BASELINE AQUATIC RESOURCES ASSESSMENT

KAKAMAS BULK WATER SUPPLY PROJECT

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KAI !GARIB MUNICIPALITY
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Prism EMS | P.O. Box 1401, Wilgeheuwel, Johannesburg, 1736 | Tel: 066 208 1585 | E-Mail: prism@prismems.co.za

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	Name	Signature	Date
Site Assessment	**Mr. D. Botha** (M.A. Env. Man.) (PHED) **Aquatic & Wetland Specialist | Pr. Sci. Nat.**		April 2026
Report compilation	**Mr. D. Botha** (M.A. Env. Man.) (PHED) **Aquatic & Wetland Specialist | Pr. Sci. Nat.** **Mr. G. Bouwer** (MSc. Env. Sci.) **Aquatic Specialist | Pr. Sci. Nat.** **Dr W. Vlok** (PhD) **Principal Ecologist | Pr. Sci. Nat**		May / June 2026 July / August 2026
Document Review	**Mr. G. Bouwer** (MSc. Env. Sci.) **Aquatic Specialist | Pr. Sci. Nat.** **Mr. C. de Beer** (MSc. Env. Sci. & Eco Water Reqs) **Aquatic Specialist | Cand. Sci. Nat. | SASS5**		June 2026 August 2026
Document Signoff	**Mr. D. Botha** (M.A. Env. Man.) (PHED) **Aquatic & Wetland Specialist | Pr. Sci. Nat.**		September 2026

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Specialist Name	Mr. D. Botha
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
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EXECUTIVE SUMMARY

The Kai !Garib Municipality identified a need to upgrade and extend the water reticulation network in Kakamas and Augrabies settlements to replace ageing infrastructure and to supply increased water demand. It was noted that the larger portion of the existing water infrastructure has surpassed the design capacity and life expectancy and the Kakamas Water Treatment Works was last significantly upgraded in 1987. Currently the critical mechanical, electrical and dosing equipment is in a poor condition, resulting in frequent breakdowns, high maintenance costs and an unreliable water supply to the communities.

The reticulation network was designed for smaller populations and lower demand levels and with the population growth, housing development, tourism activities and agricultural expansion in the last 50 years, there is an increased demand for reliable potable water. The Kai !Garib Municipality's Integrated Development Plan (IDP) has identified several water-related projects, including:

- Upgrading of bulk water supply infrastructure in Kakamas.
- Refurbishment of the water purification system in Augrabies.
- Feasibility studies and long-term planning for water infrastructure improvements.
- Expansion of water supply networks to accommodate future development.

PRISM Environmental Management Services (PRISM EMS) was appointed by EnviroAfrica (EAP) on behalf of **Kai !Garib Municipality** (the Applicant), to undertake a baseline aquatic resources assessment for the upgrade and related construction of the proposed Kakamas Bulk Water Supply Project. The network supply potable water to Kakamas, five (5) other villages and several commercial farmers. The current capacity supply 10 000 people, but must be expanded to service approximately 46 000 people (a daily demand of 94 l/s with a peak summer demand of 149.1 l/s). The distribution network will service 7 795 households and 4 000 learners with an estimated per capita consumption of 120 l/capita/day which means the Water Treatment Plant is required to supply 10.5 ML/day.

This report presents the Aquatic Assessment conducted on 13 to 15 April 2026 to inform the Environmental Authorisation (EA) application, the Environmental Impact Assessment (EIA) process and the Water Use License Application (WULA) for the proposed Kakamas Bulk Water Supply Project.

The study area within the Northern Cape represents drainage of surface water across a wide hydrological spectrum and the diversity of streams and rivers are classified based on surface flow duration, flow predictability and geomorphic position. The different drainage systems include wash sheets and hillslope, ephemeral streams and rivers, seasonal rivers and permanent or perennial rivers. The ecological integrity of a river is based on the concept of biological integrity that is “the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of natural habitat of the region” (Karr and Dudley 1981).

During the desktop investigation, several aquatic resources were identified that may be impacted by the construction and/or authorised activities. Most however are unnamed streams (wash sheets and ephemeral channels) with poorly defined channels or riparian vegetation. Most of these ephemeral channels drain into the Hartbees, Brabees and Slang rivers, all tributaries of the Lower Orange River (receiving environment)

Rivers in the lower Orange River catchment are largely rated as having a C and D PES category. The water resources in this catchment are dominated by depression, seep and unchanneled valley bottom wetlands which cover approximately 2% of the catchment area. The Orange River from Upington to Hartbees River confluence show changes to water quality, with a PES category of D/E (decline). The reach dominated by intensive agricultural activity and includes the Neusberg weir and WMS monitoring point (important for monitoring the proposed project). From the Hartbees (Kakamas) further west (to Augrabies Waterfall) the mainstem of the Orange River is dominated by intensive agricultural activity. Flow and water quality is similarly impacted with the PES predominantly a C/D category. This section of the river is an important fish sanctuary with a number of red data species present (Moodley et al., 2025).

The different systems where characterised as follows:

- Class 1 streams (wash sheets) with no discernible or visible drainage line and includes the wash sheet and ephemeral channels.
- Class 2 ephemeral drainage lines with some marginal vegetation (referred to as xeroriparian vegetation).
- Class 3 systems with a clearly defined ephemeral drainage line and defined riparian vegetation component.
- Class 4 systems with an obvious, discernible drainage line and a clear sign of sediment transportation (seasonal rivers).
- Class 5 systems with a well-defined river channel and riparian vegetation component (perennial rivers).

After the assessment the number of aquatic resource crossings mapped (total 207 sites):

Route	Class 1	Class 2	Class 3	Class 4	Class 5
All Routes Combined	147	46	10	3	1
Total	207				

Site Sensitivity Verification Statement for the Aquatic Biodiversity Theme

The Screening Tool Report (STR) related to the Aquatic Biodiversity Theme (Section 6.2) show that the resources in the study area are rated with a **very high sensitivity**. This includes the abstraction point in the Orange River and the pipeline crossings of the Hartbees, the Slang and the Brabees rivers.

The STR protocol requires a review of the environment to confirm or dispute the rating. To comply to the regulations a specialist impact assessment was conducted to evaluate the aquatic ecosystem integrity. The ephemeral and seasonal systems are fragile alluvial and riparian ecological systems that function as critical ecological corridors in the arid environment. In these stochastic stream systems, the dynamic flood scouring, sediment transportation and bank erosion may directly threaten their linear infrastructure integrity.

After the review of the study area, it is recommended that the **very high sensitivity rating for the aquatic biodiversity** theme, as reflected in the STR **is maintained.** This recommendation is based on the assessment during the site visit and desktop review that indicated that current and historic activities have a negative impact on the ecosystem. The pressure on the water resources and the receiving environment need to sensitise developers, regulators and society of the fragility of the arid environments. Cumulative downstream risks related to the trenching activities during pipeline construction will be low (negligible), if all recommendations and mitigation strategies are rigorously employed.

Recommendations

To maintain the very high sensitive habitat at linear pipeline crossings along arid ephemeral streams and seasonal rivers requires targeted trenchless construction methods, rigorous erosion control and continuous hydrological surveillance.

Construction and Engineering Mitigation

- It is recommended to use trenchless crossings. The horizontal directional drilling (HDD) or micro-tunnelling to pass beneath the bed and banks of seasonal watercourses will avoid surface disturbance of sensitive riparian zones.
- It is important to minimise the footprint near the sensitive areas. It is critical to only use the approved corridor width when working in the streambed and streambanks. Restrict all laydown areas, vehicle staging and fuel storage to areas outside the riparian boundary of any ephemeral wash or riverbed. It is recommended that existing construction yards are used for the project.
- The use of rock-pack gabions instead of hard concrete liners to protect stream banks and channels is recommended. The gabions reduce flow velocity and movement of water through the structure which reduces erosion downstream.

  - Only clear areas where construction will take place. This will lower the risk of erosion (wind and water) in exposed areas where no work is taking place.
  - Areas must be rehabilitated immediately after the installation of the pipeline is completed.
  - If large areas are exposed, geotextiles can be used to stabilise soils – prevent wind and water erosion.
- Construction (trenches) must be limited to the dry, winter months. On larger crossings the use of temporary diversions with flow velocity dissipaters to manage any unexpected flow must be employed. It will be important to have effective sediment screens to ensure no impacts downstream of the site.

Ecological and Rehabilitation Protocols

- It is critical that the top 30 cm of biologically active alluvial soil (topsoil) is stripped and stockpiled. Once activities are completed, the topsoil must be backfilled immediately to preserve local seed banks and soil bacteria.
- In addition, alien vegetation eradication must be cleared within the working corridor. It is important to implement a 24-month follow-up weed control program after completion of the work at a site.
- After completion of the work, micro-topography restoration is critical and re-contour of the ephemeral stream bed and banks must match the pre-construction cross-sections to avoid the diversion of water that can impact on the natural flood scouring patterns, especially the stream banks.

Monitoring and Surveillance Strategies

- Pre- and post-rainfall inspections must be carried out by the Environmental Control Officer (ECO) to evaluate changes at all crossings before forecasted summer thunderstorms and immediately after initial seasonal flow events. All impacts must be recorded and rehabilitated immediately.
- As an additional monitoring option, erosion and scour tracking can be done with ground-level photo monitoring points at crossing points to detect bed lowering or lateral bank erosion.
- It is recommended to do two-year (annually after completion) integrity audits. The ecologist can assess the crossing points and advise the client on the effective maintenance of the impacted areas.

Conclusion

PRISM Environmental Management Services (PRISM EMS) was appointed by EnviroAfrica (EAP) on behalf of Kai !Garib Municipality to undertake a baseline aquatic resources assessment for the upgrade and related construction of the proposed Kakamas Bulk Water Supply Project.

The network will supply potable water to Kakamas, five (5) other villages and several commercial farmers. Currently the network supple water to approximately 10 000 people, but the expansion needs to include

approximately 46 000 people. This means that the daily demand will be 94l/s with a peak summer demand of 149.1l/s. The distribution network will service 7 795 households (719 economic units and 7 076 subeconomic units) and 4 000 learners at a number of schools.

From an aquatic ecological perspective, the proposed project is supported, provided that all recommended mitigation measures, management interventions, and monitoring requirements are implemented throughout the project lifecycle. The receiving environment comprises a network of sheetwash areas, ephemeral drainage features, and low-order stream systems that collectively contribute to hydrological connectivity, sediment transport, water quality regulation, and the provision of habitat for aquatic and semi-aquatic biota.

Although temporary disturbances to the aquatic environment are anticipated during construction and implementation activities, these impacts are expected to be limited in extent and duration if best-practice environmental management measures are effectively applied. Potential risks include increased sedimentation, localised erosion, vegetation disturbance, alteration of surface water flow patterns, and deterioration of water quality. However, with appropriate planning, construction controls, rehabilitation, and ongoing environmental oversight, these impacts can be minimised to negligible or low significance levels.

Refer to Appendix C for detailed mitigation and monitoring recommendations.

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1. INTRODUCTION

1.1 Background

There is a need to upgrade and extend the water reticulation network in Kakamas and Augrabies settlements (Kai !Garib Municipality) as the existing ageing infrastructure must supply an increase water demand, cope with recurring service interruptions and water quality concerns and the need to support future socio-economic development of the region.

During a recent assessment by the authorities, it was noted that the larger portion of the existing water infrastructure in the Kai !Garib Municipality is old and has surpassed the design capacity and life expectancy. The Kakamas Water Treatment Works was last significantly upgraded in 1987, with critical mechanical, electrical and dosing equipment in a poor condition. This has resulted in frequent breakdowns, high maintenance costs and an unreliable water supply to the communities.

The reticulation network was designed for smaller populations and lower demand levels and with the population growth, housing development, tourism activities and agricultural expansion in the last 50 years, there is an increased demand for reliable potable water. Existing pipelines and distribution systems are increasingly unable to maintain adequate pressure and supply capacity, particularly during peak demand periods. In addition, the residents experienced recurring water shortages, intermittent supply, and poor water quality with reports of “brown or untreated water” in some areas.

The Kai !Garib Municipality's Integrated Development Plan (IDP) has identified several water-related projects, including:

- Upgrading of bulk water supply infrastructure in Kakamas.
- Refurbishment of the water purification system in Augrabies.
- Feasibility studies and long-term planning for water infrastructure improvements.
- Expansion of water supply networks to accommodate future development.

The existing old asbestos cement and steel pipelines are prone to leaks, bursts and excessive water losses and the planned upgrades to the reticulation network should:

- Ensure a more reliable service to the users.
- Reduce physical water losses.
- Improve system efficiency.
- Lower maintenance and operational costs.
- Improve pressure management across the network.
- Support the economy of the region e.g. the tourism facilities and hospitality businesses, irrigation-related economic activities, residential expansion and industrial and commercial development.

The Department of Water and Sanitation (DWS) has highlighted deficiencies in drinking water quality management and infrastructure performance within the municipality, and the upgrades are vital to improve compliance with national water quality standards and ensure sustainable service delivery.

1.2 Project Description

PRISM Environmental Management Services (PRISM EMS) was appointed by EnviroAfrica (EAP) on behalf of **Kai !Garib Municipality** (the Applicant), to undertake a baseline aquatic resources assessment for the upgrade and related construction of the proposed Kakamas Bulk Water Supply Project (Figure 1-1).

The network will supply potable water to Kakamas, five (5) other villages and several commercial farmers. Currently the network supple water to approximately 10 000 people, but the expansion needs to include approximately 46 000 people. This means that the daily demand will be 94l/s with a peak summer demand of 149.1l/s. The distribution network will service 7 795 households (719 economic units and 7 076 subeconomic units) and 4 000 learners at a number of schools.

The estimated per capita consumption is 120l/capita/day which means the Water Treatment Plant is required to supply 10.5ML/day.

Included in the upgraded reticulation network is two (2) new reservoirs, one in Kakamas (700 kilolitre) and the second in Augrabies (20 megalitre).

Distribution network details:

- Raw water pipeline (3.50 km x 450 mm diameter) from Orange River to new Kakamas Water Treatment Plant with treatment capacity of 10 500m^3/day.
- Bulk pipelines to the existing:
    - Kakamas Reservoirs (1 150 m x 315 mm diameter)
    - Kliprand Reservoir (existing – 1 700 m x 250 mm diameter
    - Langverwag Reservoir (existing – 3 450 m x 160 mm diameter.
- Augrabies Pipeline – 36.0 km x 350 mm diameter, reducing to 160 mm diameter.
    - Feeds new 20 megalitre Reservoir located at high point (Renosterkop area) – Feeds Alheit Reservoir, Marchand reservoir and 2 x Augrabies Reservoirs.
- Schroder Pipeline – 11.32 km x 200 mm diameter, reducing to 110 mm diameter.
    - Feeds Cillie Reservoir
- Lutzburg Pipeline – 1.0 km x 160 mm diameter.
    - Feeds Lutzburg Reservoir
- Kakamas-East Pipeline – 9.40 km x 125 mm diameter.

1.3 Project Location

The study area falls within the Vaal-Orange Water Management Area (WMA 4) that is centrally managed by the Vaal-Orange Catchment Management Agency (VOCMA). The WMA 4 encompasses the expansive catchment of the Orange River system (Figure 1-10), including major tributaries like the Modder, Riet, Caledon, Kraai, Ongers and Hartbees rivers.

The Orange River is divided into the Upper and Lower Orange that supply water for the massive agricultural schemes, inter-basin transfers and international river sharing protocols which is part of the Orange-Senqu River Basin project. The Lower Orange River (Figure 1-11) spans the arid northern areas of the Northern Cape, from the Orange-Vaal confluence at Dougles down to its estuary at Alexander Bay on the Atlantic coast.

The Lower Orange River is associated with the hyper-arid, rugged desert landscape in the Northern Cape and supports vital riparian habitats, irrigated agriculture and mining activities. The terrain is dominated by the flat, arid plains with rocky outcrops and deeply incised gorges, and the arid climate receives between 50 mm and 400 mm of rain annually. The region is characterised by extreme summer heat and all activities along the river relies heavily on water regulated by upstream impoundments.

The riparian zone along the Orange River is a narrow, dense strip of gallery forest and shrubs that contrasts sharply with the surrounding desert. The mixed woody indigenous vegetation, such as *Olea europaea* subsp. *africana* (Wild Olive), *Ziziphus mucronata* (Buffalo Thorn), *Tamarix usneoides* (Wild Tamarisk), *Vachellia karroo* (Sweet Thorn), *Searsia burchellii* (Karoo Kunibush), *S. lancea* (Karee), *S. undulata* (Namakwa Kunibush), *Salix mucronata* (Small-leaved Willow) and *Phragmites australis* (Common Reed) are important to stabilise the riverbanks and to prevent bank erosion and degradation. In some areas the anthropogenic activities (agriculture, mining, grazing) have cleared large sections of the riparian vegetation, and some alien vegetation species may be present. In the catchment, some areas are dominated by impenetrable thickets of invasive alien vegetation such as *Prosopis glandulosa* (Honey Mesquite) with other species present i.e. *Nicotiana glauca* (Wild Tobacco), *Argemone ochroleuca* (Mexican Poppy) and *Ricinus communis* (Castor Oil bush). These alien species threaten the riparian ecosystem by depleting vital groundwater that sustain the indigenous species.

The river supports several endemic freshwater fish species in a broad spectrum of biotopes and the diverse macroinvertebrate communities are the food source for the fish. The fish species present include:

- *Namaquacypris hospes* (open water over sand and gravel – spawn September to March)
- *Engraulicypris gariepinus* (open water and backwaters – breeds early summer)
- *Enteromius oraniensis* (pools and impoundments – breeds summer, eggs in vegetation)
- *Enteromius paludinosus* (slow well vegetated waters – eggs in vegetation)
- *Enteromius trimaculatus* (prefer vegetation, migrate upstream to breed in summer)

- *Labeo capensis* (running water, graze on rocks and plants – breed in summer on shallow rapids)
- *Labeo umbratus* (prefers standing or slow-moving water, feed on soft sediment and detritus – breed in summer and spawn on grass inundated grass beds)
- *Labeobarbus aeneus* (deep pools or flowing water with sandy or rocky substrate – 5+ km home ranges, sensitive to weather events – breeds spring/summer after substantial freshets, spawn of suitable gravel beds)
- *Labeobarbus kimberleyensis* (Near Threatened) (adults in flowing water below rapids, home range up to 12 km, breed mid- to late summer over well oxygenated gravel beds)
- *Pseudocrenilabrus philander* (variety of habitats, prefer vegetated zones – breed early spring to late summer in constructed nest (male)
- *Tilapia sparrmanii* (wide habitat, but prefer standing water with rooted vegetation – males make a shallow nest)
- *Austroglanis sclateri* (Benthic species in riffles – unknown breeding biology)
- *Clarias gariepinus* (wide habitat – breeds after good rains on grass banks)

The macroinvertebrates recently recorded include:

- Porifera, Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Perlidae, Baetidae (>2 *spp*.), Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae (>2 *spp*.), Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydraenidae, Hydrophilidae, Ceratopogonidae, Chironomidae, Culicidae, Empididae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Planorbinae, Thiaridae, Corbiculidae, Sphaeridae, Unionidae.

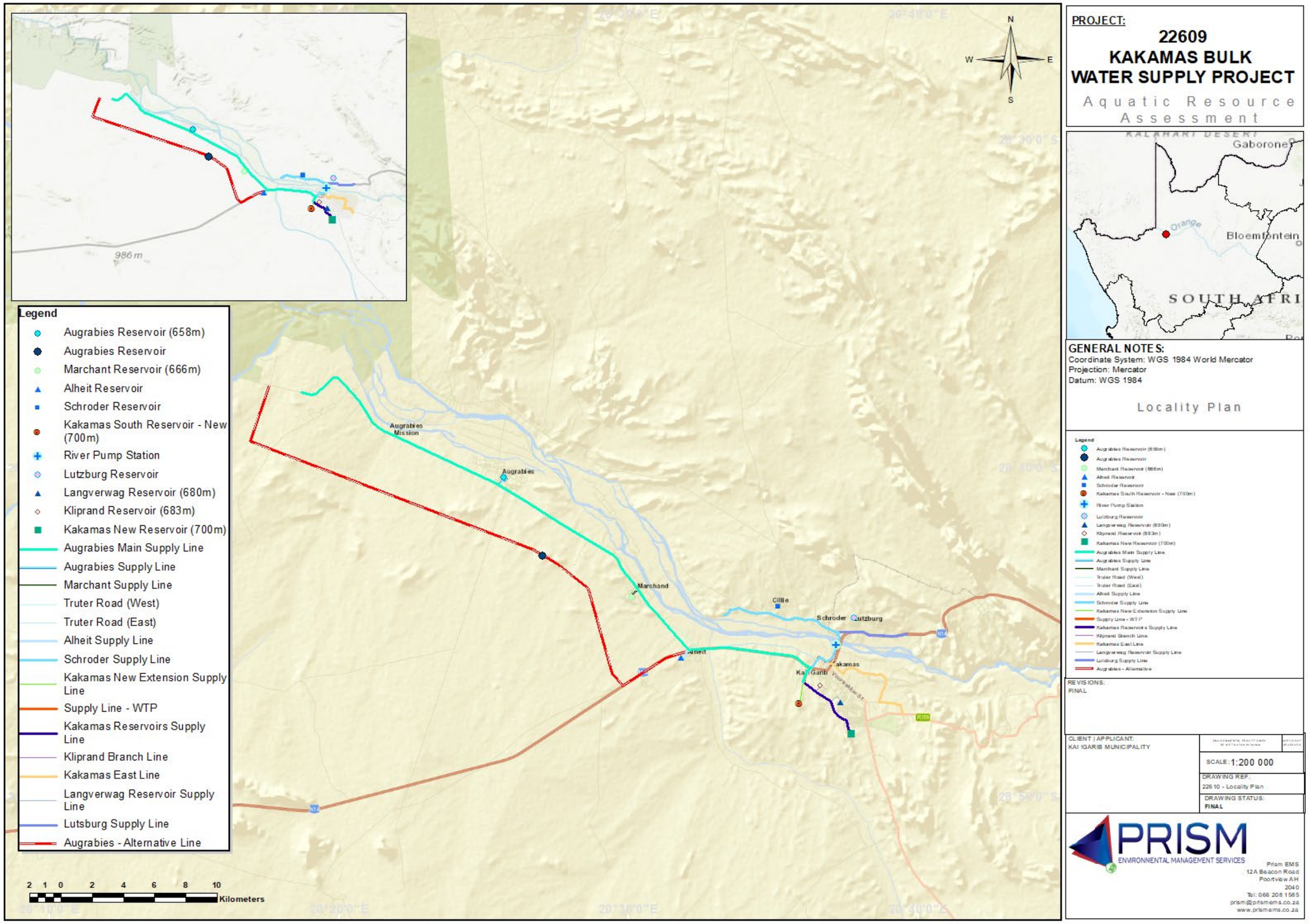


Figure 1-1: Locality Plan

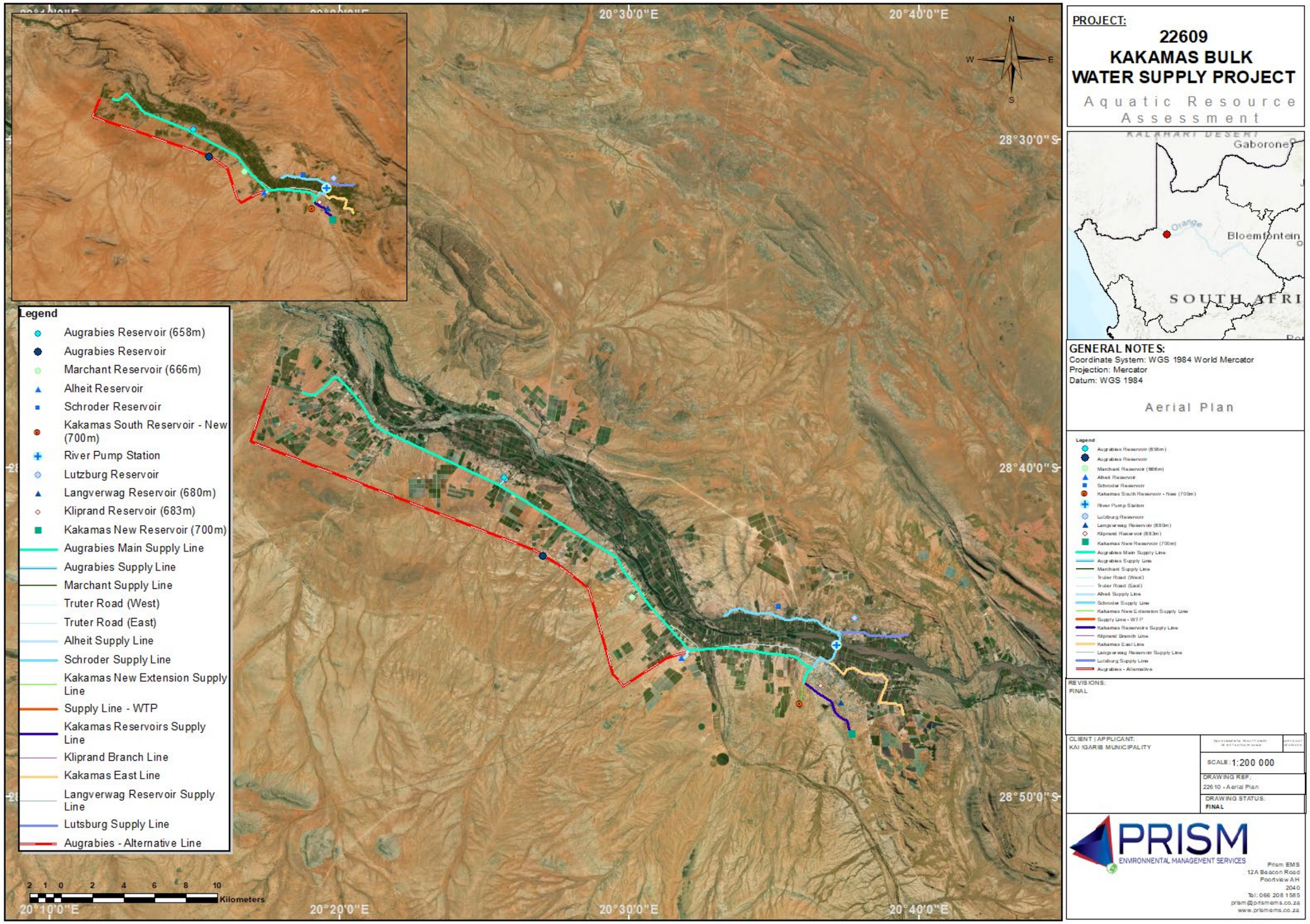


Figure 1-2: Aerial Plan of Study Area

1.4 Climate

1.4.1 Temperature

Between the period of 2020 and 2025, the average daily recorded temperatures ranged from 13°C (average minimum) to 29°C (average maximum) (Figure 1-3 and Figure 1-6).

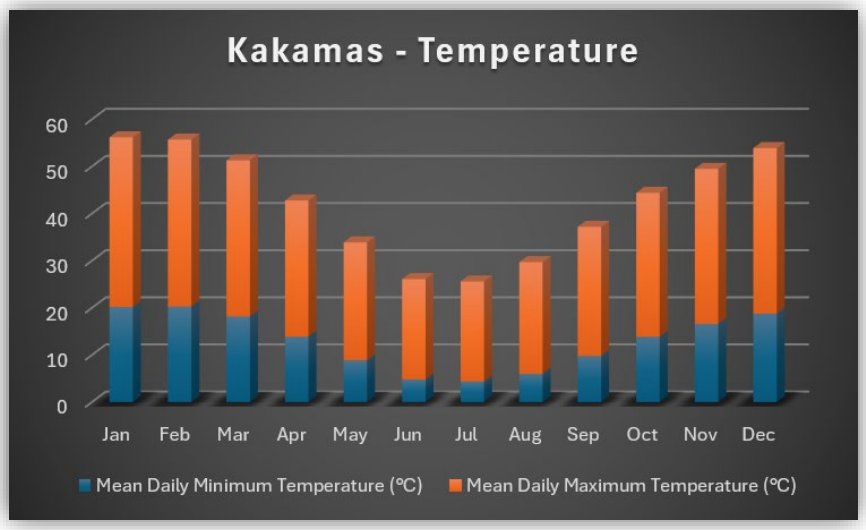


Figure 1-3: Average Daily Temperature data for Kakamas (World Meteorological Organization Online)

1.4.2 Rainfall

Between the period of 2020 and 2025, the average daily rainfall in the area ranged from 2mm (usually July and August) to 36mm (usually December and January) (Figure 1-4 and Figure 1-5).

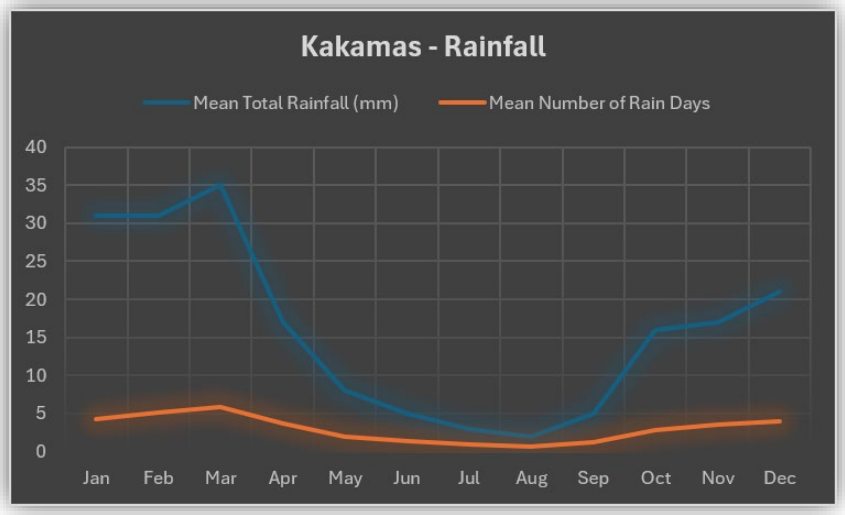


Figure 1-4: Average Monthly Rainfall data for Kakamas (World Meteorological Organization Online)

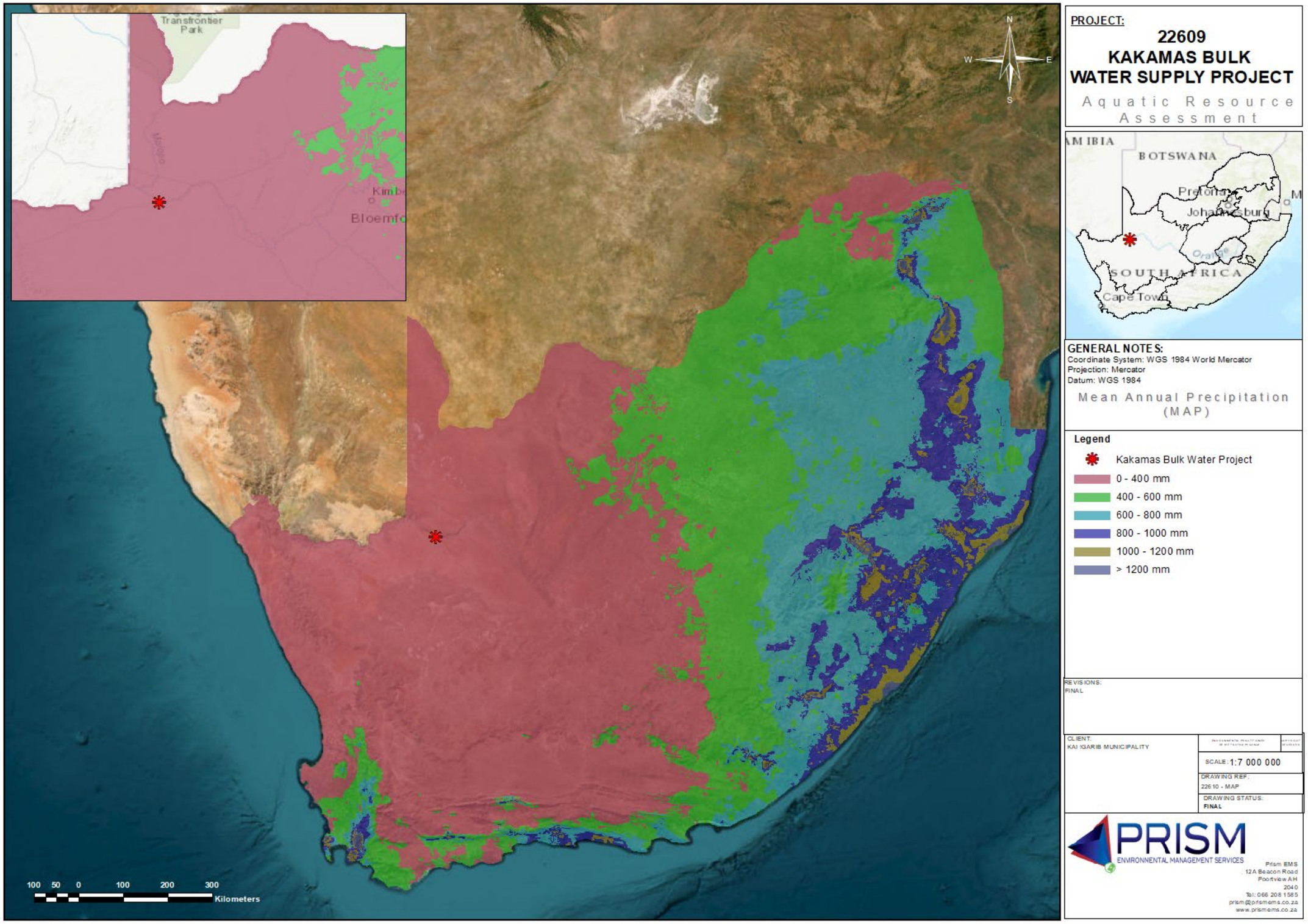


Figure 1-5: Mean Annual Precipitation (MAP)

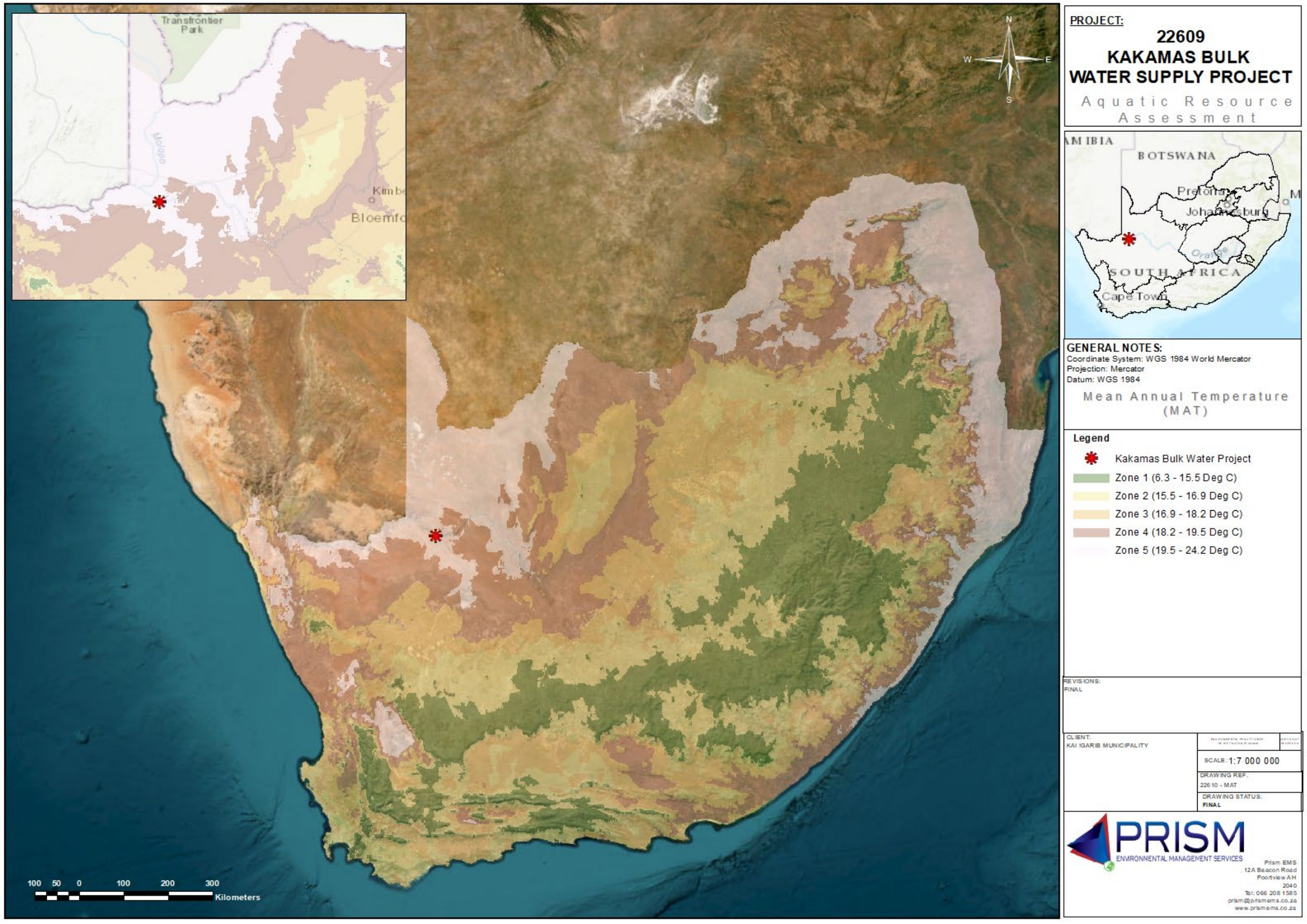


Figure 1-6: Mean Annual Temperature(MAT)

1.5 Topography

1.5.1 Overview

Kakamas sits at an elevation of 670 m above sea level, positioned on the interior plateau of the Northern Cape. The town lies on the banks of the Orange River. This plateau surface is part of the broader southern African interior tableland, which drops from elevations of more than 2 438 m in the basaltic Lesotho region to about 610 m in the sandy Kalahari to the west. Kakamas occupies an intermediate position on this gradient.

1.5.1.1 The Orange River Valley and Floodplain

The defining topographic feature of the Kakamas area is the Orange River corridor. The river here is not defined by single-channel valley, but as a geomorphologically complex system (braided). The perennial Orange River flows through arid terrain consisting mainly of Precambrian granites and gneisses, and has preferentially eroded bedrock joints, fractures, and foliations to form multiple channels which divide around numerous, large (up to ~15 km long and ~2 km wide), stable islands formed of alluvium and/or bedrock.

This stretch of the river constitutes a 150 km long reach of anabranching river above Augrabies Falls and refers to a river pattern where a single watercourse divides into multiple, interconnected, individual channels that are separated by semi-permanent, vegetated islands or ridges before rejoining downstream. This isa prime example of a mixed bedrock-alluvial anabranching river system. The pattern arises from the interplay between local gradient variations and sediment supply and in the relatively long (>10 km) lower gradient reaches, the sediment supply exceeds local transport capacity. The bedrock usually crops out in channel beds, and channels divide around alluvial islands formed by accretion in the lee of bedrock outcrops or at junctions with ephemeral tributaries. In shorter, higher gradient reaches, local transport capacity exceeds sediment supply where the bedrock crops out extensively, and channels flow over an irregular bedrock pavement or divide around rocky islands.

The islands themselves are substantial topographic features consisting of prominent bedrock outcrops that can rise 10 – 50 m above the surrounding floodplain surfaces. Many of these islands are well vegetated and form permanent features in the system.

1.5.1.2 Geomorphology of the River Channels

Island surfaces are generally at similar elevations, and riparian vegetation plays a key role in the survival and growth of these islands by increasing flow roughness and inducing deposition. Floodplain and island formation is also linked to tributary inputs where the sediment accumulates at tributary mouths, sometimes resulting in the formation of a deferred junction. this results in the tributary flowing parallel to

the main river for a distance before finally joining it. Later dissection of the floodplain during major floods may form more extensive anabranches that divide around large islands.

1.5.1.3 The Augrabies Threshold — A Dramatic Topographic Break

Approximately 30km downstream (west) of Kakamas, the landscape changes abruptly and dramatically. The Augrabies Falls National Park follows the course of the Orange River from just outside Kakamas to the Namibian border, spanning more than 800km². The Augrabies Falls is a powerful series of cascades about 56m high that drops into the Orange River gorge (about 240m deep) and runs for about 18km through the park, making for dramatic geological formations along the way.

This gorge represents a major knickpoint — a topographic step cut into the ancient granitic planation surface. Upstream of the falls, the river occupies a wide, braided, island-dotted valley, whilst downstream, it is suddenly confined within a narrow, sheer-walled granite gorge. The Kakamas area sits on the broad upper part of this stepped landscape, just above this dramatic descent.

1.5.1.4 Surrounding Upland Topography

Away from the river corridor, the landscape rises onto rocky, undulating plains underlain by metamorphic gneisses and granites. The area is characterised by a desolate semi-arid landscape punctuated by solitary quiver trees and rocky outcrops.

One notable local topographic feature is Duiwelsnek, a mountain pass located just on the outskirts of Kakamas, very close to the banks of the Orange River. The rocky hill on the northern side of the summit is referred to as Duiwelskop. This is typical of the wider terrain where the isolated rocky hills and ridges rising abruptly from the plateau surface are separated by shallow, poorly drained plains (**Figure 1-7**).

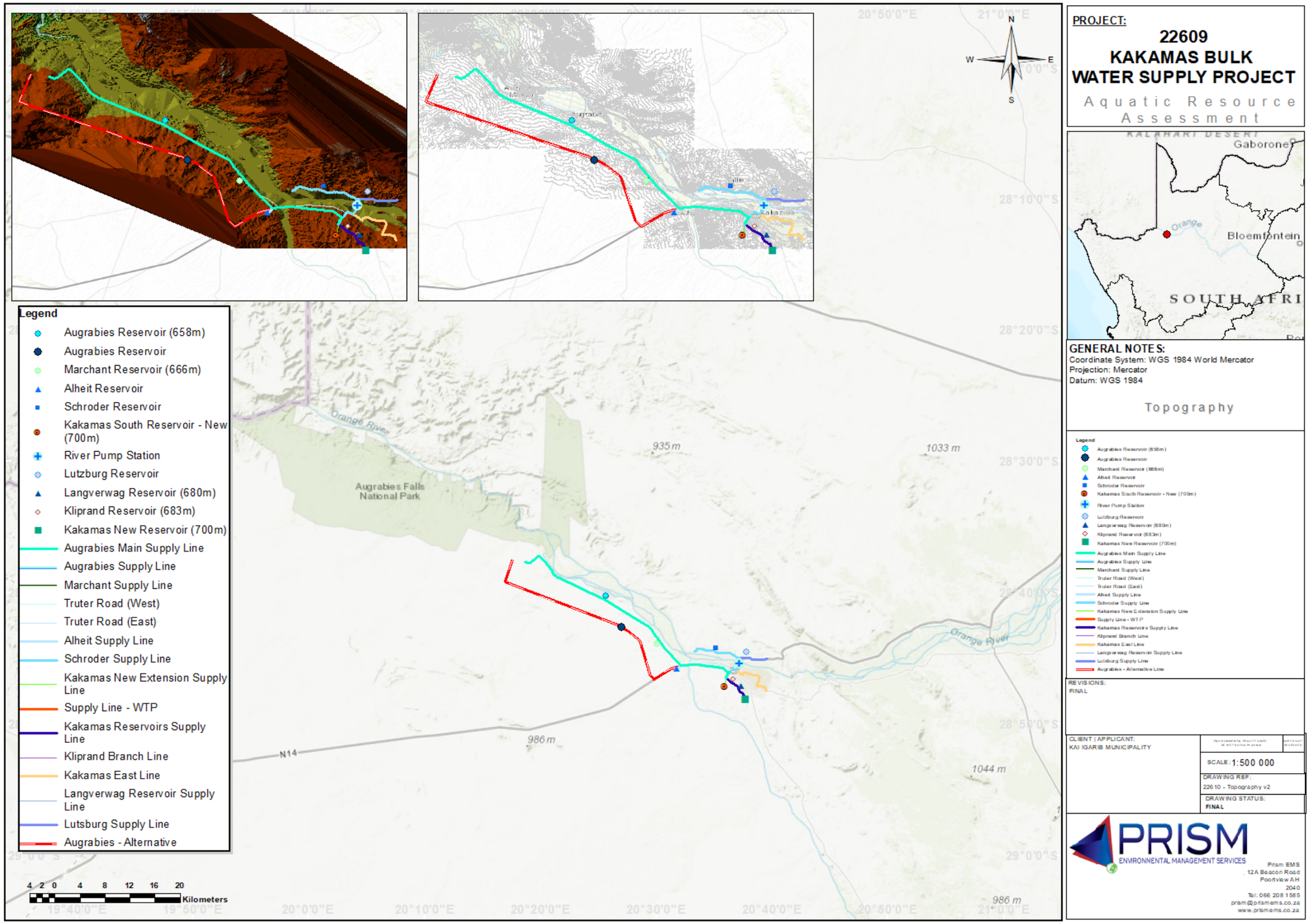


Figure 1-7: Topography of the Study Area

1.6 Geology and Soils

The geology of the Kakamas region (Figure 1-8) in South Africa is dominated by the Namaqua-Natal Metamorphic Province, a highly deformed and metamorphosed terrain. It consists of Mesoproterozoic supracrustal rocks (like the Korannaland Group), syntectonic granitic gneisses, and extensive pegmatite swarms that formed during the Namaqua Orogeny roughly 1.2 to 1.0 billion years ago. The Kakamas area lies within a geologically complex part of South Africa and exhibits a strong link between Precambrian basement geology, fluvial geomorphology, and semi-arid soil development.

The geology and soils of the Kakamas area in the Northern Cape, South Africa, create a stark, unique contrast. While the surrounding desert features highly ancient, rigid metamorphic rocks and shallow, nutrient-poor soils, the Orange River basin provides rich alluvial floodplains. This distinct combination underpins the area's thriving, world-renowned table grape and raisin agricultural sector.

Kakamas sits directly within the Namaqua Sector of the Mesoproterozoic Namaqua-Natal Metamorphic Province.

- Rock Composition
    - The basement rock consists primarily of granite gneisses and high-grade granulite metamorphic rocks (such as pelitic gneisses and quartzites) formed between 1.35 and 1.0 billion years ago.
- Structural Boundaries
    - The landscape is segmented into distinct crustal blocks by vast structural faults and shearing systems, notably the Kakamas Shear Zone and the Neusspruit Lineament.
- Pegmatites
    - The region forms part of the Lower Orange River Pegmatite Belt, injecting the basement rocks with rich mineral veins bearing quartz, feldspar, beryl, and lithium minerals.

The soils transition abruptly from the rugged desert highlands to the riverbanks, falling into three primary categories:

Table 1-1: Soil Primary Categories

Soil Environment	Dominant Characteristics	Agricultural Suitability
Alluvial Floodplains (Orange River riverbanks)	Deep, fertile sandy loam to silt loam soils with a high nutrient base status. Formed from historical river depositions.	Very High Heavily irrigated for commercial table grapes, raisins, and lucerne.
Arid Inland Plains	Coarse, dry, cohesionless sandy soils (71% to 96% sand content) transported by wind over hard bedrock.	Low Predominantly limited to extensive livestock or game grazing due to low water retention.
Rocky Ridges & Slopes	Extremely shallow, stony lithosols directly overlying weathering granite gneiss and hard rock.	None - non-arable terrain that creates the signature jagged Northern Cape desert topography.

Key Soil Constraints and Chemistry of the study area:

- Dorbank and Calcrete Layers
    - In the arid subsurface plains outside the floodplains, hardpan layers of silica (dorbank) or calcium carbonate (calcrete) are common. These cement-like layers require heavy mechanical ripping if used for infrastructure or deep-rooted agriculture.
- High Base Status
    - Because the climate is intensely hot and arid, minimal leaching occurs. The regional soils naturally maintain a high base status (rich in calcium, potassium, and magnesium).
- Salinity Risk
    - Due to high evaporation rates and sluggish natural drainage away from the river, improper irrigation can quickly lead to saline soil development and efflorescence (salt crusting) (Van Bever Donker, 1979).

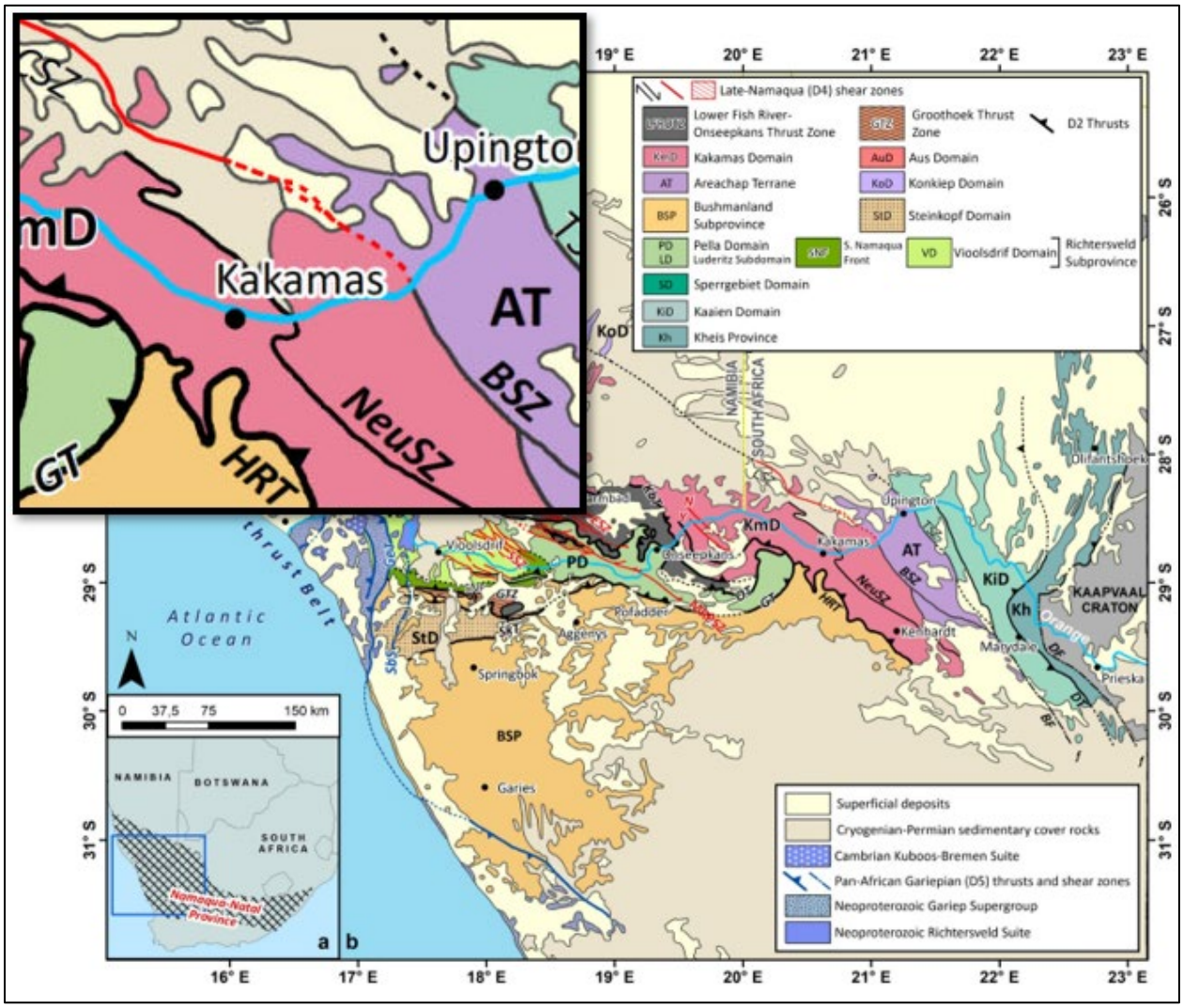


Figure 1-8: Geology of the Study Area (South African Journal of Geology (2026)

1.7 Vegetation

According to the latest South African Vegetation map (SANBI, 2018), the study area will impact mainly one vegetation type, namely the Bushmanland Arid Grassland (Figure 1-9), a vegetation type considered **"Least Concern"**, in terms of the "*Revised National list of ecosystems that are threatened and in need of protection*" (GN. No. 2747 of 18 November 2022 (DFFE, 2022)). Relatively small portions of the study area intersect the vegetation types of the Lower Gariep Broken Veld and Lower Gariep Alluvial Vegetation. These are also classified as **"Least Concern"** (DFFE, 2022).

Bushmanland Arid Grassland is found in the Northern Cape Province from around Aggeneys in the west to Prieska in the east. The southern border of the unit is formed by edges of the Bushmanland Basin while in the north-west this vegetation unit borders on desert vegetation (north-west of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonia Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. Altitude varies from 600 – 1 200 m. The vegetation is described as occurring on extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland, which is dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semi-desert "steppe". In years of abundant rainfall rich displays of annual herbs can be expected (Mucina & Rutherford, 2006).

The Lower Gariep Broken Veld occurs in the Northern Cape Province along the Orange River from around Onseepkans through the Augrabies Falls area to Keimoes and Prieska, with additional occurrences on inselbergs, koppies, and ridges between Kakamas, Groblershoop, and Marydale. The vegetation type also extends into neighbouring Namibia and occurs at elevations of approximately 400–1,200 m above sea level. It is characterised by hills, low mountains, irregular plains, and locally rugged terrain, supporting sparse shrubland dominated by shrubs and dwarf shrubs, with annual herbs becoming particularly prominent following seasonal rainfall. Perennial grasses and herbs are interspersed throughout the landscape, while scattered trees, including quiver trees and black thorn, occur on rocky slopes and sandy footslopes. The vegetation is associated with a geologically diverse landscape and predominantly shallow, skeletal soils. The region experiences an arid climate with low annual rainfall, hot summers, cold winters, and variable frost incidence. It remains largely intact, with minimal transformation and relatively low conservation concern (Mucina & Rutherford, 2006).

The Lower Gariep Alluvial Vegetation is restricted to the broad floodplains, river terraces, and islands of the Orange (Gariep) River between Groblershoop and the river mouth at Oranjemund on the Atlantic coast. The vegetation type occurs from sea level to approximately 1,000 m above sea level and is embedded within the surrounding Desert and Nama-Karoo biomes. It is characterised by a mosaic of riparian thickets dominated by indigenous tree and shrub species, extensive reed beds, and seasonally flooded grasslands and herblands occupying sandbanks and alluvial terraces. The vegetation is

associated with recent alluvial deposits and fertile soils that are periodically replenished by seasonal flooding, particularly following summer rainfall in the upper catchment. The region experiences an arid to semi-arid climate with low and highly variable rainfall (Mucina & Rutherford, 2006).

1.8 Catchment

The study area falls within the D73F, the D53J and the D81A sub-quaternary catchments located in the arid Lower Orange River region of South Africa in an area between Upington and Kakamas. The sub-quaternary catchments serve as a vital hydrological reporting and water management units used by the Department of Water and Sanitation (DWS) in understanding its characteristics as this information is critical to inform local environmental planning (Figure 1-10 and Figure 1-11).

The sub-quaternary catchment to the east (D73F) is where the town of Kakamas is located and the site where the abstraction point for the new project is. An important tributary draining from the south, the Hartbees River, falls in D53J with the Slang and Brabees rivers associated with the D81A sub-quaternary catchment. The section of the distribution network to Augrabies (west of Kakamas) falls within the D81A sub-quaternary catchment. In this sector, the upgrades and installation of new reticulation network will impact the receiving environment.

According to the DWS database, the aquatic ecosystem and ecological importance are generally rated as "moderate" for the D73F catchment. It is important to note that these catchment areas (sub-quaternary catchments) dictate how surface and groundwater interact and flow. In this arid region, the natural flows after rain events in most of the river channels (ephemeral systems) are sporadic. The Orange River corridor in contrast to the arid environment is highly utilised for agricultural irrigation. Because of this importance of the river basin and proximity to flood lines and groundwater zones, any planned local developments trigger strict environmental baseline assessments.

Because it is a highly arid region, natural surface runoff ratios are extremely low, and local streams are ephemeral, flowing only after rare, intense convective cloudbursts and therefore the use of long-term rainfall data, evaporation rates and simulated streamflow datasets are critical in the planning of water resource utilisation. The exceptionally high potential evaporation rates (<2 400mm/a) are significantly higher than the Mean Annual Precipitation of 163mm/a.

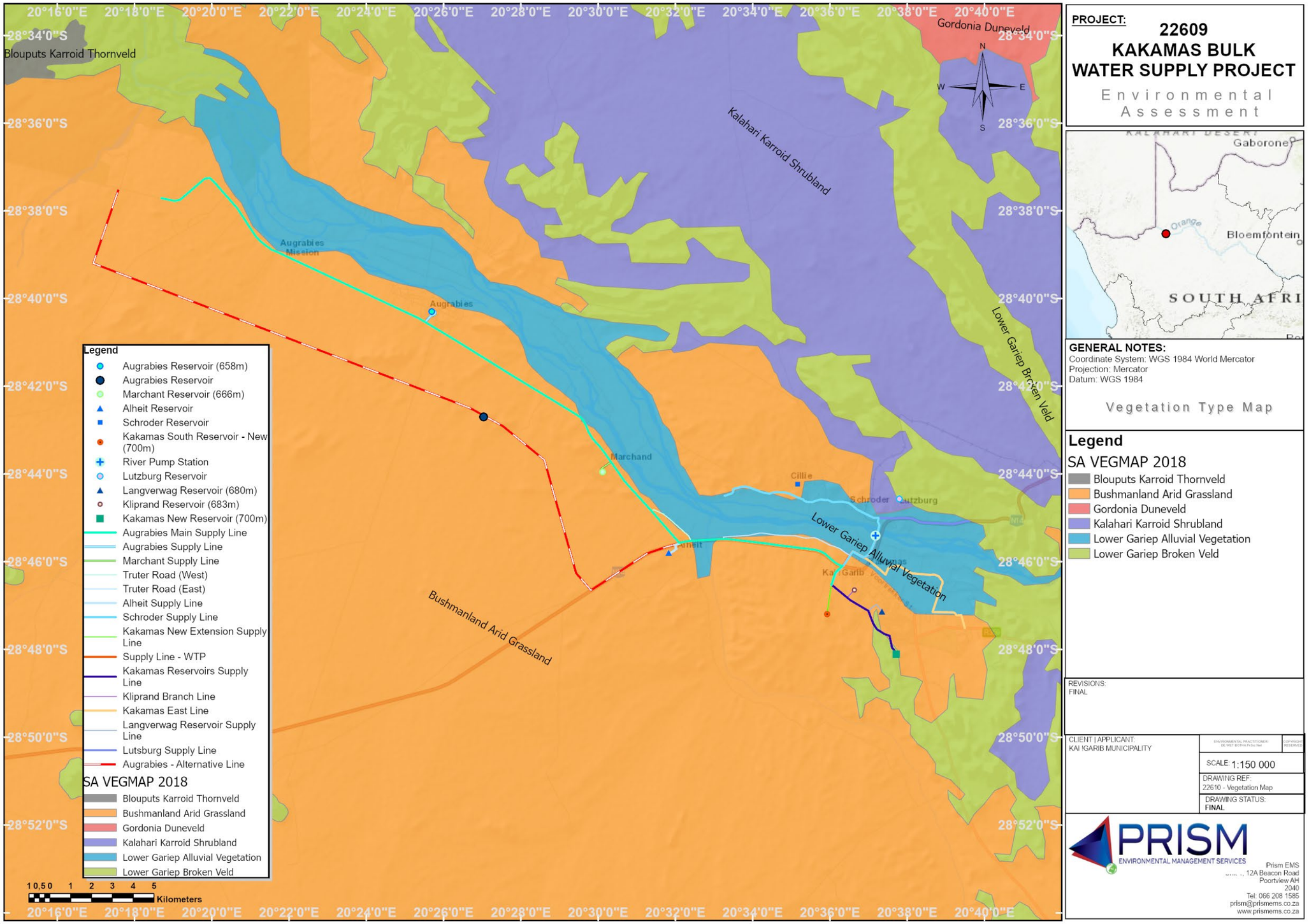


Figure 1-9: Vegetation Type Map (SA VEGMAP 2018)

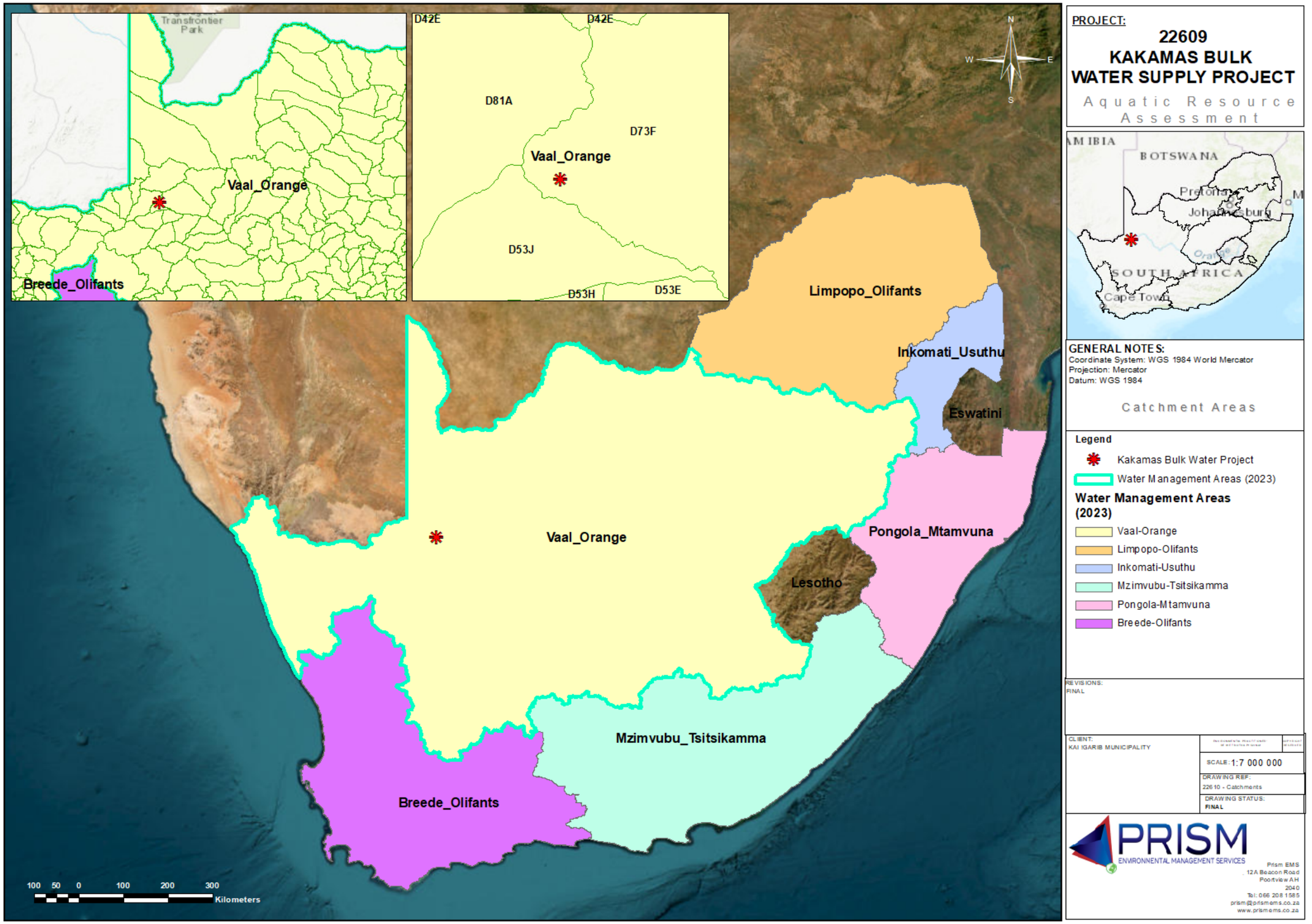


Figure 1-10: The map of the Vaal-Orange River Water Management Area (WMA 4 – [2023]).

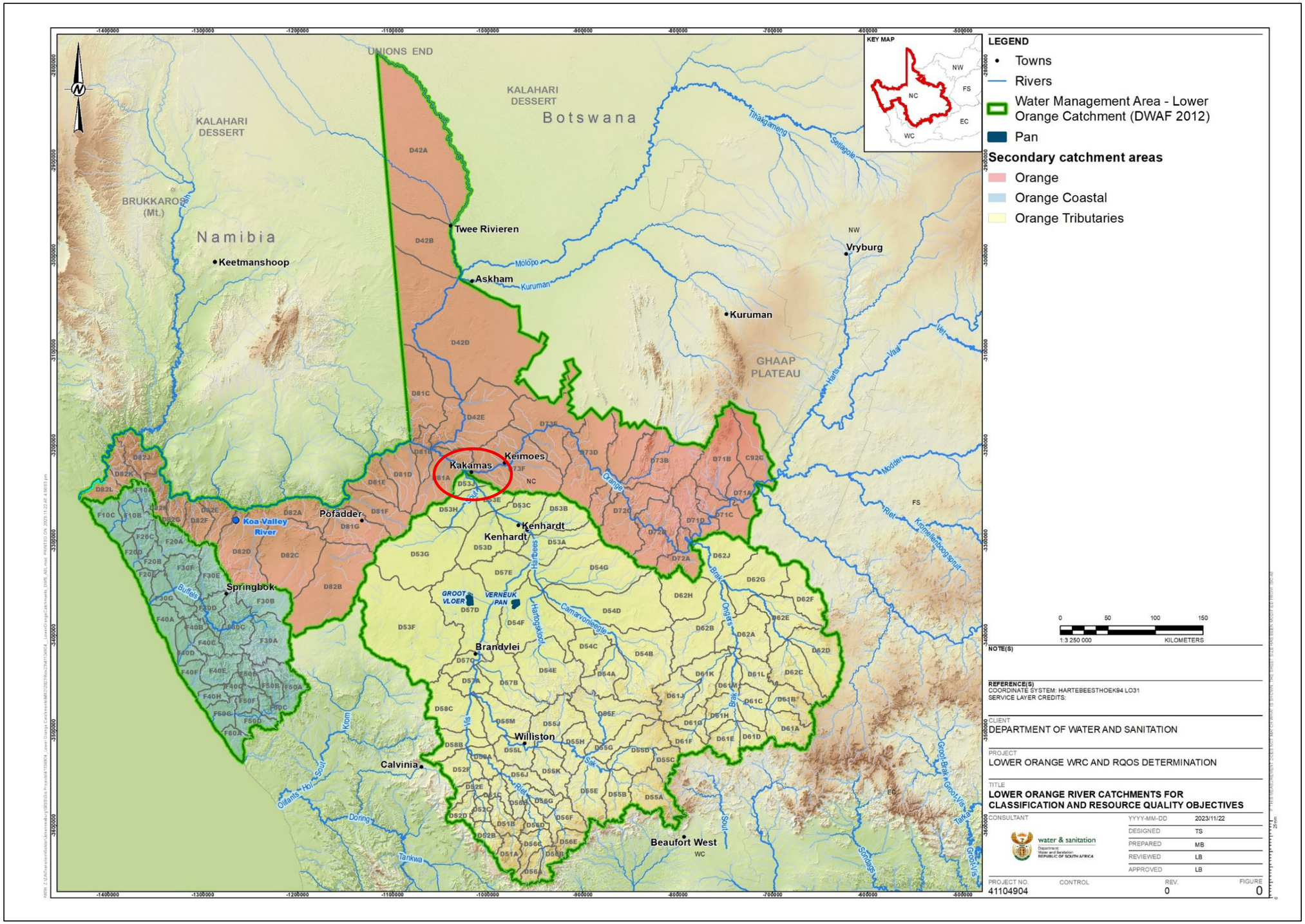


Figure 1-11: The Lower Orange River area associated with the study area circled in red.

1.9 Scope and Purpose

Prism Environmental Management Services was appointed by EnviroAfrica (EAP) on behalf of **Kai !Garib Municipality** to undertake an aquatic resources assessment for the construction of the proposed Kakamas Bulk Water Supply Project (*hereafter referred to as 'the study site'*).

This report presents the aquatic assessment conducted, along with a team of specialist scientists, on 13 to 15 April 2026. (wet season survey). The assessment was conducted to inform the Environmental Authorisation (EA) application and Environmental Impact Assessment (EIA) process as well as the Water Use License Application (WULA) for the proposed Kakamas Bulk Water Supply Project.

1.10 Overview of Specialist

Company:	Prism Environmental Management Services
Address:	Unit 1, 12A Beacon Road, Poortview, Roodepoort, Gauteng.
Tel:	066 208 1585
Email:	dewet@prismems.co.za

Designation	Name	Qualification	Professional Registration	Role
Specialist Team				
Wetland & Biodiversity Specialist	Mr. D. Botha	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma **Supplementary Courses** Wetland and Wetland Delineation *(DWAF Accredited Short Course)* Soil Classification and Wetland Delineation – Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University* SASS5 Aquatic Biomonitoring Training – *Department of Water Affairs, Ground Truth* Wetland Plant Taxonomy – *Water Research Commission* Hydropedology and Wetland Functioning – *Water Business Academy / Terra Soil Science* Wetland Legislation | Law application in wetland management – *WetRest Centre for Wetland Research and Training* Hydropedology and Wetlands Course – *WetRest Centre for Wetland Research and Training | Digital Soils Africa (DSA)*	Pr. Sci. Nat. (119979) EAPASA (2019/1209) IAIAsa (1653) Member of the Gauteng Wetland Forum Member of the South African Wetland Society Member of the Freshwater Ecosystem Network (FEN)	Field Assessment; Mapping; Report co-author.
Aquatic specialist	Dr. W. Vlok	M. Sust. Agri (2003) PhD (Zoology) (1992) M.Sc. (1986) B.Sc. (Hons) (1985) B.Sc. (1984) 30^{+} Years' Experience	Pr. Sci. Nat. (400109/95)	Report co-author, peer review.
Aquatic specialist	Mr. G. Bouwer	MSc Environmental Science BSc Hons. Environmental Science BSc Biological Sciences SASS5 Accredited Practitioner (DWS and WRC) 6^{+} Years' Experience	Pr. Sci. Nat.(157017)	Report co-author, peer review.
Aquatic specialist	Mr C de Beer	M.Sc. Environmental Management with Ecological Water Requirements BSc Hons. Env. Sci. Aquatic Ecosystem Health B.Sc. Biological Sciences SASS5 Accredited Practitioner (DWS)	Cand. Sci. Nat. (168416)	peer review.

2. LITERATURE REVIEW

Southern Africa has freshwater biodiversity that is highly diverse and of great importance to livelihoods and economies. However, the conservation and importance of these aquatic ecosystems are often disregarded during the development planning process, and subsequently development is often not compatible with the conservation of these resources. The value of the goods and services derived from freshwater ecosystems include essential products such as food and drinking water, but many anthropogenic activities have led to the rapid decrease in the state of these resources (Darwall, Smith, Tweddle, & Skelton, 2009).

Due to the rapid population growth rate in Africa and the increased demand for safe drinking water and sanitation, there is a potential large-scale impact to freshwater resource biodiversity (Figure 2-1). Action and mitigation are required to assess the status of freshwater ecosystems and to integrate that information into the water development planning process. This information is critical to minimise or mitigate significant impacts to freshwater resources and the subsequent loss to livelihoods and economies which are dependent on these goods and services (Darwall, Smith, Tweddle, & Skelton, 2009).

In 1994, the South African Department of Water Affairs and Forestry (DWAF) initiated the River Health Programme (RHP), now the River Eco-status Monitoring Programme (REMP). The purpose of this programme was to establish a source of information on the ecological status of aquatic ecosystems in South Africa. The South African National Water Act (NWA) came into effect in 1998, acknowledging the importance of protecting aquatic ecosystems and the maintenance of goods and services provided by these resources. This required the establishment of the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) (DWS, 2016).

The REMP focuses on the monitoring of ecological conditions in river ecosystems by assessing system drivers and biological responses. The REMP monitoring system primarily uses biological indicators such as fish communities, riparian vegetation and aquatic macroinvertebrates to assess the current state or health of river systems in support of the management of these natural resources. The use of biological indicators provides a direct, complete and integrated measure of the current ecological state of the river. This is conducted to measure, assess and report on the spatial and temporal trends of the aquatic ecosystem to identify and report emerging problems by providing scientifically and managerially relevant information for national aquatic ecosystem management (DWS, 2016). An integral part of the assessment is the status of the catchment. Although not specifically covered with the various biological indicator assessments, it is important to have a good insight into the surrounding landscape and land uses, as this directly impact on the bioindicators (Figure 2-1).

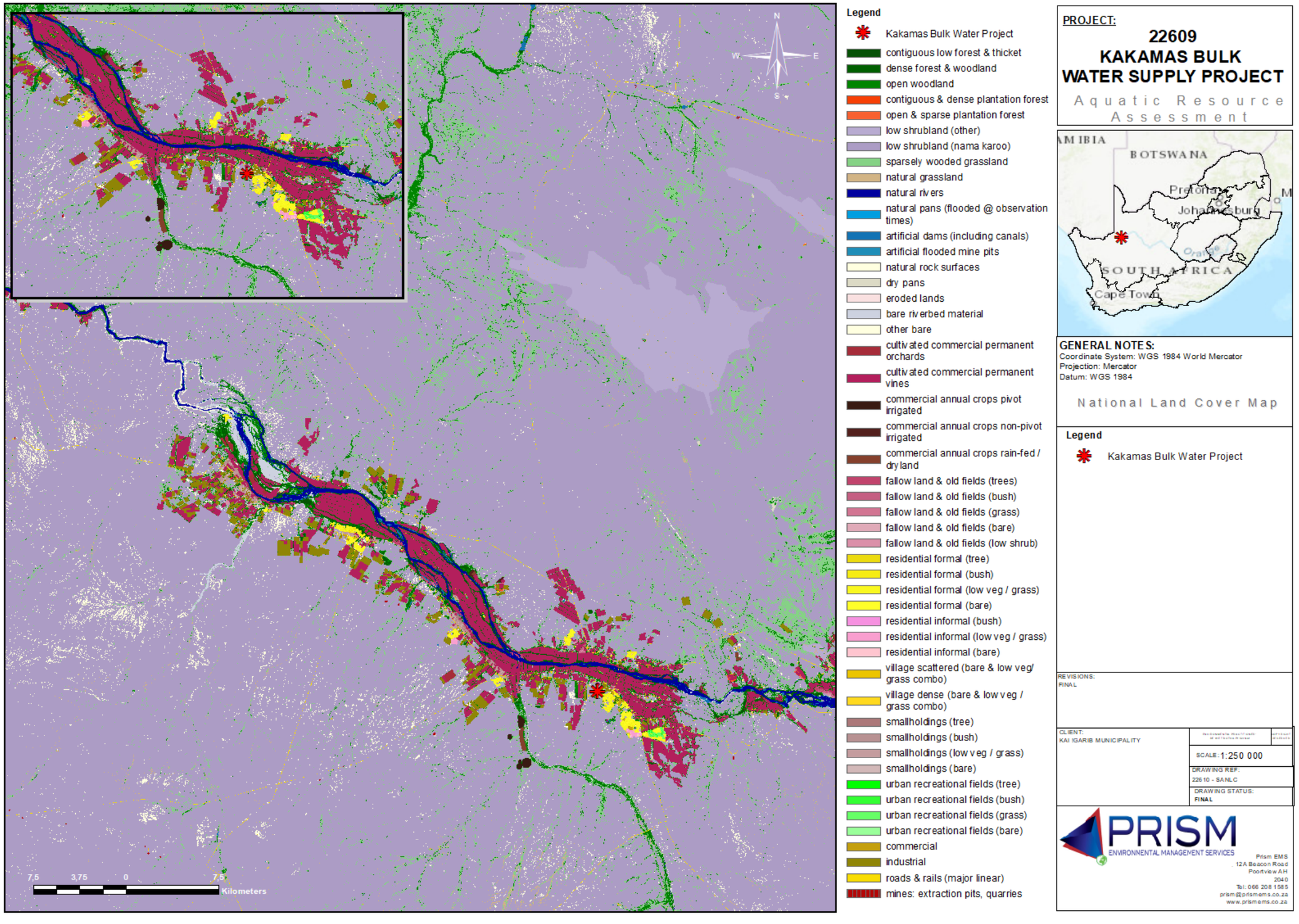


Figure 2-1: National Land Cover Map

Biomonitoring or “biological monitoring” is an important tool in assessing the condition of aquatic ecosystems. Various components are evaluated and include the habitat, water quality and bioindicators i.e. riparian vegetation, macroinvertebrates, fish and diatoms.

Instream water quality guidelines for aquatic ecosystems were developed by the South African Department of Water Affairs and Forestry (DWAF), now known as the Department of Water and Sanitation (DWS). The guidelines were developed to protect and conserve the health of aquatic ecosystems. The term *water quality* is used to describe the physical, chemical, biological and aesthetic properties of water that determines its fitness for a variety of uses including protection of the health and integrity of aquatic ecosystems. Many of these properties are controlled or influenced by constituents that are either dissolved or suspended in water. In the DWAF (1996b) guidelines, the Target Water Quality Range (TWQR) was proposed, but not as a water quality criterion but rather as a management objective which have been derived from quantitative and qualitative criteria. This is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems and should therefore ensure their protection.

- For this project the water quality parameters and standards for drinking water will apply as implemented by the municipality to the customers/consumers.
- The final monitoring standards will be determined by DWS as part of the licence application and approval and is not in the scope of the project.

Aquatic macroinvertebrates have been used to assess the biological integrity of river ecosystems all over the world (Thirion, 2008). The physical aquatic habitat refers to the environment for the instream biota that is created by the interaction of the physical structure of the channel and flow regime. The aquatic habitat created by this interaction creates an area for aquatic macroinvertebrates to survive. Therefore, the physical habitat quality and quantity determine the structure and composition of the biotic communities (Thirion, 2008). To determine the health of the aquatic communities, the quality and quantity of the habitat need to be assessed. Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community and must include a general overview of the catchment (Barbour, Gerritsen, & White, 1996). Habitat quality and availability play a critical role in the occurrence of aquatic biota. For this reason, a habitat assessment is conducted simultaneously with biological evaluations to facilitate the interpretation of results.

In a similar way, the freshwater fish species is used as key bio-indicators of aquatic ecosystem health. This approach evaluates ecological integrity by comparing expected natural fish communities against those observed. The standardised indices used by the national River Health Programme (RHP) to evaluate river conditions, the Fish Assemblage Integrity Index (FAII, 1999) evaluates the status of fish communities by rating the intolerance and specific habitat preferences of indigenous species in relation to human-induced impacts. The Fish Response Assessment Index (FRAI), an updated, habitat-based approach introduced in 2007 is used to establish a cause-and-effect foundation by measuring how fish assemblages respond to specific environmental drivers e.g. hydrology,

geomorphology and water chemistry. Fish are regarded as effective bioindicators because they are relatively long-lived and occupy various levels of the food web and therefore reflect prolonged cumulative impacts across wide temporal scales. Fish are used to monitor environmental sensitivity changes or fluctuations because they are highly sensitive to both chemical contamination and physical alterations in impoundments and weirs and reduced river flows. These alterations reduce connectivity in the rivers, and the sum of all the impacts therefore degrade their habitat.

The macroinvertebrates and fish in the Orange River were not assessed, as continuous monitoring by DWS and licensees using water from the system is tasked with the protocols. This project will only have the single abstraction point from the Orange River and limited impacts to the biota will occur. Some management, mitigation and monitoring actions will be done in this report (refer to Appendix C).

2.1 General Habitat Assessment

The habitat and landscape associated with Kakamas is a fertile irrigation area adjacent to the Lower Orange River with the vast, scrub desert plains and rugged rocky outcrops in the larger landscape. The region's defining feature is the stark contrast between the verdant river valley and the harsh, sun-baked interior. The river valley is a narrow, flat, and highly cultivated alluvial floodplain along the Orange River with the network of historic, hand-built canals. Adjacent to the river the terrain transitions into flat to undulating arid scrublands punctuated by the rocky inselbergs (isolated hills) and deep gorges.

The geology is dominated by the underlying highly metamorphosed and deformed ancient rock from the Mesoproterozoic Namaqua Province (roughly 1 to 1.2 billion years old) that is dominated by ancient granites, gneisses and the intensely folded metasedimentary rocks. The nearby Riemvasmaak and Augrabies areas are dominated by the massive geological faulting and shear zones. The alluvial soil along the river is highly fertile, nutrient-rich and deep. The soils of the surrounding terrestrial areas are very poorly developed, shallow and stony lithosols which is nutrient-poor, rocky and gravelly that are highly susceptible to wind erosion.

The study area falls within the Nama-Karoo biome, specifically the Lower Orange River Nama Karoo and Bushmanland Arid Grassland vegetation types. The vegetation is dominated by drought-resistant dwarf shrubs, succulents and hardy, sparse grasses. Larger, iconic species include the Quiver Tree (*Aloe dichotoma*) which thrives on the rocky outcrops, and various *Euphorbia* and *Vachellia* and *Senegalia* species along dry riverbeds.

The study area within the Northern Cape represents drainage of surface water across a wide hydrological spectrum. To categorise the diversity of streams and rivers it is important to classify them based on surface flow duration, flow predictability and geomorphic position as the region’s waterways exist on an environmental continuum. Hughes (2005) emphasises that perennial, seasonal and

ephemeral river regimes are merely points on a continuum and it is not always straightforward to assign rivers to simple categories and the basis of their flow regime characteristics.

In the study area and the associated catchments the following types of watercourses are identified:

1) Wash Sheets (Hillslope Drainage)

- **Definition:** This represents diffuse, unchanneled and highly scattered surface runoff.
- **Characteristics:** Water flows as a broad sheet over the landscape, rather than within a defined channel. These sheet flows are activated only during extreme, localised downpours that dissipates quickly (soon after the rainfall event).

2) Ephemeral Rivers

- **Definition:** These are non-perennial streams that flow briefly and unpredictably (stochastic events) in direct response to high-intensity rainfall.
    - **They are fed from the runoff from the wash sheets and landscape in the catchment**.
- **Characteristics:** For most of the year, these are dry riverbeds or strings of isolated standing pools. Where strong subsurface flow is present, riparian vegetation trees e.g. *Vachellia erioloba* (Camel Thorn) and xeroriparian vegetation are present. In some instances, the plants will be denser stands of the terrestrial vegetation in the area indicating wetter, subsurface conditions.

3) Seasonal Rivers

- **Definition:** Non-perennial rivers that flow predictably for extended periods (usually during the wet or rainy season) but dry up completely during the dry season.
- **Characteristics:** They have a well-defined channel, and flow is driven by seasonal climate patterns rather than just isolated thunderstorms. More distinct riparian vegetation zone with larger terrestrial species and riparian species.

4) Permanent (Perennial) Rivers

- **Definition:** Rivers that flow continuously throughout the year, even during dry cycles.
- **Characteristics:** These are sustained by consistent rainfall in distant, higher-elevation catchments (outside the Northern Cape) and deep groundwater aquifers.

The ecological integrity of a river is based on the concept of biological integrity that has been described as “the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of natural habitat of the region” (Karr and Dudley 1981). Habitat integrity in this sense refers “to the maintenance of a balanced, integrated composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region and therefore indicate that a river will provide the template for a certain level of biotic integrity to be realised”. The habitat integrity and biotic integrity together constitutes ecological integrity (Kleynhans 1996).

3. LEGISLATION AND GUIDELINES

3.1 National Water Act (Act 36, 1998)

3.1.1 General

- Internationally regarded as the most advanced water legislation in the world, specifically in terms of environmental protection;
- Equity (water for everyone) and sustainability (long-term protection of resources) are its main principles; and
- Balance between use and protection (sustainability).

3.1.2 Purpose and intent

To ensure that the nations natural resources are protected, used, developed, managed and controlled in a way that takes into account, amongst others – see Section 2 of the Act -

- meeting basic human needs both present and future;
- promoting equitable access;
- facilitating social and economic development; and
- protecting ecosystems and biodiversity:
    - Balance between social development and equal access to water, economic growth and maintaining ecological integrity;
    - Focus on long term benefits for society;
    - Protection of the water resource to ensure sustainable use;
    - Does not aim to at all costs prevent impacts to the water environment (since this may inhibit the much-needed economic development); but
    - Instead aims to achieve the right balance between use and protection of water resources (i.e. sustainable use).

DWS assumes public trusteeship of the nation's water resources. ***Water resource: includes a watercourse, surface water, estuary or aquifer***. ***Watercourse: means***-

a) ***a river or spring***;
b) ***a natural channel*** in which water flows regularly or intermittently;
c) ***a wetland, lake or dam*** into which, or from which, water flows, and
d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Protection: in relation to a water resource, means—

a) ***maintenance of the quality*** of the water resource to the extent that the water resource may be used in an ecologically sustainable way;
b) ***prevention of the degradation*** of the water resource; and
c) the ***rehabilitation*** of the water resource.

3.1.3 Section 21: Water Use

For the purposes of this Act, ***water use includes***--

(a) taking water from a water resource;
(b) storing water;
(c) impeding or diverting the flow of water in a watercourse;
(d) engaging in a stream flow reduction activity contemplated in Section 36;
(e) engaging in a controlled activity identified as such in Section 37(1) or declared under Section 38(1);
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
(g) disposing of waste in a manner which may detrimentally impact on a water resource;
(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
(i) altering the bed, banks, course or characteristics of a watercourse;
(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

3.1.4 Section 22: Permissible water use

(1) A person may only use water--

a. without a licence--
   (i) if that water use is permissible under Schedule 1;
   (ii) if that water use is permissible as a continuation of an existing lawful use; or
   (iii) if that water use is permissible in terms of a general authorisation issued under Section 39; ***(It is important to note that at the present time there are no General Authorisations*** [section 22(1) a (iii)] ***relating to any wetlands)***
b. if the water use is authorised by a licence under this Act; or
c. if the responsible authority has dispensed with a licence requirement under subsection (3).

(3) A responsible authority may dispense with the requirement for a licence for water use if it is satisfied that the purpose of this Act will be met by the grant of a licence, permit or other authorisation under any other law.

(4) In the interests of co-operative governance, a responsible authority may promote arrangements with other organs of state to combine their respective licence requirements into a single licence requirement.

Essentially then, **to utilise a water resource** (water, river channel, riparian area or wetland) **one needs a water licence from DWS unless:**

- the activity was existing and lawful prior to the act (i.e. before 1998);
- the activity is included in the Schedule 1 activities (domestic use, stock watering, emergencies, recreation, portage, discharge into a canal – refer below for more detail) or General Authorisations (there are none applicable to wetlands); or
- the need for a licence has been dispensed with by the relevant authority (under section 22, subsection 3).

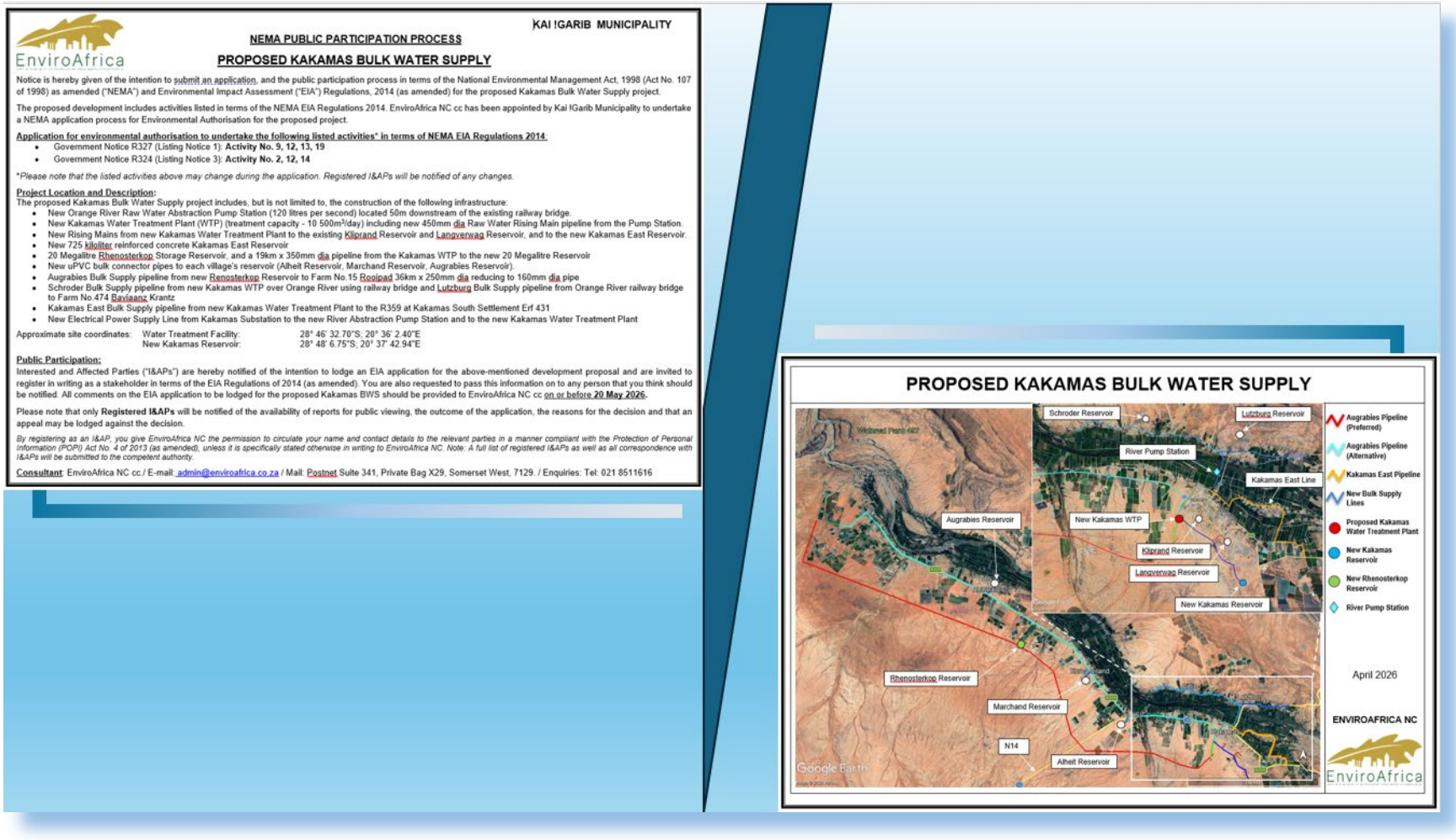
3.2 NEMA (National Environmental Management Act, 1998)

The new NEMA regulations (Republic of South Africa, 1998b) have narrowed the spectrum of activities requiring an EIA application process and are more specific in describing the listed activities. The new regulations include activities previously omitted. The NEMA regulations also differentiate between a basic and a thorough assessment, the process allows for upfront decision making (e.g. fatal flaws, emergency circumstances and clearly no/very small impact situations) and it prescribes time frames for evaluation. Specific listed activities in terms of this Act (Government Gazette of 7 April 2017, no. 324-327), require authorisation and are related to the National Water Act, 1998 section 21 activities.

3.2.1 Public Participation Process (PPP)

EnviroAfrica has given notice on behalf of the applicant, Kai !Garib Municipality, of the intention to submit an application (Figure 3-1), and the public participation process 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) for the proposed Kakamas Bulk Water Supply project.

The proposed development includes activities listed in terms of the NEMA EIA Regulations 2014. EnviroAfrica NC cc has been appointed by Kai !Garib Municipality to undertake a NEMA application process for Environmental Authorisation for the proposed project.



EnviroAfrica

KAI !GARIB MUNICIPALITY

NEMA PUBLIC PARTICIPATION PROCESS

PROPOSED KAKAMAS BULK WATER SUPPLY

Notice is hereby given of the intention to submit an application, and the public participation process 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) for the proposed Kakamas Bulk Water Supply project.

The proposed development includes activities listed in terms of the NEMA EIA Regulations 2014. EnviroAfrica NC cc has been appointed by Kai !Garib Municipality to undertake a NEMA application process for Environmental Authorisation for the proposed project.

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

- Government Notice R327 (Listing Notice 1): **Activity No. 9, 12, 13, 19**
- Government Notice R324 (Listing Notice 3): **Activity No. 2, 12, 14**

**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 Kakamas Bulk Water Supply project includes, but is not limited to, the construction of the following infrastructure:

- New Orange River Raw Water Abstraction Pump Station (120 litres per second) located 50m downstream of the existing railway bridge.
- New Kakamas Water Treatment Plant (WTP) (treatment capacity - 10 500m³/day) including new 450mm dia Raw Water Rising Main pipeline from the Pump Station.
- New Rising Mains from new Kakamas Water Treatment Plant to the existing Kliprand Reservoir and Langverwag Reservoir, and to the new Kakamas East Reservoir.
- New 725 kilolitre reinforced concrete Kakamas East Reservoir
- 20 Megalitre Rhenosterkop Storage Reservoir, and a 19km x 350mm dia pipeline from the Kakamas WTP to the new 20 Megalitre Reservoir
- New uPVC bulk connector pipes to each village's reservoir (Alheit Reservoir, Marchand Reservoir, Augrabies Reservoir).
- Augrabies Bulk Supply pipeline from new Renosterkop Reservoir to Farm No.15 Rooipad 36km x 250mm dia reducing to 160mm dia pipe
- Schroder Bulk Supply pipeline from new Kakamas WTP over Orange River using railway bridge and Lutzburg Bulk Supply pipeline from Orange River railway bridge to Farm No.474 Baviaanz Krantz
- Kakamas East Bulk Supply pipeline from new Kakamas Water Treatment Plant to the R359 at Kakamas South Settlement Erf 431
- New Electrical Power Supply Line from Kakamas Substation to the new River Abstraction Pump Station and to the new Kakamas Water Treatment Plant

Approximate site coordinates: Water Treatment Facility: 28° 46' 32.70"S; 20° 36' 2.40"E
New Kakamas Reservoir: 28° 48' 6.75"S; 20° 37' 42.94"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 Kakamas BWS should be provided to EnviroAfrica NC cc on or before **20 May 2026**.

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.

Consultant: EnviroAfrica NC cc./ E-mail: admin@enviroafrica.co.za / Mail: Postnet Suite 341, Private Bag X29, Somerset West, 7129. / Enquiries: Tel: 021 8511616

Figure 3-1: Proof of Public Participation Process (PPP) – Site Notice

4. METHODOLOGY

The aquatic assessment focussed on the possible impact zones in term of the proposed routes for the new water distribution infrastructure. The description and state of the aquatic environment was determined by assessing the site (desktop and *in-situ*) and the stressors and habitat.

4.1 Desktop Assessment

The Department of Water and Sanitation database (DWS, 2014), the National Wetland Map version 6 (NWM6) and NFEPA Rivers Map as presented by the South African National Biodiversity Institute (SANBI) (Van Deventer, et al., 2019) were consulted to obtain historical and ecological data for the study area. This information was used to determine sensitive areas that needed investigation and verification during the site assessment.

4.2 Field Investigation

The field investigation was planned for 13 to 15 April 2026 (wet season survey) to assess the conditions of the aquatic resources associated with the project. The assessment will include the assessment of identified “hot spots” that were noted during the desktop review. This information was gathered from the GIS layers, aerial photographs and google images.

4.3 Mapping

Mapping of the aquatic resource and sensitivity(s) will be done by computerised processing using GPS tools and GIS modelling software. Various databases such as the Department of Water and Sanitation’s environmental shapefiles will be used as guidelines and incorporated into the sensitivity mapping (post survey processing). The information will be used to generate maps in accordance with the WGS84 projection and using spatial tools available on the ArcMap GIS software. The map will be used in reports and information shared to the client (shape files).

4.4 Site condition and Photographic Record

For each site the coordinates of the proposed stream crossing will be recorded, and photographic records and conditions of the surveyed sites will be done. The site condition will be assessed according to available habitat indicators and the river/stream dynamics. Photographs will be recorded reflecting the resources and sites to represent each class and category.

4.5 General Habitat Assessment

Due to the number of aquatic resources and contact zones encountered during the desktop assessment it was decided that it is impractical and too complex to document each individual stream crossing (site). For this project, in terms of the assessment scope of work and requirements for the specific EA and WUL applications, it was decided to group similar stream types together. For each stream type a Risk Assessment will be conducted and the WUL application will then reflect the groups that will be covered within the scope of the project.

A water resource Risk Assessment (RA) is a systematic tool designed to evaluate the probability and consequences of water-related risks e.g. shortages, pollution and infrastructure failure. The aim with the RA process is to align the developments with the National Water Act (NWA) to ensure the sustainable management, equitable use and comprehensive protection of the limited water supply in South Africa. These aims are achieved through:

- **Balancing the use and protection of aquatic resources:** This is done by establishing a sustainable equilibrium between the abstraction of water for basic human needs, agriculture and industry and at the same time ensure the protection of the physical, chemical and biological integrity and diversity of aquatic ecosystems.
- **Safeguard the water quality of the water resources:** This can only be achieved when the water resources remain "fit for use" through the identification and tracking of hazardous chemical and/or microbial contaminants before it threatens public health and the environment and ensure effective monitoring and mitigation strategies are in place.
- **It is important to ensure climate resilience:** One must identify and the evaluate vulnerabilities to extreme weather events which include droughts, floods and loss through evaporation. Once identified, strategies must be formulated and implemented to secure long-term water availability despite the country's semi-arid climate.
- **It is important to support regulatory compliance:** Through effective monitoring one can ensure that robust, scientific data will assist water resource managers to enforce environmental legislation, refine water quality guidelines and improve processing license applications to ensure protection of resources and the supply of quality water to the various end users (“fit for use” principle).
- **The RA will mitigate infrastructure risks:** The process will identify the diversity of risks within a complex system and this include the degradation and/or failure of the water supply and wastewater treatment infrastructure to prevent supply disruptions, downstream contamination and health threats to the users (people and the environment).

The drainage lines, depending on their size and functionality, will be divided into 5 classes (Table 4-1). This method assists in the quantification and qualification of the resources in grouped format to assist with a more palatable and reasonable assessment format.

For this study, the streams in Classes 1, 2 and 3 were recorded and the coordinate at the proposed crossing point for each site added to the data base (Appendix B). For the report, only the number of crossings for each class will be reflected in the results section. For the streams in Class 4 and 5, more detail regarding the stream width, and marginal vegetation will be recorded. The existing and potential impacts related to the project activities will be recorded at each crossing site. The information related to impacts will be used to guide the mitigation, rehabilitation and monitoring strategies that will be reflected in the EMPr.

The resources in Class 3, 4 and 5 will be included in the WULA, as these streams are more susceptible to significant project-related impacts. However, provided that the recommended mitigation measures and management strategies are implemented effectively and throughout the project lifecycle, potential negative impacts are anticipated to be reduced to small or negligible levels.

Detail photographic and coordinate records will be recorded and will be on record for any post processing requirements. Relevant and the most appropriate photographs will be included in the main report for ease of reference and to illustrate the different types of systems and impacts present.

Table 4-1: Aquatic Resource Classification and Assessment

Class	Characteristics
Class 1	There is no discernible or visible drainage line and includes the **wash sheet and ephemeral channels**.
Class 2	There is an **ephemeral drainage** line. with some **marginal vegetation** (referred to as xeroriparian vegetation).
Class 3	A **clearly defined ephemeral drainage** line with a **defined riparian vegetation** component.
Class 4	There is an obvious, **discernible drainage line**, with clear **signs of sediment transportation** (seasonal rivers).
Class 5	This is well **defined river channel and riparian vegetation** component (permanent rivers).

4.6 Index of Habitat Integrity (IHI)

The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The assessment follows a step-by-step process when evaluating the habitat associated with the streams and rivers (Kleynhans et al., 2008).

The habitat integrity assessment is approached from an instream and riparian zone perspective where various metric groups consisting of several metrics are used to facilitate the assessment of the habitat integrity of a system. Each evaluation of a site is based on an “interpretation of the deviation from the reference condition where the specification of the reference condition follows an impact-based approach and the intensity and extent of anthropogenic changes are used to interpret the

impact on the habitat integrity of the system". This is done with surveys or available data sources and the information on abiotic changes inform the potential influence on the river habitat integrity (Kleynhans et al., 2008).

According to the authors (Kleynhans et al., 2008), "these changes are all related and interpreted in terms of modification of the drivers of the system, namely hydrology, geomorphology and physico-chemical conditions and how these changes would impact on the natural riverine habitats".

This assessment is based on five metric groups (Kleynhans et al., 2008):

- **Hydrological modification** is based on the modification assessment of three metrics:
    - **Base (low) flows**: A change in seasonality as well as the natural degree of perenniality is used as the basis of the assessment.
    - **Zero (no) flows**: A decrease or increase in the natural frequency of no flow conditions (e.g. on the continuum: perennial to ephemeral) is the basis of the assessment.
    - **Floods**: A change in the natural frequency of floods is assessed in terms of a change in the seasonality of floods. Large and moderate floods (including freshes) are assessed separately and combined in a matrix to derive an integrated rating for the impact on the instream habitat.

      Hydrological modification is a primary determinant of change in several habitat characteristics and changes to it are considered in all the other metric groups.
- **Physico-chemical modification** is based on the alteration of seven metrics that should be considered in terms of generally expected reference conditions:
    - **pH**
    - **Inorganic salts**
    - **Nutrients**
    - **Water temperature**
    - **Water clarity**
    - **Oxygen concentration**
    - **Toxics** (generally considered as an anthropogenic change).
- **Bed modification** has a direct bearing on the amount and substrate characteristics of available habitats. This relates to the cover provided by the substrate as well as feeding opportunities associated with a particular substrate and is considered in terms of a decrease or increase in:
    - **Sedimentation**
    - **Benthic growth** (Algal growth)
- **Bank modification** is considered based on a change in cover for biota provided by:
    - **Marginal characteristics** (vegetation and abiotic e.g. undercut banks)
    - **Non-marginal characteristics** (vegetation and abiotic).

- **Connectivity modification** is assessed according to changes that would influence the life-history stage requirements and recolonisation options of instream biota. These relate to changes that influence movement in terms of the following dimensions:
    - **Longitudinal**: This is associated with the upstream and downstream movement of biota to avoid detrimental conditions and movement to a particular required habitat.
    - **Lateral**: Movement of biota onto floodplains, and side channels within the main river channel should be considered.
- **Instream Habitat Integrity Calculation**: The metric group ratings are weighted according to the following percentages and then summed and expressed as a percentage:
    - Hydrology 100%
    - Physico-chemical 85%
    - Bed modification 80%
    - Bank modification 45%
    - Connectivity 65 %

Riparian Zone Habitat Integrity (Kleynhans et al., 2008).

This assessment is based on three metric groups:

- **Hydrological modification** with four metrics considered:
    - **Baseflow** (approached in the same way as for instream assessment)
    - **Zero flow** (approached in the same way as for instream assessment)
    - **Moderate floods and freshes**
    - **Large floods** play a specific role in the functioning and geomorphic characteristics of the riparian zone and are considered separately but in the same fashion as for the instream assessment regarding a change in frequency and seasonality.
- **Bank structure modification** is based on two metrics:
    - Marginal and
    - Non-marginal
- These two metrics are rated based on the maximum rating for any of the following indicators:
    - **Substrate exposure**
    - **Invasive vegetation**
    - **Physico-chemical changes**
    - **Erosion**
    - **Channel straightening**
- Riparian zone connectivity is assessed according to the same principles as the instream connectivity but is based on fragmentation in the riparian zone. Changes in the structure and hydrology are used to assess changes in connectivity in terms of:
    - Lateral
    - Longitudinal
- **Riparian Zone Habitat Integrity Calculation**: The metric group ratings are weighted according to the following percentages and then summed and expressed as a percentage:
    - Hydrology 75%

- Bank structure modification 100%
- Connectivity 50%

As noted in Section 4.5 (Table 4-1) the sheer numbers of Class 1 and Class 2 drainage lines associated with the project don't allow to list all the sites in this report. The Class 3, Class 4 and Class 5 systems will be listed and discussed in more detail.

An assessment and rating system has been developed in spreadsheet (MS Excel) format to facilitate this assessment. In essence the procedure involves the separate assessment of the instream habitat integrity and the riparian zone habitat integrity that is linked to key criteria listed in Table 4-2. What is recorded during the field assessment is then compared to the status of the unmodified conditions and this will indicate a change in the habitat integrity. The rating system (Table 4-3) is driven on a model of differing weights (Table 4-4) for each criterion in relation to its perceived importance when determining the habitat integrity. That then give a full spectrum view of the total habitat integrity when evaluating the instream and riparian zone components for the site.

In the final assessment of the criteria for the riparian zone and the water abstraction, the flow modification, bed modification, channel modification, water quality and inundation criteria for the instream component also receive an additional weight when impacts are large, serious or critical. A descriptive integrity category to classify the instream and riparian zone facets is then calculated (Table 4-5).

Table 4-2: Criteria used in the assessment of habitat integrity.

CRITERION	RELEVANCE
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing. Includes both exotic and indigenous vegetation.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 4-3: Descriptive classes for the assessment of modifications to habitat integrity.

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area is affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 4-4: Weights of criteria used for the assessment of instream and riparian zone habitat integrity.

INSTREAM CRITERIA	WEIGHT	RIPARIAN ZONE CRITERIA	WEIGHT
Water abstraction	14	**Indigenous vegetation removal**	13
Flow modification	13	**Exotic vegetation encroachment**	12
Bed modification	13	**Bank erosion**	14
Channel modification	13	**Channel modification**	12
Water quality	14	**Water abstraction**	13
Inundation	10	**Inundation**	11
Exotic macrophytes	9	**Flow modification**	12
Exotic fauna	8	**Water quality**	13
Solid waste disposal	6		
TOTAL	100	**TOTAL**	100

Table 4-5: Habitat integrity assessment categories.

CATEGORY	DESCRIPTION	SCORE (PERCENT OF TOTAL)
A	Unmodified, natural.	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

4.7 PES

In South Africa, the **Department of Water and Sanitation (DWS)** uses key ecological assessment metrics to classify and protect water resources (rivers, wetlands and estuaries). This is referred to as the **Present Ecological State** (**PES)** and the **Ecological Importance and Sensitivity (EIS)**. The activity falls under the Resource Directed Measures (RDM) Directorate (DWS) as mandated by the National Water Act with the main aim to balance economic development with ecological sustainability.

- **PES (Present Ecological State):** Evaluates the *current health* or condition of a water resource and measures how much the ecosystem has deviated from its original, natural state (ranging from Category A: Natural to Category F: Critically Modified).
- **EIS (Ecological Importance and Sensitivity):** Evaluates the *importance* of the ecosystem in maintaining biodiversity and its *sensitivity* to environmental changes or flow modifications.
- **The DWS uses the PES and EIS to**:
    - Determine the **Ecological Water Requirements (EWR)**.
    - Set **Resource Quality Objectives (RQOs)** (the limits on how much a resource can be used or altered without destroying it).
    - Assess risks in the DWS **Risk Assessment Matrix** for Environmental Impact Assessments.

For the project the existing PES/EIS assessment was used, as the only impacts are related to the installation of the pipes. The main impacts related to the activities will be potential water quality changes and erosion. If the mitigating and rehabilitation recommendations are employed, the changes to any water resource downstream of the activity will be negligible.

4.8 Risk Assessment

A short summary from the DWS Risk Assessment documents for the Class 4 and Class 5 systems will be included. This is based on the desktop assessment and the field observations. The aim of the Department of Water and Sanitation (DWS) Risk Assessments is to protect the country's scarce water resources, safeguard public health and prevent environmental degradation. The proses ensures regulatory compliance, identify infrastructure vulnerabilities and guide targeted interventions for sustainable water management. This is done determine if the proposed activities pose a *Low*, *Medium*, or *High* risk and to ensure that the developers implement mitigation measures to protect biodiversity and water resources.

In South Africa, the risk assessment process for water resources and habitat management is guided by the **National Water Act (NWA) (Act No. 36 of 1998)** and managed by the **Department of Water and Sanitation (DWS)**. It assesses potential ecological, flow and water quality impacts for streams and rivers.

The risk assessment methodology involves appraising specific aspects and impacts on resource quality i.e. the flow regime, water quality, habitat and biota the aim to determine mitigation measures and legal authorisation requirements.

During the baseline study of the habitat the two main components, the Present Ecological State (PES and the Ecological Importance and Sensitivity (EIS). The matrix quantitatively calculates risk using the formula:

Risk = Consequence × Likelihood

Consequence evaluates:

- Severity of how severely the activity impacts flow, water quality, habitat and biota.
- Spatial scale of the physical footprint of the impact.
- Duration of how long the impact will last.

Likelihood evaluates:

- Frequency of the activity, measure of how often the hazard occurs.
- Frequency of the impact indicating how often the habitat is affected.
- Detection, the ability to observe and mitigate the impact.
- Legal issues that will ensure compliance with existing regulations.

Based on the matrix score, the risk is the categorised as a **Low Risk** (qualifies for a General Authorisation (GA) or a **Medium to High Risk** (needs a comprehensive Water Use Licence Application (WULA) and includes a detailed Environmental Impact Assessment (EIA) and specialised management plans. The risk assessment therefore informs the Environmental Management Programme (EMPr) and the Maintenance Management Plan (MMP and outlines site-specific operational controls (e.g. sediment barriers, buffer zones and ecological monitoring schedules to minimise habitat degradation.

4.9 Impact Assessment

The assessment will be informed by the findings of the desktop assessment and observations recorded during the field survey. Potential impacts will be considered in terms of their nature, extent, duration, magnitude, reversibility and probability, while taking into consideration the effect of potential impacts on aquatic habitat, water quality, ecological functioning, and associated aquatic biodiversity. The assessment will also consider the potential for impacts to be avoided, minimised, or rehabilitated through the implementation of appropriate mitigation and management measures. Therefore, the assessment will be conducted for both the pre-mitigation and post-mitigation scenarios. The pre-mitigation assessment reflects the anticipated significance of impacts in the absence of mitigation, while the post-mitigation assessment considers the expected reduction in impact significance following the implementation of the recommended mitigation and management measures.

Each identified impact will be assessed using a standardised rating system, whereby the severity of the relevant impact factors was assigned a score from 1 to 5. The assessment will consider five impact factors, namely Extent (E), Duration (D), Magnitude (M), Reversibility (R), and Probability (P). Each factor will be assigned a rating from 1 (very low) to 5 (very high) based on the anticipated characteristics and severity of the impact. The individual ratings will subsequently be used to determine the overall significance of each impact. This approach provides a consistent and transparent means of comparing impacts and evaluating the potential consequences of the proposed activities on aquatic ecosystems. The impact factors, ratings and corresponding definitions are provided in Table 4-6 below.

Table 4-6: Impacts criteria rating.

CRITERIA	DEFINITION	SCORE
Extent (E)	Impact is confined to the immediate activity footprint or site of disturbance.	1
	Impact is restricted to the immediate surrounding area within the broader activity area.	2
	Impact extends beyond the activity area but remains localised to the surrounding environment.	3
	Impact extends substantially beyond the site boundary and may affect a broader area, such as adjacent properties, a drainage area, catchment or ecological system.	4
	Impact extends extensively beyond the site and may affect regional, national or transboundary areas.	5
Duration (D)	Impact is very short-term and ceases immediately or shortly after the activity or disturbance occurs.	1
	Impact is short-term and is expected to cease within the project lifespan, generally within approximately 5 years.	2
	Impact is medium-term and is expected to persist for approximately 5–10 years before ceasing or substantially diminishing.	3
	Impact is long-term and is expected to persist for most or all of the project lifespan, or for more than approximately 10 years.	4
	Impact is indefinite or is expected to persist beyond the project lifespan with no foreseeable end point.	5
Magnitude (M)	No discernible impact on ecological processes, environmental resources or receiving systems.	1
	Minor deterioration, disturbance or nuisance with limited effects on ecological processes, species, habitat, biodiversity or environmental resources. No measurable or negligible deterioration in environmental quality is expected.	2
	Moderate deterioration or disturbance resulting in a measurable effect on ecological processes, habitat, biodiversity or environmental resources. Partial loss or alteration may occur, and recommended environmental thresholds may occasionally be exceeded.	3
	Substantial deterioration or disturbance resulting in significant effects on ecological processes, habitat, biodiversity or environmental resources. Loss of habitat, biodiversity or resources may occur, with recommended environmental thresholds frequently exceeded.	4
	Permanent cessation or severe alteration of important ecological processes, resulting in substantial or permanent loss of habitat, biodiversity or environmental resources.	5
Reversibility (R)	Impact is readily reversible through natural recovery processes and does not require rehabilitation, remediation or specific mitigation measures.	1
	Impact is reversible with limited intervention and may require minor rehabilitation, remediation or mitigation measures to facilitate recovery.	2
	Impact is reversible through active rehabilitation, remediation and/or mitigation measures, but recovery is expected to require substantial intervention and/or an extended period.	3

CRITERIA	DEFINITION	SCORE
	Impact is only partially reversible. Significant rehabilitation, remediation and/or mitigation may reduce the impact, but complete recovery to the pre-impact condition is unlikely.	4
	Impact is irreversible. Recovery to the pre-impact condition is not possible, even with rehabilitation, remediation or mitigation measures.	5
Probability (P)	Impact is highly unlikely to occur, with negligible or no identified risk or vulnerability to natural or human-induced hazards.	1
	Impact is unlikely to occur, with a low level of risk or vulnerability to natural or human-induced hazards.	2
	Impact is possible and there is a distinct possibility of occurrence, with a moderate level of risk or vulnerability to natural or human-induced hazards.	3
	Impact is highly likely to occur and may be continuous or recurrent, with a high level of risk or vulnerability to natural or human-induced hazards.	4
	Impact is certain or almost certain to occur, irrespective of prevention, mitigation or management measures.	5

The overall significance of each identified impact was determined using a widely accepted numerical quantification approach. The significance (S) score was calculated by combining the ratings assigned to extent (E), duration (D), reversibility (R), and magnitude (M), with the resulting value weighted by the probability (P) of the impact occurring. The significance score is used to determine the impact categories as indicated in Table 4-7. The calculation is expressed as:

$$S = (E + D + R + M) \times P$$

Where:

S = Overall significance of the impact

E = Extent of the impact

D = Duration of the impact

R = Reversibility of the impact

M = Magnitude of the impact

P = Probability of the impact occurring

Table 4-7: Significance score and Impact category

SIGNIFICANCE SCORE	IMPACT CATEGORY
0-30	Low
31-60	Medium
61-100	High

5. ASSUMPTIONS, GAPS AND LIMITATIONS

The report is based on survey and assessment techniques which were limited by time and budgetary constraints relevant to the type and level of investigation undertaken. GPS coordinates may vary as they were recorded with a handheld GPS. It must be noted that, during the process of converting spatial data to final output drawings, several steps are followed that may affect the accuracy of marked points and boundaries. Due care has been taken to preserve accuracy. Printing or other forms of reproduction may also distort the scale indicated in maps.

The study was limited to a snapshot view during a single site visit and may therefore only be indicative of site conditions and aquatic diversity during the respective season. The field investigation was undertaken during April 2026 (wet season). **It must be noted that the catchment area has received excessive rain during the week leading up to the survey and most systems were inundated and in state of flooding.**

It was not possible to conduct macroinvertebrate or fish assessments during the survey period as the Orange River (and other) was in flood after recent rains. It was decided that the surveys are not critical for this assessment, as the only impact on the river will be the abstraction point that will be cleared for the installation of the floating pump system.

It is unlikely that more surveys would alter the outcome of this study radically due to the study being conducted by SACNASP registered Professional Scientist.

6. RESULTS AND DISCUSSION

6.1 Desktop Assessment

During the desktop investigation, several aquatic resources were identified that may be impacted by the construction and/or authorised activities (Figure 6-1). Most of the aquatic resource are unnamed streams (wash sheets and ephemeral channels) with poorly defined channels or riparian vegetation. Most of these ephemeral channels drain into the Hartbees, Brabees and Slang Rivers, tributaries of the Lower Orange River (receiving environment) (Figure 6-5). According to Moodley (et al., 2025), the Hartbees, Slang and Brabees rivers are ephemeral systems that are groundwater driven. The PES data for this section of the Orange River is presented in Table 6-1 and include the mainstem Orange River and the lower sections of the Hartbees, Slang and Brabees rivers**.**

According to Moodley (et al., 2025) the lower Orange from the Vaal confluence to Augrabies Waterfall, the Orange River has no major seasonal tributaries, only the three major ephemeral systems (Hartbees, Slang and Brabees). Important towns and villages: include Griekwastad, Postmasburg, Prieska, Grobblershoop, Upington, Keimoes and Kakamas. The impacts of the river include intensive abstraction and irrigation along the river, some mining and livestock farming with the Augrabies Falls National Park forming an integral part of the unit. The socio-economic zones are the Agricultural SEZ (predominantly) and the Mining SEZ 1 (in 6 of the catchments).

Rivers in the lower Orange River catchment are largely rated as having a C and D PES category. The water resources in this catchment are dominated by depression, seep and unchanneled valley bottom wetlands which cover approximately 2% of the catchment area. (Moodley et al., 2025).

The Orange River from Upington to Hartbees River confluence show changes to water quality, with a PES category of D/E (decline). The reach dominated by intensive agricultural activity and includes the Neusberg weir and WMS monitoring point (important for monitoring the proposed project). From the Hartbees (Kakamas) further west (to Augrabies Waterfall) the mainstem of the Orange River is dominated by intensive agricultural activity. Flow and water quality is similarly impacted with the PES predominantly a C/D category. This section of the river is an important fish sanctuary with a number of red data species present (Moodley et al., 2025).

Table 6-1: PES data for upper section of the Orange River from Upington to the confluence with the Hartbees River (Moodley et al., 2025).

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator
Orange River from Upington to Hartbees River confluence	Low flows			✓	A flow measurement will provide an indication of the required maintenance flows being met. There is a need to maintain ecological integrity and health.	Base flows
	High flows (floods)					
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios). There is an impact of algae observed in the reach.	Orthophosphates, Nitrate, Ammonia, Chlorophyll *a*
	Salts	✓			Fitness for use for users	Total Dissolved Solids
	Pathogens	✓			Indicators of faecal contamination from upstream in the catchment WWTWs and Upington	*Escherichia coli*, total coliform
	System Variables			✓	Fitness for use for users and ecological health. Sediment impacts from upstream land uses.	Total Suspended Solids (TSS); pH and Dissolved oxygen (DO).
	Toxics			✓	Fitness for use for human health and ecological health of biota	Aluminium (Al), Iron (Fe), Fertilizers (to be confirmed)
	Fish		✓		Indicator of ecological integrity (maintenance of ecological category)	FRAI score and category; Indicator fish (rheophilic, riparian vegetation, water quality); Fish health; Alien invasive fish.
	Instream		✓		Indicator of ecological integrity and health	IHI, RHAM.
	Riparian habitat		✓		Indicator of ecological integrity and health	IHI; riparian
	Aquatic invertebrates		✓		Indicator of ecological integrity (maintenance of ecological category)	MIRAI score and category; SASS5 score and ASPT value; Indicator taxon (preference for flow, marginal vegetation, water quality). Dominant taxon
	Diatoms					

Table 6-2: PES data for upper section of the Orange River from Kakamas to Augrabies Waterfall (Moodley et al., 2025).

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator
Kakamas to Augrabies Waterfall	Low flows			✓	A flow measurement will provide an indication of the required maintenance flows being met. There is a need to maintain ecological integrity and health.	Base flows
	High flows (floods)					
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios). There is an impact of algae observed in the reach.	Orthophosphates, Nitrate, Ammonia, Chlorophyll *a*
	Salts	✓			Fitness for use for users	Total Dissolved Solids
	Pathogens	✓			Indicators of faecal contamination from WWTWs and protection required for recreational users.	*Escherichia coli*, total coliform
	System Variables			✓	Fitness for use for users and ecological health. Sediment impacts from upstream land uses.	Total Suspended Solids (TSS); pH and Dissolved oxygen (DO).
	Toxics			✓	Fitness for use for human health and ecological health of biota	Aluminium (Al), Iron (Fe), Fertilizers (to be confirmed)
	Fish		✓		Indicator of ecological integrity and health – however no biotic data available for this reach. A River Ecosystems Monitoring Site (REMP) must be included in this RU. Will need to extrapolate from upstream and downstream sites.	Indicator fish (rheophilic, riparian vegetation, water quality). Fish health. Alien invasive fish. Baseline data needs to be collated.
	Instream		✓		Indicator of ecological integrity.	IHI. RHAM
	Riparian habitat		✓		Indicator of ecological integrity.	IHI.
	Aquatic invertebrates		✓		Indicator of ecological integrity and health – however no biotic data available for this reach. A River Ecosystems Monitoring Site (REMP) must be included in this RU. Will need to extrapolate from upstream and downstream sites.	Indicator taxon (preference for flow, marginal vegetation, water quality); Dominant taxon. Baseline data needs to be collated.
	Diatoms					

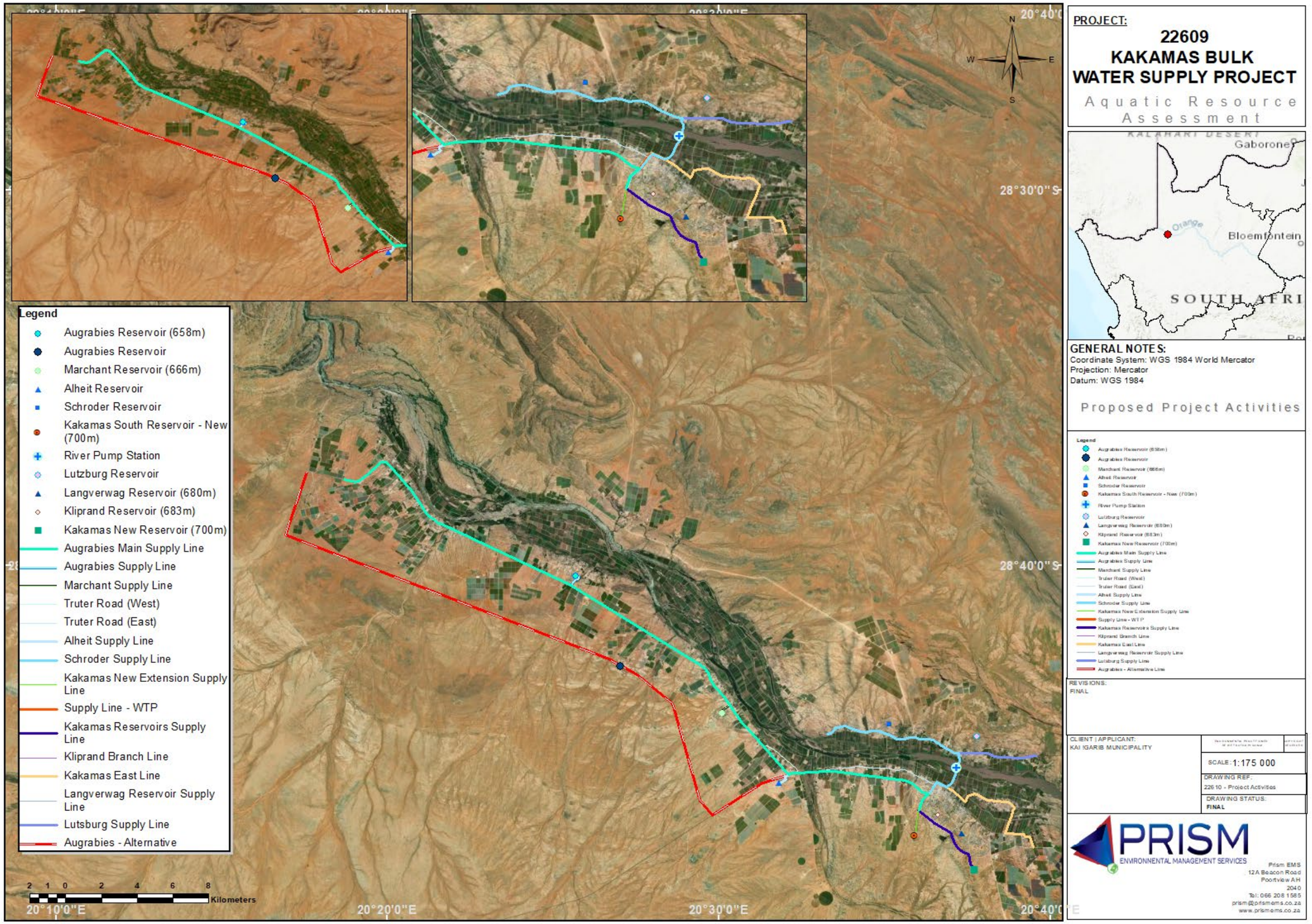


Figure 6-1: Project Activities

Table 6-3: Historic PES, EI and ES data for Orange (D73F – 0329) where the abstraction point and some related network activities are proposed.

Present Ecological State		Ecological Importance		Ecological Sensitivity	
D (Largely Modified)		**Moderate**		**High**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	Large	Fish species per sub quaternary catchment	9	Fish Physico-Chemical sensitivity description	High
Modifications to Riparian/ Wetland Zone Continuity	Serious	Invertebrate taxa per sub quaternary catchment	52	Fish No-flow sensitivity description	High
Modifications to Riparian/ Wetland Zones	Moderate	Habitat Diversity Class	Moderate	Invertebrate Physico-Chemical sensitivity	Very High
Potential Flow Modifications	Serious	Instream Migration Link Class	Moderate	Invertebrate velocity sensitivity	Very High
Potential Physico-Chemical Modifications	Large	Riparian-Wetland Zone Migration Link	Low	Stream size sensitivity to modified flow/water level changes description	High
		Instream Habitat Integrity Class	Moderate	Riparian-Wetland Vegetation intolerance to water level changes description	Low
Anthropogenic Impacts					
Irrigation - mostly from canal system, urban (Kakamas), road crossing, gauging weir, AIP .					

Table 6-4: Historic PES, EI and ES data for Hartbees River (D53J – 3408) where some related network activities are proposed.

Present Ecological State		Ecological Importance		Ecological Sensitivity	
D (Largely Modified)		**Moderate**		**High**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	Small	Fish species per sub quaternary catchment	1	Fish Physico-Chemical sensitivity description	Moderate
Modifications to Riparian/ Wetland Zone Continuity	Large	Invertebrate taxa per sub quaternary catchment	4	Fish No-flow sensitivity description	Moderate
Modifications to Riparian/ Wetland Zones	Large	Habitat Diversity Class	Low	Invertebrate Physico-Chemical sensitivity	Low
Potential Flow Modifications	Moderate	Instream Migration Link Class	Very high	Invertebrate velocity sensitivity	Moderate
Potential Physico-Chemical Modifications	Moderate	Riparian-Wetland Zone Migration Link	Moderate	Stream size sensitivity to modified flow/water level changes description	Low
		Instream Habitat Integrity Class	High	Riparian-Wetland Vegetation intolerance to water level changes description	Low
Anthropogenic Impacts					
Livestock, roads and crossings, intensive irrigation and return flows near confluence with the Orange River.					

Table 6-5: Historic PES, EI and ES data for Brabees River (D81A – 3241) where some related network activities are proposed.

Present Ecological State		Ecological Importance		Ecological Sensitivity	
D (Largely Modified)		**Moderate**		**High**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	None	Fish species per sub quaternary catchment	0	Fish Physico-Chemical sensitivity description	
Modifications to Riparian/ Wetland Zone Continuity	None	Invertebrate taxa per sub quaternary catchment	0	Fish No-flow sensitivity description	
Modifications to Riparian/ Wetland Zones	None	Habitat Diversity Class	High	Invertebrate Physico-Chemical sensitivity	
Potential Flow Modifications	None	Instream Migration Link Class	N/A	Invertebrate velocity sensitivity	
Potential Physico-Chemical Modifications	None	Riparian-Wetland Zone Migration Link	N/A	Stream size sensitivity to modified flow/water level changes description	High
		Instream Habitat Integrity Class	N/A	Riparian-Wetland Vegetation intolerance to water level changes description	
Anthropogenic Impacts					
Livestock, roads and crossings, intensive irrigation and return flows near confluence with the Orange River.					

Table 6-6: Historic PES, EI and ES data for Slang River (D81A – 3369) where some related network activities are proposed.

Present Ecological State		Ecological Importance		Ecological Sensitivity	
D (Largely Modified)		**Moderate**		**High**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	None	Fish species per sub quaternary catchment	0	Fish Physico-Chemical sensitivity description	
Modifications to Riparian/ Wetland Zone Continuity	None	Invertebrate taxa per sub quaternary catchment	0	Fish No-flow sensitivity description	
Modifications to Riparian/ Wetland Zones	None	Habitat Diversity Class	Very low	Invertebrate Physico-Chemical sensitivity	
Potential Flow Modifications	None	Instream Migration Link Class	N/A	Invertebrate velocity sensitivity	
Potential Physico-Chemical Modifications	None	Riparian-Wetland Zone Migration Link	N/A	Stream size sensitivity to modified flow/water level changes description	
		Instream Habitat Integrity Class	N/A	Riparian-Wetland Vegetation intolerance to water level changes description	
Anthropogenic Impacts					
Livestock, roads and crossings, intensive irrigation and return flows near confluence with the Orange River.					

6.2 Department of Forestry, Fisheries and the Environment (DFFE) Screening Tool

The aim of the National Web-Based Environmental Screening Tool to simplify the Environmental Impact Assessment (EIA) process by identifying environmental sensitivities upfront, guide developers to avoid high-risk ecosystems, and determine exactly which specialist studies are required. It is used to ensure data-driven precision for project planning, surveys and management. By mapping out sensitivities (ranging from very high to low), it empowers developers to adjust their project boundaries and avoid impacting sensitive habitats early in the design phase. Instead of forcing generic and blanket studies, the tool prescribes custom protocols and minimum requirements for specialist assessments based on the exact nature of the proposed site. The site information (locality) used in the web-based assessment, generate a Screening Tool Report (STR) where a sensitivity rating is given for the various components assessed for an ecological assessment. Listed in the table below (Table 6-7) is a summary of the development site's environmental sensitivities as per the DFFE Screening Tool.

According to the map for the Aquatic Biodiversity Theme generated in STR (Figure 6-2), the resources affected are the larger drainage systems linked to the Orange River. According to the screening tool, the Aquatic Biodiversity Theme is classified as having “Very High” sensitivity.

For this project the first step was to generate a Screening Report from the DFFE Screening Tool portal. This was done by uploading the proposed footprint for the project (.kmz file) and selecting the relevant application category (i.e. local infrastructure). The platform then lists the sensitivity ratings for each component whereafter a report was generated. The report details the required specialist assessments based on the identified environmental sensitivities (e.g. Aquatic Biodiversity).

Once the report was reviewed an initial site sensitivity verification was conducted by appraising satellite imagery and existing databases to evaluate the land uses, potential impacts and identifying any additional sensitive areas for validation (desktop review). This was followed by the on-site inspection to verify if the actual land use and environmental sensitivities align with the Screening Tool's and desktop assessment findings. The information from these assessments were then captured in this verification report that contain motivations, recommendations, mitigations, rehabilitation strategies and evidence (e.g. photographs) to confirm or dispute the screening tool’s sensitivity ratings.

Table 6-7: STR Environmental Sensitivities

Theme	Very High Sensitivity	High Sensitivity	Medium Sensitivity	Low Sensitivity
Agriculture Theme	X			
Animal Species Theme		X		
Aquatic Biodiversity Theme	X			
Archaeological and Cultural Heritage Theme	X			
Civil Aviation Theme		X		
Defence Theme				X
Paleontology Theme			X	
Plant Species Theme		X		
Terrestrial Biodiversity Theme	X			

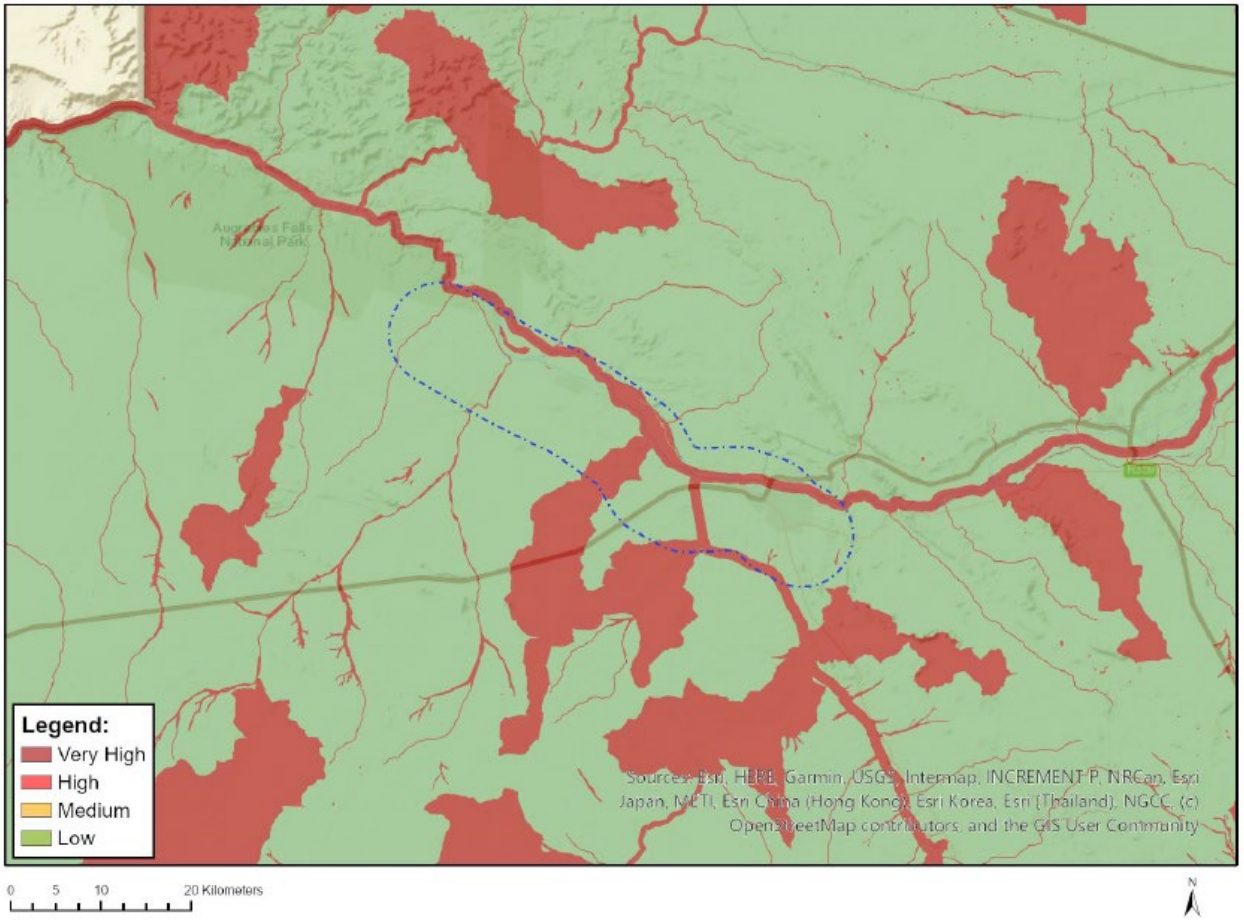


Figure 6-2: Map of Relative Aquatic Biodiversity Theme Sensitivity, as per the National Screening Tool Report.

6.3 Aquatic Resources Assessment

6.3.1 Aquatic Resources Defined

6.3.1.1 Wash Sheets

These resources constitute discreet, diffuse, unchanneled and highly scattered areas of surface runoff. Wash sheets occur throughout the landscape and are activated only during extreme, localised rainfall events, with the resulting flow dissipating rapidly thereafter. Within the landscape, water moves as a broad, unconfined sheet rather than along defined channels. Where rainfall is of sufficient magnitude, however, water begins to accumulate within ephemeral drainage channels, which are themselves discreet features. (Figure 6-8).

Impacts on these resources include grazing, trampling, roads, fences and erosion.

6.3.1.2 Ephemeral Drainage Lines

The non-perennial drainage lines flow briefly and unpredictably, in direct response to high-intensity rainfall events. As noted, these channels are discreet in nature. Water accumulates from the wash sheets into subtle, barely distinguishable channels. Most very small (1st order) drainage lines lack identifiable riparian vegetation, owing to the short duration of the wet period associated with these minor channels.

As runoff volumes increase, water accumulates into larger ephemeral channels (2nd order). With increasing channel size, a faint riparian vegetation zone becomes apparent, comprising predominantly grasses and small forbs that grow denser and marginally larger than the surrounding vegetation.

As channel size and water volume increase further (3rd and 4th order channels), grasses are progressively replaced by shrubs, such as *Rhigozum trichotomum*. The presence of small trees, including *Vachellia karoo*, indicates a greater volume of water retained within the channels for more extended periods. (Figure 6-8).

Impacts on these resources include grazing, trampling, roads, fences, erosion, limited cultivation, farm infrastructure e.g. housing and stores and alien vegetation (e.g. *Prosopis glandulosa*).

6.3.1.3 Seasonal River

As water congregates further, the channels coalesce to form non-perennial rivers that flow predictably for extended periods, usually during the wet or rainy season, but cease to flow entirely during the dry season. These rivers possess a well-defined channel, with flow driven by seasonal climatic patterns rather than isolated thunderstorm events. Water within these systems is generated during the rainy season; limited percolation results in subsurface flow, which in turn gives rise to surface flow in the lower reaches of the

river. Within the study area, this typically occurs in the reach immediately preceding the confluence with the Orange River. (Figure 6-8).

Impacts on these resources include grazing, trampling, roads, bridges, stream modification, fences, erosion, siltation, cultivation, water quality changes (i.e. return flows), farm infrastructure e.g. housing and stores and alien vegetation (e.g. *Prosopis glandulosa*).

6.3.1.4 Perennial River

Perennial rivers flow continuously throughout the year, even during dry cycles. Under natural conditions these rivers are sustained by consistent rainfall in distant, higher-elevation catchments or deep groundwater aquifers and wetlands. (Figure 6-8).

As mentioned, the lower Orange River depends heavily on additional water from the Lesotho (Senqu River), large impoundments (Lake Gariep and Lake van der Kloof) and flows from the Vaal River to sustain the intensive agriculture and mining ventures.

Impacts on these resources include erosion, loss of riparian vegetation, cultivation, water abstraction, farm infrastructure e.g. housing and stores, return flows and alien vegetation (e.g. *Prosopis glandulosa*).

Table 6-8: Aquatic Resource Classification and Assessment as defined for this project.

Class	Characteristics	Type
Class 1	There is no discernible or visible drainage line and includes the **wash sheet and ephemeral channels**.	Wash Sheets
Class 2	There is an **ephemeral drainage** line. with some **marginal vegetation** (referred to as xeroriparian vegetation).	Drainage lines
Class 3	A **clearly defined ephemeral drainage** line with a **defined riparian vegetation** component.	Drainage lines
Class 4	There is an obvious, **discernible drainage line**, with clear **signs of sediment transportation** (seasonal rivers).	Streams and rivers
Class 5	This is well **defined river channel and riparian vegetation** component (perennial rivers).	River

6.3.2 Field Investigation

The field investigation was undertaken, along with a team of specialist scientists, on 13 to 15 April 2026. (wet season survey), to assess and determine the baseline habitat indicators on the aquatic resources. Photographic record and condition of the survey sites are also presented in this study. The following riparian indicators to determine the riparian zone and outer edge were considered (DWAF, 2005):

- **Active channel** – the stream is an active channel with flowing water (channelled valley bottom wetland).
- **Topography** – sand bars due to width of stream, active channel bank present (eroded), flood benches and macro channel bank closely washed.
- **Vegetation** – marginal vegetation, more prevalent at meandering areas, distinguishable species composition and growth forms present in isolated areas.
- **Alluvial soils** – recent depositions of sand (bank erosion), mud and stones present; however, heavily sedimented.

6.3.2.1 Wash sheets and small ephemeral streams

In the study area, there are a number of pipelines planned to supply water to treatment plants and into the distribution network. The discussion refers to Figure 6-4, Figure 6-5 and Figure 6-6. It is noted in Figure 6-5 and Figure 6-6 that a number of the stream channels have been incorporated into the vineyards when looking at the original river channels mapped (blue lines – labelled as “streams and rivers”).

Many of the old drainage lines have been re-routed between vineyards and are maintained as channels to transport rain runoff and return flows from irrigation canals and cultivated vineyards. Many of the channels are modified with alien and indigenous vegetation but can’t be considered as “natural” due to the artificial flows, enriched water quality and modified plant communities. (Figure 6-3).

- Augrabies Pipeline (red)
    - This is a large supply line south of the Orange River and most of the streams crossed are ephemeral streams in open land south of the cultivated areas.
    - The channels in the open habitat are modified with road crossings, grazing and dumping of solid waste observed in communal areas.
    - During construction, dust, solid waste, chemical waste and oils and fuel are the added impacts on the environment.
- Augrabies Pipeline (aquamarine)
    - This is a large supply line south of the Orange River and most of the streams crossed are ephemeral streams between the vineyards or in open land between the cultivated areas.
    - Many of the stream channels have been incorporated into the vineyards when looking at the original channel mapped (blue lines – labelled as “streams and rivers”).
    - The channels in the open habitat are modified with road crossings, grazing and dumping of solid waste observed in communal areas.
    - In the cultivated areas chemical pollution and increased nutrient loads from return flows influence the receiving environment.
    - During the construction period dust and siltation, oil and fuel spills and chemical spills will contribute to impacts on the ecosystem.

- Kakamas Reservoirs Supply Line (purple)
    - This is a short supple line south of the river on the eastern section of the project with some wash sheets and ephemeral streams.
    - The site is near settlements with grazing and erosion the noted impacts in the channels.
    - During construction dust, solid waste, chemical waste and oils and fuel are the added impacts on the environment.
- Kakamas East Line (yellow)
    - A short supple line on the banks of the river (southern side).
    - Impacts related to the natural drainage lines are very high as vineyards and agricultural infrastructure (strong, packing facilities and dwellings dominate).
    - The existing impacts are related to chemical and return flows from the industry and dust, solid waste, chemical waste and oils and fuel are the added impacts during construction on the on the environment.
- Schroder and Alheit supply lines (dark and light blue)
    - These water lines are on the northern side of the river and associated with vineyards and some open land between.
    - Many of the stream channels have been incorporated into the vineyards when looking at the original channel mapped (blue lines – labelled as “streams and rivers”).
    - The current impacts are chemical, oils and fuels, return flows and solid waste pollution.
    - During construction the dust, siltation and increased chemical and fuels and oils can impact the receiving environment.

Refer to Figure 6-5.

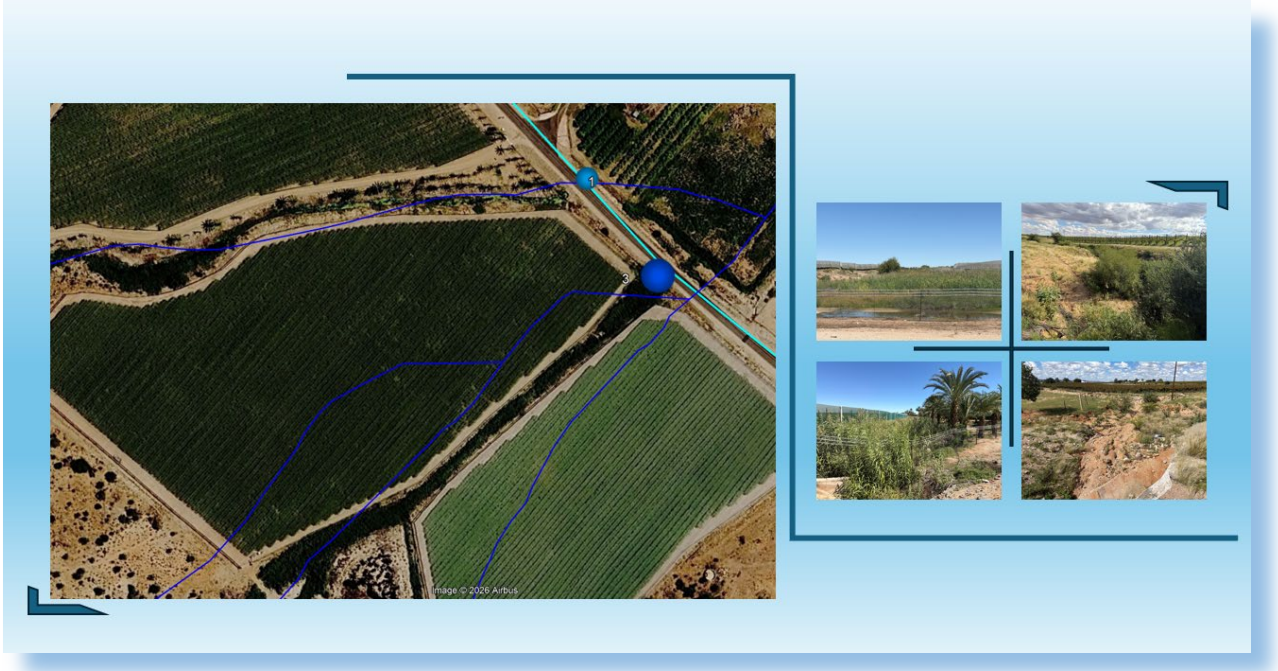


Figure 6-3: Old drainage lines re-routed between vineyards

6.3.2.2 Larger ephemeral streams and seasonal rivers

- The three larger systems draining from the south to the Orange River are the Hartbees River, the Slang River and the Brabees River.
- These systems originate well to the south and are formed in low lying hills and mountains.
- The main contributions of water are from the flat and undulating landscape and here the wash sheets and small ephemeral streams are the main sources of water for the larger channel near the Orange River.
- The Slang, Brabees and Hartbees rivers are considered as larger ephemeral systems that only flow for short periods during heavy rain events.
- The lower sections of the Hartbees and Slang rivers near the confluence with the Orange River has a more permanent and distinct riparian zone.
    - This is regarded as “artificially seasonal” due to pushback into the rivers from the Orange River (artificially high flows) and return flows from canals overflows and from nutrient enrich water from the vineyards.
- The current impacts in the upper catchments are related to the extensive farming and local infrastructure and include grazing, trampling, erosion, roads and bridges, limited infrastructure e.g. housing and stores and alien vegetation.

- In the lower sections near the Orange River return flows from agricultural activities, industries and towns and villages are the sources of pollution that impact water quality, habitat loss and biodiversity loss of indigenous species (terrestrial and aquatic).
- During construction, increased dust and siltation, chemical, fuel and oil spills and habitat modifications will occur. In the current landscape, these impacts will be negligible compared to the existing effects of activities.

6.3.2.3 Perennial rivers

- As discussed, the lower Orange River is the only perennial river associated with the project area.
- The regulated flows have modified the ecosystem as the flow regimes are managed to supply water for irrigation in all seasons.
- Floods are less frequent as water is retained in Gariep Dam and Van der Kloof Dam during the summer to augment the releases in the dryer periods.
- The abstraction point for water for the upgrade of the water purification and reticulation project is on the Orange River in Kakamas.
- The habitat in this area is modified with the cultivated areas encroaching into the riparian zone. Many of the indigenous trees have been replaced with alien invasives (refer to the botanical assessment for detail).
- The current impacts on the river are related to:
    - Upstream impacts which originate the whole system and are mostly water quality related, alien plant and aquatic species that threaten natural biodiversity and water abstraction.
    - Near the project area, the return flows from the intensive agricultural industry, abstraction, loss of riparian vegetation and habitat modification are severely changing the ecosystem.
    - During construction, dust and siltation, chemical, fuel and oil spills and habitat modifications will occur. In the current landscape, these impacts will be negligible compared to the existing effects of activities.

6.3.3 Aquatic Resources Quantification

The aquatic resources were assessed in the field and recorded in accordance with the survey protocols, with each resource verified against site-specific conditions prior to classification. The aquatic resources were classified as described in Table 6-8, whereby resource units were assigned to discrete classes on the basis of their physical, hydrological and ecological characteristics, ensuring a consistent and reproducible classification framework across the study area. Following classification, the resources were packaged into data sets for further evaluation, with attribute data captured for each resource unit to

facilitate subsequent spatial and statistical analyses. The systems were thereafter grouped per class, allowing for a structured comparison of resource extent and distribution, and were quantified as indicated in Table 6-9, providing a quantitative basis for assessing the relative abundance and significance of each aquatic resource class within the study area.

Table 6-9: Number of Aquatic Resource Crossings

Route	Class 1	Class 2	Class 3	Class 4	Class 5
All Routes Combined	147	46	10	3	1
Total	207				

6.3.4 Risk Assessment

According to the DWS protocol for the Risk Assessment the aims are the evaluation of impacts on resource quality (i.e. the flow regime, water quality, habitat and biota) to verify mitigation measures and legal authorisation requirements. The protection of water resources and the associated habitat management that include the river catchment, the instream and riparian habitat is guided by the National Water Act (NWA) (Act No. 36 of 1998). When assessing the potential ecological impacts, flow regime alterations and potential water quality impacts the framework gives integrated catchment management strategies and mitigation actions that must be incorporated into the management plans.

The extensive reticulation and water purification project will abstract water from the Orange River in Kakamas (S28.75314620 E20.62134197) to feed the **Kakamas Bulk Water Supply Project**. Reviews and assessment have indicated the need to upgrade and extend the water reticulation network in the Kai! Garib Municipality to supply the Kakamas and Augrabies settlements. It was reported that the existing ageing infrastructure can't effectively supply the increased water demand that is needed to support the expanding socio-economic developments.

With this information the Kai! Garib Municipality's Integrated Development Plan (IDP) has identified several water-related projects that include the upgrading of bulk water supply infrastructure in Kakamas, the refurbishment of the water purification system in Augrabies, a need for feasibility studies and long-term planning for water infrastructure improvements and critically needed expansion of water supply networks to accommodate future development.

The Risk Assessment (RA) model was done for several rivers and streams to give baseline information related to the current impacts on the water resources. These assessments were conducted at the water abstraction point in the Orange River and the river and stream crossing on the Hartbees, Slang and Brabees rivers and the Class 3 ephemeral streams. Table 6-12 is a summary of the sites where the RAs were done. In Table 6-11, the summary for each site RA is expressed. The impacts for the various resources will be **low** if well managed and all recommendations and mitigation measures are actively employed during the project.

Table 6-10: Coordinates for the watercourse crossings evaluated – Class 3 – 5.

River and stream identifier	Coordinates
Orange River – Class 5	20.62134197 -28.75314620
Hartbees River (A) – Class 4	20.53791592 -28.76058074
Brabees River – Class 4	20.38135706 -28.66134627
Hartbees River (B) – Class 4	20.53791592 -28.76058074
Class 3 Ephemeral crossings **1** **2** **3** **4** **5** **6** **7** **8** **9** **Slang Rivier**	 20.30212235 -28.62726729 20.35146511 -28.64237722 20.35370174 -28.64531291 20.36233068 -28.64912689 20.47306343 -28.70359214 20.58565842 -28.76201543 20.57821185 -28.73937779 20.56545807 -28.73697563 20.50205004 -28.72422778 20.48877928 -28.72924124

Table 6-11: Summary of the Risk Assessment for the Class 3 – 5 watercourses.

Orange River			
Phase	**Activity**	**Impact**	**Risk Ratings**
PRE-CONSTRUCTION (DESIGN)	Vegetation clearing	Siltation	**L**
		Erosion	**L**
		Solid waste	**L**
	Stabilisation of riverbank	Installation of geotextiles	**L**
CONSTRUCTION	Construction of anchor point and pump station	Pouring of foundations	**L**
		Building of structures	**L**
		Clearing of building rubble	**L**
	Installing the floating pump	Fixing pipes, pump and floating device	**L**
		Deploying into the water	**L**
OPERATIONAL	Erosion maintenance	Rehabilitation as required	**L**
Hartbees River			
Phase	**Activity**	**Impact**	**Risk Ratings**

PRE-CONSTRUCTION	Vegetation clearing	Siltation	L
		Erosion	L
		Solid waste	L
CONSTRUCTION	Digging of trench	Vehicles in channel	L
		Oil and fuel spills	L
		Solid waste	L
		Siltation and dust	L
	Installation	Vehicles in channel	L
		Solid waste	L
		Oil and fuel spills	L
	Backfilling	Vehicles in channel	L
		Oil and fuel spills	L
	Rehabilitation	Revegetation	L
OPERATIONAL	Erosion maintenance	Inspections and maintain as needed	L

Brabees River

Phase	Activity	Impact	Risk Ratings
PRE-CONSTRUCTION	Vegetation clearing	Siltation	L
		Erosion	L
		Solid waste	L
CONSTRUCTION	Digging of trench	Vehicles in channel	L
		Oil and fuel spills	L
		Solid waste	L
		Siltation and dust	L
	Installation	Vehicles in channel	L
		Solid waste	L
		Oil and fuel spills	L
	Backfilling	Vehicles in channel	L
		Oil and fuel spills	L
	Rehabilitation	Revegetation	L
OPERATIONAL	Erosion maintenance	Inspections and maintain as needed	L

Class 3 Ephemeral streams, including the Slang River

Phase	Activity	Impact	Risk Ratings
PRE-CONSTRUCTION	Vegetation clearing	Siltation	L
		Erosion	L
		Solid waste	L

CONSTRUCTION	Digging of trench	Vehicles in channel	L
		Oil and fuel spills	L
		Solid waste	L
		Siltation and dust	L
	Installation	Vehicles in channel	L
		Solid waste	L
		Oil and fuel spills	L
	Backfilling	Vehicles in channel	L
		Oil and fuel spills	L
	Rehabilitation	Revegetation	L
OPERATIONAL	Erosion maintenance	Inspections and maintain as needed	L

6.4 Mapping

This section presents the spatial datasets and mapping outputs that underpin the aquatic resources assessment for the proposed project.

Figure 6-1 illustrates the proposed project activities and associated infrastructure footprint in relation to the study area.

Figure 6-2 presents the Relative Aquatic Biodiversity Theme Sensitivity, derived from the National Screening Tool Report, providing a preliminary indication of aquatic ecological sensitivity within the area.

Figure 6-4 depicts the National Wetland Map version 6 (NWM6), as developed and published by the South African National Biodiversity Institute (SANBI, 2024), reflecting the most recent national-scale mapping of wetland and aquatic ecosystems.

Figure 6-5 illustrates the surface water resources occurring within the quaternary catchment(s) relevant to the study area, providing context on the broader hydrological setting.

Figure 6-6 presents the classification of aquatic resources identified within the study area, categorised according to a five-class system (Class 1 to Class 5), reflecting their relative ecological state and importance.

Collectively, these figures provide the spatial and contextual basis for the findings and recommendations presented in this report.

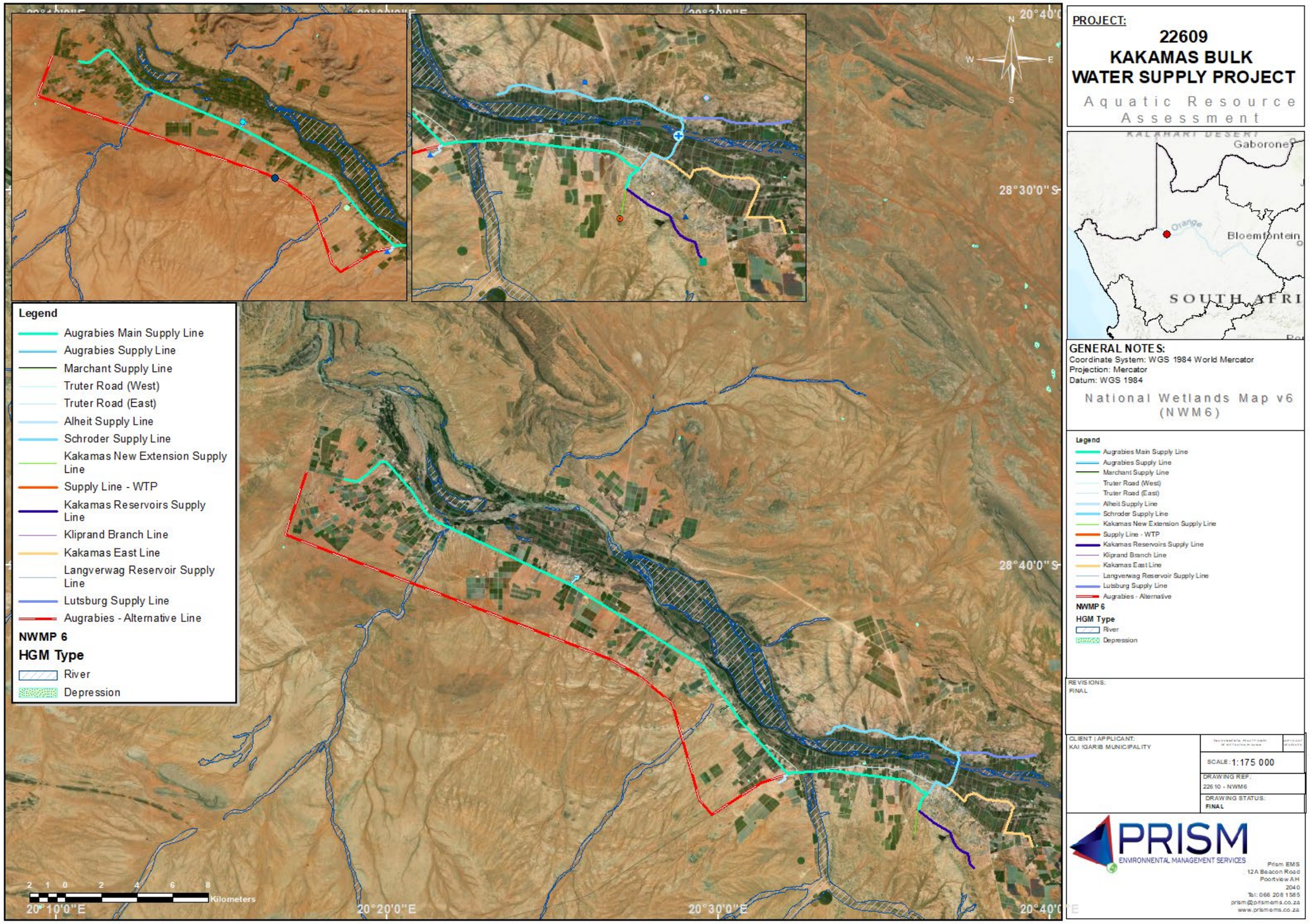


Figure 6-4: National Wetlands Map v6 (NWM6) (SANBI, 2024).

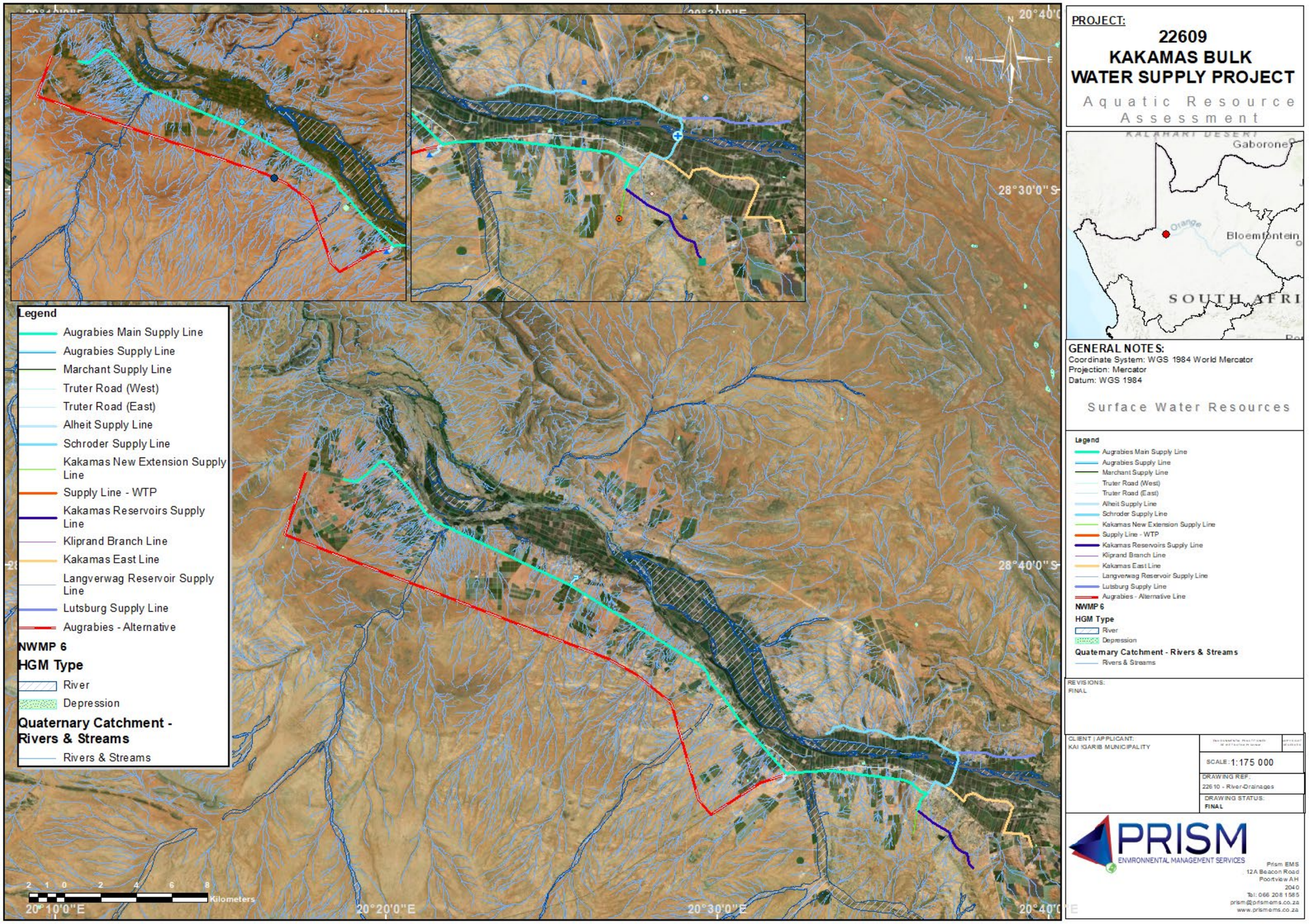


Figure 6-5: Surface Water Resources.

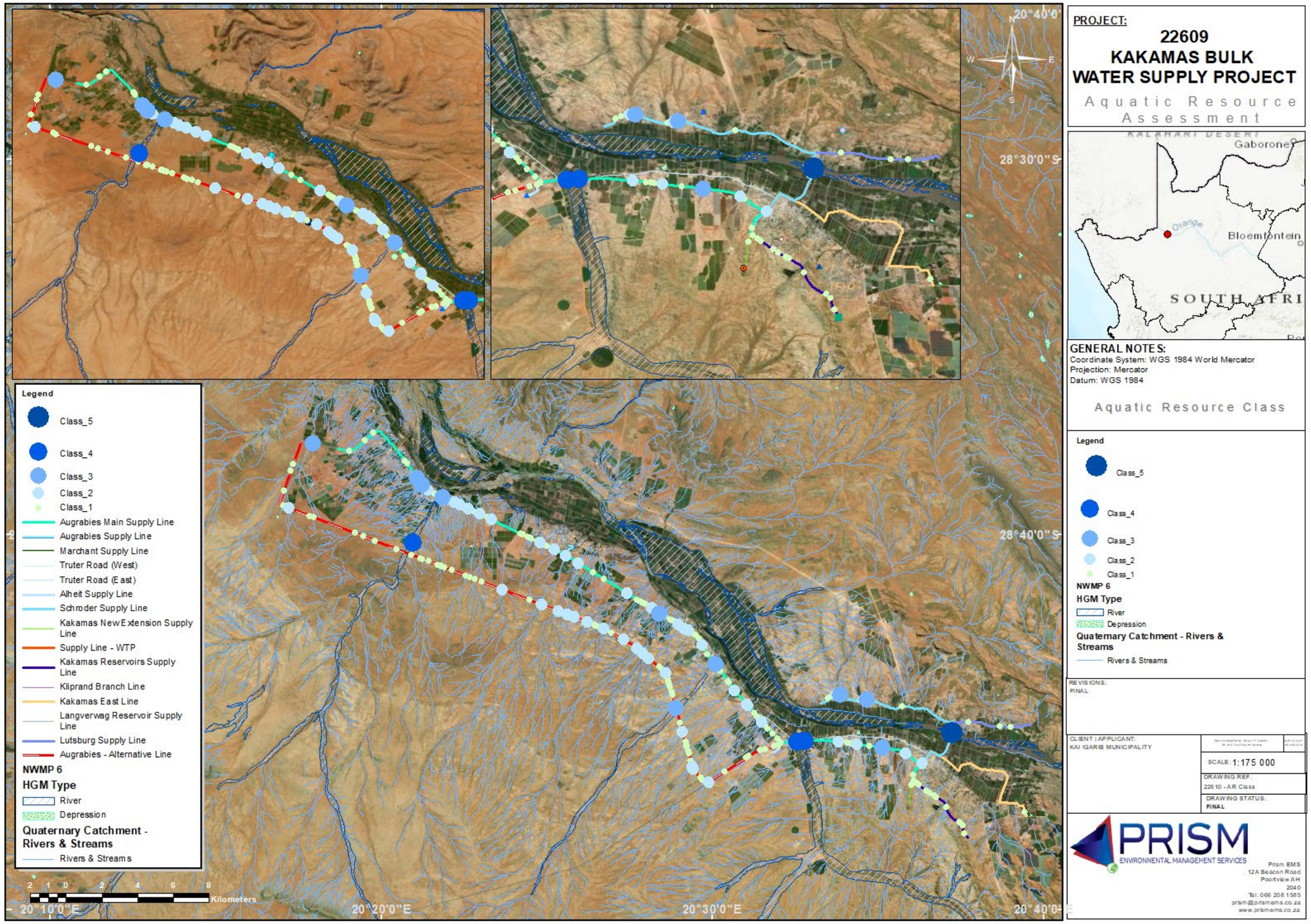


Figure 6-6: Aquatic Resource Classes

6.5 Site Condition and Photographic Record



Figure 6-7: Site condition Class 5 system – Orange River.



Figure 6-8: Site condition Class 4 system – Hartbees and Brabees Rivers.



Figure 6-9: Site condition typical for Class 3 system.

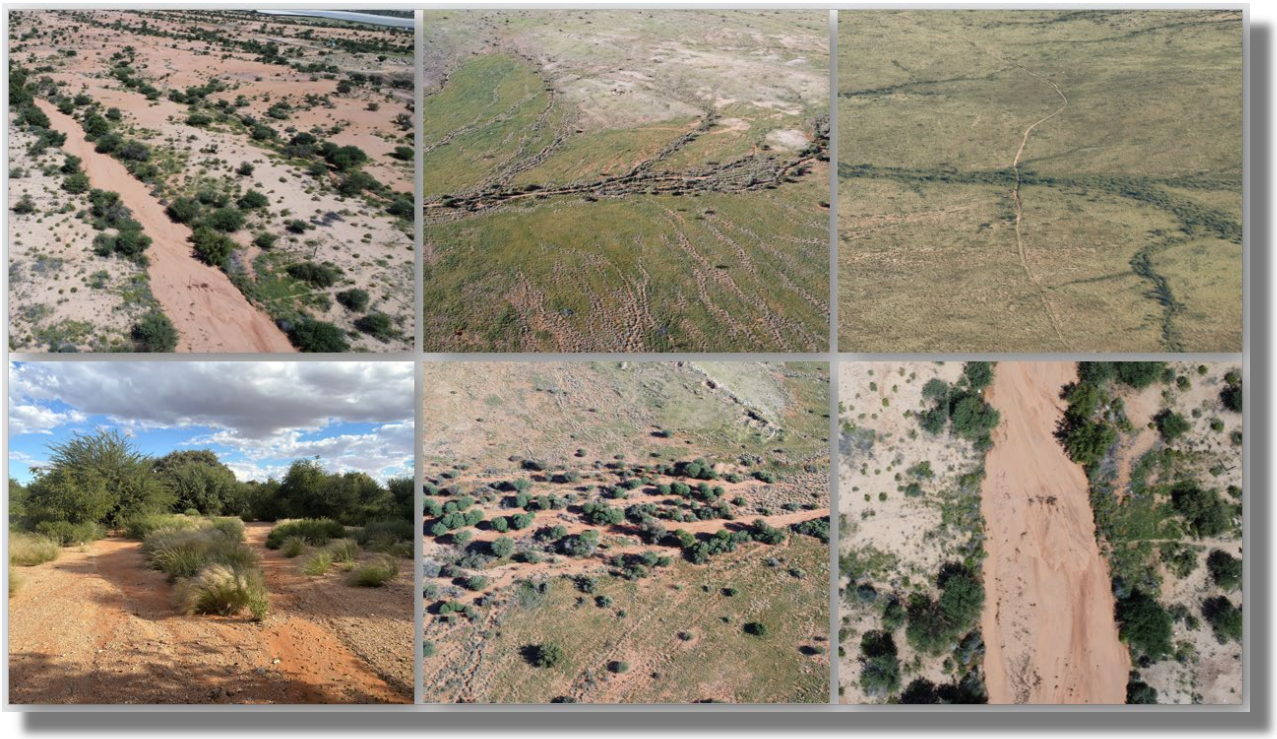


Figure 6-10: Site condition typical for Class 2 system.

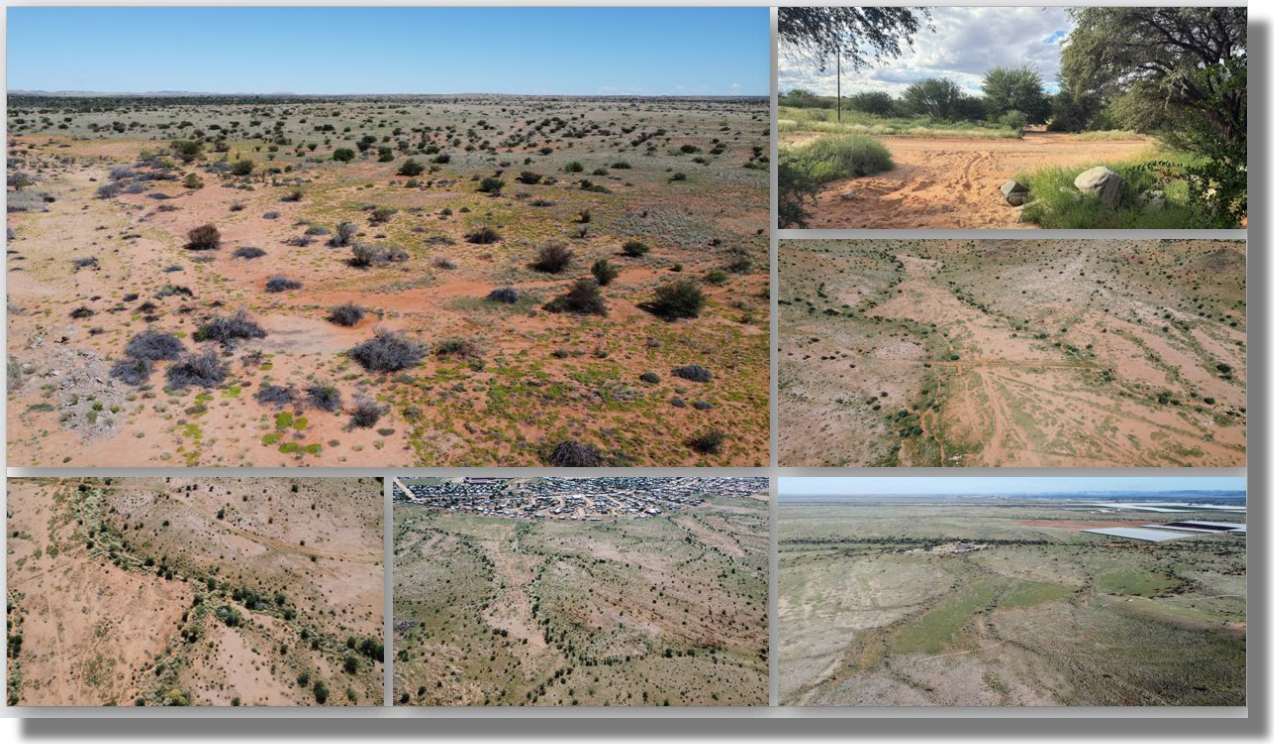


Figure 6-11: Site condition typical for Class 1 system.

6.6 Abstraction Site

For this project it is proposed to abstract 10.5 ML/day (0.12 m³/s) from the Lower Orange River and this is considered a **low-impact volume** within the current water use in the system. The Lower Orange River features strong baseline flows as water is released from numerous impoundments to support the economic activities. The localised consequences for water quality and river habitats are considered low for a single-entry point for the abstraction site. Changes and impacts are highly manageable but that implies that the abstraction and site is properly regulated, monitored and maintained.

6.6.1 Water Quantity and Flow

- **Flow Volume:** The proposed abstraction daily volume (10.5ML/day - 0.12m³/s) is negligible compared to the river's natural and regulated flow regime, which frequently runs into hundreds of cubic meters per second *(average flow of 365m³/s)*.
- **Ecological Reserve:** The proposed abstraction volume has a minimal impact on the river's required ecological flow. It is important that it must still be factored into the Department of Water and Sanitation allocation planning through the appropriate application and licencing procedures.

6.6.2 Water Quality

- **Dilution and Salinity:** In general, the abstraction of raw water will not alter the chemical composition of the river, but in the arid region where salinity and high pH are existing concerns. The removal of fresh water can mathematically concentrate the remaining dissolved salts, but with the small volume extracted and high flow velocities, this is a negligible concern.
- **Return Flows:** When evaluating the primary long-term impact on water quality, the return flows is the main concern. As the water will be used for drinking water and agricultural irrigation it is assumed that a large percentage can re-enter the river (return flows). Untreated urban wastewater and agricultural return flows can introduce high levels of nitrates and phosphates, elevating the risk of eutrophication and toxic algal blooms downstream. It is recommended that the WWTW must ultra filter water before returning it to the source or reuse it for drinking water.
- **Education**: The municipality must sensitise all water user of water scarcity, reduced water uses and pollution. The agricultural community must be alerted on products used and how this impact on the environment.

6.6.3 Habitat and Ecology

- **Fish and Macroinvertebrates:** When evaluating the impacts at the abstraction point and lower in the river, the 0.12m³/s is a fractional percentage of total flow. It will therefore not significantly lower water levels or alter critical habitats i.e. riffles and pools downstream of the site.
- **Screening Measures:** On site there is a risk to local aquatic life i.e. *entrainment* where the smaller fish, larvae, eggs and macroinvertebrates are drawn into the intake pipe. For the larger fish, *impingement* i.e. trapping against the intake screen is a risk. These risks can be easily mitigated by using well-designed, low-velocity intake screens and ensure the intake area is large enough to lower loss of biota.

6.7 Ephemeral Stream Crossings

When evaluating potential impacts for the distribution system, the focus is on the numerous crossings across the ephemeral streams. A single pipeline in an ephemeral stream in the Lower Orange River catchment can be assessed as generally having a **low to moderate, localised impact**. It is important that construction occurs during the dry season and proper rehabilitation is enforced. The arid region drainage lines are mostly dry with the immediate impacts related to physical habitat alteration and limited continuous water pollution.

In addition, it will be important to limit impacts outside the pipeline corridor. Travelling must be restricted to existing roads and construction camps, and storage areas must be on existing modified sites. On site litter and toilet facilities are important to manage. All oils and fuel spills must be immediately reported and rehabilitated (EMPr protocols).

- **Habitat Alteration:** The trenching and earthworks on site will remove stabilising riparian vegetation (e.g. *Vachellia karoo*) at sites where present. At the disturbed areas there will be an alteration of the natural sediment regime which will increase vulnerability to wind and flash-flood erosion.
- **Water Quality:** In the event of sustained rainfall on site or in the catchment there will be temporary spikes in Total Suspended Solids (TSS) and turbidity. Most of the material in suspension will be from the catchment, but a very small percentage will be from the loose sediment in the reinstated trench. Hydrocarbon and chemical spills from the construction machinery will further degrade water quality (if not adequately rehabilitated).
- **Biodiversity and Flow:** The ephemeral systems associated with the upper catchments of the area do not host permanent aquatic biodiversity (i.e. macroinvertebrates and fish). When sufficient flows are present the channels will be temporary corridors for movement and seasonal

breeding habitats for opportunistic fauna. Poorly installed infrastructure will disrupt surface flows and trigger erosion in the stream channels.

6.7.1 Regulatory and Mitigation Requirements

The proposed developments for the water infrastructure for this project (linear infrastructure) trigger water use authorisations under Section 21 (c) and (i) under the National Water Act (Act 36 of 1998). In this project the competent authorities can mandate the following to minimise ecological damage:

- **Trenching and Backfilling:** The excavated trench must be properly compacted and profiled to match the original bed elevation to prevent scouring or damming.
- **Riparian Management:** Topsoil and indigenous vegetation (e.g. *Diospyros* or *Pteronia* species) must be carefully stockpiled (to retain seed bank), replanted or naturally reseeded.
- **Erosion Control:** Gabions or reno mattresses are often needed to stabilise stream banks to ensure the pipeline is not exposed during intense flash floods.
- **Monitoring and Rehabilitation:** It will be important to monitor all stream crossings after rain events. Monitoring must be done for at least the first 3 years to ensure the soil scars will be stabilised. After that, monitoring every 5 years must be carried out. Any erosion noted must be immediately rehabilitated and photographic evidence must be kept.

6.8 Habitat Indicators – Habitat Assessment

Habitat quality and availability play a critical role in the occurrence of aquatic biota. The habitat quality is further important when assessing the stream or river integrity. This is particularly important in this project, as permanent habitat for biota is only present in the Orange River. The fact that most of the water resources are devoid of biota (i.e. macroinvertebrates and fish) doesn't negate the importance of the habitat quality and integrity. The Index of Habitat Integrity (IHI) is still a measure of system health and aspects such as erosion, pollution and alien vegetation encroachment must be tracked in management and protection of arid ecosystems.

Integrated habitat assessments are vital in arid, ephemeral rivers because they evaluate complex, shifting connections between surface flows, subsurface groundwater and riparian vegetation. A holistic review of the catchment guides sustainable water management, protect drought-tolerant biodiversity and preserve crucial ecological services for surrounding environments. As noted, the wash sheets and ephemeral riverbeds flow briefly after rainfall and despite being dry most of the year, these ecosystems still require comprehensive habitat assessments due to several key factors:

- **Ecohydrological Connectivity**
  - **Subsurface dependence:** In arid landscapes, riparian trees i.e. *Vachellia erioloba* or *Faidherbia albida* found in Southern Africa, rely entirely on deep groundwater and shallow soil moisture recharged by episodic floods.
  - **Nutrient transport:** During the episodic flows critical organic matter, sediments and nutrients are transported along the catchment systems, and this reiterate the importance of continuous-flow monitoring essential to the overall health of the catchment.
- **Preserving Drought Refugia**
  - **Vital oases:** Even without surface flow, isolated pools and damp riverbeds function as critical refugia for endemic aquatic and terrestrial wildlife.
  - **Biodiversity corridors:** Flora and fauna abundance in these river corridors is disproportionately higher than in the surrounding, harsh uplands, making these habitats vital migration corridors.
- **Sustainable Water Governance**
  - **Groundwater abstraction:** In this arid region, many municipalities and agricultural operations tap directly into the aquifers beneath ephemeral rivers.
    - Integrated assessments help ensure that water extraction limits do not drop below the thresholds required to sustain deep-rooted riparian vegetation.

Early warning systems: the highly sensitive nature of the vegetation structure serve as early-warning to changes in subsurface moisture and holistic ecological model indicators for declining environmental conditions.

6.8.1 Index of Habitat Integrity (IHI) – Instream and riparian

The primary aim of the Index of Habitat Integrity (IHI) for this project is to assess and quantify the ecological health and structural condition of the instream and riparian zones. The goal is to evaluate if anthropogenic factors e.g. water abstraction, flow regulation and land modification have degraded the system relative to its natural reference state.

Assessment Objectives

- **Impact Evaluation:** This component identifies and rates major disturbance factors that will affect the instream and riparian habitats.
- **Ecological Health Determination:** The process at its conclusion assigns a habitat integrity category (ranging from A for natural to F for critically modified) to establish the Present Ecological State (PES).
- **Resource Protection:** The process during the preconstruction phase will provide critical baseline information that must be aligned to the ecological water requirements (the "Reserve") mandated

by South Africa's National Water Act. The long-term monitoring will measure if changes occur over time and if it is related to the impacts from the construction of the water distribution network.

Focus for Ephemeral and Seasonal Streams

The ephemeral and seasonal streams are included. These systems in the Lower Orange River catchment rely on irregular and episodic flow events rather than permanent water. Therefore, the IHI aims to protect these unique systems by measuring:

- **Connectivity Modifications:** This metric determines how the physical barriers e.g. roads, mining infrastructure or impoundments disrupt the natural flow of water and sediment downstream.
- **Channel and Bed Modification:** This is a critical metric to understand the extent to which the physical structure of the riverbed or active channel has been altered by excavation, erosion, trampling and sedimentation.
- **Riparian Zone Health:** The aim is to determine the current condition of the vegetation fringing the watercourse, specifically measuring how the removal of indigenous trees/shrubs and the encroachment of invasive alien species impact on the ecosystem.
- **Hydrological Alterations:** Identify changes to the natural frequency and duration of no-flow periods and episodic flood events.

It is important to note that the catchment impacts must be reflected when evaluating the **Index of Habitat Integrity (IHI)** for ephemeral and seasonal streams (at site level). The **South African River EcoClassification guidelines** reiterate the importance of catchment assessments, as the habitat integrity is fundamentally determined by anthropogenic modifications acting on a reach and its broader catchment.

These include:

- **Hydrological Connectivity:** The ephemeral and seasonal streams are dry for most of the year, but are still the primary conveyers of water, sediment and materials to the main stem of the Orange River. Catchment-scale impacts, such as alien invasive encroachment, will directly alter these natural drivers.
- **Metric Requirements:** The IHI models for both instream and riparian systems explicitly evaluate metrics such as *flow modification* and *physico-chemical modifications*. These cannot be accurately assessed without considering upstream or catchment-wide land-use practices.
    - For this project, the metrics will not be severely modified where a pipe is buried across the stream channel, but if erosion result at a site, this will impact the system.
- **Cumulative Effects:** Land uses such as overgrazing, mining, agricultural abstractions and the construction of small farm impoundments in the upper catchment drastically affect bank stability and downstream sediment loads, which must be reflected in the final IHI scores.

For the project, a rapid assessment of the habitat associated with the project area was conducted. This included a drive through the project area and more detailed visits to selected crossings of streams where the proposed waterlines will cross the water resources. The IHI assessment is just an overall summary for the different resource classes as defined for the project i.e. Class 1 to Class 5 (Table 6-7). The survey data and observations at the crossing points were used with the desktop assessment of the catchments of the main tributaries associated with the project area i.e. the Hartbees, Slang and Brabees rivers. These systems originate to the south of the project area and drain into the lower Orange River at Kakamas and Augrabies.

All these tributaries are ephemeral systems that cover vast catchment in the arid landscape of the Northern Cape. The impacts reflected in the IHI assessment include the site evaluations and the desktop reviews. The parameters are therefore a combined score reflected in the spreadsheet. For the Hartbees River (Table 6-12).

Table 6-12: Index Habitat Integrity Assessment of the water resources in the project area.

System	Index of Habitat Integrity Summary	Classification and primary drivers
Include the sites (crossings) in the project area and the sub quaternary catchment associated with the project.	**Orange River**	**Instream:** Class D – water abstraction, flow modification, streambed modification, water quality
		Riparian: Class C – Alien vegetation (mainly *Prosopis glandulosa*)
	Hartbees River	**Instream:** Class D – water abstraction, flow modification, streambed modification, water quality, alien vegetation
		Riparian: Class D - vegetation removal, exotic vegetation (mainly *Prosopis glandulosa*), bank erosion, channel modification, water abstraction
	Slang River	**Instream:** Class C – water abstraction, flow modification, streambed modification, water quality, alien vegetation
		Riparian: Class C - vegetation removal, exotic vegetation (mainly *Prosopis glandulosa*), bank erosion, channel modification, water abstraction
	Brabees River	**Instream:** Class C – water abstraction, flow modification, streambed modification, water quality, alien vegetation
		Riparian: Class C - vegetation removal, exotic vegetation (mainly *Prosopis glandulosa*), bank erosion, channel modification, water abstraction

Based on the baseline IHI the results for the systems indicate varied impacts that threaten the ecosystem. The arid environment means that the low rainfall limit flow in the streams and rivers and where vegetation is modified, recovery or indigenous plants are poor. In the catchments associated with the project area that include the Hartbees, Slang and Brabees rivers the negative impact of *Prosopis glandulosa* is expanding. This alien tree is replacing natural vegetation in many areas and dense encroachment of river

channels are a concern. The result of the dense alien vegetation stands is loss of water as these plants consume more water than the indigenous plants. The loss of water means that subsurface flows in the ephemeral tributaries are dwindling with the result of loss of *Vachellia erioloba* and *Faidherbia albida* that are endemic to the region.

The loss of subsurface water further impact on the terrestrial and aquatic fauna that rely of the resources as drinking water. The larger ephemeral streams also loose the grasses, forbs and shrubs which are critical resource for the fauna that use these watercourses as migration corridors. Many farmers rely of the groundwater to sustain the farms and is an important source of drinking water to humans and cattle.

6.9 Department of Water and Sanitation (DWS) Risk Assessment

The risk assessment presented in this section was undertaken in accordance with the methodology prescribed by the Department of Water and Sanitation (DWS) for evaluating potential impacts on water resources, as required under the National Water Act (Act 36 of 1998) and associated guidelines for Water Use Licence Applications (WULAs). This approach provides a structured, defensible basis for determining the significance of identified impacts on aquatic ecosystems, both prior to and after the implementation of mitigation measures.

It should be noted that the risk ratings presented below are based on the findings of the aquatic ecosystem assessment, read together with the nature and scale of the proposed development. The results should be interpreted within the context of the receiving environment's sensitivity and the cumulative pressures already acting upon it.

As noted in **Section 6.3.4**, there will be risks (stream and river crossings) during the preconstruction, construction and operational phases of the proposed project. This will be related to the clearing of vegetation (where needed) and the corridor where the pipelines will be installed. Most of the impacts will be related to the installation phase with limited impacts during the operational phase.

Erosion and the related water quality impacts and the most noticeable concerns during the project. Erosion will be related to rain events where exposed or modified soils can be affected. This can result in turbidity and inputs of nutrients and salts from the disturbed soils. This will result in limited impacts on the system, as the activity site is very small related to the river catchment. Other additional concern will be related to chemical, oil and fuel spill during the preconstruction and construction phases. The impacts from a site can be regarded as negligible, but it will contribute to the cumulative impacts on the river system (negligible). This doesn’t negate stringent monitoring and rehabilitation on each site.

From the Risk Assessments conducted, the risk for the different stream classes evaluated (Class 3 – Class 5) were **low**, but that is only relevant if the management, mitigation and rehabilitation measures are enforced. Refer to **Section 6.3.4** and **Table 6-11**.

6.10 Site Sensitivity Verification Statement for the Aquatic Biodiversity Theme

The Screening Tool Report (STR) related to the Aquatic Biodiversity Theme (Section 6.2) show that the resources in the study area are rated with a **very high sensitivity**. This includes the abstraction point in the Orange River and the pipeline crossings of the Hartbees, the Slang and the Brabees rivers.

The STR protocol requires a review of the environment to confirm or dispute the rating. To comply to the regulations a specialist impact assessment was conducted to evaluate the aquatic ecosystem integrity. The ephemeral and seasonal systems are fragile alluvial and riparian ecological systems that function as critical ecological corridors in the arid environment. In these stochastic stream systems, the dynamic flood scouring, sediment transportation and bank erosion may directly threaten their linear infrastructure integrity.

After the review of the study area, it is recommended that the **very high sensitivity rating for the aquatic biodiversity** theme, as reflected in the STR **is maintained.** This recommendation is based on the assessment during the site visit and desktop review that indicated that current and historic activities have a negative impact on the ecosystem. The pressure on the water resources and the receiving environment need to sensitise developers, regulators and society of the fragility of the arid environments. Cumulative downstream risks related to the trenching activities during pipeline construction will be low (negligible), if all recommendations and mitigation strategies are rigorously employed.

6.11 Impact Assessment

The assessment was informed by the findings of the desktop assessment and observations recorded during the field survey. Potential impacts were considered in terms of their nature, extent, duration, magnitude, reversibility and probability, while taking into consideration the effect of potential impacts on aquatic habitat, water quality, ecological functioning, and associated aquatic biodiversity. Only the main river systems were assessed in detail due to the extent of the project. These rivers included the Orange, Hartbees, Brabees and Slang River. The assessment was conducted for both the pre-mitigation and post-mitigation scenarios. The pre-mitigation assessment reflects the anticipated significance of impacts in the absence of mitigation, while the post-mitigation assessment considers the expected reduction in impact significance.

6.11.1 Current Impacts

As part of the impact assessment, the current impacts for the rivers were assessed for better understanding and interpretation of the potential anticipated impacts. The main current impacts are listed below:

- Orange River
    - Agricultural Activities (irrigation).
    - Urbanisation (Kakamas)
    - Roads and road crossings.
    - Weir.
    - Instream impoundment.
- Hartbees River
    - Agricultural Activities (livestock, irrigation).
    - Roads and road crossings.
- Brabees River
    - Agricultural Activities (livestock, irrigation).
    - Roads and road crossings.
- Slang River
    - Agricultural Activities (livestock, irrigation).
    - Roads and road crossings.

6.11.2 Quantitative Impact Assessment

Table 6-13 illustrates the quantitative impact assessment and significance ratings associated with the project. The potential direct and indirect impacts are expected to threaten the integrity of the local aquatic ecology during the project activities if unmitigated. The post-mitigation significance ratings have been calculated considering various parameters for watercourses. According to the impact assessment some impacts are expected to have a moderate impact and can be change to low if all mitigation measures are adhered to.

Table 6-13: Quantitative Impact Assessment ratings

River System	Orange		
Phase	**Pre-Construction**		
Impact	**Mitigation**	**Significance**	
Loss of natural vegetation due to vegetation clearing, potentially resulting in siltation, erosion and solid waste.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Riverbank Stabilisation through the installation of geotextiles.	**Pre-Mitigation**	21	Low
	Post-Mitigation	10	Low
Phase	**Construction**		
Impact	**Mitigation**	**Significance**	
Construction of anchor point pump station potentially resulting in increased erosion, accidental spills, water quality impairment, altering of hydro-dynamics and loss of natural biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Installation of floating pump.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Phase	**Operational**		
Impact	**Mitigation**	**Significance**	
Potentially increased erosion and subsequent water quality impairment.	**Pre-Mitigation**	33	Medium
	Post-Mitigation	16	Low
River System	**Hartbees**		
Phase	**Pre-Construction**		
Impact	**Mitigation**	**Significance**	
Loss of natural vegetation due to vegetation clearing, potentially resulting in siltation, erosion and solid waste.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Phase	**Construction**		
Impact	**Mitigation**	**Significance**	
Digging of trench potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Installation potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Backfilling potentially altering the hydro-dynamics, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Rehabilitation.	**Pre-Mitigation**	4	Low
	Post-Mitigation	4	Low

Phase	Operational		
Impact	**Mitigation**	**Significance**	
Potentially increased erosion and subsequent water quality impairment.	**Pre-Mitigation**	33	Medium
	Post-Mitigation	16	Low
River System	**Brabees**		
Phase	**Pre-Construction**		
Impact	**Mitigation**	**Significance**	
Loss of natural vegetation due to vegetation clearing, potentially resulting in siltation, erosion and solid waste.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Phase	**Construction**		
Impact	**Mitigation**	**Significance**	
Digging of trench potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Installation potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Backfilling potentially altering the hydro-dynamics, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Rehabilitation.	**Pre-Mitigation**	4	Low
	Post-Mitigation	4	Low
Phase	**Operational**		
Impact	**Mitigation**	**Significance**	
Potentially increased erosion and subsequent water quality impairment.	**Pre-Mitigation**	33	Medium
	Post-Mitigation	16	Low
River System	**Ephemeral and Slang**		
Phase	**Pre-Construction**		
Impact	**Mitigation**	**Significance**	
Loss of natural vegetation due to vegetation clearing, potentially resulting in siltation, erosion and solid waste.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Phase	**Construction**		
Impact	**Mitigation**	**Significance**	
Digging of trench potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Installation potentially resulting in siltation, erosion, solid waste, oil and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Pre-Mitigation**	40	Medium
	Post-Mitigation	21	Low
Backfilling potentially altering the hydro-dynamics, oil	**Pre-Mitigation**	40	Medium

and fuel spills and subsequently causing water quality impairment and loss of aquatic biota.	**Post-Mitigation**	21	Low
Rehabilitation.	**Pre-Mitigation**	4	Low
	Post-Mitigation	4	Low
Phase	**Operational**		
Impact	**Mitigation**	**Significance**	
Potentially increased erosion and subsequent water quality impairment.	**Pre-Mitigation**	33	Medium
	Post-Mitigation	16	Low

The potential impacts associated with the pre-construction, construction and operational phases of the proposed project are anticipated to result in moderate pre-mitigation impacts on the freshwater ecosystems. With the implementation of appropriate and effective mitigation measures, these impacts are expected to be reduced to low post-mitigation significance. This reduction in impact significance will be dependent on the effective implementation and ongoing maintenance of measures relating to erosion and sediment control; the appropriate handling, use and storage of hazardous substances and chemicals; rehabilitation of disturbed areas; and the prevention of contaminated or otherwise detrimental runoff from hardened surfaces entering the watercourses. Furthermore, unauthorised access and operation of heavy vehicles within delineated watercourses and their associated buffer areas should be strictly prohibited.

7. REASONED OPINION AND RECOMMENDATIONS

7.1 Reasoned Opinion

The drainage lines, depending on their size and functionality, was be divided into 5 classes (Table 4-1). This method assisted in the quantification and qualification of the resources in grouped format to assist with a more palatable and reasonable assessment format.

For this study, the streams in Classes 1, 2 and 3 were recorded and the coordinate at the proposed crossing point for each site added to the data base (Appendix B). For the report, only the number of crossings for each class was reflected in the results section. For the streams in Class 4 and 5, more detail regarding the stream width, and marginal vegetation was recorded. The existing and potential impacts related to the project activities was recorded at each crossing site. The information related to impacts was used to guide the mitigation, rehabilitation and monitoring strategies that will be reflected in the EMPr.

The resources in Class 3, 4 and 5 will be included in the WULA, as these streams are more susceptible to significant project-related impacts. However, provided that the recommended mitigation measures and management strategies are implemented effectively and throughout the project lifecycle, potential negative impacts are anticipated to be reduced to small or negligible levels.

7.2 Recommendations

To maintain the very high sensitive habitat at linear pipeline crossings along arid ephemeral streams and seasonal rivers requires targeted trenchless construction methods, rigorous erosion control and continuous hydrological surveillance.

7.2.1 Construction and Engineering Mitigation

- It is recommended to use trenchless crossings. The horizontal directional drilling (HDD) or micro-tunnelling to pass beneath the bed and banks of seasonal watercourses will avoid surface disturbance of sensitive riparian zones.
- It is important to minimise the footprint near the sensitive areas. It is critical to only use the approved corridor width when working in the streambed and streambanks. Restrict all laydown areas, vehicle staging and fuel storage to areas outside the riparian boundary of any ephemeral wash or riverbed. It is recommended that existing construction yards are used for the project.
- The use of rock-pack gabions instead of hard concrete liners to protect stream banks and channels is recommended. The gabions reduce flow velocity and movement of water through the structure which reduces erosion downstream.

  - Only clear areas where construction will take place. This will lower the risk of erosion (wind and water) in exposed areas where no work is taking place.
  - Areas must be rehabilitated immediately after the installation of the pipeline is completed.
  - If large areas are exposed, geotextiles can be used to stabilise soils – prevent wind and water erosion.
- Construction (trenches) must be limited to the dry, winter months. On larger crossings the use of temporary diversions with flow velocity dissipaters to manage any unexpected flow must be employed. It will be important to have effective sediment screens to ensure no impacts downstream of the site.

7.2.2 Ecological and Rehabilitation Protocols

- It is critical that the top 30 cm of biologically active alluvial soil (topsoil) is stripped and stockpiled. Once activities are completed, the topsoil must be backfilled immediately to preserve local seed banks and soil bacteria.
- In addition, alien vegetation eradication must be cleared within the working corridor. It is important to implement a 24-month follow-up weed control program after completion of the work at a site.
- After completion of the work, micro-topography restoration is critical and re-contour of the ephemeral stream bed and banks must match the pre-construction cross-sections to avoid the diversion of water that can impact on the natural flood scouring patterns, especially the stream banks.

7.2.3 Monitoring and Surveillance Strategies

- Pre- and post-rainfall inspections must be carried out by the Environmental Control Officer (ECO) to evaluate changes at all crossings before forecasted summer thunderstorms and immediately after initial seasonal flow events. All impacts must be recorded and rehabilitated immediately.
- As an additional monitoring option, erosion and scour tracking can be done with ground-level photo monitoring points at crossing points to detect bed lowering or lateral bank erosion.
- It is recommended to do two-year (annually after completion) integrity audits. The ecologist can assess the crossing points and advise the client on the effective maintenance of the impacted areas.

7.3 Assessment of Alternatives

All available routes were assessed during the survey.

A key focus and detailed surveys on:

- Augrabies Main Supply Line

- Augrabies Supply Line
- Marchant Supply Line
- Alheit Supply Line
- Schroder Supply Line
- Kakamas New Extension Supply Line
- Kakamas Reservoir Supply Line
- Kliprand Branch Line
- Kakamas East Line
- Lutsburg Supply Line
- WTP Supply Line

Less intensive surveys:

- Truter Road (West)
- Truter Road (East)
- Langverwag Reservoir Line
- Augrabies Alternative Line

7.4 Mitigation and Monitoring Requirements

The recommended mitigation measures are presented in Appendix C of this document.

8. CONCLUSION

PRISM Environmental Management Services (PRISM EMS) was appointed by EnviroAfrica (EAP) on behalf of Kai !Garib Municipality (the Applicant), to undertake a baseline aquatic resources assessment for the upgrade and related construction of the proposed Kakamas Bulk Water Supply Project.

The network will supply potable water to Kakamas, five (5) other villages and several commercial farmers. Currently the network supple water to approximately 10 000 people, but the expansion needs to include approximately 46 000 people. This means that the daily demand will be 94l/s with a peak summer demand of 149.1l/s. The distribution network will service 7 795 households (719 economic units and 7 076 subeconomic units) and 4 000 learners at a number of schools.

The study area falls within the D73F, the D53J and the D81A sub-quaternary catchments and the sub-quaternary catchments serve as a vital hydrological reporting and water management units used in understanding its characteristics as this information is critical to inform local environmental planning.

The DWS uses key ecological assessment metrics to classify and protect water resources (rivers, wetlands and estuaries) and this is referred to as the **Present Ecological State** (**PES)** and the **Ecological Importance and Sensitivity (EIS)**. PES evaluates the *current health* or condition of a water resource and measures how much the ecosystem has deviated from its original, natural state. The EIS is a measure of the *importance* of the ecosystem in maintaining biodiversity and its *sensitivity* to environmental changes or flow modifications. The sub-quaternary catchment (D73F) is associated with Kakamas (abstraction point for the new project) with the Hartbees River (D53J) and the Slang and Brabees (D81A) the important tributaries downstream of Kakamas. The PES for the four rivers are in a **Class D** with the EI rated as a **Moderate** and the ES rated as **High**. ***These categories are still relevant for the current study.***

This report focusses on the Aquatic Assessment conducted on 13 to 15 April 2026. (wet season survey). The assessment was conducted to inform the Environmental Authorisation (EA) application and Environmental Impact Assessment (EIA) process as well as the Water Use License Application (WULA) for the proposed Kakamas Bulk Water Supply Project.

For this study, the streams in Classes 1, 2 and 3 were recorded and the coordinate at the proposed crossing point for each site added to the data base. For the report, only the number of crossings for each class is reflected in the results section. The recommendation is to group the Class 1 and Class 2 stream systems, comprising sheetwash systems and small ephemeral drainage features. The presence of these systems within the landscape reflects a broad and extensive drainage network across relatively flat

terrain, where it is often difficult to clearly define discrete flow channels. Instead, these areas function as expansive zones where runoff accumulates, disperses, and dissipates during rainfall events.

Given their diffuse nature and extensive spatial distribution, it is not practical to accurately capture each individual system within the GA application, as mapping every feature is neither feasible nor meaningful at the required scale. This does not, however, diminish the importance of monitoring, management, and rehabilitation within these areas.

Each corridor that forms part of the proposed drainage distribution network contributes to the functioning of a sensitive ecosystem. Historical and current land-use activities have altered the natural landscape, highlighting the need for proactive environmental management. Every reasonable measure should therefore be implemented to prevent additional negative impacts on the receiving environment. Particular attention should be given to avoiding further habitat modification, loss of indigenous vegetation, proliferation of alien invasive species, and deterioration of water quality. Maintaining the ecological integrity of these drainage corridors is essential for supporting ecosystem function and resilience within the broader landscape.

For the streams in Class 4 and 5, more detail regarding the stream width and marginal vegetation was recorded. The existing and potential impacts related to the project activities was recorded at each crossing site and is used to guide the mitigation, rehabilitation and monitoring strategies that will be reflected in the EMPr.

Detail photographic and coordinate records was recorded and will be on record for any post processing requirements. Relevant and the most appropriate photographs was included in the main report for ease of reference and to illustrate the different types of systems and impacts present.

From an aquatic ecological perspective, the proposed project is supported, provided that all recommended mitigation measures, management interventions, and monitoring requirements are implemented throughout the project lifecycle. The receiving environment comprises a network of sheetwash areas, ephemeral drainage features, and low-order stream systems that collectively contribute to hydrological connectivity, sediment transport, water quality regulation, and the provision of habitat for aquatic and semi-aquatic biota.

Although temporary disturbances to the aquatic environment are anticipated during construction and implementation activities, these impacts are expected to be limited in extent and duration if best-practice environmental management measures are effectively applied. Potential risks include increased sedimentation, localised erosion, vegetation disturbance, alteration of surface water flow patterns, and

deterioration of water quality. However, with appropriate planning, construction controls, rehabilitation, and ongoing environmental oversight, these impacts can be minimised to negligible or low significance levels.

Provided that all environmental protocols, mitigation measures, and specialist recommendations are strictly adhered to, the project is unlikely to result in significant long-term adverse effects on aquatic ecological integrity. Consequently, the development is considered acceptable from an aquatic ecological perspective, subject to the implementation of the recommended environmental management and monitoring requirements.

Refer to Appendix C for detailed mitigation and monitoring recommendations.

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APPENDIX A – SPECIALIST QUALIFICATIONS

Table A1: Specialists consulted for this Aquatic Assessment and their qualifications

ASPECT INVESTIGATED	SPECIALIST	QUALIFICATION	DATE
Field Survey	D. Botha (Aquatic and Wetland Specialist) Pr. Sci. Nat. (119979) Reg. EAP (2019/1209)	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma Wetland and Riparian Delineation (*DWAF Accredited Short Course*) Soil Classification and Wetland Delineation - Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University (Cum Laude)* SASS5 Aquatic Biomonitoring Training – *Department of Water Affairs, Ground Truth* Wetland Plant Taxonomy – *Water Research Commission* Hydropedology and Wetland Functioning (*Water Business Academy / Terra Soil Science*) Wetland Legislation | Law application in wetland management – WetRest Centre for Wetland Research and Training Hydropedology and Wetlands Course – WetRest Centre for Wetland Research and Training | *Digital Soils Africa (DSA))*	April 2026
Report Compilation Mapping			May / June 2026 July / August 2026
Report co-author, Peer review.	Dr. W. Vlok (Aquatic Specialist) Pr. Sci. Nat. (400109/95)	M. Sust. Agri (2003) PhD (Zoology) (1992) M.Sc. (1986) B.Sc. (Hons) (1985) B.Sc. (1984)	May / June 2026 July / August 2026
Report co-author, Peer review.	G. Bouwer (Aquatic Specialist) Pr. Sci. Nat. (157017)	M.Sc. Environmental Science BSc Hons. Ecological Remediation and Sustainable Development B.Sc. Biological Sciences SASS5 Accredited Practitioner (DWS and WRC) SACNASP 157017 (Aquatic Science)	May / June 2026
Peer review.	C de Beer (Aquatic Specialist) Cand. Sci. Nat. (168416)	M.Sc. Environmental Management with Ecological Water Requirements BSc Hons. Env. Sci. Aquatic Ecosystem Health B.Sc. Biological Sciences SASS5 Accredited Practitioner (DWS and WRC) SACNASP 168416 (Aquatic Science)	August 2026

APPENDIX B – Crossing Data

Class	ID	Longitude	Latitude
Class 5	Orange River	20.62134197	-28.75314620
Class 4	Hartbees River (A)	20.53791592	-28.76058074
Class 4	Brabees Rivier	20.38135706	-28.66134627
Class 4	Hartbees River (B) - Wetland	20.53791592	-28.76058074
Class 3	1	20.30212235	-28.62726729
Class 3	2	20.35146511	-28.64237722
Class 3	3	20.35370174	-28.64531291
Class 3	4	20.36233068	-28.64912689
Class 3	5	20.47306343	-28.70359214
Class 3	6	20.58565842	-28.76201543
Class 3	7	20.57821185	-28.73937779
Class 3	8	20.56545807	-28.73697563
Class 3	9	20.50205004	-28.72422778
Class 3	Slang Rivier (3)	20.48877928	-28.72924124
Class 2	1	20.35494001	-28.64461540
Class 2	2	20.35788571	-28.64743741
Class 2	3	20.37007416	-28.65260103
Class 2	4	20.37243727	-28.65345253
Class 2	5	20.37668724	-28.65515497
Class 2	6	20.38241829	-28.65740703
Class 2	7	20.38907737	-28.66001820
Class 2	8	20.41344683	-28.67060863
Class 2	9	20.41954642	-28.67320841
Class 2	10	20.42518158	-28.67674581
Class 2	11	20.43087775	-28.68054284
Class 2	12	20.45141440	-28.69148776
Class 2	13	20.46714542	-28.69983199
Class 2	14	20.47209561	-28.70144837
Class 2	15	20.48236805	-28.70698612
Class 2	16	20.48684836	-28.70896594
Class 2	17	20.48684836	-28.70896594
Class 2	18	20.49483506	-28.71653841
Class 2	20	20.51206334	-28.73643080
Class 2	21	20.51804523	-28.74286739
Class 2	22	20.51804523	-28.74286739
Class 2	23?	20.52630029	-28.75019388
Class 2	24?	20.49962430	-28.77709442
Class 2	25	20.56289385	-28.75884917
Class 2	26	20.57402012	-28.76026498
Class 2	27	20.59718551	-28.76402521
Class 2	28	20.60446717	-28.76835379
Class 2	29	20.57687949	-28.74036214
Class 2	30	20.56317975	-28.73815670
Class 2	30	20.56317975	-28.73815670
Class 2	30	20.56317975	-28.73815670
Class 2	31	20.29224968	-28.65456957
Class 2	31	20.29224968	-28.65456957
Class 2	31	20.29224968	-28.65456957
Class 2	32	20.39571534	-28.69124959
Class 2	32	20.39571534	-28.69124959
Class 2	32	20.39571534	-28.69124959
Class 2	33	20.41448463	-28.69768635
Class 2	33	20.41448463	-28.69768635
Class 2	33	20.41448463	-28.69768635
Class 2	34	20.42255551	-28.70066730
Class 2	34	20.42255551	-28.70066730

Class	ID	Longitude	Latitude
Class 2	34	20.42255551	-28.70066730
Class 2	35	20.42766333	-28.70213266
Class 2	35	20.42766333	-28.70213266
Class 2	35	20.42766333	-28.70213266
Class 2	36	20.43131039	-28.70305486
Class 2	36	20.43131039	-28.70305486
Class 2	36	20.43131039	-28.70305486
Class 2	37	20.43700253	-28.70525885
Class 2	37	20.43700253	-28.70525885
Class 2	37	20.43700253	-28.70525885
Class 2	38	20.44572471	-28.70866965
Class 2	38	20.44572471	-28.70866965
Class 2	38	20.44572471	-28.70866965
Class 2	39	20.45488724	-28.71337371
Class 2	39	20.45488724	-28.71337371
Class 2	39	20.45488724	-28.71337371
Class 2	40	20.46305543	-28.71762478
Class 2	40	20.46305543	-28.71762478
Class 2	40	20.46305543	-28.71762478
Class 2	41	20.46603841	-28.71925526
Class 2	41	20.46603841	-28.71925526
Class 2	41	20.46603841	-28.71925526
Class 2	42	20.46920491	-28.72080708
Class 2	42	20.46920491	-28.72080708
Class 2	42	20.46920491	-28.72080708
Class 2	43	20.47889798	-28.72790667
Class 2	43	20.47889798	-28.72790667
Class 2	43	20.47889798	-28.72790667
Class 2	44	20.48642246	-28.75427644

Class	ID	Longitude	Latitude
Class 2	44	20.48642246	-28.75427644
Class 2	44	20.48642246	-28.75427644
Class 2	45	20.49107286	-28.77054111
Class 2	45	20.49107286	-28.77054111
Class 2	45	20.49107286	-28.77054111
Class 2	46	20.49107286	-28.77054111
Class 2	46	20.49107286	-28.77054111
Class 2	46	20.49107286	-28.77054111
Class 1	1	20.31879637	-28.62958992
Class 1	2	20.32667740	-28.62477704
Class 1	3	20.33022281	-28.62201858
Class 1	4	20.34572783	-28.63443466
Class 1	5	20.34572783	-28.63443466
Class 1	6	20.35832324	-28.64783424
Class 1	7	20.35981694	-28.64852100
Class 1	8	20.36192061	-28.64950598
Class 1	9	20.37200226	-28.65368364
Class 1	10	20.37200226	-28.65368364
Class 1	11	20.37505280	-28.65454973
Class 1	12	20.37755522	-28.65596351
Class 1	13	20.37956552	-28.65691338
Class 1	14	20.38259236	-28.65765555
Class 1	15	20.38259236	-28.65765555
Class 1	16	20.38653500	-28.65899262
Class 1	17	20.38750937	-28.65915789
Class 1	18	20.38891663	-28.65965231
Class 1	19	20.40373296	-28.66664711
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APPENDIX C – MITIGATION MEASURES

The linear construction activities for this project will impact the integrity of the habitat between the various water resources and the riparian areas and watercourses of the numerous stream crossings. Activities within the watercourses and/or riparian areas is firstly governed and authorised by the competent authority with the best interests of the water resources at the forefront. Once the project is approved and the relevant authority is received, activities in/near the watercourse can commence.

Due to the extent of the project, control measures must be in place to prevent any construction and excavated material from entering the riparian areas and watercourses. Although the resources are dominated by ephemeral systems, the contractors must ensure that control measures are in place to prevent impacts on the natural resources. This includes bed and bank modifications, surface water pollution with contaminants e.g. hydrocarbons and lubricants from machinery and equipment, hazardous and general waste, sediments with bound contaminants and excavated soil and sand. Once an installation at a crossing in completed, the immediate rehabilitation of the riparian area and watercourse at that site must be done to lower the risk of any degradation to the environment (i.e. wind and water erosion). Implementing and managing the mitigation measures will reduce impacts to water quality and will mitigate the expected impacts on habitat.

10.1 Soil erosion prevention

To prevent wind erosion (main threat) and flow damage during rain events, progressive surface stabilisation and wind barriers is needed. At sites where runoff is expected, construct temporary berms or diversion channels to protect the active stream bed from heavy winds and direct runoff. The use of biodegradable erosion control blankets is recommended to protect against scouring caused by wind and water flows. Limit vegetation clearance and restrict clearance to the absolute minimum footprint required. The remaining rooted indigenous plants will hold the soil together against wind and flash floods.

Dry, loose soils are highly susceptible to wind erosion and dust storms. Progressive stabilisation. The application of temporary surface mulches (e.g. straw) that are crimped into the soil can be effective in areas with large exposed loose material. In addition, the use of eco-friendly, natural binding polymers onto stockpiles and disturbed surfaces and the roughing of the soil surface (tillage, chisel ploughing) will lower wind velocity and trap smaller moving particles. Shade cloth or fine-mesh netting is also effective to reduce wind speed across the site and keep airborne particles closer to the ground. Where needed, fine aggregate or soil stockpiles can be covered with industrial-grade tarps when not in use. By preventing airborne dust, the contractors ensure compliance with environmental regulations and local community health requirements.

- Soils and sands from excavation activities of the construction must be stockpiled away from drainage, and possible drainage areas.
- Stockpiling areas should be bermed (where applicable) to reduce soil and sand movement.
- Excavation activities should be limited to outside the riparian and/or riparian buffer areas, unless authorised by the necessary authorisation body, i.e.
- Northern Cape Department: Agriculture, Environmental Affairs, Rural Development and Land Reform (DAERL) and/or Department of Water and Sanitation (DWS).
- The ECO and staff should monitor and report any introduction of excavated soils and sediments into the aquatic resource.
    - These issues must be rectified immediately and measures put in place to prevent future transgressions.
- Erosion control measures to be implemented.
- The contractor is to ensure that should there be any excessive quantities of sand, silt and silt-laden water, it does not enter the storm water system.
- Soil and spoil must be stored outside the sensitivity buffer area.
- In order to prevent excessive sedimentation from occurring, it is critical that for any construction activities, for example, trench excavations that topsoil stockpiles are located at least 100 m away from the regulated area, i.e. the 1: 100 year floodline, or riparian habitat, whichever is the greatest.
- Excavated material is recommended to be placed on the upstream side of the trench. Should any excavated material be displaced during rainfall, it will flow back into the trench rather than towards the watercourse.

10.2 Chemical spillage prevention

- Changing of oil, servicing, repairs, refuelling and lubricating of equipment should only be carried out in the designated area as approved for the project.
    - Daily inspections of machinery for leaking oils must be done. If any leaks are observed found a drip trays must be placed under the machinery/vehicle, the incident must be reported and the leak fixed before use on the construction site.
- A specific area must be designated for the storage of hazardous chemicals such as fuel.
- Construction materials that are prone to spillage are to be stored in suitable containers with impermeable flooring to prevent pollution of the environment.
- Oil and fuel storage areas should be surrounded by a bund wall in order to contain spillages. In the case where soil becomes contaminated with oil, it must be removed for proper disposal or treatment (e.g. bioremediation).
    - Incidents to be reported, rehabilitated and monitored.

- Contaminated water needs to be isolated. Water with a chemical signature different to that of the receiving aquatic environment should be considered contaminated and should be isolated.
- It is recommended that during the construction activities the *in-situ* water quality variables be monitored in line with the GA Requirements (if applicable).
- Stock piling outside the wetland area, stormwater management, wet season construction, filtration.
- The ECO and staff should monitor and report any spillage into/near the aquatic resource.
- Stormwater and flood attenuation ponds should be constructed to reduce the flow velocity into the river.
- Dredging activities should be kept to the minimum practicable timescales.
- It is recommended that silt curtains are used after rain events (where needed) to contain turbidity pollution into the stream. Excavated sediment should not be placed on the shoreline prior to disposal. Same must be removed from site and/or stockpiled 32 m outside the delineated riparian zone.
    - If long-term construction is expected, berms or protective covers around the stockpiling area should be placed to prevent the loss soils (wind erosion).
- The design consideration for construction activity should be based on environmentally best practices.
- Access roads need to be inspected regularly for signs of erosion. Preferential flow paths (usually on the side of the roads) should have anti-erosion measures in place to limit surface runoff of road soils.
- Frequent monitoring should consider possible sources of sediment input and whether these are controlled and managed appropriately. Special attention should be given to the presence of any new erosion features and unstable slopes.
- The banks of the riparian area and riverbed would need to be stabilised and prevented from becoming broader in areas that may be susceptible to erosion.

10.3 Protection of aquatic biodiversity

Alterations in aquatic community structures might be attributed to changes in water quality and are typically characterised by a decrease in biotic diversity, habitat loss and higher abundances of more tolerant species. According to Hill and Kleynhans (1999), activities within/near a river may potentially alter the habitat availability for biota to live and thrive, as construction in proximity of a river may impact on the fundamental characteristics that are optimum for the survival and presence of aquatic invertebrates and fish species. At the abstraction site from the Orange River, these impacts will be negligible. Activities will be related to the securing of the floating pump installation. Limited clearing of vegetation is needed and once completed, the site must be rehabilitated. It is recommended that geo-matting is used to stabilise the exposed soil on the riverbank. Seeding with indigenous grass is suggested as a means to ensure that the root structure can stabilise the soil. Regular inspections at this site are needed (after flood events) as rehabilitation on the exposed area is critical. This protocol is recommended at the crossings of the Hartbees, Slang and Brabees rivers.

At the ephemeral stream sites, stabilisation of the banks is important. Where more sloped banks are present (site specific approach) a more aggressive strategy will be needed to ensure no erosion occur in the future. Geotextiles and seeding are an option to ensure that the soils will be protected against wind and water erosion.

10.3.1 Habitat loss and clearing of vegetation

- Habitat plays an integral role in species richness, hence any reduction/deviation from the optimal vegetation, stones, gravel, sand, mud, and/or differential flow availability may reduce biodiversity in aquatic systems.
- Stabilisation of the riverbank should be implemented at sections of the river with a high probability of being affected by the construction activities. The stabilisation methods should ensure that adequate marginal vegetation is available for aquatic biota (specifically Class 4 and 5 rivers).
- Re-vegetation with functional indigenous species on accessible margins of the river should be actioned during the rehabilitation process and will ensure adequate habitat rehabilitation and ensure succession of indigenous plant species over alien species.
- Vegetation clearing must be done by hand. Vegetation clearing shall be removed and disposed of correctly, especially alien species (prevent seed distribution).
- No clearing of vegetation or construction activities to take place other than on the footprint of the activity. Dedicated implementation of the EMPr is important and impacted area(s) must be rehabilitated with indigenous vegetation.
- Stock piling must be outside the riparian area with minimal ingress and egress.
- Stabilisation of banks should be implemented at sections of the river with a high probability of being affected by the construction activities and wind and water erosion.

10.3.2 Contamination – hazardous, general and human waste

- Hazardous (oils, fuel, chemicals) waste, general solid waste and human waste will contribute to pollution of the habitat (terrestrial and aquatic). It is therefore imperative that all waster spills must be cleared immediately to ensure the effective protection of the terrestrial environment, water courses and the associated riparian areas.
    - The hazardous material must be stored in bermed areas and spills cleared, reported and rehabilitated.
- Construction vehicles must be monitored daily for oil and fuel leaks. Any spillage must be immediately mitigated with the appropriate methods and leaks repaired before the vehicles are used on the construction sites.
- Under no circumstances should hazardous materials and wastes be stored or temporary placed in the delineated riparian zones or outside the designated storage zones.

- All solid waste from human activities and ablution facilities be monitored and cleared only a daily basis.
- Waste material and management must be monitored and any contamination or situation that may lead to contamination should be reported immediately, cleared as per EMPr protocol in order to protected the receiving environment (terrestrial and aquatic).

10.4 Resuspension and introduction of sediment/materials

An increase in turbidity due to suspended sediments from construction activities after rain or flood events will have a limited impact on the receiving environment. It will be important that the proposed monitoring and rehabilitation protocols are rigorously implemented to prevent impacts on the receiving environment.

- The clearing of land within/adjacent to the riparian area for stockpiling and access will impact negatively on the stability of the banks and surrounding soils, leading to soil erosion and further inputs into the water resources.
- Where needed, dissipaters should be used to reduce the flow downstream of any activity zones in stream channels.
- Appropriate measures such as the implementation of silt traps, or areas to contain silt before entering the watercourses, should be used.
- The ECO and staff should monitor and report any benthic disturbances on account of stormwater inputs and surface run-off.
- The contractor is to ensure that should there be any excessive quantities of sand, silt and silt-laden water, it does not enter the natural water resources.
- Excavated material is recommended to be placed on the upstream side of the trench so that should any excavated material be displaced during rainfall; it will flow back into the trench rather than towards the watercourse.

10.5 Flow modification

- Construction and operational activities for the project should not impact negatively on the flow of the aquatic resource.
- No impedances to flow other than approved erosion control measures must be present in the channels.
- Stock piling should be done outside the buffer areas associated with the aquatic resource(s).
- Effective and sustainable stormwater management should include inspections at construction sites (active and completed) to ensure no erosion occurred.
    - Any erosion must be rehabilitated according to the accepted protocols in the EMPr.
- Construction to be initiated during the dry season to limit impacts to aquatic resource.

- Effective control for wind erosion to form part of every construction site (protocols as captured in the EMPr).
- Energy dissipating structures to be used to attenuate stormwater velocity were deemed necessary (in consultation with the aquatic specialists).

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