater Treatment Works

- Fresh Water Report Calvinia Sports Grounds Irrigation
- Fresh Water Report CA Bruwer Agricultural Development Kakamas
- Fresh Water Report Zwartfontein Farm Dam, Hermon
- Statement Delsma Farm Wetland, Hermon
- Fresh Water Report Lemoenshoek Farms Pipelines Bonnyvale
- Fresh Water Report Water Provision Pipeline Brandvlei
- Fresh Water Report Erf 19992 Upington
- Botanical Report Zwartejongensfontein Sand Mine, Stilbaai
- Fresh Water Report CA Bruwer Feldspath Mine, Kakamas
- Sediment Yield Calculation, Kenhardt Sand Mine
- Wetland Demarcation, Grabouw Traffic Center
- Fresh Water Report, Osdrift Sand Mine, Worcester
- Fresh Water Report, Muggievlak Storm Water Canal, Vredenburg
- Fresh Water Report, Marksman's Nest Rifle Range, Malmesbury
- Biodiversity Report, Muggievlak Storm Water Canal, Vredenburg
- Strategic Planning Report, Sanitation, Afghanistan Government, New Delhi, India
- Fresh Water Report, Potable Water Pipeline, Komaggas
- Fresh Water Report, Wastewater Treatment Works, Kamieskroon
- Fresh Water Report, Turksvy Farm Dam, Upington
- Fresh Water Report, Groblershoop Urban Development, IKheis Municipality
- Fresh Water Report, Boegoeberg Urban Development, IKheis Municipality
- Fresh Water Report, Opwag Urban Development, IKheis Municipality
- Fresh Water Report, Wegdraai Urban Development, IKheis Municipality
- Fresh Water Report, Topline Urban Development, IKheis Municipality
- Fresh Water Report, Grootdrink Urban Development, IKheis Municipality
- Fresh Water Report, Gariep Urban Development, IKheis Municipality
- Fresh Water Report, Bonathaba Farm Dam, Hermon
- Botanical Report, Sand Mine Greystone Trading, Vredendal
- Botanical Report Namakwa Klei Stene, Klawer
- Fresh Water Report Buffelsdrift Quarry, George
- Fresh Water Report Styerkraal Agricultural Development, Onseepkans.
- Technical Report Arabella Country Estate Wastewater Treatment Works, Kleinmond
- Fresh Water Report Calvinia Bulk Water Supply
- Fresh Water Report Swartdam Farm Dams, Riebeeck Kasteel
- Fresh Water Report Erf 46959, Gordon's Bay
- Fresh Water Report Melkboom Farm Dam, Trawal
- Stormwater Management Plan, Bot River Bricks
- Freshwater Report, Bot River Bricks
- Freshwater Report Sanddrif Farm, Joubertina
- Freshwater Report Zouterivier Cell phone tower, Atlantis
- Biodiversity Report Birdfield Sandmine, Klawer
- Freshwater Report New Wave Dam, Klawer
- Freshwater Report Harvard Solar Energy Plant, Bloemfontein
- Freshwater Report Doorn River Solar Energy Plant, Virginia
- Freshwater Report Kleingeluk Farm, De Rust
- Freshwater Report, Solar Energy Plant, Klein Brak River
- Site Verification Report Laaiplek Desalination Plant
- Freshwater Report, CA Bruwer Quarry, Kakamas
- Freshwater Report, Orren Managanese Mine, Swellendam
- Wetland Delineation, Klipheuvel ZCC Solar Energy
- Freshwater Report Delville Park, George
- Freshwater Report Wolseley bulk water pipeline
- Freshwater Report Urban Settlement No.1 Pababello Upington
- Freshwater Report Urban Settlement No.2 Pababello Upington
- Freshwater Report Pringle Rock Distillery, Rooiels

- Freshwater Report De Kuilen Resort, Kamiesberg
- Wetland Delineation, Klipheuvel ZCC Solar Energy
- Freshwater Report Delville Park, George
- Freshwater Report ZCC Akkerboom electric vehicle charging station, Keimoes
- Freshwater Report ZCC Piketberg electric automobile charging station
- Freshwater Report ZCC electric truck charging station Piketberg
- Freshwater Report ZCC electric truck charging station Prince Albert Weg
- Freshwater Report Vleesbaai Wastewater Treatment Works
- Freshwater Report ZCC Brandvlei electric vehicle charging station.
- Site Sensitivity Report desalination plant Velddrif
- Technical Report desalination plant Velddrif
- Freshwater Report Abbottsdale High Voltage Power Line
- Freshwater Report Darling Solar Energy Plan
- Freshwater Report Malmesbury Klipkoppie Solar Energy Plant
- River Rehabilitation Plan Louterwater, Langkloof
- River Rehabilitation Plan Kloof Please Krakeelrivier
- Freshwater Report ZZC Potchefstroom electric automobile charging station

26 Appendix

Table 26.1 Numerical Significance

Table 26.1.1 Conservation Value

Conservation Value		
Refers to the intrinsic value of the area or its relative importance towards the conservation of an ecosystem or species or even natural aesthetics. Conservation status is based on habitat function, its vulnerability to loss and fragmentation or its value in terms of the protection of habitat or species	Low 1	The area is transformed, degraded not sensitive (e.g. Least threatened), with unlikely possibility of species loss.
	Medium / Low 2	The area is in good condition but not sensitive (e.g. Least threatened), with unlikely possibility of species loss.
	Medium 3	The area is in good condition, considered vulnerable (threatened), or falls within an ecological support area or a critical biodiversity area, but with unlikely possibility of species loss.
	Medium / High 4	The area is considered endangered or, falls within an ecological support area or a critical biodiversity area, or provides core habitat for endemic or rare & endangered species.
	High 5	The area is considered critically endangered or is part of a proclaimed provincial or national protected area.

Table 26.1.2 Significance

Significance	Score	Description
Insignificant	4 - 22	There is no impact or the impact is insignificant in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site.
Low	23 - 36	An impact barely noticeable in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site, or will be of very short-term or is unlikely to occur. Impact is unlikely to have any real effect and no or little mitigation is required.
Medium / Low	37 - 45	Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved. Impacts may have medium to short term effects on the natural environment within site boundaries.
Medium	46 - 55	Impact is real, but not substantial. Mitigation is both feasible and fairly easily possible, but may require modification of the project design or layout. These impacts will usually result in medium to long term effect on the natural environment, within site boundary.
Medium High	56 - 63	Impact is real, substantial and undesirable, but mitigation is feasible. Modification of the project design or layout may be required. These impacts will usually result in medium to long-term effect on the natural environment, beyond site boundary within local area.
High	64 - 79	An impact of high order. Mitigation is difficult, expensive, time-consuming or some combination of these. These impacts will usually result in long-term change to the natural environment, beyond site boundaries, regional or widespread.
Unacceptable	80 - 100	An impact of the highest order possible. There is no possible mitigation that could offset the impact. The impact will result in permanent change. Very often these impacts cannot be mitigated and usually result in very severe effects, beyond site boundaries, national or international.

Table 26.2.3 Scoring system

Parameter	1	2	3	4	5
Conservation value Likelihood Duration Extent Severity	Low Unlikely Temporary Site specific Zero	Medium /Low Possible Short term Local Very low	Medium More possible Medium term Regional Low	Medium / High Probable Long term National Medium	High Definite Permanent International High

Significance = Conservation value (Likelihood + Duration + Extent + Severity)

26.2 Methodology used in determining significance of impacts.

The methodology to be used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks associated with the alternatives is provided in the following tables:

Table 26.2.1 Nature and type of impact

Nature and type of impact	Description
Positive	An impact that is considered to represent an improvement to the baseline conditions or represents a positive change
Negative	An impact that is considered to represent an adverse change from the baseline or introduces a new negative factor
Direct	Impacts that result from the direct interaction between a planned project activity and the receiving environment / receptors
Indirect	Impacts that result from other activities that could take place as a consequence of the project (e.g. an influx of work seekers)
Cumulative	Impacts that act together with other impacts (including those from concurrent or planned future activities) to affect the same resources and / or receptors as the project

Table 26.2.2 Criteria for the assessment of impacts

Criteria	Rating	Description
Spatial extent of impact	National	Impacts that affect nationally important environmental resources or affect an area that is nationally important or have macro-economic consequences.
	Regional	Impacts that affect regionally important environmental resources or are experienced on a regional scale as determined by administrative boundaries or habitat type / ecosystems.
	Local	Within 2 km of the site
	Site specific	On site or within 100m of the site boundary
Consequence of impact/ Magnitude/ Severity	High	Natural and / or social functions and / or processes are severely altered.
	Medium	Natural and / or social functions and / or processes are notably altered.
	Low	Natural and / or social functions and / or processes are slightly altered.
	Very Low	Natural and / or social functions and / or processes are negligibly altered.
	Zero	Natural and / or social functions and / or processes remain unaltered.
Duration of impact	Temporary	Impacts of short duration and /or occasional
	Short term	During the construction period
	Medium term	During part or all of the operational phase
	Long term	Beyond the operational phase, but not permanently
	Permanent	Mitigation will not occur in such a way or in such a time span that the impact can be considered transient (irreversible)

Table 26.2.3 Significance Rating

Significance Rating	Description
High	High consequence with a regional extent and long-term duration High consequence with either a regional extent and medium-term duration or a local extent and long-term duration Medium consequence with a regional extent and a long-term duration
Medium	High with a local extent and medium-term duration High consequence with a regional extent and short-term duration or a site-specific extent and long-term duration High consequence with either local extent and short-term duration or a site-specific extent with a medium-term duration Medium consequence with any combination of extent and duration except site-specific and short-term or regional and long term Low consequence with a regional extent and long-term duration
Low	High consequence with a site-specific extent and short-term duration Medium consequence with a site-specific extent and short-term duration Low consequence with any combination of extent and duration except site-specific and short-term Very low consequence with a regional extent and long-term duration
Very low	Low consequence with a site-specific extent and short-term duration Very low consequence with any combination of extent and duration except regional and long term
Neutral	Zero consequence with any combination of extent and duration

Table 26.2.4 Probability, confidence, reversibility and irreplaceability

Criteria	Rating	Description
Probability	Definite	>90% likelihood of the impact occurring
	Probable	70 – 90% likelihood of the impact occurring
	Possible	40 – 70% likelihood of the impact occurring
	Unlikely	<40% likelihood of the impact occurring
Confidence	Certain	Wealth of information on and sound understanding of the environmental factors potentially affecting the impact
	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact
	Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.
Reversibility	Reversible	The impact is reversible within 2 years after the cause or stress is removed.
	Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Irreplaceability	Replaceable	The resources lost can be replaced to a certain degree.
	Irreplaceable	The activity will lead to a permanent loss of resources.

26.3 Risk Matrix Methodology

TABLE 1 – IMPORTANCE OF AFFECTED WATERCOURSE/S		
What is the overall importance of the watercourse/s, based on the criteria and guidelines provided below?*		
(If no formal assessment of EI / EIS / Wetland Importance has been completed, assign rating according to criterion below that results in the highest score)		
Low or Very Low EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Low rating based on presence of: - no areas identified to be of conservation importance (i.e. OESA at most); and/or - only species/habitats of Least Concern on the IUCN Red List or on a regional/national Red List (including freshwater ecosystem types of Least Concern in terms of the NBA); and/or - only species which are common and widespread and/or habitats of low conservation interest; and/or - highly degraded habitat of extremely small size	**Low / Very low** = 2	
Medium EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Moderate rating based on presence of: - CESAs; and/or - species/habitats listed as VU or NT on the IUCN Red List or on a regional/national Red List (including VU/NT freshwater ecosystem types in terms of the NBA); and/or - functionality as an important ecological corridor or buffer area	**Moderate** = 3	
High EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, High rating based on presence of: - CBA2; and/or - species or degraded habitats (in poor condition) listed as EN or CR on the IUCN Red List or on a regional/national Red List (including EN/CR freshwater ecosystem types in terms of the NBA)	**High** = 4	
Very high EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Very high rating based on presence of: -CBA1; and/or - FEPA; and/or - species or intact habitats (in fair or good condition) listed as EN or CR on the IUCN Red List or on a regional/national Red List (including EN/CR freshwater ecosystem types in terms of the NBA); and/or - KBA or IBA or Ramsar site	**Very high** = 5	
* EI=Ecological Importance; EIS=Ecological Importance & Sensitivity; OESA=Other Ecological Support Areas; IUCN=International Union for Conservation of Nature; CESA=Critical Ecological Support Area; NBA=National Biodiversity Assessment; VU=Vulnerable; NT=Near Threatened; EN=Endangered; CR=Critically Endangered; CBA=Critical Biodiversity Area; FEPA=Freshwater Ecosystem Priority Area; KBA=Key Biodiversity Area; IBA=Important Bird Area.		

TABLE 2- INTENSITY OF IMPACT	
What is the intensity of the impact on the resource quality (hydrology, water quality, geomorphology, biota)?	
Negative Impacts	
Negligible / non-harmful; no change in PES	0
Very low / potentially harmful; negligible deterioration in PES (<5% change)	+1
Low / slightly harmful; minor deterioration in PES (<10% change)	+2
Medium / moderately harmful; moderate deterioration in PES (>10% change)	+3
High / severely harmful; large detrioration in PES (by one class or more)	+4
Very high / critically harmful; critrical deterioration in PES (to E/F or F class)	+5
Positive Impacts	
Negligible; no change in PES	0
Very low / potentially beneficial; negligible improvement in PES (<5% change)	-1
Low / slightly beneficial; minor improvement in PES (<10% change)	-2
Medium / moderately beneficial; moderate improvement in PES (>10% change)	-3
Highly beneficial; large improvement in PES (by one class or more) and/or increase in protection status	-4
Very highly beneficial; improvement to near-natural state (A or A/B class) and/or major increase in protection status	-5
NOTE: Positive Impacts must be given a negative Intensity Score	
***PES of affected watercourses must be considered when scoring Impact Intensity**	

TABLE 3 – SPATIAL SCALE (EXTENT) OF IMPACT	
How big is the area that the activity is impacting on, **relative to the size of the impacted watercourses**?	
Very small portion of watercourse/s impacted (<10% of extent)	1
Moderate portion of watercourse/s impacted (10-60% of extent)	2
Large portion of watercourse/s impacted (60-80%)	3
Most or all of watercourse/s impacted (>80%)	4
Impacts extend into watercourses located well beyond the footprint of the activities	5

TABLE 4 – DURATION OF IMPACT	
How long does the activity impact on the resource quality?	
Transient (One day to one month)	1
Short-term (a few months to 5 years) OR repeated infrequently (e.g. annually) for one day to one month	2
Medium-term (5 – 15 years)	3
Long-term (ceases with operational life)	4
Permanent	5

TABLE 5 – LIKELIHOOD OF THE IMPACT	
What is the probability that the activity will impact on the resource quality?	
Improbable / Unlikely	20%
Low probability	40%
Medium probability	60%
Highly probable	80%
Definite / Unknown	100%

TABLE 6: RISK RATING CLASSES

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	**(L) Low Risk OR (+) Positive (+ +) Highly positive**	Acceptable as is or or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.
30 – 60	**(M) Moderate Risk**	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
61 – 100	**(H) High Risk**	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

TABLE 7: CALCULATIONS AND MAXIMUM VALUES	
Intensity = Maximum Intensity Score (negative value for positive impact) X 2	MAX = 10
Severity = Intensity + Spatial Scale + Duration (<Intensity - Spatial Scale - Duration> for positive impact)	MAX = 20 (MIN = -20 for +ve impacts)
Consequence = Severity X Importance rating	MAX = 100
Significance\Risk = Consequence X (Likelihood / 100)	MAX = 100