

KOTULO TSATSI ENERGY (PTY) LTD

FRESHWATER REPORT

For the construction of a water provision pipeline along the R27 trunk road to
Kenhardt, Northern Cape

A requirement in terms of the
National Environmental Management Act (107 of 1998)
and the
National Water Act (36 of 1998)

November 2022
Version 4.1 December 2024



Executive Summary

Kutulo Tsatsi Energy (Pty) Ltd is planning a large green hydrogen plant along the Sishen-Saldanha railway line to the west of a point on the R27 trunk road halfway between Kenhardt and Brandvlei in the Bushmanland of the Northern Cape. Water will be abstracted from the Orange River at Keimoes and pumped to the plant via a 190km long pipeline. Along the way several water reservoirs and a water purification plant will be constructed. Water out of the pipeline will be supplied to the towns of Kenhardt and Brandvlei as well.

This Freshwater Report deals solely with the extension of the pipeline, the last 72km to the south, to connect the town of Brandvlei.

Concentrated solar-thermal power (CSP) installations will form the core of the energy-provision for the manufacture of hydrogen out of water. In fact, the CSP/ hydrogen combination may and likely will radically and globally move energy generation away from fossil fuels, along with contemporary solar and wind generation, which will augment CSP energy generation on the envisaged plant.

Hydrogen can be used widely in several applications apart from green energy. It is planned, among other, to manufacture green ammonia on a large scale, which in turn can be used for the manufacture of agricultural fertiliser.

For all of this, the pipeline and associated infrastructure, the CSP, solar and wind installations for the generation of electricity, the hydrogen and ammonia plant and the evaporation ponds authorisation must be obtained from the relevant authorities such as the national Department of Water and Sanitation and the Department of the Fisheries, Forestry and the Environment as well as from their provincial offices. This Freshwater Report is one of the requirements for official authorisation.

This project hinges on the authorisation of water abstraction from the Orange River at Keimoes. The pipeline will be constructed for most of the way along the R27 trunk road where it will cross numerous drainage line. Although mostly dry, these drainage lines are legitimate water resources in terms of the National Water Act. All of this will have to be properly authorised and licensed, as well as the evaporation ponds at the production site.

The consortium of national and international entities has already spent a great deal of funding towards the planning and authorisation. Several consulting companies have been appointed. This process has been ongoing for more than 10 years.

This initiative will predictably have a vast impact on the regional economy. The export of green hydrogen and its derivatives will earn the country valuable foreign currency. Green hydrogen is a global trend included in national energy strategies. Our authorities are cordially pressed upon to treat this application with the weight and urgency it deserves.

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Abbreviations

Critical Biodiversity Area	CBA
Department of Fisheries, Forestry and the Environment	DFFE
Department of Water and Sanitation	DWA
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
Northern Cape Department of Environment & Nature Conservation	DENC
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 following paragraphs were taken from an information document that was compiled by Dr A. Botha in June 2022 of Kotulo Tsatsi Energy International Consortium:

“The Kutulo Tsatsi Energy International Consortium envisages to develop a USD 7 to 10 billion green hydrogen based green ammonia production plant on a 55000ha (plus a further up to 30000ha under option) site in the Northern Cape province of South Africa with water abstraction from the Orange River.....

“The total investment value in time may exceed USD 10 billion, with up to 6000 jobs to be created. Social, economic- and enterprise development, job creation and socio-economic upliftment, especially for local communities, are prominent goals of the consortium.

The project will be base load powered by a 3-to-6-gigawatt hybridisation of renewable energy based on solar photovoltaic, concentrated solar-thermal power (CSP) and wind power. The production plants, at 6-gigawatt baseload power capacity, utilised for the electrolysis of water, will be able to produce up to a million metric tons of electrolytic green hydrogen per annum and up to 6 million metric tons of green ammonia per annum. Up to five million tons of nitrogen will be produced per annum for use in the production of green ammonia”.

This is a major project of an unprecedented scale. It has been in the planning stage for the past 10 years (<https://sr.energy/kotulo-tsatsi/>).

“The project will have a significant Black Economic Empowerment (BEE) shareholding, and a percentage of total project revenues will be set aside for enterprise and socioeconomic development which will be invested for the benefit of local communities each year”.

The envisaged pipeline has the potential to supply water to the towns of Kenhardt and Brandvlei as well. Plans along with the constitutional arrangements have already been developed to make this a possibility.

On social media it is evident that green hydrogen is still deemed with scepticism, as most novelties are. This is clearly based on ignorance, as the informed understand technology is to provide the world's current and growing energy demand. There are literally hundreds of postings on the internet to explain the importance of green hydrogen and green ammonia in the developed world. Tendencies in South Africa are likewise highlighted. Green hydrogen is not a novelty any longer and leading economies in the world are currently scrambling to share in the trend. South Africa is not lagging.

It stands to reason that the green hydrogen project, along with its various components, would be a major and welcome injection of capital and opportunities in a left-behind region that is almost devoid of opportunities and economic progress.

The consortium already has spent a great amount of money, energy and time towards the various components of the larger, overarching project's official approval. This application is for one such component, the water provision pipeline from the Orange River at Keimoes to the envisaged production plant that is to be located on the farm Uitkyk in the Bushmanland between the towns of Kenhardt and Brandvlei.

This application solely deals with the water provision pipeline, the last 72km from the Soafskolk turnoff further south to the town of Brandvlei. Other project components have been dealt with separate applications. A great deal of capital has already been spent on EIA's and official approvals, the detail of which is available from the consortium.

This Freshwater Report must provide information to the EIA and its various process and reports. Several prescribed evaluations and content are focussed on the EIA and its legal requirements.

Mr Bernard de Witt of Enviro Africa in Somerset West was appointed to conduct the EIA.

The EIA includes a public participation process. This process has been undertaken, with the legally prescribed notices put up in public places (Figure 1). Notices for the expansion of the project were posted during March 2024 and are shown in the Appendix.

Much of the Freshwater Report is focussed on the WULA and the DWS approval.

The WULA must be accompanied by a Freshwater Report as well as a completed Risk Matrix as published on the DWS webpage and in terms of GN509 of 2017. The completed Risk Matrix must be signed by a registered SACNASP scientist.

Dr Dirk van Driel of WATSAN Africa of Knysna was appointed to produce this report.

The Fresh Water Report must contain adequate information to allow for informed decision-making. The decision to approve the proposed development rests with DWS officials, in terms of S21 of the NWA. The Fresh Water Report must contain specified information according to a set profile, which has been developed over several years over many such reports.

The Freshwater Report must contain information for budgeting purposes. This first round budget is for the construction and trenching of the proposed pipeline. It was established that the pipeline will have to be buried deeper. Special attention is to be given in places along the path of the pipeline. These places are highlighted and quantified in the report.

A site visit was conducted, along with a team of specialist scientists, on 18 to 20 October 2022 as well as on 11 to 13 March 2024.

NEMA PUBLIC PARTICIPATION PROCESS

PROPOSED KTE BRANDVLEI WATER PIPELINE

Notice is hereby given of the intention to submit a NEMA application and the public participation process, in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended ("NEMA"), Environmental Impact Assessment Regulations 2014 for the proposed 72km Brandvlei water pipeline and associated infrastructure, which includes activities listed in terms of the NEMA EIA Regulations 2014.

EnviroAfrica NC cc has been appointed by Kotulo Tsatsi Energy (KTE) to undertake the NEMA Application for Environmental Authorisation process.

Application for environmental authorization to undertake the following activities in terms of NEMA EIA Regulations 2014:

Government Notice R327 (Listing Notice 1): Activity No. **12, 19 and 48**

Government Notice R324 (Listing Notice 3): Activity No. **14, and 23**

**Please note that the listed activities above may change during the NEMA Application process. Registered I&APs will be notified of any changes.*

Project Description & Location:

It is proposed that a 72km 250mm dia water pipeline be constructed from the Kotulo Tsatsi Energy (KTE) Rising Main water pipeline at the R27 and Soafskolk Road intersection, along the R27 (within the road reserve) to the existing water storage reservoir in Brandvlei. The pipeline will provide Brandvlei with approximately 500m³ of potable water per day.

The pipeline will cross a number of drainage lines and watercourses along the R27.

Public Participation:

Interested and Affected Parties ("I&APs") are hereby notified of the intended application and are invited to register (in writing) and/or provide comments and identify any issues, concerns or opportunities relating to this project to the contact details provided below, on or before 06 May 2024. To register or submit comment, I&APs should refer to the project name, provide their name, address & contact details (*indicating your preferred method of notification*) and an indication of any direct business, financial, personal, or other interest which they have in the application. You are also requested to pass this information on to any person that you think should be notified.

Please note that only Registered Interested and Affected Parties will be notified of the:

- environmental reports that become available for public viewing and comment, and
- outcome of the application, the reasons for the decision; and that an appeal may be lodged against the decision; and if applicable, and
- applicant's intention to appeal the decision of the competent authority.

Consultant: EnviroAfrica NC CC. P.O. Box 5367, Helderberg, 7135 / Fax: 086 512 0154 / Tel: 021 8511616 / E-mail: clinton@enviroafrica.co.za

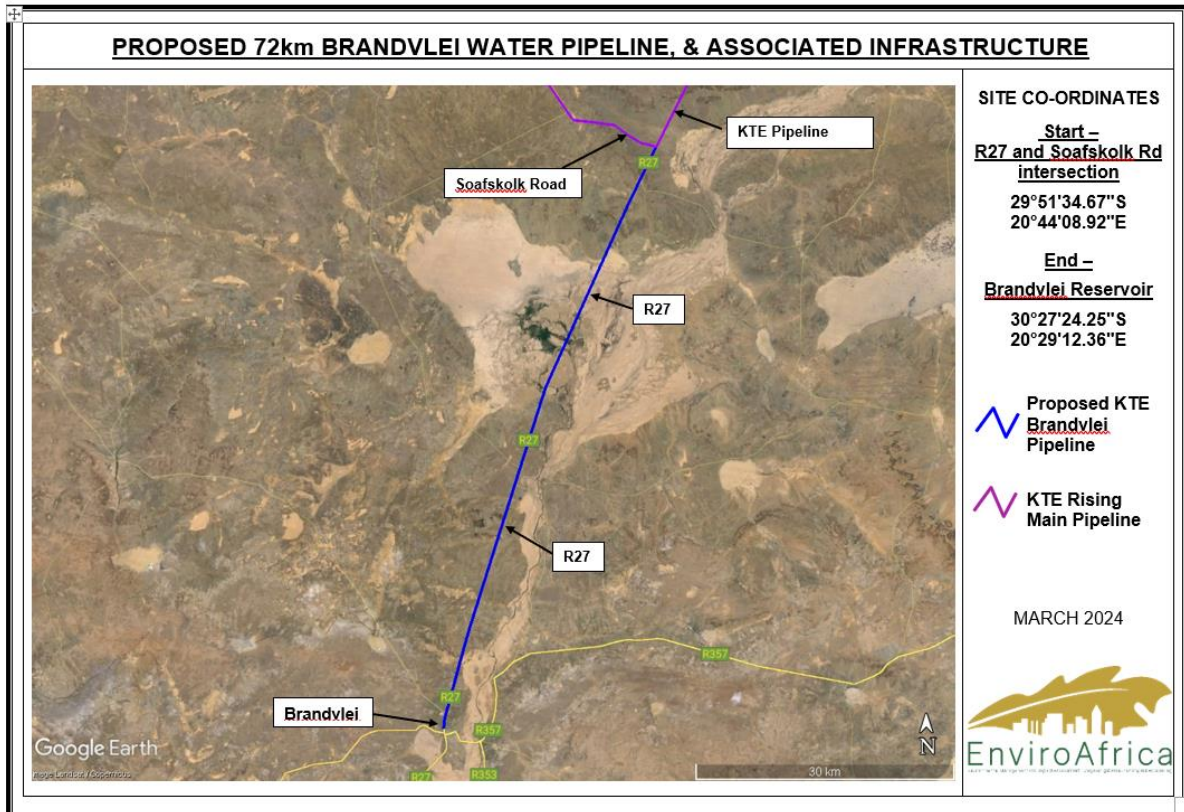


Figure 1 Public Participation

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 rock quarry is adjacent to natural drainage lines that are identified in the NWA and its regulations as legitimate water resources. The drainage lines could possibly be altered, should the development go ahead.

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

The proposed pipeline may alter the characteristics of the drainage lines.

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 DEA and its regional agencies, in this case the DENC of the Northern Cape Provincial Government, may take place within 32m of a water course. The mostly dry drainage lines are perceived to be legitimate water courses.

3 Locality

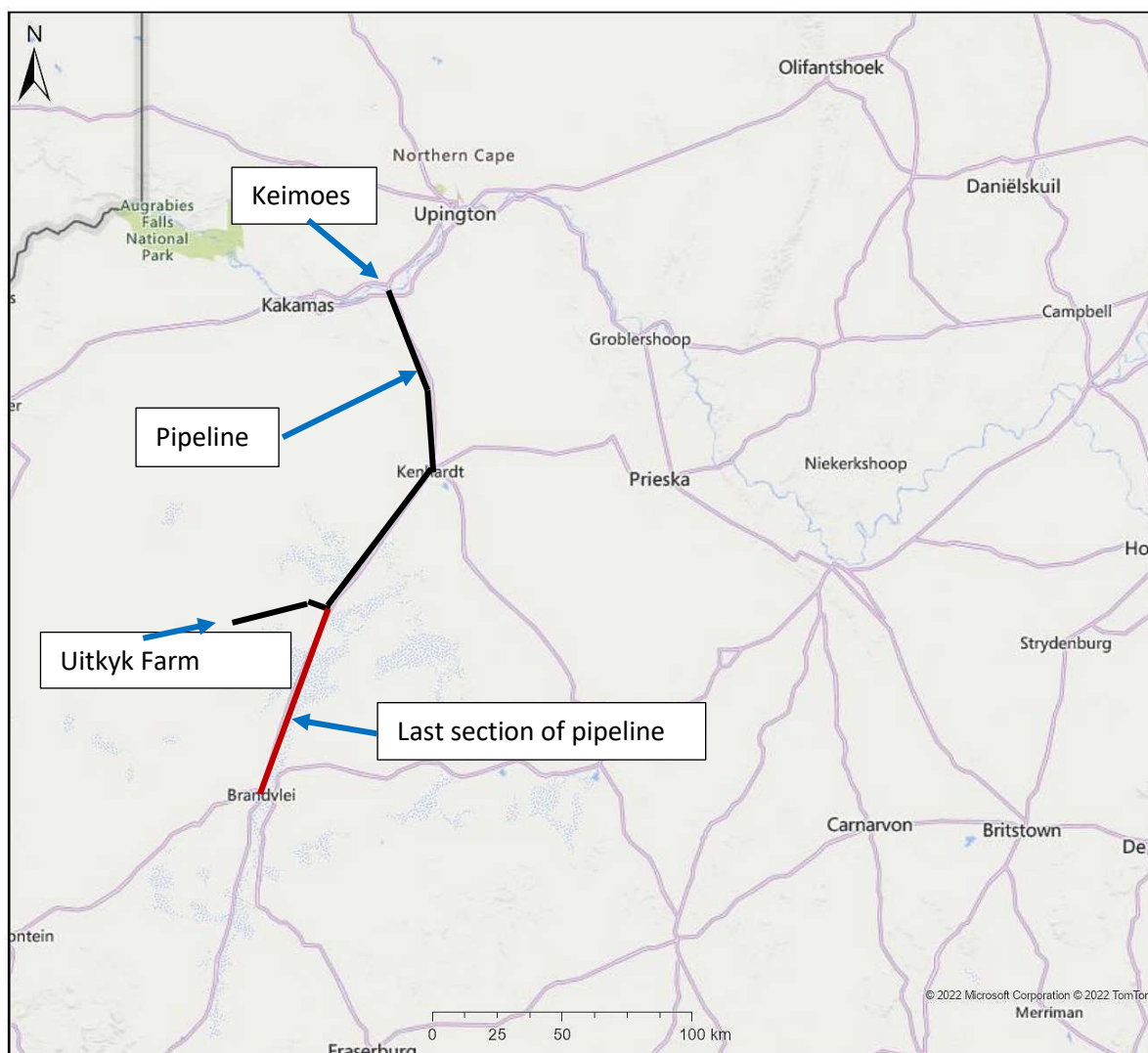


Figure 2 Locality

The proposed water provision pipeline will stretch from the Orange River south of the town of Keimoes to the Uitkyk Farm approximately halfway between Kenhardt and Brandvlei in the Northern Cape (Figure 2).

The last section of pipeline to Brandvlei now under discussion is indicated in Figure 2.

4 Brandvlei Climate

Brandvlei (Figure 1) is the closest locality to Uitkyk Farm for which an average annual rainfall is available on the internet. The scope and available budget for the average application of this nature does not allow to purchase accurate weather data but for the purpose of this application, the numbers given here are adequate.

Brandvlei normally receives about 54mm of rain per year, with most rainfall occurring mainly during autumn. The chart below (lower left, Figure 3) shows the average rainfall values for Brandvlei per month. It receives the lowest rainfall (0mm) in August and the highest (17mm) in March. The monthly distribution of average daily maximum temperatures (centre chart below) shows that the average midday temperatures for Brandvlei range from 17.1°C in July to 32°C in January. The region is the coldest during July when the mercury drops to 2°C on average during the night.

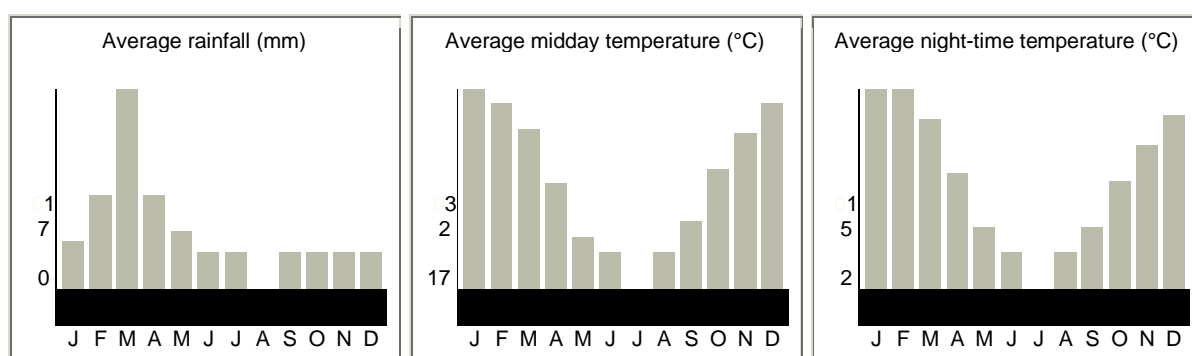


Figure 3 Brandvlei Climate

The evaporation rate amounts to 2800mm per year. This is tantamount to desert conditions.

Communities in the region are dependent on the occasional flooding of the Sak / Hartbees River system, which occasionally comes down in flood, once in a couple of years. Floods are mostly the result of violent and sudden electric thunderstorms.

The far south, the Sak River catchment touches on the winter rainfall region of the Western Cape.

Keimoes to the north receives 151mm of rain per year, which is slightly more, but still close to desert conditions.

5 Conservation Status

5.1 Vegetation

According to Mucina & Rutherford (2006), the following vegetation types occur along the path of the proposed pipeline:

Bushmanland Arid Grassland

This vegetation type is of “Least Concern” (Appendix) and are not endangered in any way. The landscape has not been subject to transformation or major impacts and the proposed pipeline will not change any of this, as it will be in existing road reserves.

5.2 DFFE Screening Tool

Table 1 DFFE Screening Tool Results

Theme	Sensitivity
Animal species	High
Aquatic biodiversity	Very High
Plant species	Medium
Terrestrial biodiversity	Very High

Animal species theme

The following birds of prey are responsible for the High sensitivity rating for the animal species theme:

<i>Polemeatus bellicosus</i>	Martial eagle
<i>Neotis ludwigii</i>	Ludwig's bustard
<i>Hydroprogna caspia</i>	Caspian tern
<i>Calendulauda burra</i>	Red lark

These birds have a wide distribution area in South Africa and even in Africa. The caspian tern has populations abroad. The red lark is a localised species with a limited distribution. The proposed pipeline is not about to have any impact on the conservation status of these birds. Ludwig's bustard is prone to collide with power

lines. The pipeline *per se* will not be provided with any power lines or high structures of the kind that pose a threat to any species of bird.

Aquatic Biodiversity

The aquatic biodiversity sensitivity is rated as “Very High” because the pans are listed as Bushmanland Bioregion Depressions. The sub-catchments and some of the drainage lines are listed as FEPA’s. This report aims to illustrate that the proposed underground pipeline is not about to change this rating, provided that the mitigating measures are adhered to.

Plant Species Theme

The plants and botanical communities will be dealt with in a separate botanical report compiled by an experienced and qualified botanist. The proposed pipeline will be constructed on existing road verge and will not impact on any natural plant communities along its path.

Terrestrial Biodiversity

The path of the proposed pipeline is rated as “Very High” for the Terrestrial Biodiversity Theme because it is identified as a CBA, an ESA, important according to the Protected Area Expansion Strategy and the rivers and some of the drainage lines are regarded as NFEPA’s.

This report aims to illustrate that the proposed underground pipeline does not pose a threat of a change to any of these ratings, provided that the mitigating measures are adhered to, as the evaluations in the following paragraphs will illustrate.

6 The Hartbees River, Sak River and the Pans

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 4).

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



Figure 4 Sak / Hartbees River system

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 Sak 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.

7 Drainage Lines

The landscape around much of the Lower Orange River and the Sak River is dominated by a dense succession of drainage lines. They spread along the river with many smaller tributaries to cover the entire area. The iron oxides in the sands renders a red hue that is visible from space on the Google Earth images. These reds are concentrated in the drainage lines, making them even more visible (Figure 5).

The drainage lines are mostly dry, with water only during rains and perhaps shortly thereafter. During the odd thunderstorm, drainage lines can come down in flood. These floods maintain the drainage line's morphological integrity, as sediments are moved and these water ways are scoured out.

Because rainfall events are far apart, the drainage lines must have been form over millennia, even since geological times.

These drainage lines are driven by the very scant rainfall events, sudden and sometimes severe thunderstorms, spread out over millennia. Rainfall is interspersed by prolonged droughts. This gives rise to a sparse and drought resistant vegetation. The shallow ground water that migrates along these drainage lines provides just enough moist for higher vegetation to take root and to hold on under these very harsh climatic conditions. Drainage lines are ecologically important, as it provides denser and higher vegetation in an otherwise barren landscape, contributing to habitat variation, biodiversity and migration routes.

The upper sub-catchments of these drainage lines are mostly near-pristine, with only grazing. The lower parts are heavily impacted by agriculture and sand winning. This stark contrast is evident all over the region.

Around the Orange River, the Hartbees River and even the Sak River, large-scale agriculture has changed the drainage lines into drainage channels among the vineyards and orchards. The upper reaches away from the rivers are less impacted, even near-pristine, as intense agriculture is not possible, apart from those areas where water is piped over long distances from the Orange River.

Much of the discussion in this report is about these drainage lines.



Figure 5 Drainage Lines

8 Sheet Wash Plains

Smaller drainage lines all over the landscape are marked by lines of driedoring (*Rhigozum trichotomum*) rather than red iron oxide depositions. These woody and thorny bushes find more soil moisture along the drainage lines than elsewhere, hence the denser stand. These small lines are visible on Google Earth images. This landform can be described as drainage line wash fields.

These drainage lines connect to one another in a continuous fan, interconnected, with no visual demarcation between drainage lines. This is visible on Google Earth Images, as well as on the ground. During rainfall events, storm water spreads out, migrates sideways, left and right, the flow slows down, deposits its sediment load to create sandy or gravelly sheet wash plains. Sediment transportation and deposition are clearly visible.

Where larger drainage lines fuse in this manner lower down sub-catchments, much larger sheet wash plains are evident.

9 Landscape further south to Brandvlei

The landscape changes from the turnoff at Soafskolk southward towards Brandvlei. Larger drainage lines give way to a multitude of small drainage line wash plains. The boundaries of sub-catchments were difficult to determine.

The landscape here is dotted by a profusion of smaller diffuse pans. These are arranged in places along preferred stormwater flow paths.

The pipeline will pass through the Grootvloer Pan, a prominent feature on the Boesmanland landscape.

10 Drainage Lines Methodology

There were numerous drainage lines along the paths of the envisaged pipeline, too many to find the coordinates for each of these crossings.

To get to grips with the volume of the work that had to be completed within the available time and budget of this application, as is the case with most if not all applications, the drainage lines, depending on their size, were divided into 5 classes (Table 2)

Classes 1 (Figure 6), 2 and 3 were only counted. Class 4 and 5 were marked, the coordinates were noted, using a hand-held GPS. These drainage lines were photographed, upstream and downstream of the road, as well as the culvert or bridge.

A complete record of these photographs is available. This photographic record is substantial and cannot be all included in this Freshwater Report, but is available upon request, should the contractor require more information.

The classification for some of the drainage lines posed difficulty because erosion downstream of a culvert can be substantial, with dongas, vertical sides and wide beds, while upstream there can be scarcely a sign of any drainage line. It was surmised that the smooth foundation of a box culvert or a large pipe culvert can cause the flow of storm water to be accelerated. Where it gushes out from underneath the road, it possesses adequate velocity and as a result an enhanced erosion potential to scour out a substantial drainage line. Upstream of the culvert, the drainage line can be a Class 1 or 2, while downstream it can be a Class 4 or 5. In this event, an average score for the class was arrived at.

This has consequences for the laying of the pipeline. It seems to be much more cost effective to excavate the trench and bury the pipeline upstream of the culverts and the roads. Downstream of the culverts, adjacent to the roads, there are many more Class 4 and 5 drainage lines that require much more earth works and other civil infrastructure.

This methodology was applied on 18, 19 and 20 October 2022 and again on 11 and 12 March 2024.

As a result, the entrances were clearly visible from a passing vehicle.



Figure 6 Class 1 drainage line with pipe culvert.

Table 2 Drainage Line Classes

Class	Characteristics	Actions
Class 1	There is no discernible or visible drainage line. There is only a culvert.	No action is required.
Class 2	There is a drainage line. The drainage line is faint.	No action is required.
Class 3	There is a discernible drainage line. The drainage line is distinct.	No action is required, apart from that the backfill must be 900mm deep.
Class 4	There is an obvious, discernible drainage line, with clear signs of sediment transportation.	Pipeline protection measures and erosion control measures must be implemented. The pipeline must be covered with 900 to 1200mm of backfill.
Class 5	Drainage lines resemble a river, more often than not incised, often with a wide riverbed.	Pipelines protection measures must be implemented, such as gabions, reno mattresses and anchors.

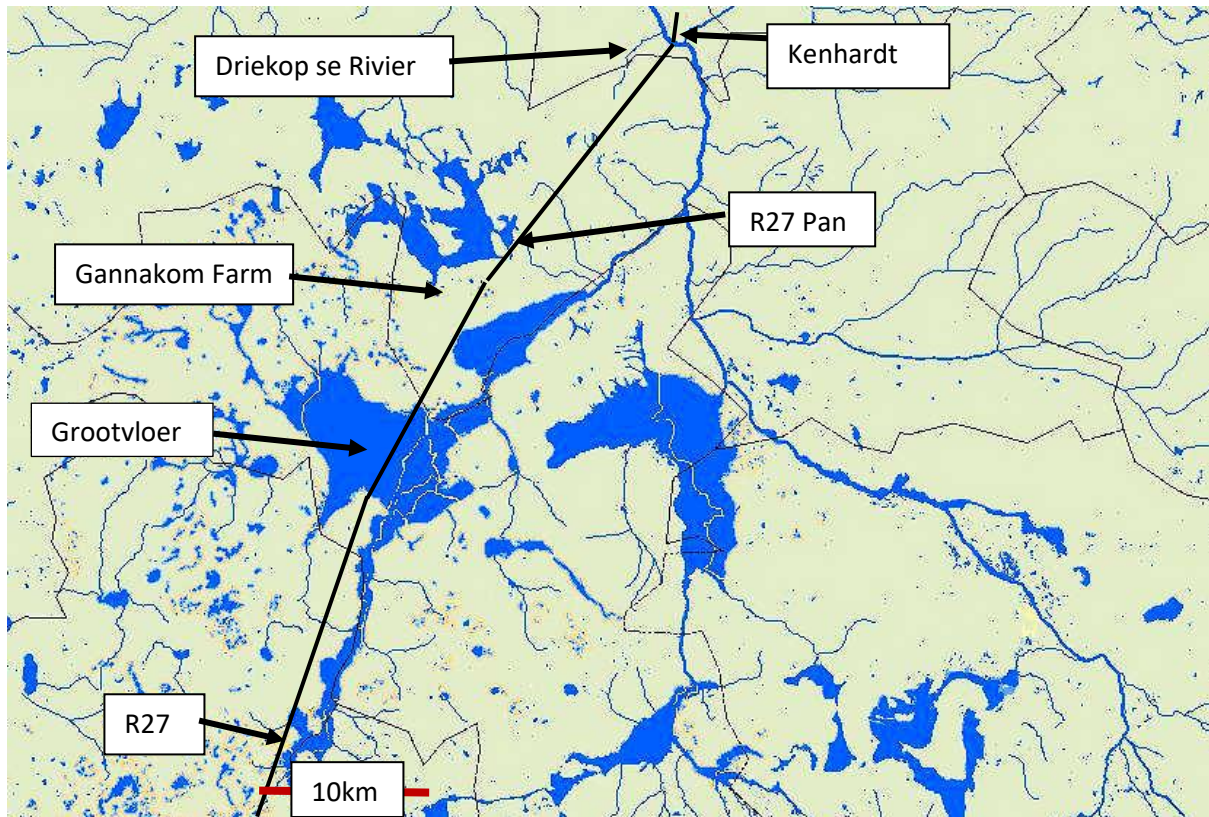


Figure 7 NFEPA (SANBI BGIS)

The proposed pipeline passes through Grootvloer Pan (Figure 7), which is one of the larger pans in a series of Bushmanland pans of the Northern Cape.

All these pans are classified as NFEPA's (SANBI BGIS webpage).

Grootvloer

The Grootvloer (Figure 8) is one of the bigger pans in the central Boesmanland and is a prominent feature on the landscape. It is roughly divided into a western part of 29000ha and an eastern part of 27000ha. This adds up to 56000ha. These two parts are connected. This connection in the north resembles the rest of the pan in the north. In the central part and further south, the connections resemble drainage lines (Figure 8).

The Grootvloer Pan is difficult to demarcate, as it has diffuse banks (“frilly edges”) with a profusion of drainage line wash fields and small diffuse pans along its banks.

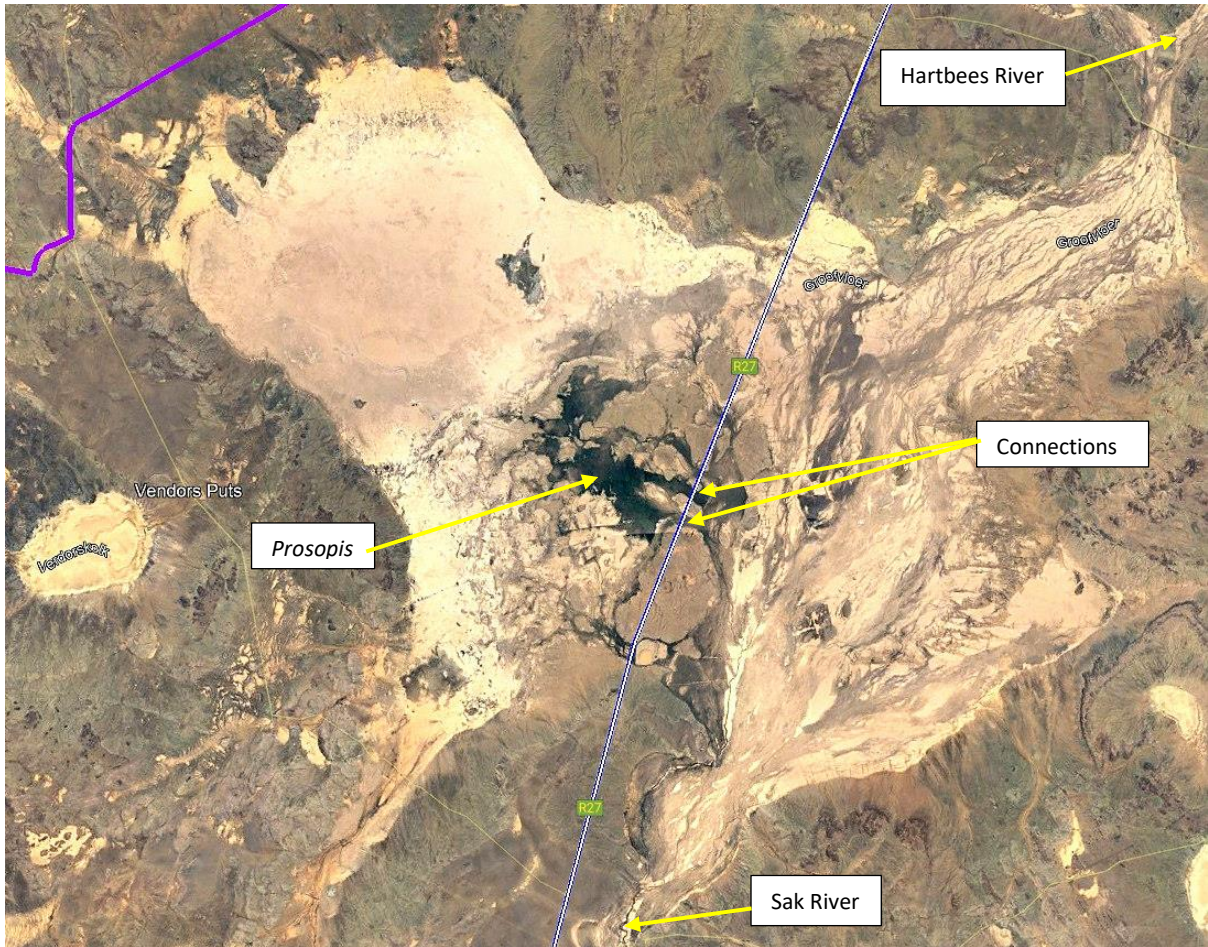


Figure 8 Grootvloer

Much of the pan can be classified as a mixed grass pan and a scrub pan. Some middle parts resemble a bare pan.

The central part of the pan, the middle connection between the two parts, is densely overgrown with *Prosopis* trees. These exotic invasive trees are clearly visible of Google Earth images (Figure 8).

The R27 trunk road passes through the pan from south to north. So will the new pipeline, in the road reserve.

The Sak River replenishes water of the Grootvloer when the winter rains far down south are enough to cause the very occasional flood. The Sak River breaks up in the middle parts of the Grootvloer in what looks like a delta. The flow in the many drainage lines in the northern parts of the Grootvloer is to the south, to the middle parts of the Grootvloer Pan, where stormwater from both north and south accumulates. Only when the Grootvloer overflows, once in 5 years or more, water flows into the Hartbees River to the north. The Hartbees River is an extension of the Sak River and ends up in the Orange River far to the north at Keimoes.

Drainage lines cross the western part of the Grootvloer from west to east. These are barren, devoid of vegetation and sandy. These are interestingly not stained by red iron oxide.

In the past attempts have been made to practice agriculture in the Grootvloer, with the lesions of ploughed over parcels of land still visible on Google Earth. These attempts proved to be unsuccessful as upstream water abstraction for agriculture and irrigation progressed, with less water entering the Grootvloer.

12 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.

12.1 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.

12.2 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.

12.3 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.

12.4 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 7000km².

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.

12.5 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 brachiopod 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.

12.6 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/dedecker_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.

12.7 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.

It seems as if the bare pan along the R27 is stable and is not about to regress.

During the site visit in September 2022, larger pans further south were overgrown with low vegetation, following the good rains of the past two or three seasons. These pans very much resemble bare pans, but during the last site visit, regression was suggested towards scrub pans.

It is not known if this small pan has any unique organisms or special planktonic assemblages. Future research will, no doubt, illustrate these pan's contribution to biodiversity. Meanwhile, mitigating measures must be taken seriously.

13 Drainage lines from Soafskolk turnoff to Brandvlei

As was stated before, it was decided to extend the proposed pipeline all the way to Brandvlei. This was not in the original plan. This added another 72km to the pipeline. Therefore, a second site visit was necessary. The site visit was undertaken in March 2024.

Driving down south from the turnoff towards Brandvlei, two more Class 4 drainage lines are encountered (Figure 9).

There are 279 more Class 1 drainage lines, 36 Class 2 and 23 Class 3 drainage lines.

Another prominent feature in the landscape is the pans of central Boesmanland.

The first Class 4 drainage line (Figure 10) is a connection between two parts of a large pan on either side of the R27. The pan here is densely overgrown with *Prosopis* trees (Figure 10). The drainage line has a constructed two-arch culvert. Downstream and adjacent to the road is a concrete slab and a reno mattress-type reinforcement of the drainage line bed.

The second Class 4 drainage line is at the well-known Oom Benna's roadhouse. The drainage line is vegetated, with some aquatic plants in the bed (Figure 11). The one bank is overgrown with *Prosopis*.

The R27 trunk road transverses a pan named Grootvloer. This is for the most a mixed grass pan. A large part is a scrub pan, with many variations between grass and scrub. The central part is heavily overgrown with *Prosopis* that is visible on Google Earth images a dark-coloured patch (Figure 9). Adjacent to the south is a stand of sweet thorn trees.

During rare occasions when the pan is under a shallow layer of water after heavy rains, wind-induced water movement can be expected, moving water over such a vast surface area from one end of the pan to the downwind shore. This could theoretically create enough velocity to bring about soil erosion. Such erosion would then be apparent at the many R27 culverts and the drainage lines. This, against expectations, does not occur. The water must be gently rising and falling with rainfall events without much wind-induced movement, as sediment transport is not apparent (Figure 12). The road engineers were probably expecting more movement as well, as some of these culverts are large (Figure 12).



Figure 9 Proposed pipeline from the Turnoff to Brandvlei.



Figure 10 Point No 1



Figure 11 Point No.2



Figure 12 Grootvloer culvert

This bodes well for the pipeline construction, as the points where the pan passes under the road can mostly be classified as Class 1. No extra construction or protection of the pipeline is required along most of the way to Brandvlei.






Table 3 gives the numbers of each class that was observed and counted during the site visits. These numbers were recorded from the Soafskolk turnoff to Brandvlei.

Table 3 Number of drainage line crossings

Route	Class 1	Class 2	Class 3	Class 4	Class 5
	●	●	●	●	●
	279	36	31	2	0
Grand Total	340				

Table 4 indicates the coordinates of the two class 4 drainage line crossings.

Table 4 Class 4 drainage line coordinates

No.	Coordinates	  
1	30°03'38.02"S 20°37'38.32"E	
2	30°19'38.23"S 20°21'14.34"E	

The first Class 4 crossing is not the usual drainage line as it is the connection between the two major parts of Grootvloer. It superficially resembles a drainage line at the culvert on the R27 but must rather be considered as a part of a pan. As previously described, when the pans fill up mostly because of rain in the upper catchment far to the south, the water level rises in this connection, only to drop when the water in the pan evaporates. It seems as if the raging torrent of water during stormwater events in most drainage lines of the region does not occur in these connections between the parts of the Grootvloer. Water movement here seems to be more benign.



Figure 13 Oom Bennis Class 4 drainage line

Likewise, the Class 4 drainage line at Oom Benna's (Number 2 in Figure 9) proved to be a connection of a much smaller pan sub-system (Figure 13). The diffuse line of pans to the west connect to the Vis River and its associated pan to the east. Again, water movement here seems to be in unison with the filling of the pans rather than a result of large thunderstorms. The pan and the connection were modified with 5 or more walls across for the retainment of water for agriculture. Water, when available, in the district is shunted around in pipelines with pumps. Perhaps the many small dam walls here are part of the same arrangement.

14 Present Ecological State

The PES is a protocol that have been produced by Dr Neels Kleynhans (Table 5 and 6) in 1999 of the then DWAF to assess river reaches. This is one of the prescribed tests and the results must be presented in the Risk Matrix. Drainage lines are legitimate water resources, in terms of the NWA and those along the R27 crossing the proposed pipeline are accordingly assessed. The scores and entirely that of the assessor.

Table 5 Habitat Integrity according to Kleynhans, 1999

Category	Description	% of maximum score
A	Unmodified, natural	90 – 100
B	Largely natural with few modifications. A small change in natural habitats and biota, but the ecosystem function is unchanged.	80 – 89
C	Moderately modified. A loss and change of the natural habitat and biota, but the ecosystem function is predominantly unchanged.	60 – 79
D	Largely modified. A significant loss of natural habitat, biota and ecosystem function.	40 – 59
E	Extensive modified with loss of habitat, biota and ecosystem function	20 – 39
F	Critically modified with almost complete loss of habitat, biota and ecosystem function. In worse cases ecosystem function has been destroyed and changes are irreversible	0 - 19

14.1 Drainage lines

Table 6 Present Ecological State of the drainage lines

	Score	Weight	Product	Maximum score
Instream				
Water abstraction	24	14	336	350
Flow modification	20	13	260	325
Bed modification	20	13	260	325
Channel modification	19	13	247	325
Water quality	24	14	336	350
Inundation	21	10	210	250
Exotic macrophytes	24	9	216	225
Exotic fauna	15	8	120	200
Solid waste disposal	25	6	150	150
Total		100	2135	2500
% of total			85.4	
Class			B	
Riparian				
Water abstraction	24	13	312	325
Inundation	20	11	220	275
Flow modification	20	12	240	300
Water quality	24	13	312	325
Indigenous vegetation removal	24	13	312	325
Exotic vegetation encroachment	22	12	264	300
Bank erosion	21	14	294	350
Channel modification	19	12	228	300
Total			2182	2500
% of total			87.3	
Class			B	

14.2 Pans

Table 7 Habitat integrity assessment criteria for palustrine wetlands (DWAF,1999)

Criteria and attributes	Relevance	Groot-vloer	Oom Bennis
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.	2	1
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	5	2
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	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	3
Hydraulic/ Geomorphic			
Canalization	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage	3	3
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.	3	3
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.	3	3
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.	3	3
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	4	3
Alien fauna	Presence of alien fauna affecting faunal community structure.	2	2
Over utilisation of biota	Overgrazing, Over-fishing, etc.	4	4
Average		3.2	2.7

Table 8 Scoring guidelines for the habitat integrity assessment for palustrine wetlands (DWAF, 1999).

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

Table 9 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

The pans were scored separately from the drainage lines according to the methodology of Kleynhans (1999). (Tables 7 to 9).

According to this assessment, Grootvloer is still in good ecological shape with minor loss of habitat.

Oom Bennis pan is worse, with more loss of habitat and with some more loss of ecosystem function.

Table 10 PES Summary

Waterway	Instream	Riparian
Drainage lines	B	B
Grootvloer Oom Bennis	B C	

The proposed pipeline is not expected to change this classification. There already is a pipeline and another one along the same route is not about to make a difference, the pipeline will be in the already disturbed road reserve and the nature of the operation, the laying of the new pipeline, is as such that it is not going to create an undue disturbance, provided that the mitigation measures are adhered to.

15 Ecological Importance

Drainage Lines

The Ecological Importance (EI) is based on the presence of especially fish species that are endangered on a local, regional or national level (Table 13).

There are no fish in the drainage lines, as there is no permanent water. According to this assessment, the drainage lines are not important.

No other endangered species, either plant or animal, were detected in or near the drainage line. A protected tree, camel thorn *Vachellia erioloba* is listed as “least concern” on the SANBI Red List. Another protected tree of the area, the shepherd’s tree *Boscia albitrunca*, was noticed along some of the drainage lines.

The riparian zones and associated higher vegetation, the ecologically important corridors this brings about and the migration routes in an otherwise featureless and homogeneous landscape render drainage lines ecologically important.

Pans

When the pans flood with the occasional rain, a fascinating ecology springs to life, as has been described previously. Current research will reveal if any species are endemic to the pans or if there are new species or if the planktonic community is unique. Until this has been researched and published, the pans are regarded as potentially ecologically important.

16 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 drainage lines are ecologically sensitive because it would take many decades for the riparian vegetation to regrow once it has been removed during the excavation of the trench for the pipeline. Most of the envisaged pipeline is in the road reserve where vegetation is controlled.

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.

17 EISC

The DWS demand that the drainage line and the wetlands be placed in a category according to the EISC methodology. The EISC is one of the essential items that is required for the Risk Matrix.

Table 11 EISC

Determinant	Drainage Lines	Pans
Rare and endangered species	1	2
Populations of unique species	1	2
Species / Taxon richness	2	2
Diversity of habitat	2	2
Migration Route/ Breeding and feeding site for wetland species	3	4
Sensitivity to water quality changes	1	2
Flood storage, energy dissipation, particulate / element removal	2	1
Protection status	1	3
Ecological integrity	4	3
Average	1.9	1.9
Score	Low	Low

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

18 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 29.3, p69, 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 p70 to derive at a value for Significance. The value for Significance can subsequently be evaluated according to Table 29.3.2.

Table 29.3.2 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 12), 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 12 Significance Score

Parameter	Drainage lines	Pans
Conservation value	1	3
Likelihood	5	5
Duration	1	5
Extent	1	1
Severity	1	1
Significance	8	15
	Insignificant	Insignificant

The significance rating for the drainage lines came out as “Insignificant”, mainly because the conservation value is regarded as low. The trenching of the pipeline through the drainage lines, the subsequent infilling and rehabilitation rating was insignificant because this is a once-of construction with a short duration on a short drainage line reach (rather a point than a reach).

The significance rating for the pans was Low as well, even though the conservation value is more. The extent and severity of the impacts are insignificant.

19 Possible Impacts and Mitigating Measures

Mitigating measures have been discussed all along in this report but the purpose of the EIA report, it is necessary that these measures be put together under a single heading.

Drainage lines

Disturbed vegetation in these arid areas takes decades to restore itself, if not a millennium. The proposed pipeline follows an existing trenched pipeline in the R27 road reserve and as such will not have an additional impact on the Bushmanland vegetation

Stormwater flow can potentially be impacted. Any change in the surface of drainage lines next to the R27 where the pipeline has been trenched can cause deposition or erosion.

The envisaged pipelines are to follow the roads, according to planning, in the road reserves.

There are numerous crossings of the pipes over or through the drainage lines. Where these crossings occur, the water supply pipeline must:

- Not wash open during the occasional storm event, when drainage lines may come down in flood.
- Allow the free flow of storm water as it was before the installation of the pipeline. Storm water must not dam up behind the pipeline. The installed pipeline and its associated infrastructure must not deviate the flow of storm water in any way.
- The pipeline, its construction and operation, must not be conducive to more sediment transportation along with occasional moving flood water.
-

These are the main aims of the environmental program during the life cycle of the envisaged pipeline.

Protection measures include the following:

- The pipeline must be entrenched deeper, with more backfill cover. It is assumed that 700mm is adequate for most of the distance, but where it crosses more prominent drainage lines, it can vary between 900mm and 1200mm, depending on the size of the drainage line.
- Where large drainage lines or rivers are crossed, the pipeline must be protected with gabions, reno mattresses or even concrete structures. It should be buried deep enough so that the chance of washing open is minimized, at 1200mm or more. The riverbanks may need stabilization as well.

The best time to construct the pipelines will be during the dry season, when the likelihood of flash floods are at its lowest.

Clusters

There are 3 clusters with one or two Class 5 drainage lines, flanked by several Class 1 up to Class 3 drainage lines, spread out over several hundred meters. It is best that these clusters are viewed as a single unit instead of only one Class 5 drainage line. In practical terms, this means that the pipeline must be trenched deeper, with 1 to 1.5m backfill over it, to ensure that it does not become exposed because of a flood. This trench must stretch over the entire width of the cluster where it passes underneath the R27, covering all the drainage lines, big and small. This policy makes provision for erosion and deposition, when drainage lines migrate over the landscape, as they do, during major flood events.

The pans are more likely to be flooded during winter, when the upper catchment far to the south receives winter rainfall.

Sandy Drainage Line Beds

Several drainage lines have smooth sandy beds with little signs of erosion, but with strong signs of deposition. It is important not to disturb the flow resistance in the floors of these drainage lines. After the pipeline has been trenched and backfilled, the ground surface must be smooth and without any obstacles that can give rise to either erosion or more deposition in the event of a flood. Careful landscaping is necessary to finish off the project in these drainage lines. This is important for the larger Class 4 drainage lines that are spanned by proper bridges and many of the Class 3 drainage lines with single or double box culverts and even some with only pipe culverts.

Granite

The substrate to the south of Kenhardt is granite, covered with a thin layer of sand. Trenching will require heavy earthmoving machinery or even blasting. The pipe, after placed in the trench, will be backfilled with sand, according to the usual practice. The trench will be further filled with gravel or broken rock, probably retrieved from the trench. Enough space must be left to backfill the top layer with the same fluvial sand that was first removed from the surface when the trench was started. Again, the surface must resemble the original smoothness and the same flow resistance of the original channel.

It is not expected to encounter much dolerite in the drainage lines, as this formation usually forms the base for the ridges. This rock is hard and would probably require blasting and even more care during the backfill and rehabilitation phase.

Eroded drainage lines

The culvert's floors underneath the R27 are flat, smooth concrete with little flow resistance, with the result that stormwater flowing through the culverts may experience a significant increase in flow velocity, coming out at the downstream end of the culvert much vaster, with an increased erosion potential. Many of the drainage lines are hardly visible or are small upstream of culverts, but apparently increase in size downstream because of erosion. A drainage line may be Class 1 or 2 upstream of the R27 but may appear as a Class 3 or 4 downstream.

It is therefore advisable to trench the pipeline upstream of the R27. This may not be possible, as the new pipeline is to follow the path of the existing one, which is either on the downstream or the upstream side of the R27.

It is suggested that already eroded areas adjacent and downstream of the R27 road culverts are paved with concrete to effectively stop any further erosion after the pipeline has been laid. This may, unfortunately, exacerbate the problem, as erosion would be transferred further downstream adjacent the newly paved exit.

If it is necessary to even further pave culvert exits, it may be done so with rock and cement, with a special effort to create a rough surface with much flow resistance to

slow stormwater down. At the far end, on the verge of the pavement, bigger rocks can be placed and cemented in to finally break up the current (Figure 14).



Figure 14 Stormwater calming infrastructure.

Observations on the ground suggest that people drive their vehicles over drainage lines in the road reserves, for whatever purpose. The rock and concrete paving must therefore be of such a nature that the usual pickup truck can still drive over it.

Gabions and other structures

Several drainage lines have gabions, reno mattresses and rock-and-cement paving that must be broken up for trenching the pipeline. Having completed the laying of the pipeline, these structures must be restored to match or improve their previous functionality.

There are a great many berms at the pipe culverts that must be restored. These were not counted, but according to estimation, there must be at least 150 such culverts, with berms on both sides of the road. The restoration of the numerous berms represents a significant cost.

To the south of Kenhardt, on the southern slope of a dolerite ridge, are 8 walls in the road reserve for the purpose of flood control (Figure 15). These will have to be demolished for the pipeline to be trenching and afterwards be fully restored.



Figure 15 Flood control walls

Pans

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 R27 and the road reserve already constitutes a preferential flow path into the R27 pan. The compacted backfill can add to this. No more water other than the natural runoff must be allowed to enter the pans.

Permanent inundation

Stormwater must not be allowed to dam anywhere on the compacted backfill on the pipeline to subtract from the natural flow down the decline into the pans. The inundation regime must not be affected.

Water quality modification

The soil will be loosened during the digging and filling in of the trench, 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 pans. It is best to instal the pipeline during the dry season. Take note that the pans may be flooded during the winter, even though the Northern Cape would be dry.

Sediment load modification

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

Canalization

Proper backfilling and compaction will assure that a canal will not be created along the R27 to the pans.

Topographic alteration

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

Terrestrial encroachment

The crossings on the Grootvloer are already overgrown with invasive trees. The installation of the pipeline will not be the cause of vegetation further encroaching onto the pan. Scheduled road maintenance, of which there was adequate evidence during the site visit, will further prevent further encroachment of vegetation onto the pan in the road reserve.

Indigenous vegetation removal

No indigenous vegetation of special note was noted on the road reserve at the pans where the pipeline is to be installed.

Invasive vegetation encroachment

There was a heavy *Prosopis* infestation no invasive at the Grootvloer crossings. It is not foreseen that the installation of the pipeline will alter the vegetation regime. It would take a serious effort to combat further encroachment.

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 pans.

Over-utilization

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

Isolation / Migration

The affected pans are 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 pipeline will obviously not alter any of this.

Ground water table

The trenched pipeline must not create a preferential flow path for the any of the pan's water, when it floods, to enter the ground water. It is not known if the pans are underlain by impermeable material, as much of the landscape in the area. The precautions that must be taken include the storage of the topsoil as it is removed for the trench, layer by layer and subsequently replaced and compacted on top of the backfilled pipeline. Once the pipeline is underground, the permeability must resemble that of the conditions prior to the pipeline, or as close as technically possible.

Waste

Portable toilets will be serviced by a reputable company and wastewater will be discharged in the municipal wastewater treatment works. Litter will be collected in household wheelie bins and it will be disposed of on the municipal waste disposal site.

20 Impact Assessment

Some of the authorities prescribe an impact assessment according to a premeditated methodology. It follows the stages of the project life cycle, planning, construction, operation and decommissioning and rehabilitation. In this event, the assessment is focussed on the aquatic environment. Only the construction and operation phase are discussed. The prevention of dirt and sand because moving into the drainage lines and the pan and the trench's filling in and the levelling and landscaping after the pipe has been laid is of particular importance.

Table 13 Impact Assessment

<p>Description of impact Construction Phase</p> <p>Trenching of the new pipeline, washing of soil down the drainage line during storm events Trenching of the new pipeline through the Grootvloer pan, washing sediments into the pan when it rains Trenching of the new pipeline along the banks of the pan, washing of sediments into the pan</p> <p>Mitigation measures</p> <p>Do not disturb any land outside of designated trenching area in the reserve of existing roads Construct outside of rainy season Ensure that the new pipeline is trenched deep enough as appropriate for various water ways. Carefully replace backfill in layers and compact to resemble permeability prior to construction Level and landscape wherever the pipeline is trenched Remove divots and bumps as not to encourage deposition or erosion Take measures to ensure that the pipeline is not denuded in drainage lines and the river.</p>								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Temporary	High	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Regional	Low	Temporary	Low	Definite	Certain	Reversible	Replaceable

<p>Description of impact Rehabilitation following construction</p> <p>Destruction of stormwater infrastructure in the road reserve such as walls, berms, gabions and reno mattresses</p> <p>Mitigation measures</p> <p>Repair the stormwater infrastructure in the road reserve to effectively prevent erosion and excessive runoff.</p>								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Temporary	High	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Regional	Low	Temporary	Low	Definite	Certain	Reversible	Replaceable

Description of impact Operational phase								
Operation of new pipeline								
Mitigation measures								
Budget for the maintenance of the pipeline and the road reserve Inspect according to schedule and repair if leaking, prevent denuding of pipeline, cover when denuded. Maintain and repair stormwater infrastructure if required								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	Medium	Permanent	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Regional	Low	Permanent	Low	Unlikely	Certain	Reversible	Replaceable

The main benefit of this exercise is that it allows for the evaluation of mitigation measures. The mitigating measures, as evaluated in this assessment, have the potential of being successful.

The methodology is set out in the Appendix.

21 Risk Matrix

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 14 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report.

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

The methodology is set out in the Appendix. It has been copied directly out of the DWS webpage.

The risks to the aquatic environment are “Low”.

The Risk Matrix indicate that a General Authorisation should be considered.

Table 14 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1.1	Construction phase	Entrench through drainage lines.	Soil and sediments in drainage lines river and pans.	26	Low
1.2		Entrench through Grootvloer		26	Low
1.3		Entrench on banks of pans.		28	Low
2	Construction phase	Destruction of stormwater management infrastructure	Sedimentation and erosion	28	Low
3	Operation of pipeline	Denuded or leaking pipeline	Habitat alteration	45	Low

Table 14 Continued Risk Rating

No	Flow	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
1.1	1	2	1	1	1.25	1	1	3.25
1.2	1	2	1	1	1.25	1	1	3.25
1.3	1	1	2	2	1.50	1	1	3.5
2	2	1	1	1	1.25	1	1	3.25
3	1	1	2	2	1.5	1	2	4.5

No	Frequency of activity	Frequency of impact	Legal issues	Detection	Likelihood	Significance	Risk Rating
1.1	1	1	5	1	8	26	Low
1.2	1	1	5	1	8	26	Low
1.3	1	1	5	1	8	26	Low
2	1	1	5	1	8	28	Low
3	2	2	5	1	10	45	Low

The goods and services delivered by the environment, in this case the drainage lines, the Grootvloer Pan and Oom Bennis diffuse pans, is a Resource Economics concept as adapted by Kotze *et al* (2009). The methodology was designed for the assessments of wetlands, but in the case of these environments, the goods and services delivered are particularly applicable, hence it was decided to include it in the report.

The diagram (Figure 16 to 18 is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 15.

Table 15. Goods and Services

Goods & Services	Drainage Lines	Grootvloer	Bennis
Flood attenuation.	4	5	2
Stream flow regulation	4	5	2
Sediment trapping	3	5	2
Phosphate trapping	1	1	1
Nitrate removal.	1	2	1
Toxicant removal	1	2	1
Erosion control	3	4	2
Carbon storage	1	1	1
Biodiversity maintenance	4	5	2
Water supply for human use	1	3	1
Natural resources	2	3	1
Cultivated food.	2	3	1
Cultural significance	1	3	1
Tourism and recreation	1	2	1
Education and research	1	4	1

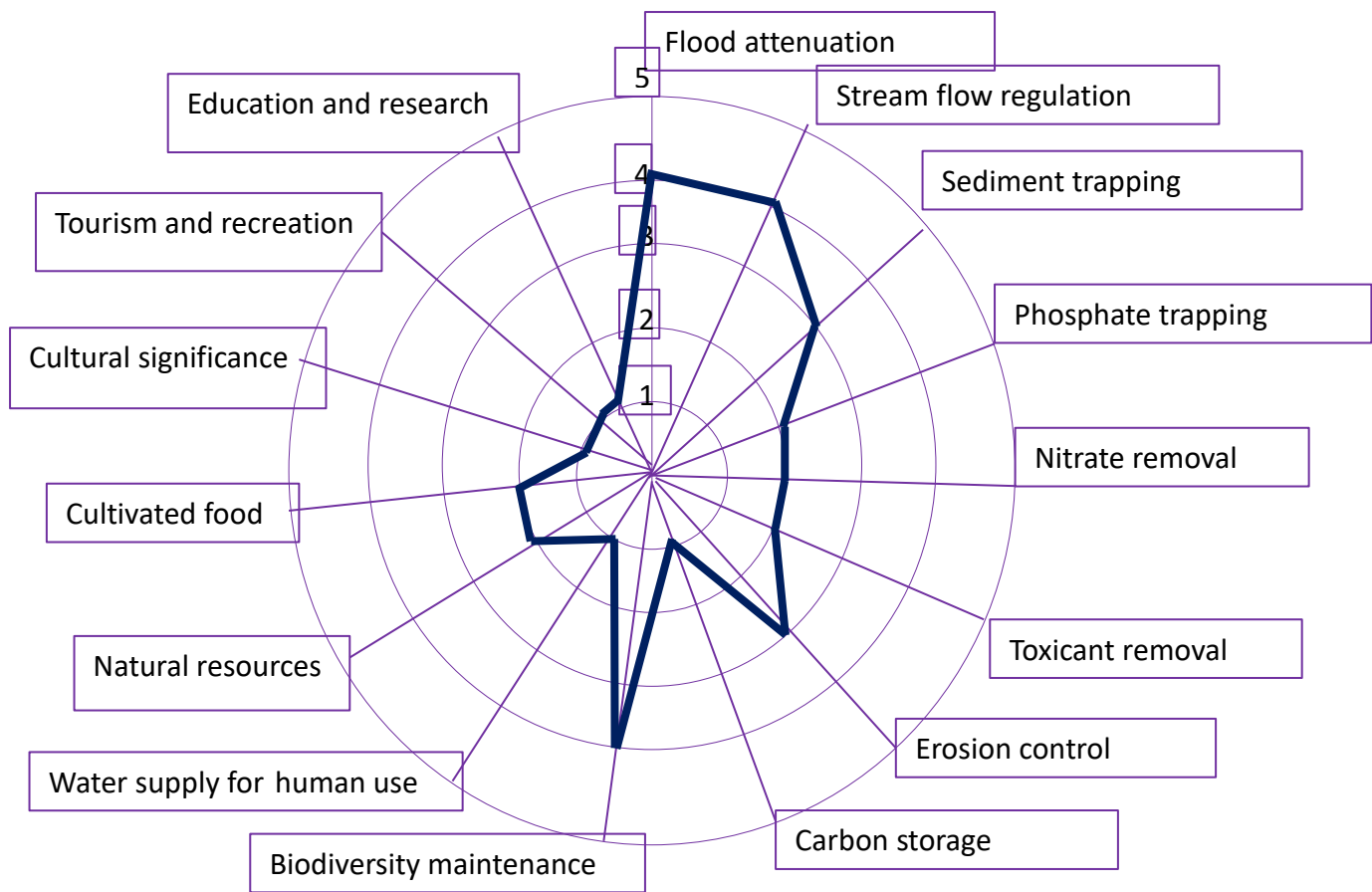


Figure 16. Resource Economics Footprint of the drainage lines

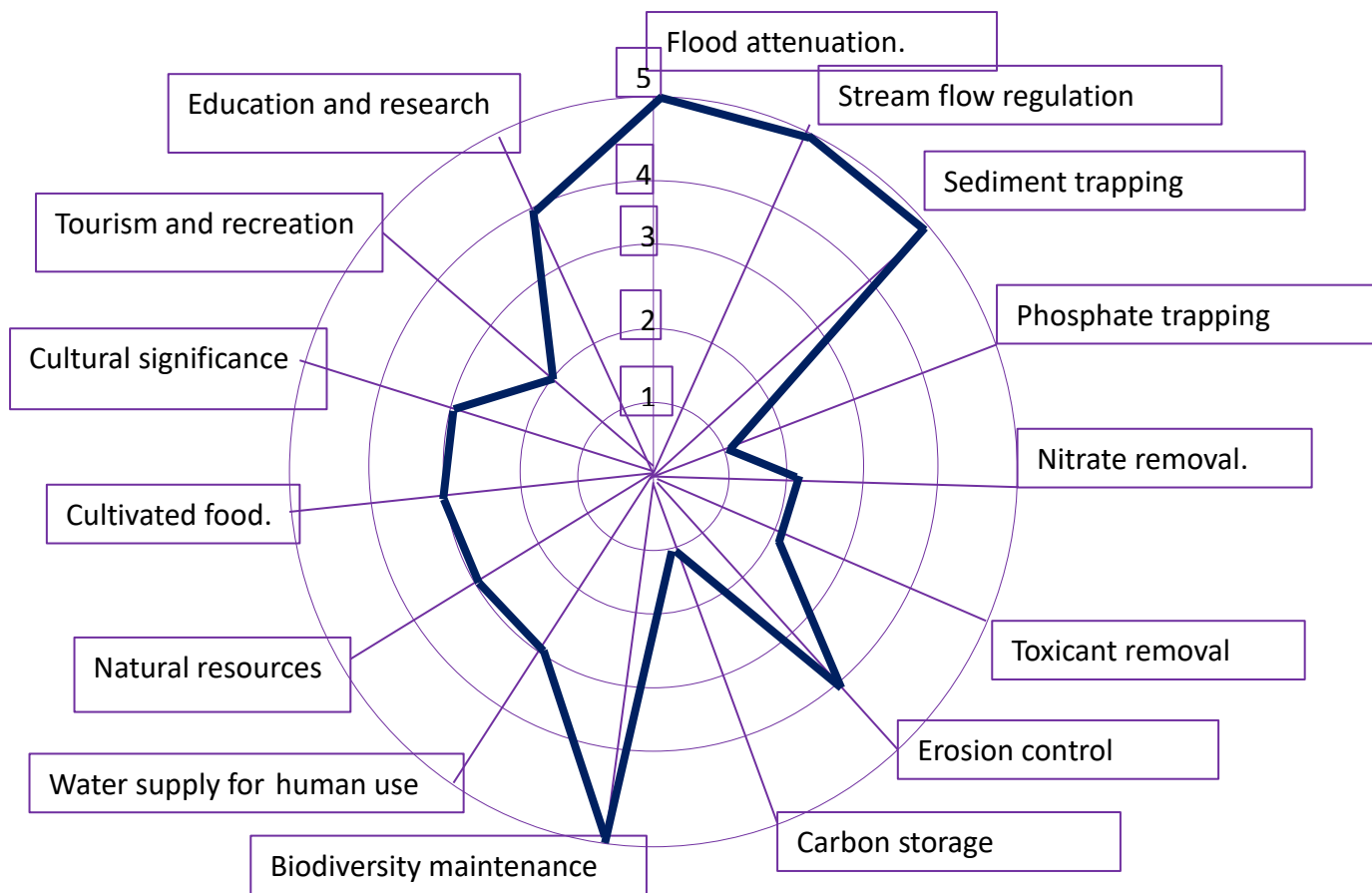


Figure 17. Resource Economics Footprint of the Grootvloer

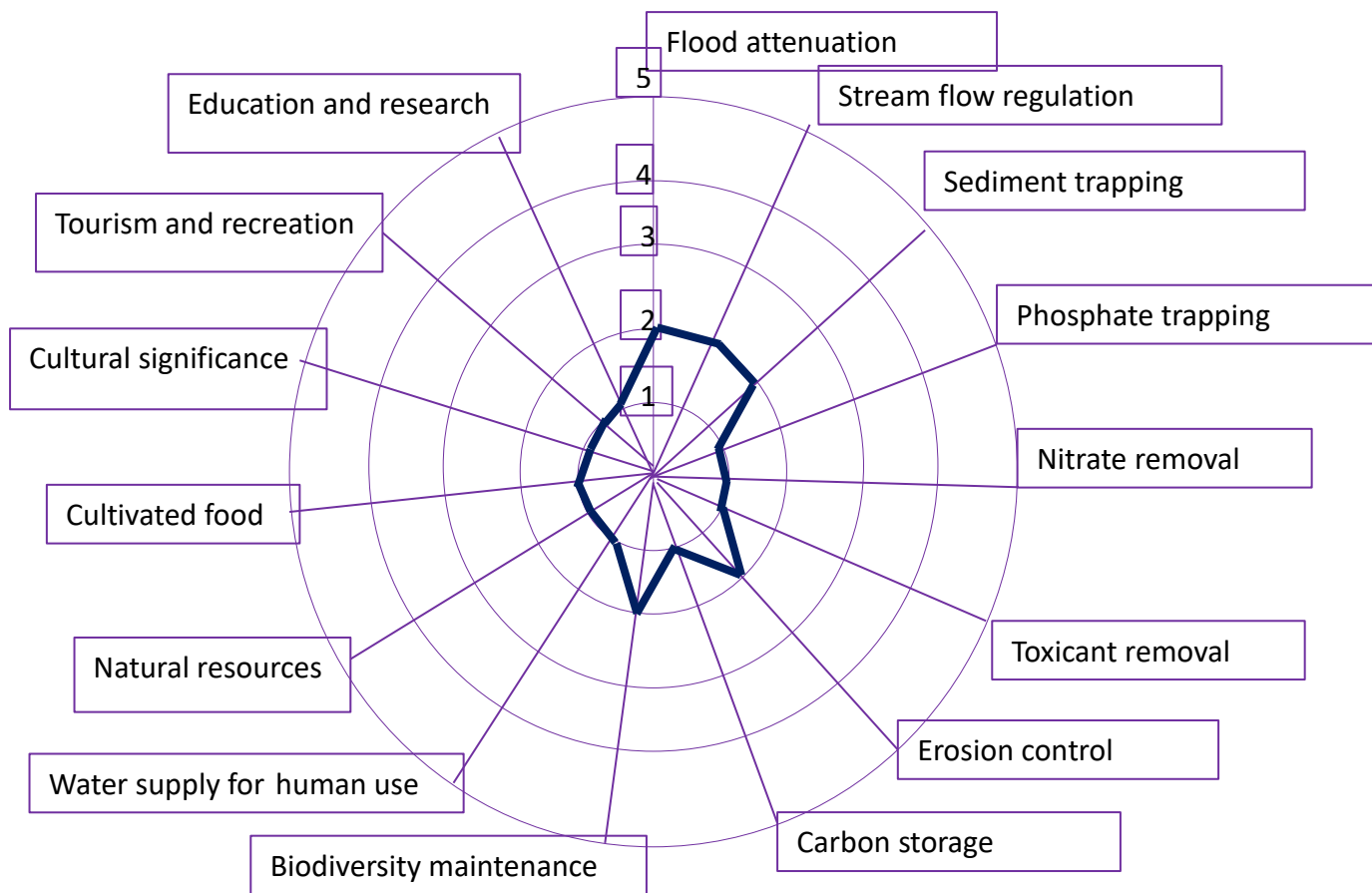


Figure 18. Resource Economics Footprint of the Bennis diffuse pans

The Resource Economics footprint is extremely small, insignificant, because is a small pan that is a part of a much bigger system, which combined has a much larger footprint.

Table 16 Summary of assessments

Aspect	Status
DFFE Screening Tool	Sensitivity Medium, High and Very High
Pipeline path	CBA, ESA, Conservation Expansion Plan
Drainage lines aquatic habitat	NFEPA
Grootvloer	NFEPA
Bennas diffuse pans	NFEPA
Bushmanland Arid Grassland	Least Concern
PES of the drainage lines	Near natural
PES of the Grootvloer	Largely natural
PES Bennas diffuse pans	Moderately impacted
Ecological Importance drainage lines	Important
Ecological importance Grootvloer	Important
Ecological Importance Bennas pans	Important
Ecological Sensitivity Drainage lines	Sensitive
Ecological Sensitivity Grootvloer	Sensitive
Ecological Sensitivity Bennas pans	Sensitive
EISC drainage lines	Low
EISC Grootvloer	Low
EISC Bennas diffuse pans	Low
Impact assessment	Mitigation measures adequate
Risk Matrix	General Authorization
Resource Economics drainage lines	Very small footprint
Resource Economics Grootvloer	Large footprint
Resource Economics Bennas pans	Insignificant footprint

Table 16 gives an overall and much condensed view of the evaluations and methodologies that have been applied to the drainage lines and the pans. Terms such as Very High Sensitivity, CBA, NFEPA and Endangered as a first thought raises red flags. However, this must be seen against the facts that the envisaged pipeline will be trenched in a road reserve next to another existing pipeline.

24 Budget

Costing the construction of the pipeline was one of the Freshwater Report's aims, or at least to assist with the budget. Most of the information is not known at this stage of the project and what follows is visioning. In the past, with similar projects, experience learned that the Freshwater Report and its findings can assist with a first-round, preliminary budget. The costing engineer might find these thoughts helpful.

There are 279 Class 1 and Class 2 drainage line crossings, which probably won't cost more than the anywhere else where the pipeline is going to be trenched. Apart from the 120 and more berms at these crossings on both sides of the road. These berms will have to be rebuilt after the trench has been closed. This may add 10 to 15% of the costs.

There are 36 Class 3 crossings where the trench will have to be deeper. This might add another 30% to 40% to the cost, apart from the costs to repair berms.

Class 4 crossings are more challenging. These demand deeper digging over a longer distance. This might double the costs.

Keep in mind that at crossing, much attention is required for levelling and landscaping to prevent accretion or erosion.

Apart from the dolerite ridges, the very hard granite substrate at the ridge past the turnoff will be extremely challenging. A train of very heavy earth-moving machinery may not prove to be enough in some places, where blasting may be required.

This paints a very rough picture of what lies ahead for budgeting purposes. These must be refined, no doubt, as costing proceeds, in successive stages.

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 19). The WULA and the EAI must provide mitigation measured for these impacts.

Figure 19 has been adapted from one of the most recent DWS policy documents.

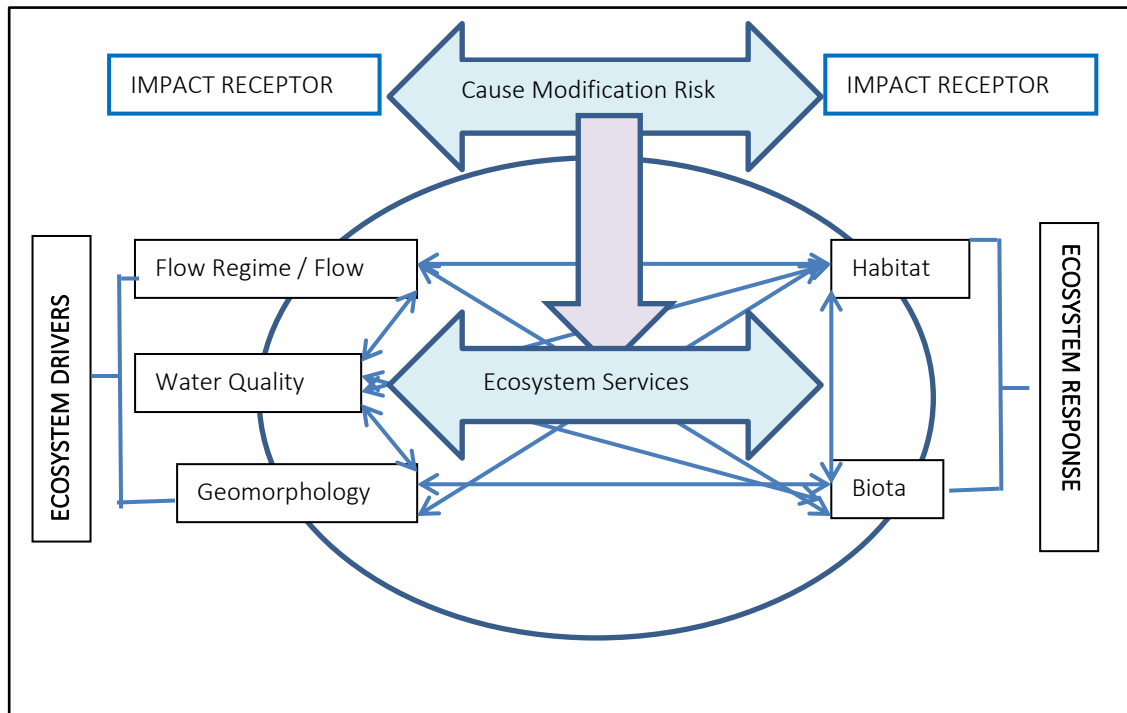


Figure 19 Minimum Requirements for a S21(c) and (i) Application

The drainage lines are driven by the very scant rainfall events, sudden and sometimes severe thunderstorms, spread out over millennia. Rainfall is interspersed by prolonged droughts. This gives rise to a sparse and drought resistant vegetation. The shallow ground water that migrates along these drainage lines provides just enough moist for higher vegetation to take root and to hold on under these very harsh climatic conditions. Drainage lines are ecologically important, as it provides denser and higher vegetation in an otherwise barren landscape, contributing to habitat variation, biodiversity and migration routes.

The upper sub-catchments of these drainage lines are mostly near-pristine, with grazing the only impact.

The pans are driven by winter rainfall far to the south in the upper catchment. While the rest of the catchment may be dry, the pans are occasionally flooded, not every year, only some years. At this time an entire aquatic ecology may spring to life, with dormant survival stages emerging from the bottom sediments.

The expected direct impact of the proposed pipeline on the drainage lines during the construction phase is going to be small, if mitigating measures are implemented. The impact during the operational phase is going to be negligible. Because of its scope and nature, the pipeline is not going to change any of the dynamics visualized in Figure 19

The Risk Matrix indicated that a General Authorization is the indicated level of official approval.

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27 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:



7 November 2022



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, Gariiep Urban Development, IKheis Municipality
- Fresh Water Report, Bonathaba Farm Dam, Hermon
- Botanical Report, Sand Mine Greystone Trading, Vredendal
- Botanical Report Namakwa Klei Stene, Klaver
- 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, Klaver
- Freshwater Report New Wave Dam, Klaver
- 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 Manganese Mine, Swellendam
- Freshwater Report Bakenrant Boerdery, Kakamas
- Freshwater Report C & A van Niekerk Boerdery, Marchant

29.1 Vegetation

Bushmanland Arid Grassland

VT 29 Arid Karoo and Desert False Grassveld (36%), VT 32 Orange River Broken Veld (36%) (Acocks 1953). LR 51 Orange River Nama Karoo (51%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Spanning about one degree of latitude from around Aggeneys in the west to Prieska in the east. The southern border of the unit is formed by edges of the Bushmanland Basin while in the northwest this vegetation unit borders on desert vegetation (northwest of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonias Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. Altitude varies mostly from 600–1 200 m.

Vegetation & Landscape Features Extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe'. In places low shrubs of *Salsola* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected.

Geology & Soils A third of the area is covered by recent (Quaternary) alluvium and calcrete. Superficial deposits of the Kalahari Group are also present in the east. The extensive Palaeozoic diamictites of the Dwyka Group also outcrop in the area as do gneisses and metasediments of Mokolian age. The soils of most of the area are red-yellow apedal soils, freely drained, with a high base status and <300 mm deep, with about one fifth of the area deeper than 300 mm, typical of Ag and Ae land types.

Climate Rainfall largely in late summer/early autumn (major peak) and very variable from year to year. MAP ranges from about 70 mm in the west to 200 mm in the east. Mean maximum and minimum monthly temperatures for Kenhardt are 40.6°C and –3.7°C for January and July respectively. Corresponding values for Pofadder are 38.3°C and –0.6°C. Frost incidence ranges from around 10 frost days per year in the northwest to about 35 days in the east. Whirl winds (dust devils) are common on hot summer days. See also climate diagram for NKb 3 Bushmanland Arid Grassland (Figure 7.2).

Important Taxa (^WWestern and ^EEastern regions of the unit only) Graminoids: *Aristida adscensionis* (d), *A. congesta* (d), *Enneapogon desvauxii* (d), *Eragrostis nindensis* (d), *Schmidtia kalahariensis* (d), *Stipagrostis ciliata* (d), *S. obtusa* (d), *Cenchrus ciliaris*, *Enneapogon scaber*, *Eragrostis annulata*^E, *E. porosa*^E, *E. procumbens*, *Panicum lanipes*^E, *Setaria verticillata*^E, *Sporobolus nervosus*, *Stipagrostis brevifolia*^W, *S. uniplumis*, *Tragus berteronianus*, *T. racemosus*^E. Small Trees: *Acacia mellifera* subsp. *detinens*^E, *Boscia foetida* subsp. *foetida*. Tall Shrubs: *Lycium cinereum* (d), *Rhigozum trichotomum* (d), *Cadaba aphylla*, *Parkinsonia africana*. Low Shrubs: *Aptosimum spinescens* (d), *Hermannia spinosa* (d), *Pentzia spinescens* (d), *Aizoon asbestinum*^E, *A. schellenbergii*^E, *Aptosimum elongatum*, *A. lineare*^E, *A. marlothii*^E, *Barleria rigida*, *Berkheya annectens*, *Blepharis mitrata*, *Eriocephalus ambiguus*, *E. spinescens*, *Limeum aethiopicum*, *Lophiocarpus polystachyus*, *Monechma incanum*, *M. spartioides*, *Pentzia pinnatisecta*, *Phaeoptilum spinosum*^E, *Polygala seminuda*, *Pteronia leucoclada*, *P. mucronata*, *P. sordida*, *Rosenia humilis*, *Senecio niveus*, *Sericocoma avolans*, *Solanum capense*, *Talinum arnotii*^E, *Tetragonia arbuscula*, *Zygophyllum microphyllum*. Succulent Shrubs: *Kleinia longiflora*, *Lycium bosciifolium*, *Salsola tuberculata*, *S. glabrescens*. Herbs: *Acanthopsis hoffmannseggiana*, *Aizoon canariense*, *Amaranthus praetermissus*, *Barleria lichtensteiniana*^E, *Chamaesyce inaequilatera*, *Dicoma capensis*, *Indigastrum argyraeum*, *Lotononis platycarpa*, *Sesamum capense*, *Tribulus pterophorus*, *T. terrestris*, *Vahlia capensis*. Succulent Herbs: *Gisekia pharnacioides*^E, *Psilocaulon coriarium*, *Trianthema parvifolia*. Geophytic Herb: *Moraea venenata*.

Biogeographically Important Taxon (Bushmanland endemic) Succulent Herb: *Tridentea dwequensis*.

Endemic Taxa Succulent Shrubs: *Dinteranthus pole-evansii*, *Larryleachia dinteri*, *L. marlothii*, *Ruschia kenhardtensis*. Herbs: *Lotononis oligocephala*, *Nemesia maxii*.

Conservation Least threatened. Target 21%. Only small patches statutorily conserved in Augrabies Falls National Park and Goegab Nature Reserve. Very little of the area has been transformed. Erosion is very low (60%) and low (33%).

Remarks This unit has a large longitudinal extent, with some species common in only part of the unit. Further research may lead to the split of this unit at a later stage.

References Acocks (1953, 1988), Du Toit (1996), L. Mucina (unpubl. data).

29.2 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 31.3.1 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 29.2.2 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 29.2.3 Significance Rating

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

Table 29.2.4 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.

Table 29.3 Numerical Significance

Table 29.3.1 Conservation Value

<p>Conservation Value</p> <p>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</p>	<p>Low 1</p> <p>Medium / Low 2</p> <p>Medium 3</p> <p>Medium / High 4</p> <p>High 5</p>	<p>The area is transformed, degraded not sensitive (e.g. Least threatened), with unlikely possibility of species loss.</p> <p>The area is in good condition but not sensitive (e.g. Least threatened), with unlikely possibility of species loss.</p> <p>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.</p> <p>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.</p> <p>The area is considered critically endangered or is part of a proclaimed provincial or national protected area.</p>
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Table 29.3.2 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 29.4.3 Scoring system

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

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

29.4 Risk Matrix Methodology

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)

Negative Rating

TABLE 1- SEVERITY

How severe does the aspects impact on the environment and resource quality characteristics (flow regime, water quality, geomorfology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5

Where "or wetland(s) are involved" it means

TABLE 2 – SPATIAL SCALE

How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

TABLE 3 – DURATION

How long does the aspect impact on the environment and resource quality?

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

TABLE 4 – FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

TABLE 5 – FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

TABLE 6 – LEGAL ISSUES

How is the activity governed by legislation?

No legislation	1
Fully covered by legislation (wetlands are legally governed)	2
Located within the regulated areas	3

TABLE 7 – DETECTION	
How quickly can the impacts/risks of the activity be observed on the environment (water resource)	
Immediately	
Without much effort	
Need some effort	
Remote and difficult to observe	
Covered	

TABLE 8: RATING CLASSES		
RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale

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

TABLE 9: CALCULATIONS
Consequence = Severity + Spatial Scale + Duration
Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection
Significance \Risk= Consequence X Likelihood