KAI !GARIB

MUNICIPALITY

Fresh Water Report

for the proposed new

WASTEWATER TREATEMENT WORKS

Plot 1654, Kakamas

A requirement in terms of the National Water Act (36 of 1998).

June 2024

bvi 50 YEAR CELEBRATION EST 1967-2017

• ENGINEERING • PROCUREMENT • MANAGEMENT

WATSAN *Africa*

EnviroAfrica

Environmental Management and Impact Assessment

Omgewingsbestuur en Impakbeoordeling

Executive Summary

The Kakamas wastewater treatment works is not coping with the current demands. These demands will increase as the population grows. The treated sewage effluent is released into the Orange River. This effluent does not meet national effluent standards.

The national Department of Water and Sanitation with its Regional Bulk Infrastructure Grant programme established the possibility for the construction of a new WWTWs on the outskirts of Kakamas. The civil engineering consultance company BVi of Upington produced a feasibility study for regional wastewater treatment works, among other for Kakamas.

The environmental authorisation process for these envisaged wastewater treatment works has now commenced. Enviro Africa Northern Cape was appointed to carry out the environmental impact assessment in terms of the National Environmental Management Act. This process has started and is ongoing. Likewise, WATSAN Africa of Knysna has been appointed to deal with the water use license applications in term sof the National Water Act.

Government Notice 509 in terms of the National Water Act demands that a Risk Matrix be completed. The Risk Matrix indicated that a License is the appropriate level of authorisation. This is commonplace for wastewater treatment works releasing treated sewage effluent into significant water resources. However, WATSAN Africa previously experienced that similar wastewater treatment works were authorised with General Authorisations. This will more than likely be the case with the envisaged Kakamas wastewater treatment works, a General Authorisation.

Index

Abbreviations

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

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1 Introduction

Kakamas on the banks of the lower Orange River in the Northern Cape developed from small beginnings to the town it is today, with continued growth as the surrounding agricultural industry expands. The current WWTW's is not keeping up with the population growth. The WWTW's traditional operations must be replaced with new technology to produce an effluent that can safely be released into the aquatic environment, the Orange River.

The DWS's Regional Bulk Infrastructure Grant (RBIG) programme is designed to construct new wastewater treatment facilities to service Kakamas, as well as villages and farms along the Orange River. The Kai !Garip Municipality in Kakamas is planning to make use of this grant to upgrade its WWTWs.

The civil engineering consultancy company BVi of Upington has been appointed to conduct a feasibility study (Meiring, 2025) for these WWTW's in the region. This study serves as the point of departure for the legally required environmental authorisations.

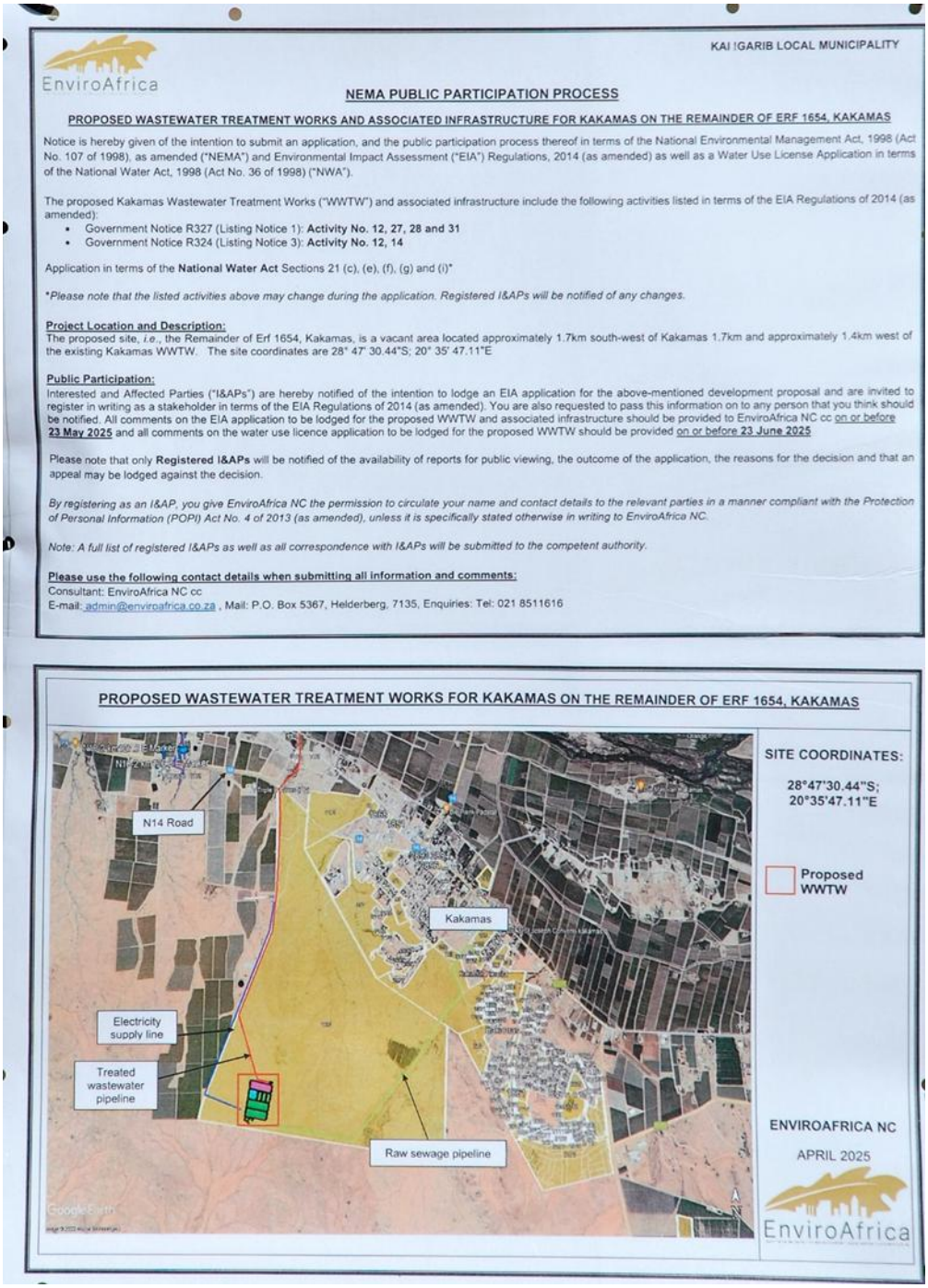
The groundwork for official environmental authorisation has now started. Enviro Africa (Northern Cape) was appointed to conduct the EIA in terms of NEMA. The public participation process is now ongoing (Figure 1).

Likewise, Dr Dirk van Driel of WATSAN Africa in Knysna was appointed to apply for a water use license in terms of the NWA. The report must contain adequate information for government officials to make an informed decision. The report has developed according to a set format and contents, with premeditated and standardised assessments.

GN 509 demands that a Risk Matrix be completed. The Freshwater Report must expain the numerical values that are assigned for the various aspects of the Risk Matrix. The Risk Matrix is a structured numerical mechanism to help decide about the correct level of authorisation. This can either be a General Authorisation of a License. The completed Risk Matrix must be signed by a registered SACNASP scientist.

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

A site visit was conducted on 9 April 2025, along with several other specialists concerned with this project.



KAI !GARIB LOCAL MUNICIPALITY

EnviroAfrica

NEMA PUBLIC PARTICIPATION PROCESS

PROPOSED WASTEWATER TREATMENT WORKS AND ASSOCIATED INFRASTRUCTURE FOR KAKAMAS ON THE REMAINDER OF ERF 1654, KAKAMAS

Notice is hereby given of the intention to submit an application, and the public participation process thereof in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended ("NEMA") and Environmental Impact Assessment ("EIA") Regulations, 2014 (as amended) as well as a Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998) ("NWA").

The proposed Kakamas Wastewater Treatment Works ("WWTW") and associated infrastructure include the following activities listed in terms of the EIA Regulations of 2014 (as amended):

- Government Notice R327 (Listing Notice 1): **Activity No. 12, 27, 28 and 31**
- Government Notice R324 (Listing Notice 3): **Activity No. 12, 14**

Application in terms of the **National Water Act** Sections 21 (c), (e), (f), (g) and (i)*

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

Project Location and Description:
The proposed site, *i.e.*, the Remainder of Erf 1654, Kakamas, is a vacant area located approximately 1.7km south-west of Kakamas 1.7km and approximately 1.4km west of the existing Kakamas WWTW. The site coordinates are 28° 47' 30.44"S; 20° 35' 47.11"E

Public Participation:
Interested and Affected Parties ("I&APs") are hereby notified of the intention to lodge an EIA application for the above-mentioned development proposal and are invited to register in writing as a stakeholder in terms of the EIA Regulations of 2014 (as amended). You are also requested to pass this information on to any person that you think should be notified. All comments on the EIA application to be lodged for the proposed WWTW and associated infrastructure should be provided to EnviroAfrica NC cc on or before **23 May 2025** and all comments on the water use licence application to be lodged for the proposed WWTW should be provided on or before **23 June 2025**

Please note that only **Registered I&APs** will be notified of the availability of reports for public viewing, the outcome of the application, the reasons for the decision and that an appeal may be lodged against the decision.

By registering as an I&AP, you give EnviroAfrica NC the permission to circulate your name and contact details to the relevant parties in a manner compliant with the Protection of Personal Information (POPI) Act No. 4 of 2013 (as amended), unless it is specifically stated otherwise in writing to EnviroAfrica NC.

Note: A full list of registered I&APs as well as all correspondence with I&APs will be submitted to the competent authority.

Please use the following contact details when submitting all information and comments:
Consultant: EnviroAfrica NC cc
E-mail: admin@enviroafrica.co.za , Mail: P.O. Box 5367, Helderberg, 7135, Enquiries: Tel: 021 8511616

PROPOSED WASTEWATER TREATMENT WORKS FOR KAKAMAS ON THE REMAINDER OF ERF 1654, KAKAMAS

Figure 1 Public participation

2 Legal Framework

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

S19 *The owner of land… on which….any activity is performed….which causes pollution or is likely to cause pollution…… must take all reasonable measures to prevent such pollution….*

The release of treated sewage effluent into the Orange River is perceived as such an activity.

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

The proposed development is spanning the banks of a drainage line. The drainage lines would be altered, should the proposed activity go ahead.

S21 (e) *Engaging in a controlled activity as identified in S37(1)*

The irrigation of treated sewage effluent onto a sports field, as is currently contemplated, is a declared activity.

S21 (f) *Discharging waste of water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit*.

The release of treated sewage effluent into a water resource such as the Orange River is such an activity.

S21 (g) *Disposing of waste in such a way that it may detrimentally impact on a water resource.*

Treated sewage effluent and sludge emanating from WWTWs are regarded as waste that may impact detrimentally on water resources.

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

The proposed development will alter the characteristics of the drainage lines in the upper reaches of the affected sub-catchments.

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, the development triggers a part of the National Environmental Management Act, NEMA, 107 of 1998).

The EIA Regulations of 2014 No.1 Activity 12 states that no development may take place within 32m of a water course without the consent of the Department of Environmental Affairs and its provincial representatives. The proposed development is in a drainage line, which fully qualifies as a water course. Consequently, this regulation is relevant to this application.

4 Location

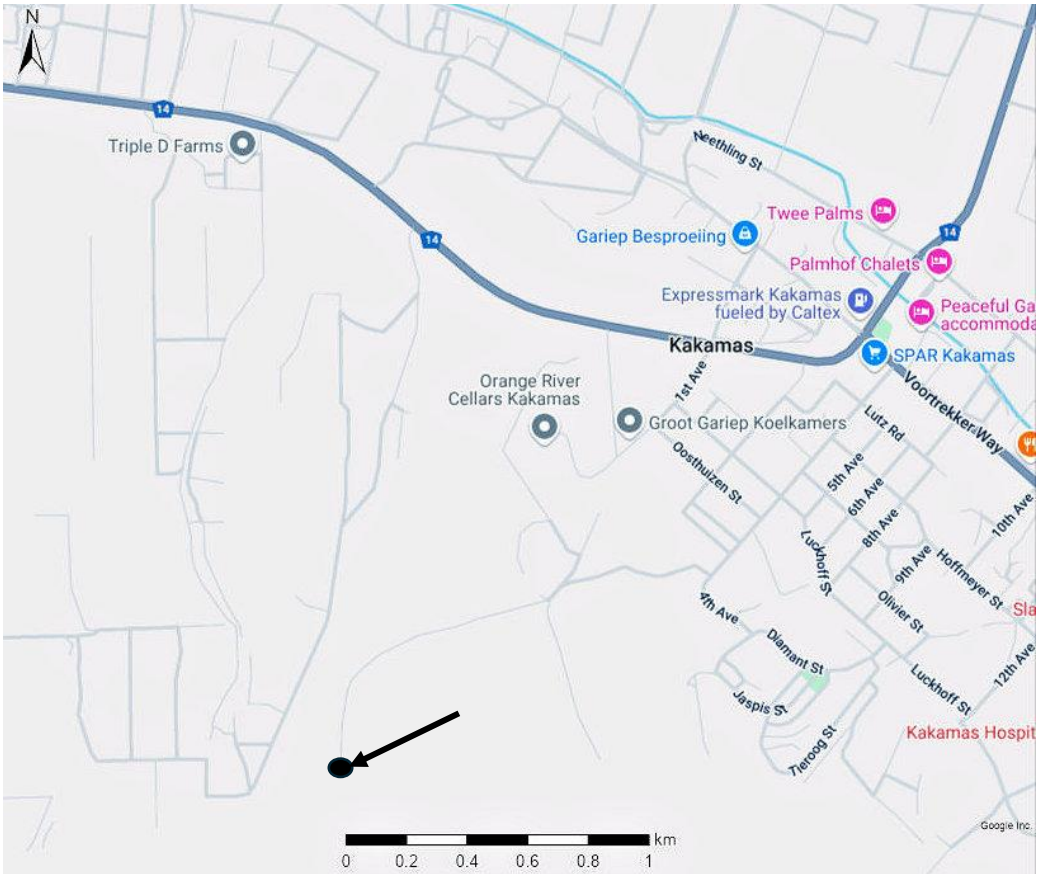


Figure 2 Kakamas WWTWs Location

Kakamas in the Northern Cape is on the southern bank of the Orange River and on the N14 trunk road 98km to the west of Upington. The proposed new WWTWs is south west of Kakamas, on the outskirts of town.

The location is at the following coordinates:

28°47'31.44"S and 20°35'46.04"E

5 Quaternary Catchment

The site of the proposed Kakamas WWTWs site is in the D73 F quaternary catchment. These are the quaternary catchment adjacent to the Orange River.

The D53J quaternary catchment only just touches upon the site along its very upper catchment right on the watershed. This quaternary catchment is therefore of less importance, but yet worth mentioning and must be included.

3 Kakamas Climate

https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/kakamas_south-africa_993014

Kakamas is in South Africa's arid region, semi-desert, bordering onto the Kalahari desert to the north.

Kakamas normally receives about 62mm of rain per year, with most rainfall occurring mainly during summer (Figure 3). The summers are exceedingly hot, with maximum temperatures well into the 40's. Overnight temperatures in winter can drop below zero. This is a harsh desert-like climate with extreme temperatures and very little rain.

Kakamas is arid. During 4 months of the year, it may not rain at all. Rainfall is erratic, intense with violent electric thunderstorms and sudden downpours. During these very scarce rainfall vents, drainage lines may convey water. The flow may be strong, of short duration, a day or even less, with a fierce erosion potential. The drainage lines must have been formed over millennia since historical times.

The contribution of the drainage lines to the flow in the Orange River is negligible.

The economy is entirely dependent on water abstraction from the Orange River. Successful farming depends on precise irrigation systems. It is therefore obligatory that the treated sewage effluent from the proposed new WWTWs be used for irrigation. It should not be merely let out into the Orange River.

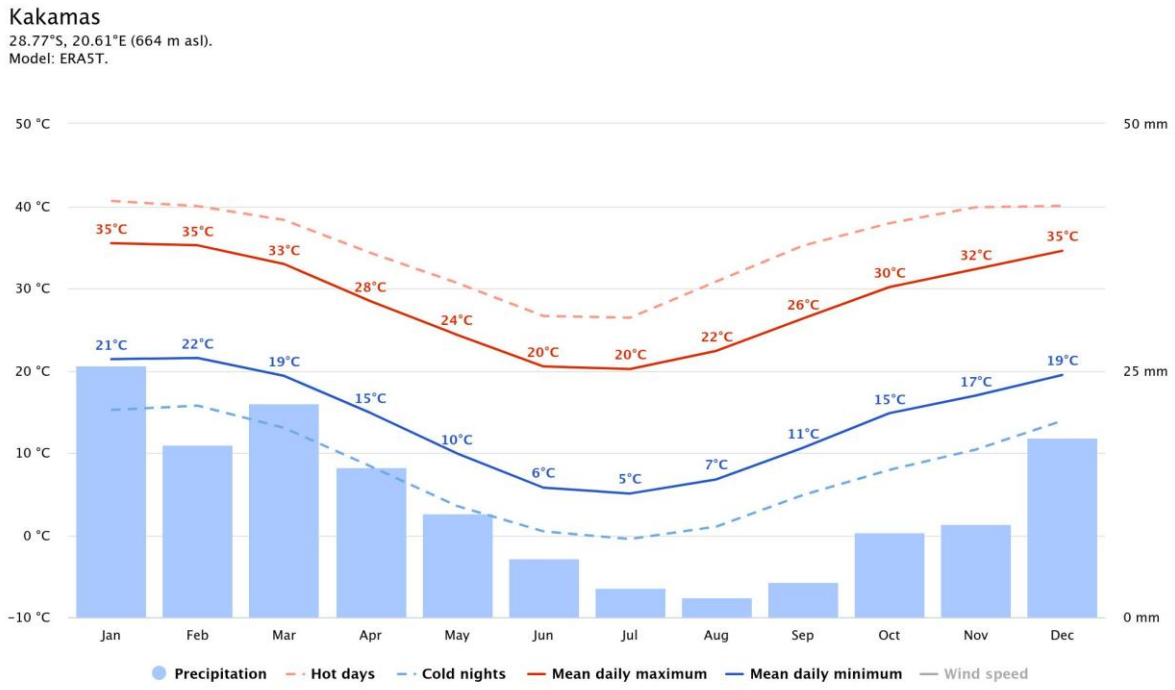


Figure 3 Kakamas Climate

6 The Project

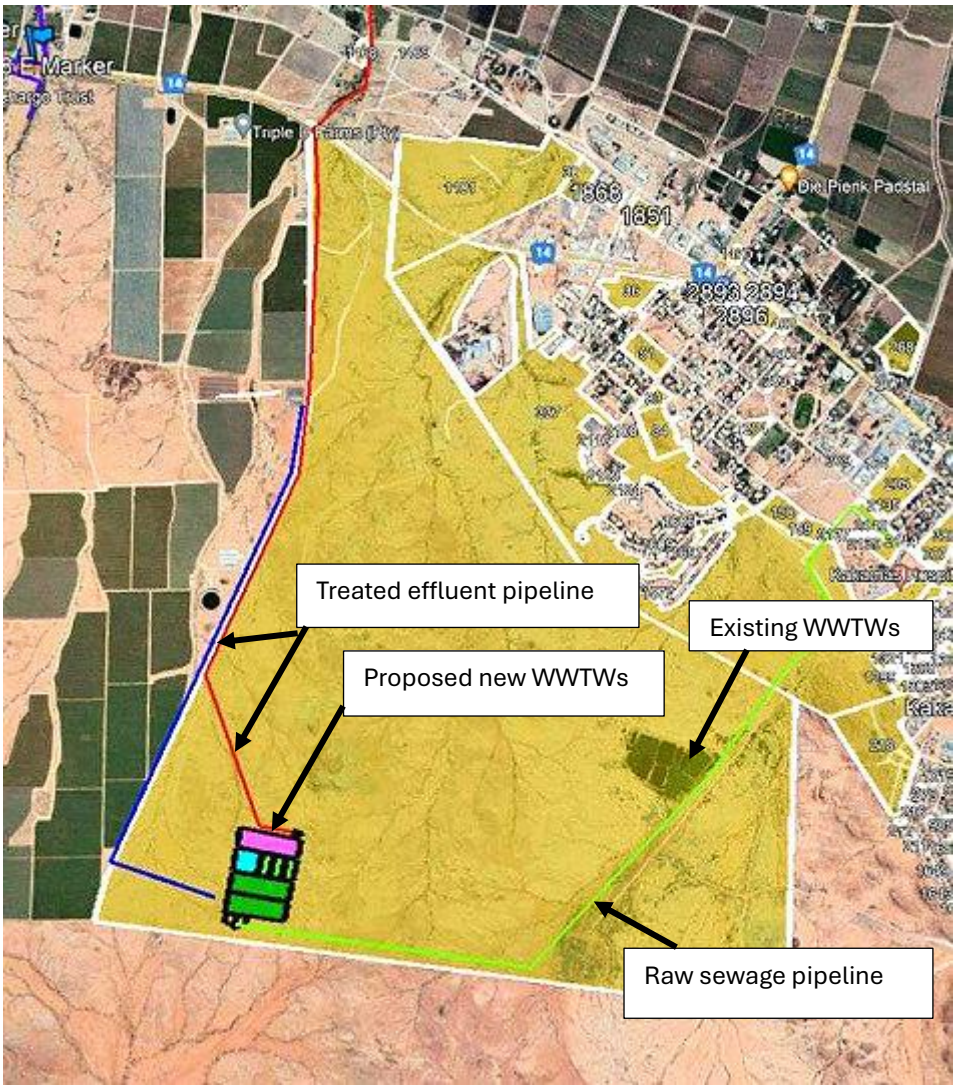


Figure 4 Kakamas proposed new WWTWs (Meiring, 2025)

The proposed new WWTWs will consist of :

1 x Inlet Works
2 x Anaerobic Ponds
2 x Facultative Ponds
3 x Aerobic Maturation Ponds
1 x Treated Effluent Storage Pond
1 x Horizontal Flow Reedbed
1 x Chlorine Contact Tank

It will have a design capacity of just more than 2 megalitres a day.

The raw sewage pipeline will be constructed from the outskirts of town past the existing works to the proposed new WTTWs (Figure 4). The treated sewage effluent will either be used for irrigation sportsfields ot will be released in the Orange River. The volumes of these alternatives and how it would vary throughout the year are still to be decised. These volumes must be available for a succesful WULA and must appear on the prescribed eWULAAS application forms.

The reposed new Kakamas WWTWs will join and existing horizontal flow reedbed works on the next-door Triple D property (Figure 5), designed by BVi of Upington.

Figure 5 Triple D horizontal flow reedbed WWTWs

7 Sub-Catchments

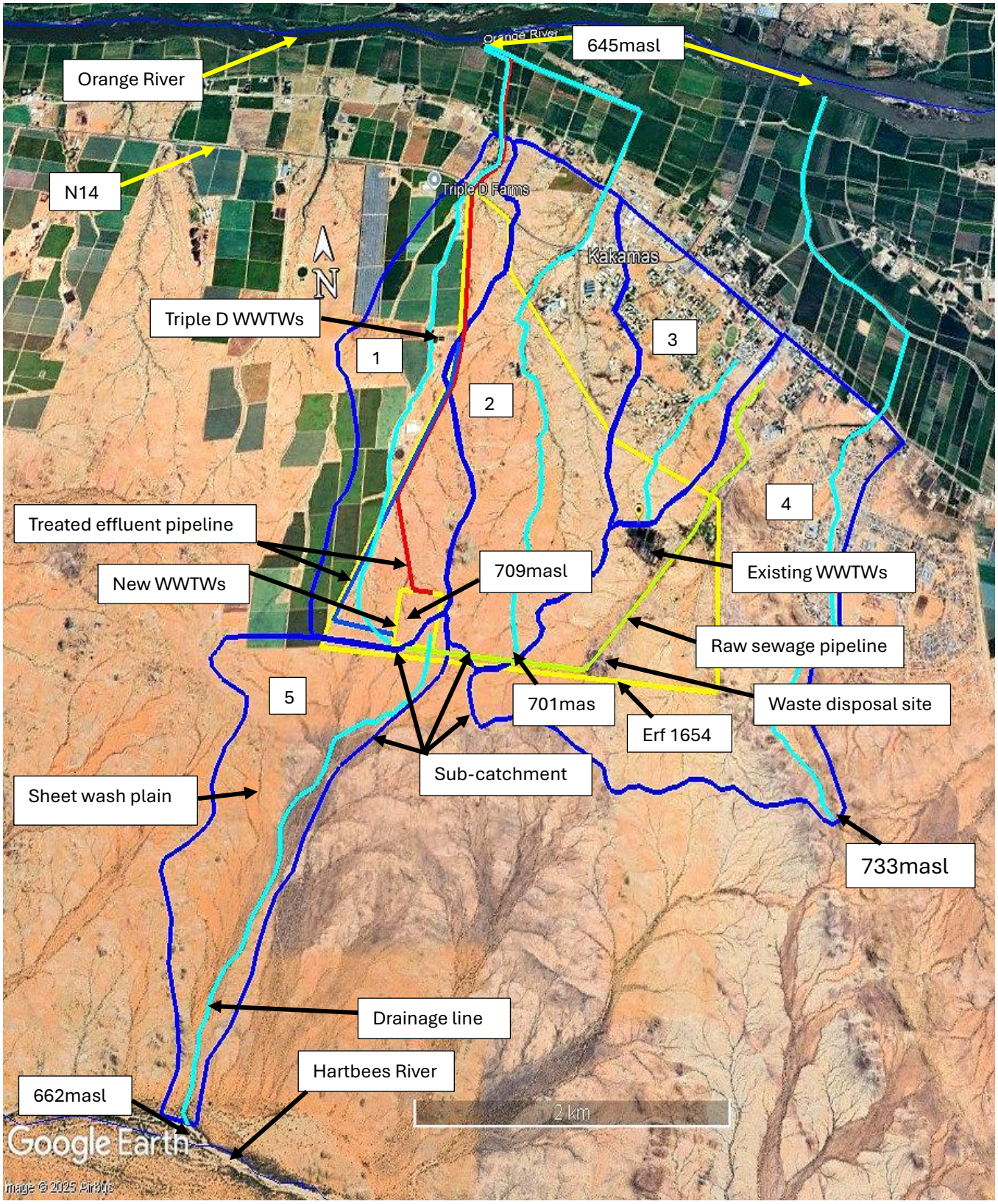


Figure 6 Sub-Catchments

Table 1 Sub-Catchments surface area and slope

Sub-Catchments	Surface area Ha	Length longest drainage line km	Slope
1	278	5.1	1.1
2	355	5.9	0.9
3	162	1.3	Not calculated
4	462	6.0	0.09
5	204	3.4	1.3

The proposed WWTWs is located where three sub-catchment borders onto one another, sub-catchments no. 2, 3 and 5. This is at the top end of these sub-catchments (Figure 6).

These are relatively small sub-catchments (Table 1). Some of them in the Northern Cape are many thousands of hectares.

Slopes are given in vertical metres in every 100 horizontal metres. The slopes are gentle, indicating slow runoff velocities. This is reiterated by the sheet wash plains, especially in sub-catchment no. 5. The drainage lines flowing to the southwest into the Hartbees River all have substantial sheet wash plains.

On the other hand, where sub-catchment no. 1 and no. 2 drainage lines flow underneath the N14 trunk road, the drainage lines are scoured out deeply because of the occasional fierce stormwater flow. Most of the new WWTWs is in sub-catchment no. 1.

Sub-Catchment No.1 and its drainage line

Figure 6 shows the locality where the proposed WWTWs is going to be constructed, looking north towards the Orange River. The drainage line here is already evident, with its line of swarthaak shrub (Figure 7).

The drainage line flows down the decline Figure 8) along the vineyards (Figure 9). It receives several tributaries from the east. These tributaries cross the dirt road to the site. They show signs of erosion, sediment transport and accretion because of the recent heavy rains (Figure 10). Some of these tributaries have pools of water next to the road during the site visit. The drainage line receives a tributary from the west as well, coming out of the vineyards. This tributary is an engineered, straightened and manicured earthen canal, like the rest of the drainage line towards the N14.

Figure 7 WWTWs site

Figure 8 Sub-Catchment No. 1 Drainage line

Figure 9 Sub-Catchment No. 1 drainage line along the vineyards.

Figure 10 Sub-catchment no.1 drainage line signs of erosion and accretion.

Figure 11 Sub-Catchment No. 1 drainage line N14 Culvert

Figure 12 Earthen canal

Figure 13 Concrete drainage canal

Figure 14 Sluice gate

The drainage line is overgrown with swarthaak shrub closer to the N14. It passes underneath the N14 through a large concrete culvert (Figure 11). The drainage line's channel here is overgrown with phragmites reeds.

Across the N14 towards the Orange River, the drainage line is transformed first into an engineered earthen canal (Figure 12) and further on into a concrete drainage canal (Figure 13). Reportedly, this canal receives irrigation return flow from the vineyards. A sluice gate regulates the flow of water down the drainage canal (Figure 14).

Sub-Catchment No. 2 and its drainage line

The very upper part of this sub-catchment touches onto the proposed WWTWs.

Like the sub-catchment no. 1, the upper parts are still in a good state, apart from the many two track vehicle paths, trampling and litter. The parts next to the Orange River are entirely developed, under vineyards, with farm roads, canals and flood control walls. It is a bigger drainage line, with more erosion and accretion.

Upstream from the vineyards along the Orange River, next to the N14, there is a path through the drainage line (Figure 15). In this area the drainage line is degraded by litter and building rubble.

Looking downstream from this point, the large embankment and N14 culvert can be observed (Figure 16). Standing on the N14 where the drainage line passes the N14, looking upstream, the bigger size of this drainage line can be appreciated (Figure 17).

Looking downstream, the lower drainage line has been transformed into a channel among the vineyards along the Orange River. This channel is straightened, with high and steep banks and with little ecological significance. It has been engineered around a right angle to follow the boundary of a large vineyard. From there it follows a straight route to the Orange River. It serves as a conduit for agricultural return flow. It is approximately 1.2km long (Figure 6).

Figure 15 Path through drainage line in sub-catchment 2

Figure 16 N14 Embankment and culvert

Figure 17 Drainage line upstream of N14 culvert

Figure 18 Infilling of bank

Sub-Catchment No. 4 and its Drainage Line

The raw sewage pipeline is planned over this sub-catchment from the town of Kakamas past the existing WWTWs to the new envisaged WWTWs (Figure 6). The new WWTWs is not located on sub-catchment no. 4.

The drainage lines here resembled those on sub-catchment no. 1 and 2. These were signs of erosion because of the recent rains, but also sediment deposition in the broader and more level reaches.

There are several existing impacts. Most notably, the existing WWTWs (Figure 19). It is overgrown with mostly swarthaak. Treated effluent flows down an earthen canal (Figure 20) towards the town of Kakamas. It passes underneath Voortrekker Road, one of the main roads through town, through a set of pipe culverts, from where it carries on in a concrete canal (Figure 21) to a side stream of the braided Orange River.

The Kakamas waste disposal site is another major impact on sub-catchment no. 4. (Figure 22). The large quantities waste dumped along the road from where it starts in town past the WWTWs to the waste disposal site is an enormous and ongoing problem with serious deleterious impacts on sub-catchment no.4 (Figure 23).

A large part of Kakamas is in this sub-catchment, notably economic and informal housing. This part of town is in the northeastern corner of the sub-catchment.

This is a heavily impacted sub-catchment. Despite of these impacts, the very upper parts away from town, where the drainage line become a faint network against the slope, the sub-catchment is still in a better shape, with some litter, footpaths, twin track paths and farm animals.

Figure 19 Existing Kakamas WWTWs

Figure 20 WWTWs treated effluent earthen canal

Figure 21 WWTWs treated effluent concrete canal

Figure 22 Kakamas waste disposal site

Figure 23 Dumped waste along the road.

Sub-Catchment No. 5 and its drainage line

The very upper reach of the drainage line on sub-catchment no. 5 rises on the proposed site of the new WWTWs (Figure 6). The drainage line flows to the south to its confluence with the Hartbees River. It differs from the other sub-catchments because of the wide and sandy sheet wash plains.

This sub-catchment is the least impacted of the sub-catchments around the proposed new WWTWs. Apart from grazing farm animals and twin track paths, no other impacts were observed during the site visit.

Sub-Catchment No. 3

This sub-catchment is not discussed any further because the proposed new WWTWs and its pipelines do not intrude on any part of the sub-catchment.

8 Conservation Status

DFFE Screening Tool

All five the sub-catchments were included in the DFFE screening tool assessment. The result is shown in Table 2

Table 2 Screening Tool Results

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

Animal species theme

The DFFE screening tool listed the following:

Peregrine falcon	*Falco biarmicus*
Martial eagle	*Polemaetus bellicosus*
Verreaux's eagle	*Aquilla verreauxii*
Ludwig's bustard	*Neotis ludwigii*
Black footed cat	*Felis nigripes*

These birds have a wide distribution area, regional and even national. Kakamas and its new WWTWs is not about to make any difference to their survival.

Ludwig's bustard is proven to end up injured or dead flying into high voltage power lines. The new WWTWs is not adding to any structure above ground that will be a threat to these birds.

Black-footed cats have a very wide distribution in the arid parts of the Southern African sub-continent. They are listed as IUCN "Vulnerable". They are naturally scarce. It is improbable to find one in the Kakamas district, but not impossible.

Aquatic biodiversity Theme

The Orange River and the Hartbees River are listed as ecologically very sensitive. The treated effluent will be released in the Orange River. The Hartbees River is far away. The sub-catchment connected to the Hartbees River only touches on the proposed new WWTWs. Unless sewage or effluent is wilfully helped along to flow over the watershed, the potential for pollution remains very low.

Plant species theme

Only one numbered unnamed species is mentioned, of which the name may not be published and must remain secret because of conservation purposes.

Vegetation

The vegetation is Bushmanland Arid Grassland. It is not endangered in any way. The site borders onto Lower Gariep Alluvial Vegetation but does not enter it. This vegetation is Endangered because of the large-scale agriculture along the lower Orange River.

Terrestrial biodiversity theme

The site is listed as a CBA, an ESA and is a part of the Protected Areas Expansion Strategy. This listing is refuted by the proximity to Kakamas. Part of this site is heavily impacted upon, degraded, trampled over by farm animals and people, with lots of litter and other debris.

9 Drainage Lines

The landscape around much of the Lower Orange River and the Hartbees 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 24).

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.

Drainage line wash fields

Smaller drainage lines all over the landscape are marked by lines of driedoring (*Rhigozum trichotonum*) 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.

Sheet wash plains

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 gravely sheet wash plains (Figure 4). 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.

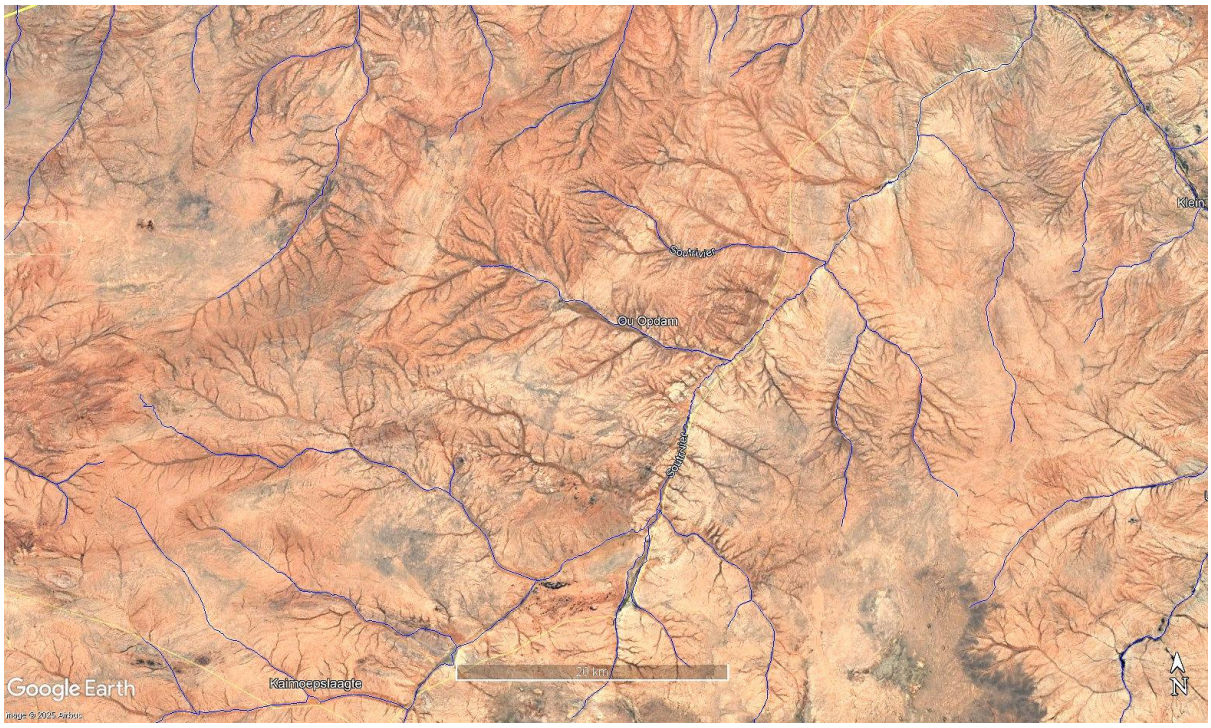


Figure 24 Drainage Lines

Smaller drainage lines all over the landscape are marked by lines of driedoring (*Rhigozum trichotonum*) 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.

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10 Biomonitoring the Lower Orange River

10.1 Methodology

The biomonitoring was carried out according to the description of Dickens & Graham (2002).

Biomonitoring was carried out on the Lower Orange River during site visits for successive WULAs. So far 14 samples have been analyzed at 13 localities (Table 1). The site furthest east was at Hopetown and furthest west at Augrabies, with Upington in the middle. Thirteen of these localities are located upstream of the Augrabies Falls. One sample was analyzed at Styerkraal just east of the border post of Onseepkans downstream of the Augrabies Falls.

The river is braided, featuring numerous streams and islands. The river sports many rapids and riffles but also pool-like features where the river is broad and flowing slower.

The bottom is mainly muddy, with some large rocky outcrops in the middle of the river.

10.2 Impacts on the Lower Orange River

The river is extensively used for agriculture, with its banks transformed into vineyards. A multitude of large electric water pumps have been placed in the river to abstract large volumes of water for irrigation. Abstraction significantly lowers the flow in the river.

Flood protection berms were built along most of the river's banks. The Department of Water Affairs built these berms, which have been part of the landscape for decades. The berms keep flood water out of adjacent agricultural land and has denaturalised the riparian zone.

The single most impact on the Orange River are the two large dams, the Gariep Dam and the Vanderkloof Dam. The river flow was adjusted to a more consistent regime, unlike the previous varied flow with high peak flow and low drought flows.

The Lower Orange River is lined with a dense system of mostly dry drainage lines. These drainage lines only flow during and shortly after heavy rains. Their contribution to the flow of the Orange River is insignificant. Most of the flow comes from the Lesotho Highlands and some from the Vaal River. However, many of these drainage lines were transformed into engineered agricultural return flow furrows that carries the excess of over irrigation back to the Orange River. Agricultural return flow adds much to the nutrient load of the Orange River because runoff contains fertilizer. Nitrogen is added in large quantities. Since phosphorus readily binds to the soil, not much phosphorus is added.

Return flow can contain a heavy silt load, thereby elevating turbidity in the river.

Pesticides in agricultural runoff are suspected to significantly lower the SASS5 score in biomonitoring results.

The banks of the Orange River in the area are densely overgrown with Spaanse Riet (*Arundo donax*). This is classified as an aggressive and exotic invasive plant, which effectively prevents access to the river. The reeds result in a homogeneous aquatic habitat. This lack of variation supresses the SASS5 score, with only a limited number of aquatic macroinvertebrate species present in this habitat.

10.3 Lower Orange River Biomonitoring Results

The biomonitoring results have been captured in Table 3 and depicted in Figure 20.

The classes from A to F in Figure 20 has been assigned for mature rivers on flood plains such as the Lower Orange River.

Only 2 of the samples were classified a good and relatively unimpacted (Class A). Five were in Class B and C, which can be regarded as acceptable under the

circumstances of an impacted river reach. These classes can possible be labelled as the ideal, a compromise between agriculture and aquatic ecological functioning.

Four samples were poor (Classes E and F), an undesirable situation.

The one sample downstream of the Augrabies Falls was extremely poor.

Table 3 Biomonitoring in the Lower Orange River

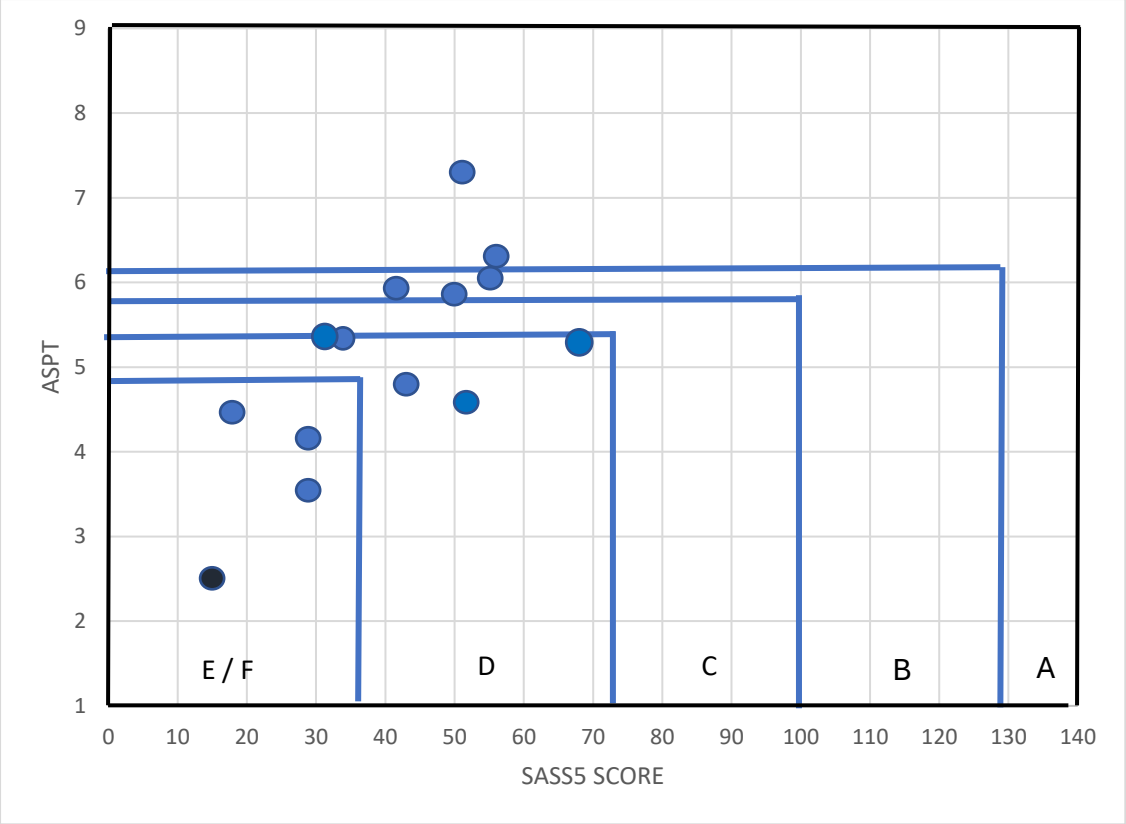
Locality	Coordinates	Date	SASS5	No Taxa	ASPT
Augrabies Lair trust	28°38'41.53S 20°26'08.49E	5/09/17	18	4	4.5
Augrabies Lair Trust	28°38'41.53S 20°26'08.49E	5/10/17	43	9	4.8
Groblershoop	28°52'31.80S 21°59'13.49E	14/8/18	41	7	5.9
Kakamas Triple D	28°45'08.37S 20°35'06.16E	15/8/18	50	9	5.6
Hopetown Sewer	29°36'05.07S 24°06'05.00E	7/10/18	29	7	4.1
Hopetown Sewer	29°36'08.06S 24°21'06.16E	7/10/18	29	8	3.6
Keimoes Housing	28°42'37.12S 20°55'07.81E	8/02/19	51	7	7.3
Upington Erf 323	28°27'11.91S 21°16'14.02E	12/2/19	56	9	6.2
Upington Affinity	28°27'11.91S 21°16'14.02E	20/5/19	54	9	6
Styerkraal	28°27'25.28S 21°15'01.87E	21/5/19	15	6	2.5
Grootdrink Bridge	28°17'15.30S 21°03'50.87E	17/5/20	34	7	5.3
Turksvy Dam	28°27'09.21S 21°17'20.72E	17/5/21	69	13	5.3
Belurana Upington	28°27'49.79S 21°14'32.67E	15/12/21	51	11	4.6
Bakenrant	28°38'35.84S 20°26'07.96E	30/9/22	33	6	5.5

10.4 Limitations

The Department of Water and Sanitation (DWS) implements a systematic and scheduled biomonitoring program across the nation, including the Lower Orange River. This gives, no doubt, a much better indication of the state of the river than self-collected data. Because this data is not available to the consulting fraternity, self-collected data such as that of Figure 25 must suffice.

Moreover, during the site visit for the Kakamas WWTWs, sampling in the Orange River was not possible because of the strong flow, but more because of the very high sediment load.

The lower Orange River in the Kakamas area is generally in Class C, measurably impacted, but with most of the ecological functioning still intact. More sampling is required to come to a trustworthy conclusion.



Integrity Class	Description
A	Pristine; not impacted
B	Very Good; slightly impacted
C	Good; measurably impacted with most ecological functioning intact
D	Fair; impacted with some loss of ecological functioning
E	Poor; loss of most ecological function
F	Very Poor; loss of all ecological function

Figure 25 Lower Orange River Biomonitoring results

11 Present Ecological State

The PES and EIS are protocols that have been produced by Dr Neels Kleynhans (Table 4, 5) in 1999 of the then DWAF to assess river reaches. The scores given are solely that of the practitioner and are based on expert opinion.

Table 4 Habitat Integrity according to Kleynhans, 1999

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

Table 5 Present Ecological State

Table 5.1 Present Ecological State of the drainage line in Sub-Catchment 1

Instream	Score	Weight	Product	Maximum score
Water abstraction	25	14	350	350
Flow modification	11	13	143	325
Bed modification	13	13	169	325
Channel modification	12	13	156	325
Water quality	19	14	266	350
Inundation	14	10	140	250
Exotic macrophytes	15	9	135	225
Exotic fauna	24	8	192	200
Solid waste disposal	24	6	144	150
Total		100	1695	2500
% of total			67.8	
Class			C	
Riparian				
Water abstraction	25	13	325	325
Inundation	12	11	132	275
Flow modification	10	12	120	300
Water quality	19	13	247	325
Indigenous vegetation removal	15	13	195	325
Exotic vegetation encroachment	14	12	168	300
Bank erosion	20	14	280	350
Channel modification	14	12	168	300
Total			1635	2500
% of total			65.4	
Class			C	

This assessment is complicated by the near pristine state of the upper sub-catchment that contrast sharply against the wholesale transformation of the lower sub catchment through the vineyards.

Agricultural return flow modifies the flow, water quality and the inundation regime. So does the deep channels in the lower end of the sub-catchment.

Table 5.2 Present Ecological State of the drainage line in Sub-Catchment 2

Instream	Score	Weight	Product	Maximum score
Water abstraction	25	14	350	350
Flow modification	15	13	195	325
Bed modification	15	13	195	325
Channel modification	15	13	195	325
Water quality	20	14	280	350
Inundation	15	10	150	250
Exotic macrophytes	15	9	135	225
Exotic fauna	24	8	192	200
Solid waste disposal	24	6	144	150
Total		100	1701	2500
% of total			68.0	
Class			C	
Riparian				
Water abstraction	25	13	325	325
Inundation	15	11	99	275
Flow modification	15	12	180	300
Water quality	15	13	195	325
Indigenous vegetation removal	15	13	195	325
Exotic vegetation encroachment	12	12	144	300
Bank erosion	23	14	322	350
Channel modification	15	12	180	300
Total			1540	2500
% of total			61.6	
Class			C	

Table 5.3 Present Ecological State of the drainage line in Sub-Catchment 4

Instream	Score	Weight	Product	Maximum score
Water abstraction	25	14	350	350
Flow modification	9	13	117	325
Bed modification	9	13	117	325
Channel modification	9	13	117	325
Water quality	10	14	140	350
Inundation	9	10	90	250
Exotic macrophytes	18	9	162	225
Exotic fauna	15	8	120	200
Solid waste disposal	2	6	12	150
Total		100	1225	2500
% of total			49.0	
Class			D	
Riparian				
Water abstraction	25	13	325	325
Inundation	8	11	88	275
Flow modification	8	12	96	300
Water quality	9	13	117	325
Indigenous vegetation removal	15	13	195	325
Exotic vegetation encroachment	18	12	216	300
Bank erosion	18	14	252	350
Channel modification	9	12	108	300
Total			1397	2500
% of total			55.9	
Class			D	

This sub-catchment is largely modified, with some ecosystem functioning at the very top end and very little in the lower reaches.

Table 5.4 Present Ecological State of the drainage line in Sub-Catchment 5

Instream	Score	Weight	Product	Maximum score
Water abstraction	25	14	350	350
Flow modification	24	13	325	325
Bed modification	24	13	312	325
Channel modification	24	13	312	325
Water quality	24	14	336	350
Inundation	24	10	240	250
Exotic macrophytes	22	9	198	225
Exotic fauna	22	8	176	200
Solid waste disposal	24	6	144	150
Total		100	2393	2500
% of total			95.7	
Class			A	
Riparian				
Water abstraction	25	13	325	325
Inundation	24	11	264	275
Flow modification	24	12	288	300
Water quality	24	13	312	325
Indigenous vegetation removal	24	13	312	325
Exotic vegetation encroachment	22	12	264	300
Bank erosion	23	14	322	350
Channel modification	24	12	288	300
Total			2375	2500
% of total			95.0	
Class			A	

This sub-catchment is near pristine with hardly any notable impacts, apart from twin track roads and footpaths.

Table 5.5 Present Ecological State of the Hartbees River

Instream	Score	Weight	Product	Maximum score
Water abstraction	15	14	210	350
Flow modification	18	13	234	325
Bed modification	20	13	234	325
Channel modification	20	13	260	325
Water quality	20	14	280	350
Inundation	18	10	180	250
Exotic macrophytes	22	9	198	225
Exotic fauna	24	8	192	200
Solid waste disposal	24	6	144	150
Total		100	1932	2500
% of total			77.2	
Class			C	
Riparian				
Water abstraction	15	13	325	325
Inundation	18	11	198	275
Flow modification	18	12	216	300
Water quality	20	13	260	325
Indigenous vegetation removal	22	13	286	325
Exotic vegetation encroachment	18	12	216	300
Bank erosion	20	14	280	350
Channel modification	20	12	240	300
Total			2021	2500
% of total			80.8	
Class			B	

It seems preposterous for one person to come up with a score for the Hartbees River, as this is in the domain of a team of specialists. However, such a grand undertaking is beyond the scope and budget of the usual WULA. Since this is required for approval, an assessment is submitted, together with its shortcomings.

Upstream the Sak and Hartbees River's water is heavily used for agriculture and irrigation. However, when the occasional flood happens, the volume of water that flows down the catchment is of such a magnitude that it overruns the abstraction capacity by far. The abstraction does indeed shorten the hydroperiod of the river system.

This assessment pertains to the lower Hartbees River where the river and its riparian zone are relatively intact. Near the confluence with the Orange River, it was canalized for the protection of vineyards against floods.

Table 5.6 Present Ecological State Orange River downstream of Kakamas

Instream	Score	Weight	Product	Maximum score
Water abstraction	12	15	180	350
Flow modification	12	15	180	325
Bed modification	20	13	260	325
Channel modification	22	13	286	325
Water quality	15	14	210	350
Inundation	15	10	150	250
Exotic macrophytes	10	9	90	225
Exotic fauna	15	8	120	200
Solid waste disposal	18	6	108	150
Total		100	1584	2500
% of total			63.3	
Class			C	
Riparian				
Water abstraction	12	13	156	325
Inundation	12	11	132	275
Flow modification	20	12	240	300
Water quality	22	13	286	325
Indigenous vegetation removal	15	13	195	325
Exotic vegetation encroachment	5	12	60	300
Bank erosion	18	14	252	350
Channel modification	8	12	96	300
Total			1417	2500
% of total			56.7	
Class			D	

The river at Kakamas, as elsewhere, has been impacted by major dams, large-scale water abstractions, an influx of agricultural chemicals, encroachment of reeds and exotic macrophytes, translocated and exotic fish, levees, bridges and many other infarctions. Hence the river was scored a C (Table 5.6), which signifies that it has been impacted, but despite these impacts still exhibits appreciable ecological functioning.

The riparian zone scores a D (Table 5.6), which signifies that ecological functioning has been lost.

Table 6 Present Ecological State Summary

Water Resource	Instream Class	Riparian Class
1	C	C
2	C	C
4	D	D
5	A	A
Hartbees River	C	B
Orange River	C	D

12 Ecological Importance

The Ecological Importance (EI) is based on the presence of especially fish species that are endangered on a local, regional or national level (Table 7).

Table 7. Ecological Importance according to endangered organisms (Kleynhans,1999).

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

There are no fish in the drainage line, as there is no permanent water. According to this assessment, which is prescribed for WULA's, the drainage line is not important.

No other endangered species, either plant or animal, were detected in or near the drainage line.

The Orange River is most important, according to this assessment.

According to Skelton (1993) 11 species of fish occur in the Lower Orange River. Since 2011 another one was added, as well as 3 exotic species. These are the following:

Barbus trimaculatus
B paludinosus
B. hospus
Labeobarbus kimberleyensis (Near threatened)
L aenus
Labeo umbratus
L capensis
Austroglanis sclateri (Widespread elsewhere)
Clarias gariepinus
Pseudocrenilabrus philander (Threatened locally but abundant elsewhere)
Pseudobarbus quathlabae
Mesobola brevianalis (critically endangered)
Cyprinus carpio
Tilapia sparrmanii
Oreochromus mossambicus

Those in blue are endangered to some extent. Those indicated in red are exotic or translocated fish.

The only one that causes real concern in the largemouth yellow fish *Labeobarbus kimberleyensis*. It is endemic to the Orange River system and hence is threatened not only on a local scale, but on a national scale as well. This puts the Lower Orange in category 4. This renders the Orange River as important.

According to the owners of the Kalahari River and Safari Co. along the northern bank of the Orange River on the Riemvasmaak Road, mature blue kurper *Oreochromus mossambicus* are regularly captured in increasing numbers. It now takes at least 4 man-days to capture a single yellow fish. Yellow fish are generally infected with cestode bladder worms, while darters (*Anhinga rufa*) that predate on these fish are heavily infected with tape worms. It seems as if the translocated Tilapia are not affected by these parasites.

13 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.

13.1 Ecological Sensitivity of the Orange River

The Orange River at Kakamas has absorbed numerous and deep-cutting human impacts. Yet is still functions as an aquatic ecosystem. In the highly improbable event of ceased human impact, the river here would probably bounce back to its previous glory. In this respect the river cannot be categorised as sensitive.

It is dreaded among conservation minded people that, according to opinions expressed by people of the water management fraternity, the Lower Orange River might have some more capacity to absorb further impact.

The inevitable truth is that anthropological impacts are permanent. The river will not return closer to its natural state. This perspective subscribes to the definition of ecological sensitivity. It underscores the notion the Orange River indeed is ecological sensitive.

13.2 Ecological Sensitivity of the Drainage Lines

If left to its own devices, the drainage lines would remain as they are now, without the need for protection measures. However, if more developments are allowed in the sub-catchments, the drainage lines would probably never recover to any resemblance of its current state. In these arid areas vegetation is slow to recover. Recovery may take many decades, even a century or more. The drainage lines in the sub-catchments can be considered as ecologically sensitive.

13.1 Ecological Sensitivity of the Hartbees River

The Hartbees River resembles drainage lines in many respects, rather than resembling the permanently inundated Orange River. The riparian zone may benefit more from shallow ground water moving downhill underneath the dry river bed than is the case in smaller drainage lines, only because there in more ground water in the river than in drainage lines. Essentially, the Hartbees River is a very large drainage

line, dry most of the time, with higher vegetation in the riparian zone. It suffers the same ills. If the riparian zone is damaged, with the vegetation removed, it may take a century or more for recovery. In this respect, the Hartbees River is ecologically sensitive.

14 EISC

Table 8 EISC

	Drainage Lines	Orange River	Hartbees River
Rare and endangered species	1	4	2
Populations of unique species	1	4	2
Species / Taxon richness	1	4	3
Diversity of habitat	2	4	3
Migration Route/ Breeding and feeding site for wetland species.	2	4	5
Sensitivity to water quality changes	2	3	2
Flood storage, energy dissipation, particulate / element removal.	1	4	3
Protection status	2	4	4
Ecological integrity	2	3	3
Average	1.6	3.8	3.0
Score	Moderate	High	High

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

The DWS demand that the aquatic habitat be placed in a category according to the EISC methodology (Table 8). The EISC is one of the essential items that is required for the Risk Matrix.

The EISC for the drainage lines combined is rated as Moderate, with a Medium level of confidence.

The EISC for the Orange River and the Hartbees River is High, with a High level of confidence.

15 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 25.1, p68, 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 p68 to derive at a value for Significance. The value for Significance can subsequently be evaluated according to Table 25.1.2.

Table 25.1.2 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 9), 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 9 Significance Score

Parameter	Drainage lines	Orange River	Hartbees River
Conservation value	1	5	5
Likelihood	5	2	1
Duration	5	5	5
Extent	2	1	1
Severity	5	1	1
Average	17	45	40
Significance	Low	Medium / Low	Medium / Low

The EISC for the drainage lines combined was estimated as “Low”.

The EISC for the Orange River was set at Medium / Low. The conservation value is high, the duration is long-term, but the impact in the river is going to be small and of a limited extent.

This assessment does not take the cumulative impacts of all the vineyards along the Orange River into consideration, only the insignificant impact of yet another new vineyard.

16 Possible Impacts and Mitigating Measures

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

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.

Unless some of the treated sewage effluent ends up in the drainage lines, the flow here will not be modified in any way.

The existing WWTWs’ flows down the sub-catchment no.4 drainage line, then into a canal and ends up in the Orange River. This is a existing flow modification. The proposed new WWTW’s treated effluent will be flowing down the concrete canal downstream of sub-catchment no.4 and then into the Orange River. This does not represent an improvement on the current situation, apart that there will be less treated effluent because most if not all of it will be used for irrigation.

Permanent inundation

No inundation is foreseen in the drainage lines because of the new WWTWs. The current inundation in sub-catchment no.4 will stop.

The extra inundation because of the treated effluent will shift from the existing locality down the Orange River to the new locality downstream. Less inundation will occur because less effluent will be released into the river as most effluent will be used for irrigation.

Water quality modification

The current WWTWs treated effluent is not meeting any of the national standards because treatment is entirely inadequate. The new WWTWs will solve this problem, with environmentally acceptable effluent sustainably released into the natural aquatic environment.

Sediment load modification

Soil will be loosened during the construction phase. None of this, along with sediment and debris must be allowed to move down the drainage lines along with the occasional stormwater. This is equally valid for the WWTWs and the pipelines.

The access roads to the site must be maintained. Stormwater management structures must be constructed to divert runoff from the roads. Erosion of roads must be prevented. No new roads must be added. Use only existing access roads. Limit the footprint to that of the demarcated construction site.

Canalization

Sewage and treated effluent will be conveyed in pipelines. No canals will be constructed. The existing canal downstream of the new WWTWs will be utilised.

Topographic alteration

The envisaged WWTWs is not about to alter the topography of the landscape, other than the low-slung infrastructure of a typical small-scale WWTWs.

Terrestrial encroachment

Mostly dry drainage lines are terrestrial habitat. The new WWTWs will not change any of this.

Indigenous vegetation removal

Prior to planting, a search-and-rescue operation is to be undertaken to remove any valuable plants. These plants should then be re-planted on a suitable site to insure their survival. The only plant of such description were two small stands of aloes, *Aloe claviflora* (Figure 26). This aloe is plentiful in the region and is not endangered in any way.

Figure 26 *Aloe claviflora*

Invasive vegetation encroachment

The main threat from invasive vegetation in these parts is *Prosopis* trees that rapidly take over in disturbed soils. This must be prevented, even long after the completion of the construction phase.

It can be expected that a thick stand of *Phragmitis* reeds will establish itself in earthen canals at the onset of treated effluent release. This represents a vast departure of the natural ecological state. It has some advantages as well, as it somehow filters return flow, with some nutrient removal qualities. Form an ecological point of view, this is not really a commendable situation, even though minutely helpful.

Alien fauna

The Land is used for grazing sheep and cattle. This will carry on after the construction of the new WWTWs.

Over-utilization

The land is used for grazing sheep and goats. The land does not seem to be over grazed. The new WWTWs will not change any of this.

Isolation / Migration

The drainage lines now under consideration are relatively small, short, with no real function as wildlife migration route corridors. The new WWTWs will not alter the situation.

Ground water table.

It is not foreseen that the water table would be elevated as the ponds will be lined, with no leakage and infiltration into the ground. The groundwater must be monitored from a downstream borehole. Periodic sampling is mandatory, along with laboratory analysis. Analytic results must be officially and publicly available.

Waste

Portable toilets will be serviced by a reputable company during the construction as well as the operational phase, as is standard operating procedure.

No litter was noted on the proposed site during the site visit.

A major effort would be required to clean up the access road past the existing WWTWs to the landfill site. This is an ongoing problem.

The pipelines

Where the pipelines cross the drainage lines, flood damage may occur. The pipes may be washed away during the occasional heavy thunderstorm.

The pipelines must be dug in deeper at these crossings, with at least a metre cover of compacted backfill. The crossing must be landscaped following construction so that no erosion or pooling occur when it rains. These crossings must be monitored so that they can be maintained and repaired following signs of erosion or any flood damage.

The crossings are indicated in Figure 27, with blue dots. Their coordinates are as follows:

28°47’11.25”S and 20°36’69.75”E
28°47’13.85”S and 20°35’32.98”E
28°47’05.53”S and 20°36’36.27”E
28°47’01.68”S and 20°39’69.70”E
28°46’50.18”S and 20°35’45.43”E
28°46’17.14”S and 20°35’52.92”E

There are two crossings at the most downstream coordinate.

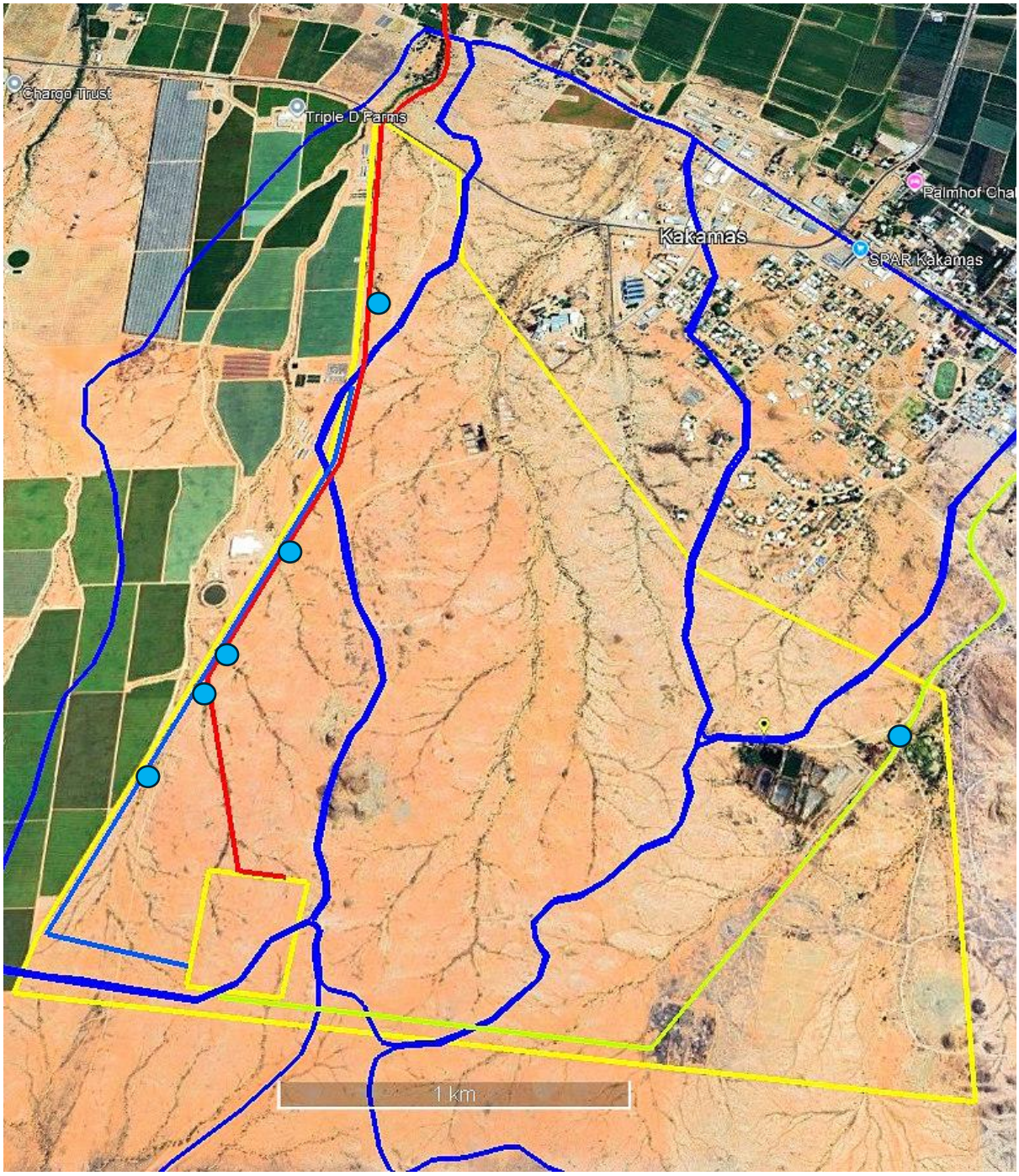


Figure 27 Pipeline crossings

17 Impact Assessment

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

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

The methodology is set out in the Appendix.

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

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

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

- Keep debris and sediment out of the aquatic habitat during construction.
- Keep agricultural return flow out of the aquatic habitat during operation.
- To maintain stormwater management infrastructure.

These aspects must be kept onto the budget for as long as the new WWTWs is in existence.

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

However, when the existing WWTWs is decommissioned, a rehabilitation plan is mandatory. This is a separate project with its own documentation and official approval.

Table 10 Impact Assessment

Description of impact: Construction Phase Removal of the vegetation Levelling the ground Digging of trenches for foundations and pipelines Construction of the new WWTWs Cleaning up after construction **Mitigation measures** Preserve drainage lines as much as possible Preserve buffer zones as much as possible Prevent loose soil and sediments from moving down the drainage line along with storm water								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Local	Low	Temporary	Low	Definite	Certain	Irreversible	Irreplaceable
With mitigation measures								
Negative	Local	Very low	Temporary	Very low	Definite	Sure	Irreversible	Irreplaceable

An exhaustive environmental management plan must be drafted for the new WWTWs construction. An ECO must be appointed to overlook and monitor the environmental issues during construction.

Table 10 Impact Assessment continued

Description of impact: Operational Phase Operate the WWTWs according to acceptable and published standards Maintain the WWTWs Maintain pipelines Montor effluent quality. Make analytical results public Keep surrounding environment tidy **Mitigation measures** Maintain the WWTWs Maintain pipelines Montor effluent quality. Make analytical results public Keep surrounding environment tidy								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Local	Medium	Permanent	Medium	Definite	Certain	Irreversible	Irreplaceable
With mitigation measures								
Negative	Local	Low	Permanent	Low	Definite	Sure	Irreversible	Irreplaceable

Again, a proper operating plan with standard operating procedures is mandatory, according to the DWS standards and regulations. This impact assessment cannot do such a document any justice.

The educational and skill levels of staff must match the demands of a properly managed WWTWs.

The local authority must aim for a persistent annual Green Drop rating.

18 Risk Matrix

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

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 11 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report. The numbers in Table 11 (continued) represent the same activities as in the Impact Assessment, with sub-activities added.

The methodology is tabled in the Appendix.

Table 11 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1.1	Construction of the new WWTWs	Removal of the vegetation Levelling the ground Digging of trenches Construction of the WWTWs Cleaning up, landscaping	Sand and mud washing down the drainage line Destruction of aquatic habitat	2.4	Low
1.2				3.6	Low
1.3				1.6	Low
1.4				2.4	Low
1.5				2.4	Low
Hartbees Orange	Operation of the WWTWs	Sewage and effluent ending up in the aquatic environment	Pollution, altering of aquatic habitat	6.4 65	Low High

Table 11 continued

No	Hydrology	Water Quality	Geomorphology	Vegetation	Fauna	Overall intensity	Spatial scale	Duration
Drainage lines								
1.1	1	1	1	1	1	2	1	1
1.2	2	2	3	1	3	6	2	1
1.3	0	0	0	1	0	2	1	1
1.4	0	2	1	1	0	4	1	1
1.5	0	1	0	0	0	2	1	1
Hartbees	0	1	0	0	0	2	1	5
Orange	2	2	0	2	3	6	2	5

No	Severity	Importance rating	Consequence	Likelihood	Significance	Risk rating	Confidence level
1.1	4	2	8	20	1.6	Low	High
1.2	9	2	18	20	3.6	Low	High
1.3	4	2	8	20	1.6	Low	High
1.4	6	2	12	20	2.4	Low	High
1.5	6	2	12	20	2.4	Low	High
Hartbees	8	4	32	20	6.4	Low	High
Orange	13	5	65	100	65	High	High

The environmental risks to the drainage lines are low. Sub-Catchment 1 drainage line is low as well despite it will receive treated effluent. Its low importance rating contributed to its low risk rating. The Hartbees River is unlikely to be impacted, with a low risk rating.

The Orange River was rated as high because of a combination of its high importance value and the effluent it is about to receive. The Risk Matrix indicates that a License is the correct level of official authorisation.

However, WATSAN Africa has in the past applied for small WWTWs for which Licenses were indicated. The DWS and its reginal offices have decided differently. General Authorisations were issued instead.

19 Resource Economics

The goods and services delivered by the environment, in this case the drainage lines on the site where the Kakamas new WWTWs is envisaged and the Orange and Hartbees River, is a Resource Economics concept as adapted by Kotze *et al* (2009).

The diagram (Figure 28) is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 12.

Table 12. Goods and Services of the waterways around the proposed Kakamas WWTWs

Goods & Services	Drainage lines combined	Hartbees River	Orange River
Flood attenuation	3	5	5
Stream flow regulation	2	5	5
Sediment trapping	2	3	5
Phosphate trapping	1	4	5
Nitrate removal	1	4	5
Toxicant removal	1	3	5
Erosion control	3	4	5
Carbon storage	1	3	5
Biodiversity maintenance	4	5	5
Water supply for human use	0	4	5
Natural resources	1	3	5
Cultivated food	1	4	5
Cultural significance	1	2	5
Tourism and recreation	1	2	5
Education and research	2	3	5

0 Low
5 High

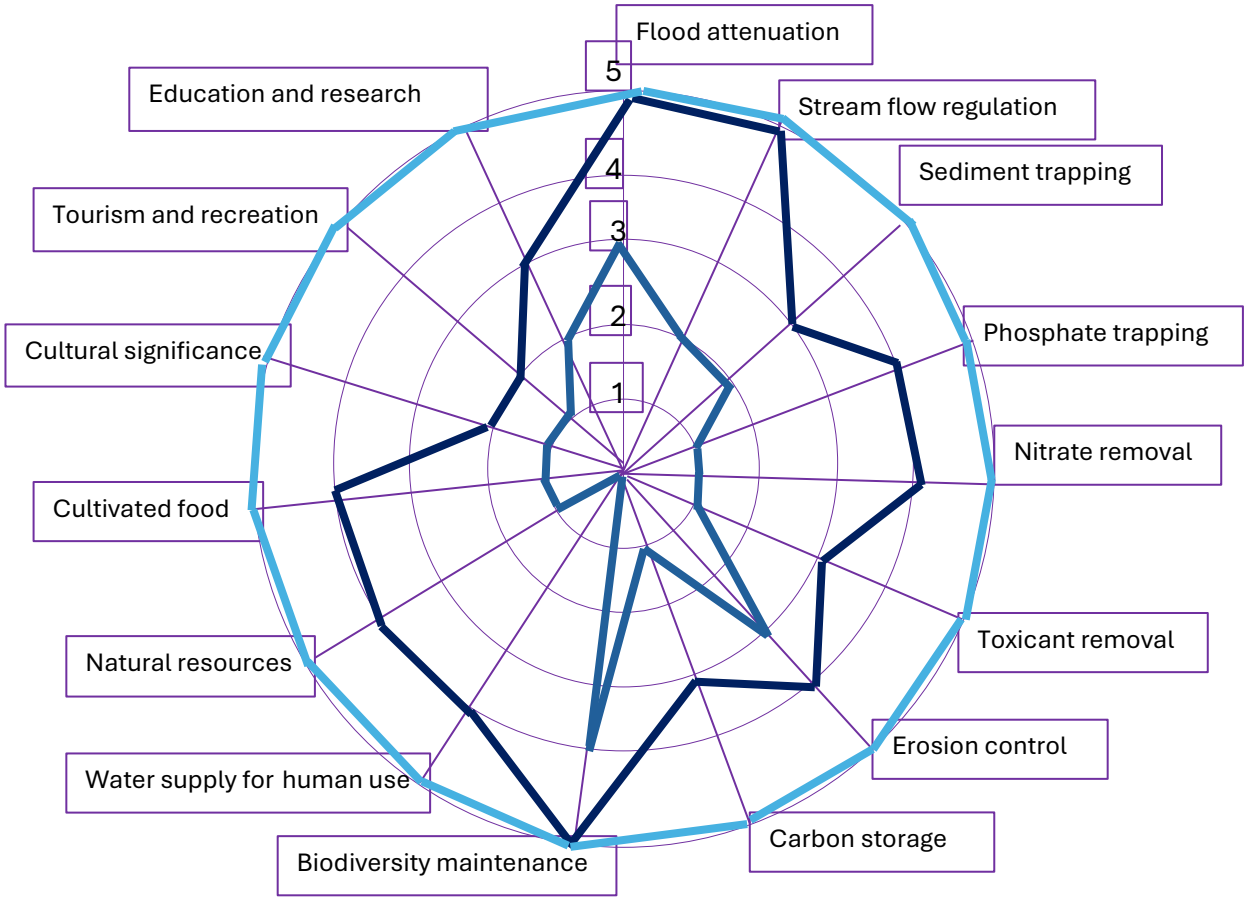


Figure 28. Resource Economics Footprint of the Lower Hartbees River

The spider diagrams outer circle represents the Orange River resource economic footprint, which is a complete circle, the largest footprint possible, as is appropriate for large South African Rivers.

The Hartbees River is smaller, more a large drainage line, mostly dry, with a smaller resource economic footprint, as illustrated by the middle circle. It is still large enough to draw the attention of decision-makers, as it contributes to economic and ecological well-being.

The inner circle, that of the drainage lines around the proposed Kakamas WWTWs, is diminutive, signifying a limited contribution to the economy and the ecology. The contribution to biodiversity, however, cannot be ignored.

The proposed Kakamas WWTWs is not about to change the resource economic footprint. Perhaps, as reeds are added to the lower sub-catchment 1 drainage line, the phosphate and nitrate trapping function would become more important.

20 Summary

Table 13 Summary of four five sub-catchment affected by the new Kakamas WWTWs

Aspect	WWTWs site
DFFE Screening Tool	Sensitivity Medium, High, Very High
Protection status	CBA, ESA
Drainage line and rivers	NFEPA
Vegetation	Least concern
PES	From D to A
Ecological Importance site	Not important
Ecological Importance rivers	Very important
Ecological Sensitivity	Sensitive
EISC drainage lines	Moderate
EISC rivers	High
Impact assessment	Mitigation can be implemented
Risk Matrix	General Authorization
Resource Economics drainage lines	Small
Resource Economics rivers	Medium to very large footprint

According to Table 13, the land on which the future WWTWs is to be constructed is environmentally sensitive, but is not environmentally important. Its contribution to the local economy is negligible. The environmental status of the Orange River into which treated effluent is to be released raises concern. The new WWTW's will alleviate this as mitigating measures can be implemented.

21 Conclusion

An anthropogenic activity can impact on any of the ecosystem drivers or responses. 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 29*). The WULA and the EAI must provide mitigation measured for these impacts.'*

Figure 29 has been adapted from DWS policy documents.

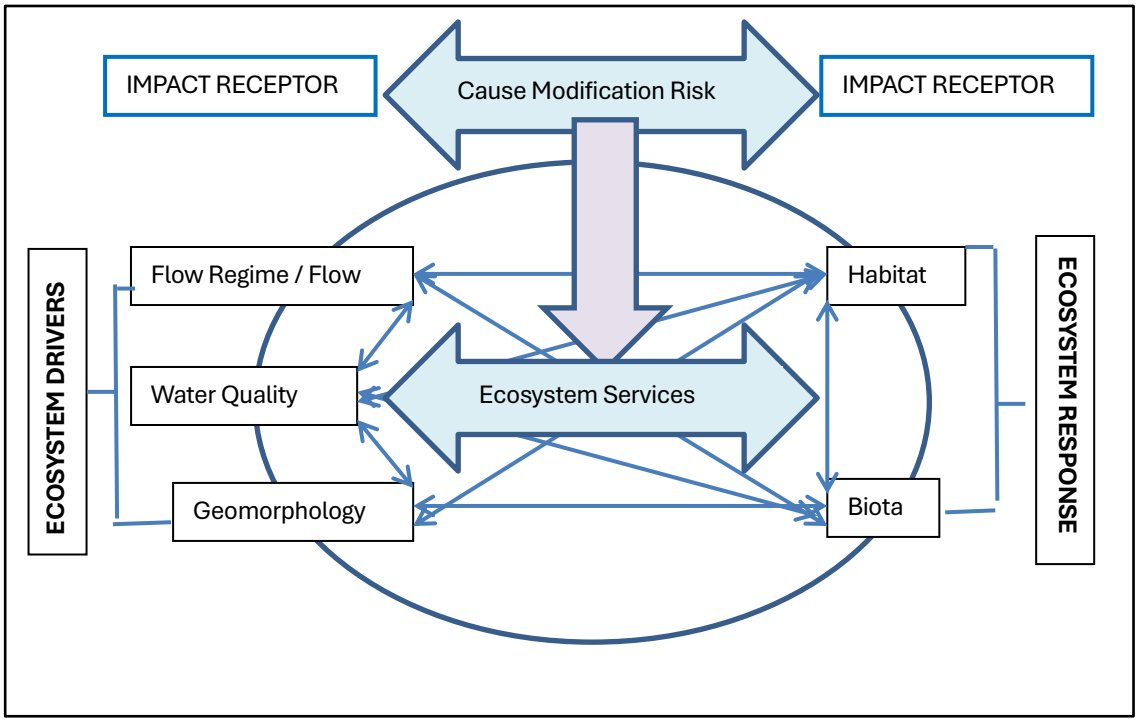


Figure 29 Minimum Requirements for a S21(c) and (i) Application

The occasional sudden and fierce electric thunderstorm drives the drainage lines of the region. The torrent of runoff scours out these drainage lines and preserves their integrity. Moreover, the shallow ground water migrating down the slopes underneath these drainage lines maintain a the rows of higher vegetation that criss-crosses the landscape. This adds so terrestrial habitat variability, more than to aquatic habitat.

The droughts in between downpours as just as much as a driver. This limits the mostly sparse vegetation in the drainage lines to hardy and specialised species.

The Orange River's main driver is the high rainfall area of the Lesotho Highlands. The arid southern Kalahari Desert of the Northern Cape does not contribute to the flow in

the river. Hence, whatever happens in and around Kakamas is not notably affecting the Orange River.

However, treated sewage effluent in a main water resource draws attention. The old Kakamas WWTWs poor quality treated sewage effluent currently is finding its way to the Orange River. This will predictably worsen, as the population increases and as the WWTWs performance does not meet the increased demand. The new WWTWs will produce an effluent that will meet the national standards, if properly managed. The volume released into the aquatic environment will be less as most of the effluent will be used for irrigation.

The Risk Matrix indicates that a License is the correct level of official authorisation. WATSAN Africa was instrumental to get several WWTWs of a similar size authorised. These were authorised with a General Authorisation instead of the recommended License. It is expected that the proposed Kakamas WWTWs will be authorised with a General Authorisation as well.

22 References

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Mucina, L. & M.C Rutherford. 2006. *The vegetation of South Africa, Lesotho and Swaziland*. SANBI, Pretoria.

23 Declaration of Independence

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

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

Signature of the specialist: D van Driel 15 May 2025

24 Résumé

Dr Dirk van Driel
PhD, MBA, PrSciNat, MWISA
Water Scientist

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Experience

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

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

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

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

University of Western Cape and Stellenbosch University 1994 - 1998 part-time

- Lectured post-graduate courses in Water Management and Environmental Management to under-graduate civil engineering students
- Served as external dissertation and thesis examiner

Service Positions

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

Membership of Professional Societies

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

Reports

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

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

- Freshwater Report De Kuilen Resort, Kamiesberg
- Wetland Delineation, Klipheuvel ZCC Solar Energy
- Freshwater Report Delville Park, George
- Freshwater Report ZCC Akkerboom electric vehicle charging station, Keimoes
- Freshwater Report ZCC Piketberg electric automobile charging station
- Freshwater Report ZCC electric truck charging station Piketberg
- Freshwater Report ZCC electric truck charging station Prince Albert Weg
- Freshwater Report Vleesbaai Wastewater Treatment Works
- Freshwater Report ZCC Brandvlei electric vehicle charging station.
- Site Sensitivity Report desalination plant Velddrif
- Technical Report desalination plant Velddrif
- Freshwater Report Abbottsdale High Voltage Power Line
- Freshwater Report Darling Solar Energy Plan
- Freshwater Report Malmesbury Klipkoppie Solar Energy Plant
- River Rehabilitation Plan Louterwater, Langkloof
- River Rehabilitation Plan Kloof Please Krakeelrivier
- Freshwater Report ZZC Potchefstroom electric automobile charging station.
- Freshwater Report ZKA Information Centre Carnavon
- Freshwater Report ZCC Estcourt electric vehicle charging station
- Freshwater Report ZCC Kohler electric vehicle charging station
- Freshwater Report ZCC Harrismith electric vehicle charging station
- Wetland demarcation, Farm Gustrouw 918, Somerset West
- Freshwater Report, New vineyard, Plot 1181, Kakamas
- Freshwater Report, Farm 91, Riversdale.
- Freshwater Report Harmony Agriculture, Koue Bokkeveld, Ceres
- Freshwater Report Toeka Agriculture, Koue Bokkeveld, Ceres
- DFFE Site Verification Report, Diemersfontein Cell Phone Tower.
- Wetland Demarcation Portion 81 Farm Gustrouw, Somerset West
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- Freshwater Report Farm Plattekloof 90 Riversdale
- Freshwater Report Franschhoek Pedestrian Bridges
- Freshwater Report Gwaing Landfill, George
- Freshwater Report Erf 977 Val de Vie
- Fresh Water Report Eerste River Bus Depot
- Freshwater Report Farm Krugerskop onion field, Merweville
- Freshwater Report, Farm Oudebosch, Riversdale

25 Appendix

Table 25.1 Numerical Significance

Table 25.1.1 Conservation Value

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

Table 25.1.2 Significance

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

Table 25.1.3 Scoring system

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

25.2 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 25.2.1 Nature and type of impact

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

Table 25.2.2 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 25.2.3 Significance Rating

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

Table 25.2.4 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.

25.3 Risk Matrix Methodology

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

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

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

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

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

TABLE 6: RISK RATING CLASSES

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

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

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