

**AQUATIC ECOLOGICAL
ASSESSMENT**

FOR

***Kangra Coal (Pty) Ltd:
Ballengeich Colliery***



M²ENCO

Title:

Aquatic Ecological Assessment for Kangra Coal (Pty) Ltd: Ballengeich located within the municipal area of Newcastle, KwaZulu-Natal Province.

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DECLARATION OF INDEPENDENCE

I, **MJ De Beer** declare that

- I act as the Independent Specialist in this Assessment
- I will perform the work relating to the WUL Compliance in an objective manner, even if this results in views and findings that are not favourable to the Licensee
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in compiling 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;

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Date	November 2023

Executive Summary

As part of Kangra Coal's Mining Right the requirement of an authorisation to treat decant water stemming from defunct coal operations at Ballengeich in the Newcastle area is required. In addition to the mining right requirements Kangra Coal is in the process of applying for a Water Use Licence (WUL; DWS Ref: WU33839), with the Phase 2 submission package compiled and submitted in June 2026. M2 Environmental Connections (Pty) Ltd was appointed by Kangra Coal (Pty) Ltd in order to conduct an aquatic ecological assessment to provide reference data on the current Present Ecological State (PES) and Health Class of the associated aquatic ecosystems, which is incorporated as a specialist input into the WULA submission. In conjunction to the WUL requirements this study is also conducted with reference to the departmental letter under reference 16/2/7/V301/C/4 regarding the Implementation Plan dated 4 October 2022 to address the non-compliances at Ballengeich Colliery as per earlier Directive.

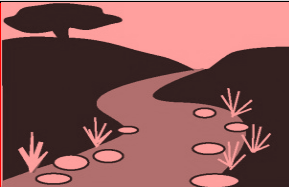
This is the second bio-monitoring assessment conducted at Ballengeich and serves as an important comparative assessment on the current Health Class Status of the associated aquatic ecosystem. The aquatic results of the current assessment will be compared to the initial aquatic assessment conducted during June 2022 which will further provide information regarding any changes within the aquatic ecosystem during the last year as well as any seasonable variability effects. A database will be obtained and compared to future assessments in order to see if there are any aggregate related effects on the receiving environment, particularly due to the on-going Acid Mine drainage as well as pollution activities related to the decant.

The health Class rating obtained for the Ngagane River is rated as a Health Class D which is slightly in an impaired state when being compared to the SANBI PES and in a comparable state when being compared to the catchment PES. The health Class rating obtained for the Horn River is rated as a Health Class D/E which is slightly in an impaired state when being compared to the catchment PES and in a comparable state when being compared to the SANBI PES.

A short summary of the monitoring results are indicated below:



Ngagane River				
Water Quality	SASS5	IHAS	Health Class	
			Class D: Largely Impacted	
Good	D	D		

Horn River				
Water Quality	SASS5	IHAS	Toxicity	Health Class
				Class D/E: Largely to Severely Impacted
Fair	D/E	D	Class IV	

It is recommended that the management actions and mitigation measures listed in **section 11** be implemented to ensure that the overall protection and Conservation of the Horn River and Ngagane River are maintained. Additional recommendations within **section 12** should also be considered in order to ensure that aquatic environmental sustainability is achieved.

In conclusion it was found that the old decant as well as AMD emanating from the colliery has localised impacts on the downstream Horn River. No direct impacts on the aquatic ecosystem Health of the Ngagane River has been observed as environmental indices produced similar aquatic results for both the upstream and downstream aquatic sites.

The assimilative capacity assessment conducted in 2022 indicated that AMD will have a more significant impact on the receiving Horn River during the wet summer season which proved to have been the case as a slight deterioration in water quality parameters, a decrease in aquatic species diversity as well as lethal toxic sediment results were obtained during the current assessment.



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ABBREVIATIONS

ASPT	Average Score Per Taxon
BMWP	British Biological Monitoring Working Party
CMA	Catchment Management Area
DO	Dissolved Oxygen
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EC	Ecological Category
EcoStatus	Ecological Status
EISC	Ecological Importance and Sensitivity Category
FEPA	Freshwater Ecosystem Priority Area
FRAI	Fish Response Assessment Index
GSM	Gravel Sand Mud
HAM	Habitat Assessment Matrix
HAI	Hydrology Driver Assessment Index
HQI	Habitat Quality Index
IHAS	Invertebrate Habitat Assessment System
NWA	National water Act (Act 36 of 1998)
IHI	Index of Habitat Integrity
ISP	Internal Strategic Perspective
MAP	Mean Annual Precipitation
MIRAI	Macroinvertebrate Response Assessment Index
MV	Marginal Vegetation
NFEPA Atlas	Atlas for the National Freshwater Ecosystem Priority Area's
PES	Present Ecological State
PESC	Present Ecological State Category
RHP	River Health Programme
RQO	Resource Quality Objectives
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SIC	Stones in current
SOOC	Stones out of current
Sub-WMA	Sub Water Management Area
TWQR	Target Water Quality Range
WMA	Water Management Area
WUL	Water Use License

1 INTRODUCTION AND TERMS OF REFERENCE

1.1 INTRODUCTION TO BIO-MONITORING

EcoStatus can be defined as “The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services” (Kleynhans & Louw, 2007). Rivers and their tributaries are the “vascular system” of the planet, performing much the same function as the vascular or circulatory systems found in humans, animals and plants, just on a larger scale. Rivers and tributaries’ main constituent is water, which is increasingly being considered as the most precious natural resource on earth.

Just as much as rivers are the starting point, it is also the end point for most of our anthropogenic activities, resulting in industrial and urban pollution entering this life transporting system. The amount of water used exceeds that which is put back into circulation, and the water that is re-entering the circulation, is usually polluted and depleted of any life supporting capacity. This ultimately decreases the life giving capacity of each river or tributary downstream from the point of impact, resulting in much the same effect as a clogged artery, vein or lymph vessel within the human body. The problem is not necessarily the pollution itself, but rather the rate at which pollution is taking place. The river systems are subsequently overloaded and not capable of filtering and remediating the cumulating effect of pollution. This leads to an increase in river systems that fail and may ultimately lead to the complete failure of the entire system.

It is for this reason that it is essential to ensure that some level of ecological integrity be maintained in all aquatic ecosystems. Factors affecting the magnitude that anthropogenic activities will have on aquatic ecosystems are the:

- *Extent of the activities in the area,*
- *The types of processes,*
- *The duration over which the activities occur and*
- *The rehabilitation measures that have taken place in the past and those currently taking place.*

Any area where water is going to be abstracted or discharged with different physical or chemical properties or where the physical aquatic environment will be modified runs the risk of having environmental degrading taking place in a cumulative manner. This environmental degradation can be caused both during the development of any new facility as well as during the operational phase of an activity. Impacts also occur during closure and post closure



phases. Discharging of water into an aquatic system can have various effects on the system, particularly if the physical or chemical properties of the discharges differ from that of the system. While discharges can influence the quantity and quality of the water, it can also impact on the ecological integrity of the system. Biological communities integrate different stressors over time and can therefore be used to monitor the cumulative effects of impacts over the long-term. Therefore, the overall impact of discharges on the system under investigation should be monitored by means of a suite of indicators at various trophic levels. Such environmental risk has legal implications due to various articles of environmental law.

South Africa's National Water Act (Act No 36 of 1998) stipulates that the country's water resources (including the ecological integrity of a resource) should be managed. The act focuses on protecting the needs of the environment, the basic needs of the neighbouring countries present and the future population (The Reserve). The act defines water as a renewable natural resource. This definition means that the water resource and not just the water itself is the resource and must be treated as an integrated component. The ecological integrity (Ecosystem Health) of a resource is therefore considered an essential part of the resource, which must be managed. Included in the definition of this resource is:

- *"The physical and structural aquatic habitats (both in stream and riparian), the water, the biota and the physical, chemical and ecological; processes that link habitat and biota."* (Jooste, et al., 2000).

A healthy ecosystem is further refined and will potentially consist of the following attributes:

- *Homeostasis (tendency of biological systems to maintain a state of equilibrium),*
- *Disease absence,*
- *Biodiversity,*
- *Resilience or stability,*
- *Growth vigour, and*
- *Balance between the components in the system.*

Management strategies of water resources should be built upon the knowledge and expertise of various disciplines, with the biologist playing an important and sometimes leading role. It is for this reason that aquatic bio-monitoring is extremely important in order to give indications of harmful impacts to the ecosystem.



1.2 ROLES OF AQUATIC INVERTEBRATES IN RIVER STRUCTURES

Invertebrates include all animals without backbones. In rivers this includes aquatic insects, larvae of insects with terrestrial (often flying) adult forms, as well as mussels, clams, snails and worms that are aquatic throughout their life cycle (Allan, 1995), (O' Keeffe & Dickens, 2000). Aquatic macro-invertebrates have been used to assess the biological integrity of stream ecosystems with relatively good success throughout the world (Rosenberg & Resh, 1993), more commonly than any other biological group (O' Keeffe & Dickens, 2000).

Aquatic macro-invertebrate assemblages and communities offer a good reflection of the prevailing flow regime and water quality in a river. In addition they form an essential component of the riverine ecosystem (O' Keeffe & Dickens, 2000). They are important processors of transported organic matter in rivers, serve a vital function in purifying the water in a river and also provide a valuable food source for larger animals within and even outside the system (O' Keeffe & Dickens, 2000), (Allan, 1995).

The four major components of a stream system that determine productivity for aquatic organisms are –

- *Flow regime,*
- *physical habitat structure (e.g., channel form and substrate distribution),*
- *water quality (e.g., temperature, dissolved oxygen), and*
- *energy inputs from the watershed (e.g., nutrients and organic matter)*

Distribution of an aquatic macro-invertebrate population is ultimately set by the physical-chemical tolerance of the individuals in the population to an array of environmental factors. The distribution pattern resulting from habitat selection by a given aquatic macro-invertebrate species reflects the optimal overlap between habit (mode of existence) and physical environmental conditions that comprise the habitat - substrate, flow and turbulence, for example. Thus, the discontinuous, patchy, distribution pattern of an aquatic macro-invertebrate population is the result of interplay between habitat, habit and the availability of food resources.

1.3 BACKGROUND AND REASONS FOR BIO-MONITORING

Ballengeich Colliery (Pty) Ltd has an approved Mining Right issued by the Department of Mineral Resources for coal mining activities on portion 19 (Remaining Extent) of the farm Ballengeich 3299 HS. The project area is characterised by several defunct mining activities that ceased during the early 1990's. Based on historic records (Hancox and Gotz, 2014) Ballengeich and Kilbarchan Collieries opened in the late 1890's and was operational until the 1990's. Kangra Coal is the current owner of Ballengeich Colliery. Shanduka Coal Resources

owned a 26% shareholding in Kangra Coal and operated under Natal Cambrian Colliery opencast and underground mining activities at the following operations:

- Ballengeich 3299;
- Kilbarchan 2969; and
- Mooikrantz 9562

As part of Kangra Coal's Mining Right the requirement of an authorisation to treat decant water stemming from defunct coal operations at Ballengeich in the Newcastle area is required. In addition to the mining right requirements Kangra Coal is in the process of applying for a Water Use Licence (WUL; DWS Ref: WU33839), with the Phase 2 submission package compiled and submitted in June 2026 in terms of Section 40 of the National Water Act, 1998 (Act 36 of 1998) (NWA) and the requirements of GN 267 (March 2017) and GN 4167 (December 2023). The current aquatic assessment was conducted to provide reference data on the current PES and Health Class of the associated aquatic ecosystems, which is incorporated as a specialist input into the WULA submission package. In conjunction to the WUL requirements this study is also conducted with reference to the departmental letter under reference 16/2/7/V301/C/4 regarding the Implementation Plan dated 4 October 2022 to address the non-compliances at Ballengeich Colliery as per earlier Directive. The objective of the Implementation Plan is based on improvement of water quality in the Ngagane River with specialist studies such as an aquatic assessment being an integral part of this rehabilitation plan.

The Ngagane and Horn River tributaries of the Thukela Basin are characterised by severe water quality problems stemming from mining and heavy industrial activities within the catchment which as a result have compromised the aquatic macro invertebrate diversity and subsequent PES of the quaternary catchment over an extended period. The water quality problem that is being experienced in the Newcastle/Ballengeich area relates to Acid Mine Drainage (AMD) stemming from old historic, defunct and abandoned mining operations.

Due to on-going pollution activities stemming from the old decant and AMD applicable to the mine a directive was issued in terms of section 19(3) Water Act NO 36 of 1998. The directive has already been issued during August 14 2013.

Kangra Coal (Pty) Ltd has appointed M2 Environmental Connections (Pty) Ltd to act as independent environmental specialist to conduct an aquatic ecological assessment in order to obtain a Present Ecological Status (PES) for the Horn as well as the Ngagane River due to the

on-going Acid Mine Drainage as well as pollution activities stemming from the current decant point. This is the second bio-monitoring assessment conducted at Ballengeich and serves as an important comparative assessment on the current Health Class Status of the associated aquatic ecosystem. The aquatic results of the current assessment will be compared to the initial aquatic assessment conducted during June 2022 which will further provide information regarding any changes within the aquatic ecosystem during the last year.

This assessment will provide important information on the potential habitat for aquatic macro invertebrates and health status of the associated river systems. This information could then be used in future assessments for comparative purposes once more aquatic assessments have been conducted. A database will be obtained and compared to future assessments in order to see if there are any aggregate related effects on the receiving environment, particularly due to the on-going Acid Mine drainage as well as pollution activities related to the decant.

1.4 LEGISLATIVE BASIS: GN 320 (MARCH 2020) COMPLIANCE MONITORING

This aquatic ecological assessment has been conducted in terms of Government Notice 320 (GN 320), published in the Government Gazette No. 43108 on 6 March 2020, titled “Regulations on the Monitoring of Water Uses”, promulgated under Section 26(g) of the National Water Act, 1998 (Act 36 of 1998) (NWA). GN 320 establishes the legal framework governing the monitoring of all water uses authorised or applied for under Section 21 of the NWA, and applies to all Water Use Licence (WUL) holders and applicants whose water use activities may have a detrimental effect on the quantity or quality of a water resource.

The following regulations within GN 320 are of direct relevance to this assessment:

- 2 Regulation 4 — requires that a water user whose licence or application involves activities that may detrimentally affect the quantity or quality of a water resource must implement a monitoring programme approved by the Department of Water and Sanitation (DWS). The monitoring programme must include surface water quality monitoring, aquatic ecological monitoring, and where applicable, groundwater monitoring.
- 3 Regulation 8 — requires that monitoring results be reported to DWS on a regular basis and that all monitoring data be retained for a minimum period of five years and be made available to DWS upon request. Reports must include a formal assessment of compliance against the applicable Resource Quality Objectives (RQOs).
- 4 Regulation 10 — prescribes the minimum methodology requirements for monitoring, including the use of accredited laboratories, standardised biological monitoring protocols (SASS5 for macro-invertebrates), and validated in-situ measurement equipment. Both

bio-monitoring specialists who conducted this assessment are accredited with DWS in terms of the SASS5 protocol as required by Regulation 10.

The Ballengeich Colliery is further subject to a Section 19 Directive issued by DWS (Reference: 16/2/7/V301/A/1, August 2013) in terms of Section 19(3) of the NWA, which places an affirmative obligation on Kangra Coal (Pty) Ltd to address the uncontrolled Acid Mine Drainage (AMD) decant impacting the Horn River. This aquatic ecological assessment constitutes a component of the compliance monitoring requirements under both the Section 19 Directive and the GN 320 monitoring framework, and provides the biological and physico-chemical baseline data required to assess progress toward the target of improving the Horn River Present Ecological State (PES) from its current Health Class D/E toward the Recommended Ecological Category (REC) of Class C as set in GN 1873 (March 2022).

In terms of GN 320 Regulation 4, the applicable compliance monitoring requirements for the Ballengeich Colliery WUL (DWS Ref: WU33839) include, at a minimum:

- 5 Monthly surface water quality monitoring at a minimum of ten (10) designated monitoring points (SW01–SW10) against the GN 1873 RQOs, with results submitted to DWS in bi-annual monitoring reports;
- 6 Bi-annual SASS5 bio-monitoring assessments at five designated aquatic monitoring sites (Horn US, Horn DS1, Horn DS2, Ngagane US, Ngagane DS), conducted once during the wet season (October–March) and once during the dry season (April–September) in accordance with Regulation 10 methodology requirements;
- 7 Quarterly groundwater quality monitoring at twenty-three (23) designated monitoring boreholes (UGBH1–GW23) against the V31K groundwater RQOs in GN 1873; and
- 8 Toxicological sediment assessment at key monitoring sites on a periodic basis to track changes in sediment hazard class status, particularly at the decant point and downstream Horn River sites where Hazard Class IV conditions have been confirmed.

This assessment constitutes the second bio-monitoring event conducted at Ballengeich (wet season, November 2023), following the baseline assessment conducted during June 2022 (dry season). All monitoring data, laboratory certificates, SASS5 datasheets, and toxicological results are retained in the project file in compliance with the five-year data retention requirement of GN 320 Regulation 8(3). Results are reported herein against the current GN 1873 RQOs, which supersede the IWQMP (2016) values used in the 2022 baseline assessment

8.5 LOCATION OF PROJECT AREA

The farm Ballengeich 3299 is located 17 km south of Newcastle and approximately 2 km west of Ballengeich. Farm portions 14, 19 and 25 were assessed on the farm Ballengeich during the current assessment. The Horn River specifically the upper reaches of the Horn River have been impacted over an extended time period by several economic activities such as commercial agriculture, coal mining as well as industrial manufacturing. The project area is characterised by several defunct mining activities that ceased during the early 1990's.

The area falls within the Newcastle Local Municipality and under the Amajuba District Municipality. An illustration of the regional locality is illustrated in **Figure 1-1** while the locality description is illustrated in **Figure 1-2**.

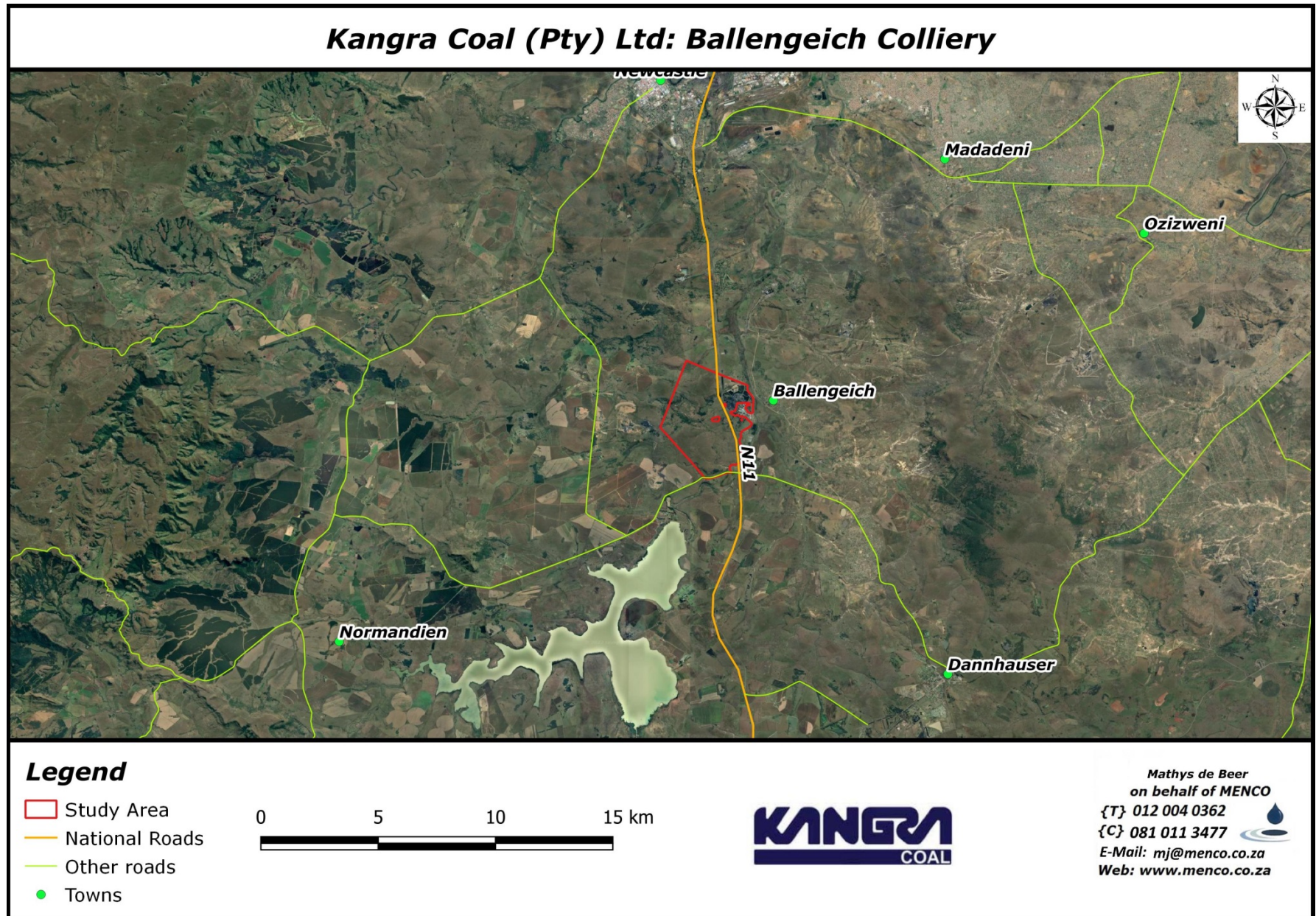


Figure 1-1: Regional Locality

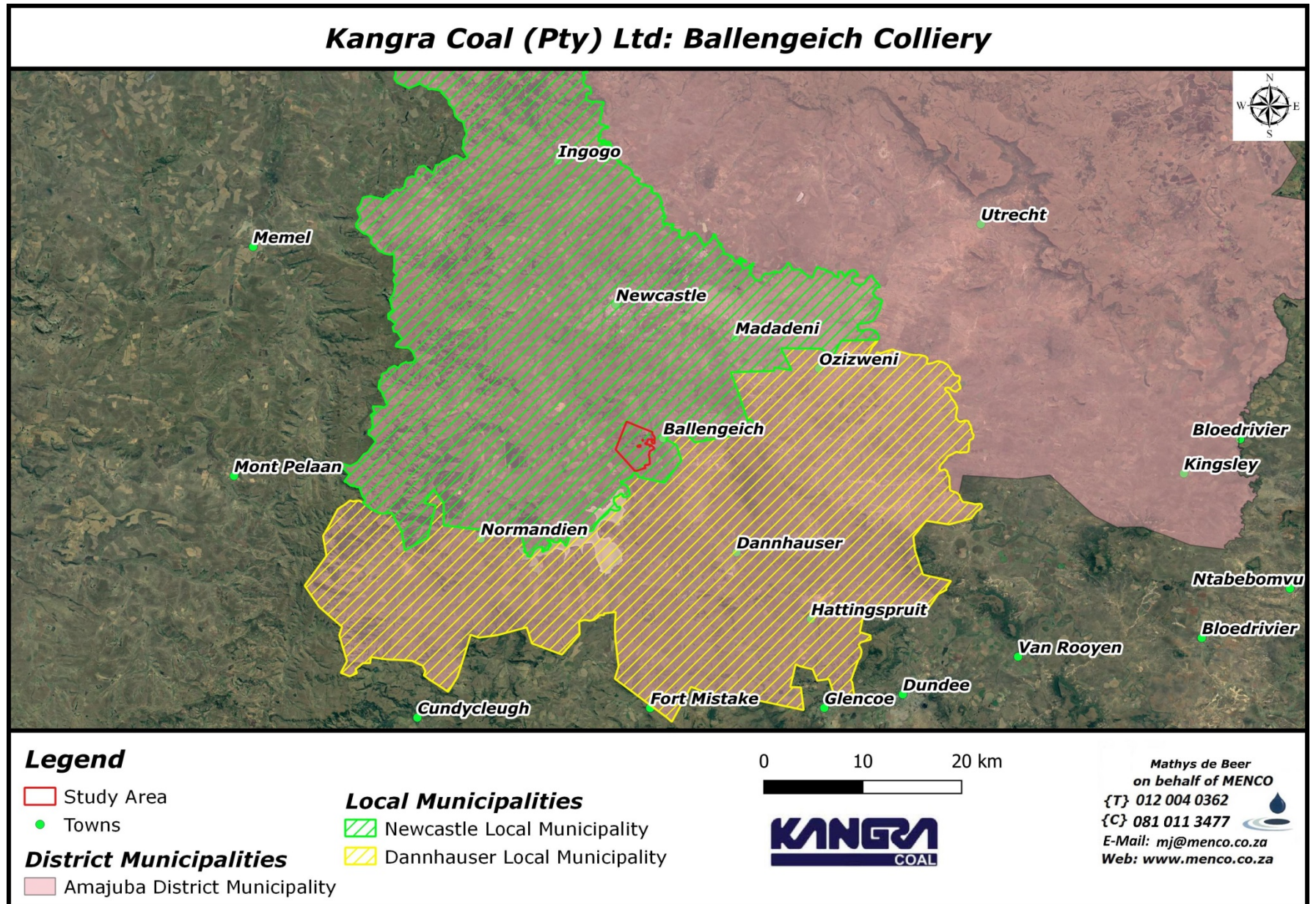


Figure 1-2: Municipalities

2 REGIONAL AND CATCHMENT DESCRIPTIONS

The proposed area falls within three applicable quaternary catchments which include the V31F, V31G as well as the V31K quaternary catchments and falls within the Pongola-Mtamvuna Water Management Area (**Figure 2-1**).

The Amajuba District Municipality (ADM) falls entirely into two primary catchments namely the Thukela and Pongola catchments. The Ngogo, Ncandu, Horn and Ngagane Rivers are important tributaries of the Buffalo River draining from the western highlands while the Slangspruit, Doringspruit and Dorpspruit form the main tributaries in the north. The headwaters of the Pongola River (including the Bivane River) are found in the high lying north eastern areas of the ADM and drain eastwards out of the district.

The Ntshingwayo Dam is fed by the Ngagane River and is situated at the boarder of the Newcastle and Dannhauser Municipalities. This dam is the most important water supply point for Newcastle – the most densely populated area and economic hub of the district. The Zaaihoek Dam is situated in the Emadlangeni Municipality and is used to primarily supply water to Majuba Power Station, but also Volksrust town and to supplement the Vaal catchment. Within the ADM the highest sensitivity is located around the key water supply features on the Ngagane and Buffalo Rivers. Not only are these critically important resources, but they are also stressed from a water quality perspective.

Land use in the ADM consists of an assortment of agriculture (commercial and subsistence), afforestation, industrial uses, mining and high-density urban settlements and sparse rural settlements. The vast majority (74%) of the district's land cover consists of natural untransformed vegetation. In almost all areas, this is grassland which is utilised as grazing land for livestock. The more densely populated settlements include Newcastle (central economic hub), Dannhauser, Madadeni, Osizweni and Utrecht.

Considering the District's topographic situation, all of the water used in the Amajuba District comes from the catchments contained within the district's boundaries. There are no transfers of water into the district and no catchments feeding into it. This provides a perspective of the importance of the catchment areas for human wellbeing and economic growth in the district. Water yield from these catchments is directly affected by vegetation types and cover and invasive alien woody species are increasingly present in these catchment areas. This represents a significant threat to water security in the district.



Water yield is also affected by land use changes. The conversion of natural veld to cultivated agriculture, industry, mining and urbanisation affects runoff and infiltration which in turn affects the quantity, quality and the timing of flows in rivers. Vegetation changes resulting from grazing also decrease the surface vegetative cover which affects water yield. These have all been identified as impacts affecting the ADM strategic water source areas.

Water quality within the ADM is mainly affected by anthropogenic pollution from the domestic, industrial, agricultural and mining sectors. The Thukela River reserve study undertaken in 2004 showed the water quality component of the Present Ecological State (PES) in the Buffalo River below the Utrecht / Osizweni road bridge to be heavily impacted, particularly with respect to various sulphate salts and nutrients. In particular, Acid Mine Drainage (AMD) is a very real threat to the water quality of the district. AMD results from the oxidation of sulphides, typically pyrite, and is characterized by low pH and high concentrations of SO₄²⁻ (sulphate), iron, metalloids, and many metals (Larsen and Mann 2005). Abandoned mines and tailings piles can be sources for AMD and represent risk to the equilibrium of different ecosystems (Moncur et al. 2005, Cravotta 2008).

Table 2-1: Regional characteristics of the catchment area

Attribute	Project Details
Water User	Kangra Coal: Ballengeich
Water Management Area	Pongola-Mtamvunu
Sub-water Management Area	Buffalo
Quaternary Drainage Region	V31G, V31K
Level 1 Eco-region	Northern Eastern Uplands
Level 2 Eco-region	14.02
Rivers	Ngagane, Horn
DWS Ecological Importance	High
SANBI 2018 PES (Ngagane)	Class C: Moderately Modified
SANBI 2018 PES (Horn)	Class E: Severely Modified
Default Catchment PES	Class D: Largely Modified
REC Horn	Class C: Moderately Modified
REC Ngagane	Class B: Slightly Modified
SANBI NFEPA Status	High

Table 2-2: Regional Characteristics of the Eco-region Applicable to Ballengeich

Criteria	Description	Impact on Biological Indices
River System	Horn River – Non-Perennial stream Ngagane River – Perennial stream	Low flow through the year with no seasonal deaths. Lower flows expected during the dry May to October months.

Criteria	Description	Impact on Biological Indices
Climate/ Rainfall	The average annual rainfall for the district is between 504mm and 1149mm, with this average been consistent throughout the district. The average temperature is approximately 17 degrees Celsius with the minimum temperature for the district being below zero degrees Celsius during winter months and the maximum often higher than 30 degrees Celsius in the summer months.	The climatic conditions of the district vary noticeably between summer and winter with very cold temperatures during the winter months and high summer temperatures.
Topography	The topography of the district ranges from 1042m to 2290m above sea level.	the central areas around Newcastle, Dannhauser and Emadlangeni are relatively flat and the terrain becomes steeper towards the northern, north-eastern and western edges.
Vegetation Types	The Amajuba District traverses four (4) biomes, namely Forest, Savannah, Grassland and Wetland and contains 14 vegetation types. Some of these include Eastern Mistbelt Forrests, Kwazulu-Natal Highveld Thornveld and Thukela Thornveld.	Several of these vegetation types are classed as endangered or vulnerable.
Invertebrates	Both of the associated Rivers are intersected by moderately to highly sensitive aquatic Ecological Sensitivity Zones.	The aquatic macro invertebrate diversity and habitat conditions are impaired by water quality as well as water quantity restrictions in the form of water abstraction activities as well as AMD discharges from mines in close proximity.
Soils/Geology	The central area of the district is underlain by Karoo Sequence sediment with higher-lying areas underlain by a combination of geological formations. Three types of soils have been identified within the district; transported soils, colluvial and residual of Pleistocene and Recent origin.	Most soils appear to be very clayey and expansive, that is they have shrunk and swell properties according to their water content, with this type of soil often associated with wetlands.



Criteria	Description	Impact on Biological Indices
Wetlands	There are several important wetlands within the surrounding area with several RAMSAR wetlands also occurring within the area.	The extensive wetlands associated with the Ngagane and Ncandu Rivers also supports a wide range of hygrophilous vegetation types.

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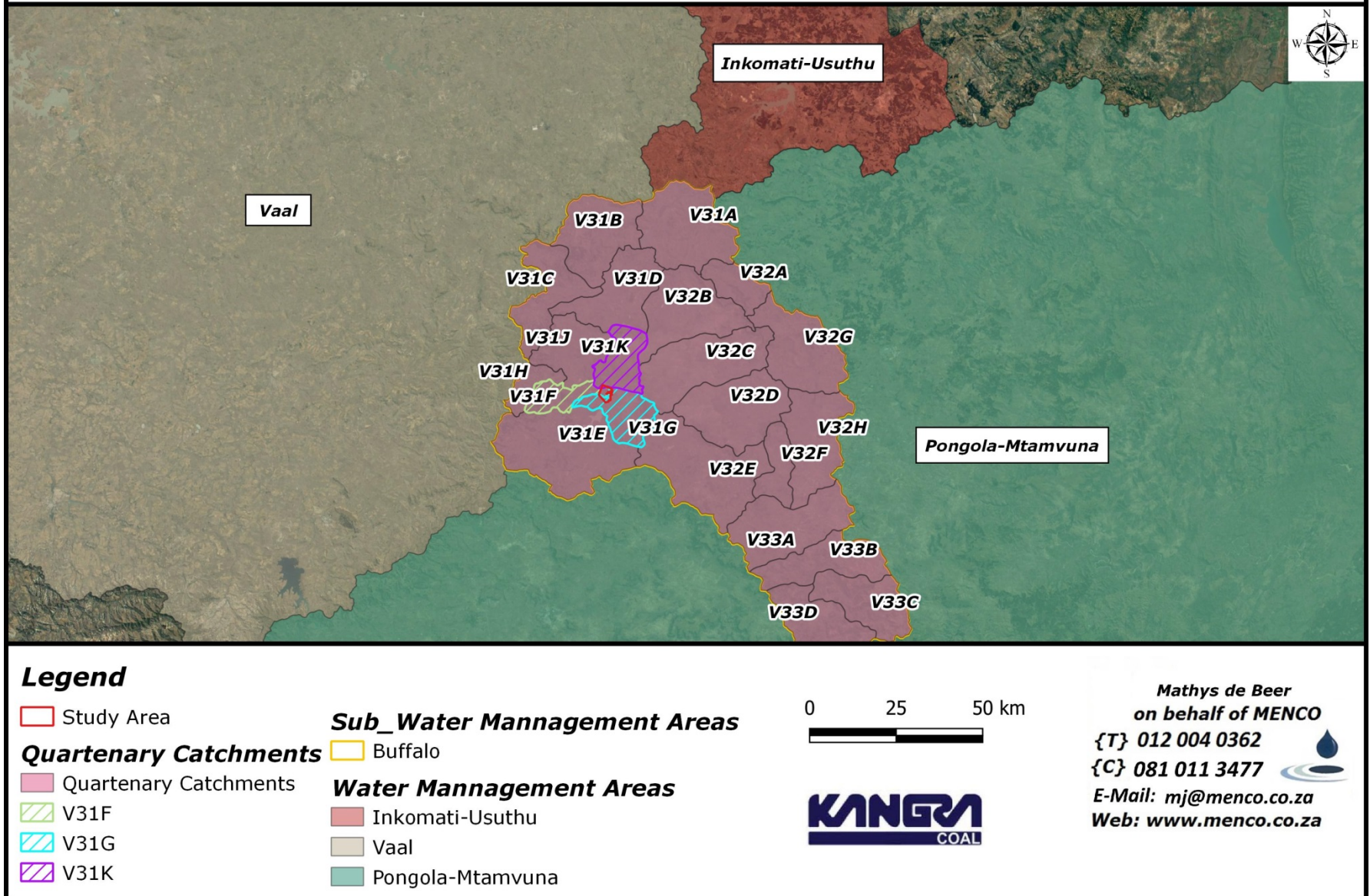


Figure 2-1: Water Management Areas Applicable to the Study Area

Kangra Coal (Pty) Ltd: Ballengeich Colliery

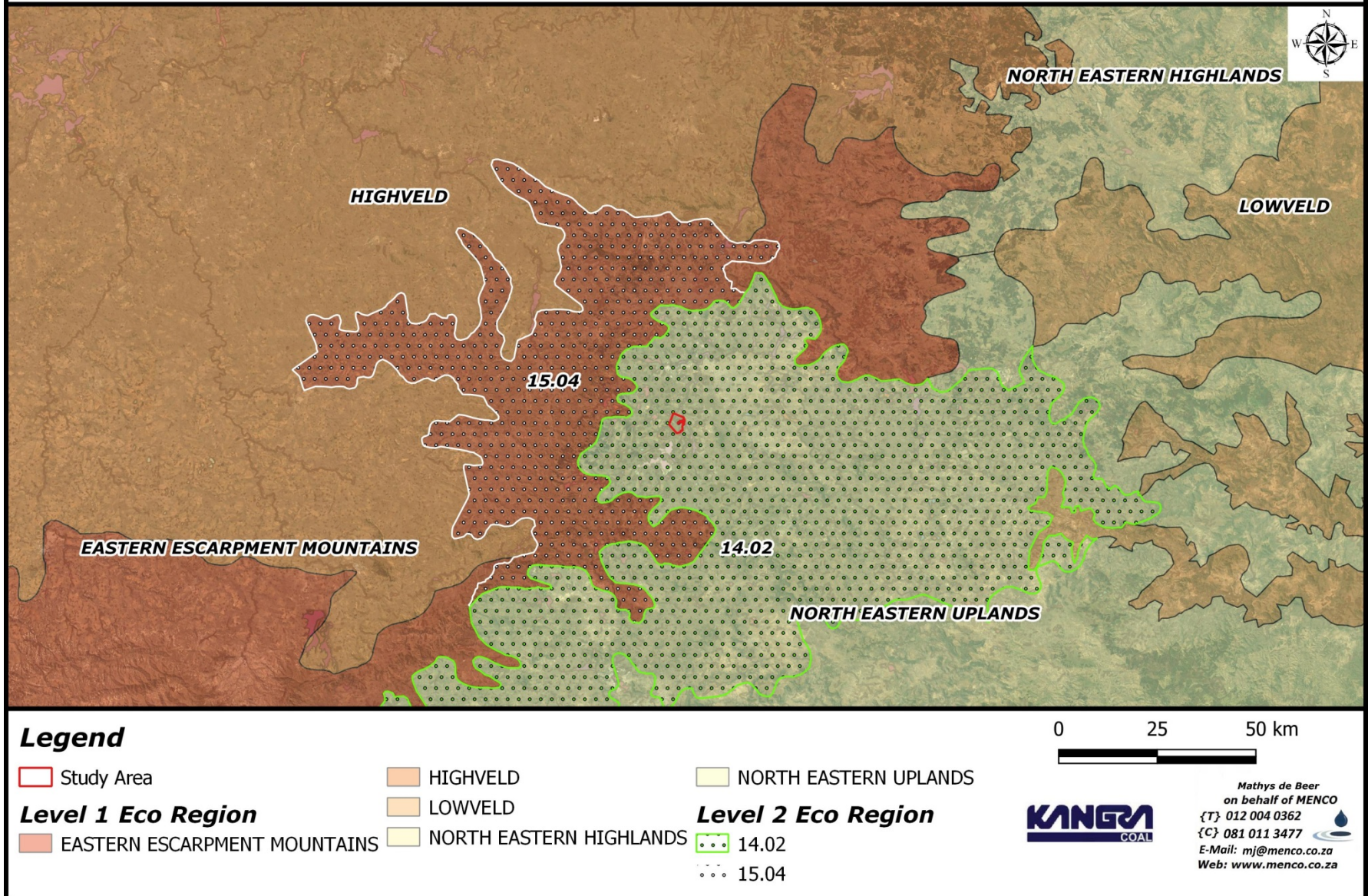


Figure 2-2: Eco-Regions Applicable to the Study Area



3 IDENTIFICATION OF MONITORING POINTS

The identified monitoring sites are depicted in **Figure 3-1** and detailed descriptions of the sites are provided in **Table 3-1**. More detailed descriptions of the Habitat Integrity and suitability are provided in **Section 6**.

3.1 METHODOLOGY OF INVESTIGATION

Bio-monitoring was conducted on the property on 16th and 17th of November 2023 at five points as indicated in **Figure 3-1**. Three sites were assessed within the Horn River (2 downstream and 1 upstream sites) while two sites were assessed within the Ngagane River (1 upstream and 1 downstream site). This was done through the SASS5 protocol as per the River Health Programme and the IHAS of each monitoring point was determined in order to obtain a Present Ecological Status (PES). Two additional surface water sites were also assessed at the outlet of the decant as well the PCD. Both aquatic scientists that conducted the bio-monitoring study are accredited with the Department of Water and Sanitation. The bio-monitoring assessment was conducted within the Horn River as well as the Ngagane River. The monitoring locations were largely selected to indicate the potential effects of AMD as well as the old decant point located in close proximity to the Horn River.

During the field survey the following guides were used to assist with the identification of the macro invertebrates encountered at the various sites:

- *Aquatic Invertebrates of South African Rivers: Field Guide (by a Gerber and MJM Gabriel, First Edition, February 2002)*
- *Aquatic Invertebrates of South African Rivers: Illustrations (by A Gerber and MJM Gabriel, 2nd Version, April 2002)*

Methodology to Site selection:

1. The sites were chosen in relation to the:

- *existing infrastructure and activities of the area,*
- *which is representative of the potential impacts related to the licensee, and*
- *to minimize the inclusion of impacts related to water users and uses not associated with the licensee.*
- *the monitoring points were selected by considering the baseline monitoring survey that was done to delineate the sensitive environments (wetlands and FEPA's).*

2. How readily a site could be accessed by vehicle to allow for the transportation of equipment.
3. Specific sites in the associated aquatic ecosystems were selected where:
 - *there were good habitat conditions,*
 - *with as good level of biotope diversity as possible,*
 - *that is able to support as diverse aquatic community as possible, and*
 - *in conjunction with the previous monitoring in order to relate the water quality variables with the biological communities to expand the depth of interpretation of potential environmental impacts.*
4. It was clearly communicated that the outcomes should reflect the potential impacts of the licensee and not arbitrary unrelated data.

Table 3-1: Selected Monitoring/Bio-Monitoring Sites

Monitoring Site	Description	Latitude	Longitude
Decant	The acidic decant along the railway line between the Jacaroo Park residential complex and the Portion 19 (Remaining Extent) of the farm Ballengeich 3299 HS mining area is regarded as a major diffuse contributor of pollution.	27°53'25.24"S	29°57'45.79"E
PCD	The Pollution Control Dam is situated on site to treat mine waste water before it is discharged into the Horn River. The PCD is situated approximately 50 m upstream of the Horn River.	27°53'17.83"S	29°58'5.79"E
Ngagane US	The site is located within the Ngagane River approximately 100m upstream of the confluence with the Horn River. This site is considered as an important reference site.	27°53'7.64"S	29°58'32.53"E
Ngagane DS	The site is located within the Ngagane River approximately 140m downstream of the confluence with the Horn River and represents an important comparative site when taking the impact of the Horn River into account.	27°53'1.33"S	29°58'31.33"E

Horn US	This site is situated within the Horn River approximately 300m upstream of the decant point. This site is considered as an important upstream reference site.	27°53'34.83"S	29°57'39.77"E
Horn DS1	This site is situated approximately 200m downstream of the decant point also situated within the Horn River. This site is situated upstream of a bridge at the N11 road.	27°53'18.60"S	29°57'51.96"E
Horn DS2	This site is located approximately 680 m downstream of the Horn DS 1 site also located within the Horn River. This site is clearly impaired by several erosion channels.	27°53'5.48"S	29°58'15.22"E

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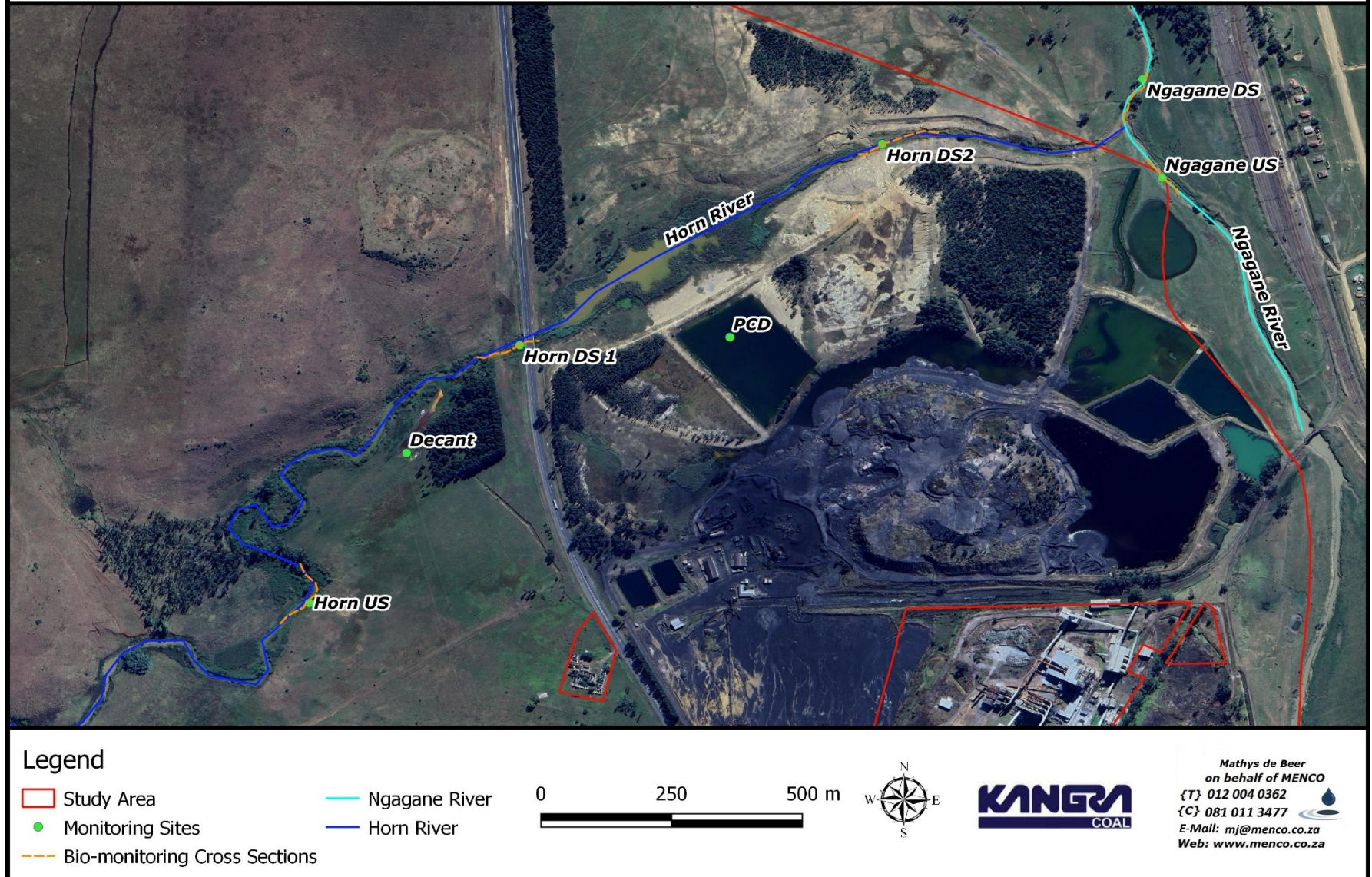


Figure 3-1: Monitoring Sites Applicable to Ballengeich

4 MATERIALS AND METHODS

4.1 WATER QUALITY

All water samples collected during the field survey were submitted to an accredited SANAS laboratory for water quality analyses. The quality certificate for the SANAS accredited laboratory is attached in Appendix A. In-situ sample analyses was conducted during the bio-monitoring assessment using a calibrated HACH HQ40d multi-parameter instrument. Readings of Water Temperature, Dissolved Oxygen, pH and Electrical Conductivity were taken in the top 200mm of the water.

4.2 HABITAT ASSESSMENT

An evaluation of habitat quality and availability to biota is critical to any assessment of ecological integrity and was conducted at each site at the time of biological sampling. On site habitat assessments were conducted using the habitat evaluation indices of (McMillan, 1998).

Habitat assessments are critical due to the fact that changes in habitat can be responsible for changes in SASS5 scores. The use of a SASS orientated habitat assessment index, namely the Invertebrate Habitat Assessment System (IHAS), is therefore important to determine the relative “health” or “availability” of sufficient habitat for the establishment or maintenance of viable biological communities.

The IHAS index was specifically designed to assess habitat and also to form a significant part of the final biological assessment of rivers. The system was developed in a way that allows different operators to obtain the same or very similar scores. The system is considered to be an improvement on the (HAM), (HAI) and (HQI) indices by (McMillan, 1998), because it allows for less subjectivity according to the assessor’s interpretation.

According to the River Health Program (www.csir.co.za/rhp), this system can be used with confidence throughout South Africa.

The habitat scoring system is based on a scoring system out of 100 and is described in terms of percentages with the assessment divided into two sections. The first makes up 55 points of the scoring system and is directly related to the SASS5 sampling habitat. The second section consisting of 45 points is based on physical features such as stream make up, average width, and depth. Other features such as colour, human disturbances and riparian vegetation are also investigated (McMillan, 1998).



For each parameter, there are up to six possible answers that can be obtained. Each of these answers has a score with a value between zero and five (0-5). Generally the higher a value is the better the habitat condition.

4.3 AQUATIC INVERTEBRATE ASSESSMENT: SASS, VERSION 5

Benthic macro-invertebrate communities of the selected sites were investigated according to the South African Scoring System, version 5 (SASS5) approach. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The SASS method is a rapid, simple and cost-effective method that has progressed through four different upgrades/versions. The current upgrade is Version 5, which is specifically designed to comply with international accreditation protocols.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion, Mocke, & Woest, 1995). In the context of this investigation, it would imply not to use SASS scores in isolation, but rather in comparison with relevant habitat scores. The rationale behind this is that some sites have less desirable habitat or fewer biotopes than others. Therefore, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better as a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions.

4.3.1 Sample Collection

An invertebrate net (30 x 30 cm square with 0.5 mm mesh netting) was used for the collection of the organisms. Various different biotopes were sampled, and each of the biotopes was sampled with different methods. The various biotypes sampled at the monitoring points were Sand (S), Vegetation (VG) as well as the Gravel, Sand and Mud (GSM) Biotopes.

Stone (S) Biotopes:

- Stones in current (SIC) or any solid object: Movable stones consisting of at least cobble size (3 cm diameter) to approximately 20 cm in diameter, within the fast and slow flowing sections of the river. Kick sampling is used to collect organisms in this biotope. This is done by putting the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick sampling) for ± two (2) minutes.
- Stones out of current (SOOC): Where the river is still, such as behind a sandbank or ridge of stones or in backwaters. Collection is again done by the method of kick



sampling, but in this case the net is swept across the area sampled to catch the dislodged biota. Approximately 1 m² is sampled in this way.

- **Bedrock or other solid substrate:** Bedrock includes stones greater than 30 cm, which are generally immovable, including large sheets of rock, waterfalls and chutes. The surfaces are scraped with a boot or hand and the dislodged organisms collected. Sampling effort is included under SIC and SOOC above.

Vegetation (VG) Biotopes:

- **Marginal vegetation (MV):** This is the overhanging grasses, bushes, twigs and reeds growing on the edge of the stream, often emergent, both in current (MvegIC) and out of current (MvegOOC). Sampling was done by holding the net perpendicular to the vegetation (half in and half out of the water) and sweeping back and forth in the vegetation ($\pm$ 2 m of vegetation).
- **Submerged vegetation (AOV):** This vegetation is totally submerged and includes filamentous algae and the roots of floating aquatics such as water hyacinth. This was sampled by pushing the net (under the water) against and amongst the vegetation in an area of approximately one square meter.

Gravel, Sand and Mud (GSM) Biotopes:

- **Sand:** This includes sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river. These biotopes were sampled by stirring the substrate by shuffling or scraping of the feet, which was done for half a minute, while the net was continuously swept over the disturbed area.
- **Gravel:** Gravel typically consists of smaller stones (2-3 mm up to 3 cm). Sampling was similar to that of sand.
- **Mud:** It consists of very fine particles, usually as dark-coloured sediment. Mud usually settles to the bottom in still or slow flowing areas of the river. Sampling was similar to that of sand.

Hand picking and visual observation:

Before and after disturbing the site, approximately 2 minute of “*hand-picking*” for specimens that may have been missed by the sampling procedures were carried out.

4.3.2 Sample Preparation

The organisms sampled in each biotope group were identified and their relative abundance noted on the SASS5 datasheet. The scoring system consists of a checklist on which the different invertebrate families have a value between 1 and 15 varying from the least intolerant to the most intolerant. The families collected at the site were identified according to (Gerber & Gabriel, 2002) and marked off against the SASS5 list. Values according to the checklist were allocated to the families, which allow for the summation of each sample to provide a sample score. The number of families was summed as the number of taxa present. Subsequently, the sample score was divided by the number of taxa to provide the Average Score per Taxon, commonly referred to as ASPT.



5 REFERENCE SCORES

5.1 WATER QUALITY

Reference scores applicable to water quality related to the activities and rivers outlined in this document were obtained from the following sources:

- South African Water Quality Guidelines (Volume 8): Field Guide (Department of Water Affairs and Forestry, South African Water Quality guidelines. Volume 7: Field Guide., 1996)
- South African Water Quality Guidelines (Volume 7): Aquatic Ecosystems (Department of Water Affairs and Forestry, South African Water Quality Guidelines, Volume 7: Aquatic Ecosystems, 1996)
- The applicable Resource Quality Objectives (RQOs) for the V31F (Horn River) and V31K (Ngagane River) quaternary catchments are set in terms of Government Notice 1873 (GN 1873, 11 March 2022) published in terms of the National Water Act, 1998 (Act 36 of 1998). These supersede the earlier IWQMP (2016) values previously referenced and represent the current regulatory compliance targets applicable to this assessment. The RQOs are set at the 95th percentile for most parameters (50th percentile for nutrients) and are presented in **Table 5-1**

Table 5-1: RQO's for Horn River (V31F) and Ngagane River (V31K) in terms of GN 1873 (March 2022)

Parameter	Unit	Horn River (V31F) RQO	Ngagane River (V31K) RQO
pH	pH units	6.5 – 9.0	6.5 – 9.0
Total Dissolved Solids (TDS)	mg/L	≤350	≤350
Electrical Conductivity (EC)	mS/m	≤70	≤70
Sulphate (SO ₄)	mg/L	≤165	≤200
Iron (Fe total)	mg/L	≤0.1	≤0.1
Manganese (Mn)	mg/L	≤0.15	≤0.15
Aluminium (Al)	mg/L	≤0.105	≤0.105
Chloride (Cl)	mg/L	≤120	≤120
Ortho-phosphate (PO ₄ as P)	mg/L	≤0.02 (50th %ile)	≤0.05 (50th %ile)
Total Inorganic Nitrogen (TIN)	mg/L	≤1.0 (50th %ile)	≤2.0 (50th %ile)



Parameter	Unit	Horn River (V31F) RQO	Ngagane River (V31K) RQO
Cadmium (Cd)	mg/L	≤0.0012	≤0.0012
Copper (Cu)	mg/L	≤0.0073	≤0.0073
Lead (Pb)	mg/L	≤0.0095	≤0.0095
Cobalt (Co)	mg/L	≤0.05	≤0.05
Zinc (Zn)	mg/L	≤0.002	≤0.002

Table 5-2: RWQO set for Aquatic Ecosystems in South Africa

Water Quality Variable	Unit	RWQO
PHYSICAL		
Conductivity	mS/m	120
pH		6.5 – 9.0
Dissolved Oxygen	% Sat	70
Suspended Solids	mg/l	-
CHEMICAL, INORGANIC		
Alkalinity, CaCO ₃	mg/l	120
Boron, B	mg/l	0.5
Calcium, Ca	mg/l	108
Chloride, Cl	mg/l	163
Fluoride, F	mg/l	0.75
Magnesium, Mg	mg/l	51
Potassium, K	mg/l	50
Sodium, Na	mg/l	115
Sulphate, SO ₄	mg/l	324
Total Dissolved Solids	mg/l	520
Sodium Adsorption Ratio (SAR)	Meq/l ^{0.5}	2.0
CHEMICAL, ORGANIC		
Dissolved Organic Carbon	mg/l	10
METALS (DISSOLVED)		
Iron, Fe	mg/l	1.0
Manganese, Mn	mg/l	1.0
Aluminium, Al	mg/l	0.2
Chromium IV	mg/l	0.05
PLANT NUTRIENTS		
Ammonia*, NH ₃ -N	mgN/l	0.007
Nitrate, NO ₃ -N	mgN/l	6
Phosphate**, PO ₄ -P	mgP/l	0.05
Total Phosphorus**	mgP/l	0.25
Total Inorganic Nitrogen**	mgN/l	2.5
MICROBIOLOGICAL		
Faecal Coliform	# per 100 ml	130

The purpose of these Water Quality Guidelines is used by DWS in water quality management as the primary source of reference information and decision support required for the management and protection of aquatic ecosystems.



The South African Water Quality Guidelines contains information similar to that which is available in the international literature. However, the information provided is more detailed, and not only provides information on the water quality requirements for the management and protection of aquatic ecosystems but in addition provides background information to help users of the guidelines make informed judgements on the likely impacts of water quality on the health and integrity of aquatic ecosystems.

5.2 SASS5

Reference scores are important to be able to determine the present health class in terms of the (Dickens & Graham, 2002) method. Modelled reference conditions set by the DWS was used for comparison between the present SASS5 and ASPT scores and the benchmark conditions for the North Eastern Uplands Eco-region, Reserve values for the V31G quaternary catchment were also used to determine the significance of any impacts by comparing the PES with the Recommended Ecological Status of the quaternary catchments on a broad scale.

There are various factors that determine the health of the biological communities in a river system. These factors include regional characteristics such as climate, rainfall, topography, geology, geomorphology, soil and natural vegetation types. An alluvial system, for instance, will provide fewer habitats than a system where the geomorphology consists of boulders/cobbles. Similarly, a non-perennial system will be a far less hospitable environment than a perennial system. As such, there are no definitive rules when setting a background value for biological indices. Therefore, a background/reference site is important when doing Bio-monitoring in a particular river system.

Typical scores that could be expected in the North Eastern Uplands (Lower) are presented in **Table 5-3** This method serve as the most accurate means of estimating IHAS, SASS5 as well as ASPT scores, it allows for the identification of a possible reference, or background score to compare current values to.

Table 5-3: Aquatic Reference Scores Applicable to the Eco-Region

Class	Level 1 Eco-region description	DWS Reference	
	Description	SASS Score	ASPT
A	Excellent – Unimpaired. High diversity of taxa with numerous sensitive taxa. Optimum community structure.	>116	>8.5
B	Very Good – Slightly impaired. High diversity of taxa, but with fewer sensitive taxa. Largely natural with minor modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.	106 - 116	6.1 – 8.5
C	Good – Moderately impaired. Moderate diversity of taxa. Community composition lower than expected due to loss of	85 - 105	5.4 – 6.1

Class	Level 1 Eco-region description	DWS Reference	
	Description	SASS Score	ASPT
	some sensitive forms. Basic ecosystem functions predominantly unchanged.		
D	Fair – Largely impaired. Mostly tolerant taxa present. Basic ecosystem functions have changed.	71 -84	4.8 – 5.4
E	Poor – Severely impaired. Only tolerant taxa present. An extensive loss of basic ecosystem functions has occurred.	70	<4.8
F	Very Poor – Critically impaired. Very few tolerant taxa present.	<70	Variable

It is recommended that SASS surveys must be done on a bi-annual basis, once during the wet season and once during the dry season. SASS total scores recorded downstream may not be more than 20 % less than that of the upstream scores, and the ASPT score may not be more than 10 % less, except after major floods or drought periods. Any negative impacts on the aquatic health must be mitigated / rehabilitated and prevented from reoccurring.

Figure 5-2 provides an overview of the Threatened ecosystems and protected areas in the surrounding area. The project area falls adjacent a vulnerable ecosystem with the Chelmsford protected area also being situated upstream of the study area.

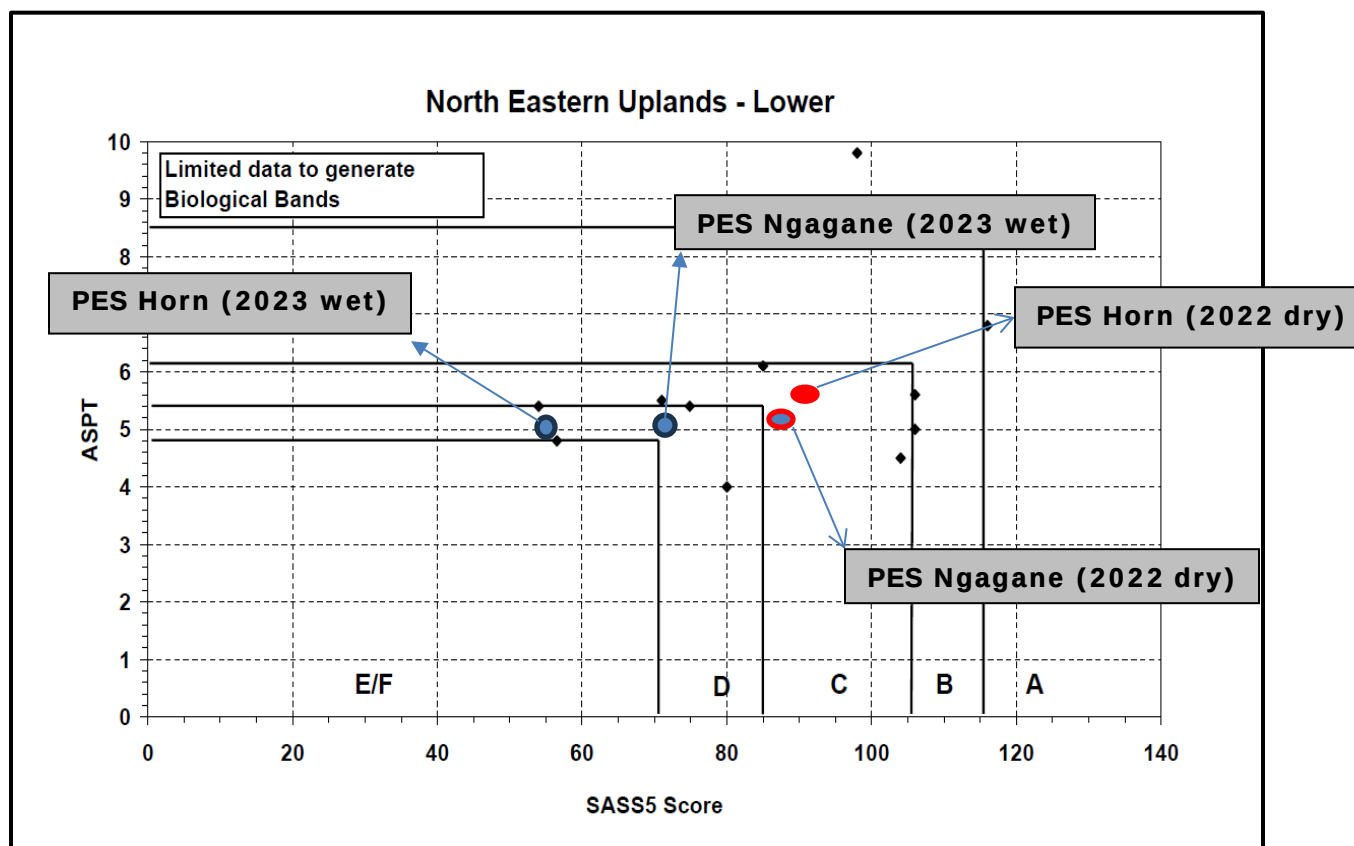


Figure 5-1: Biological Bands for the North Eastern Uplands Eco-region

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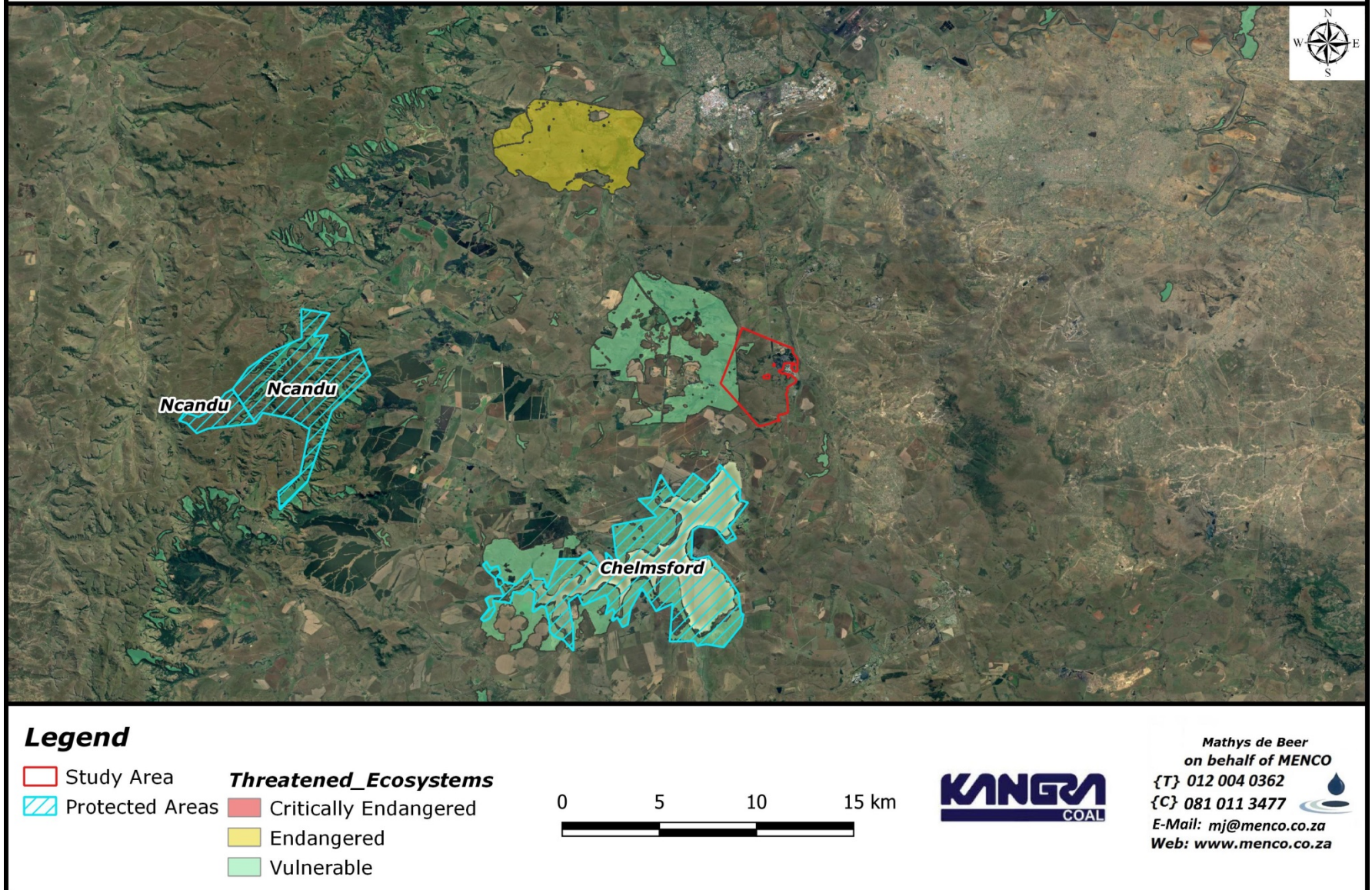


Figure 5-2: Threatened Ecosystems Applicable to the Eco-Region

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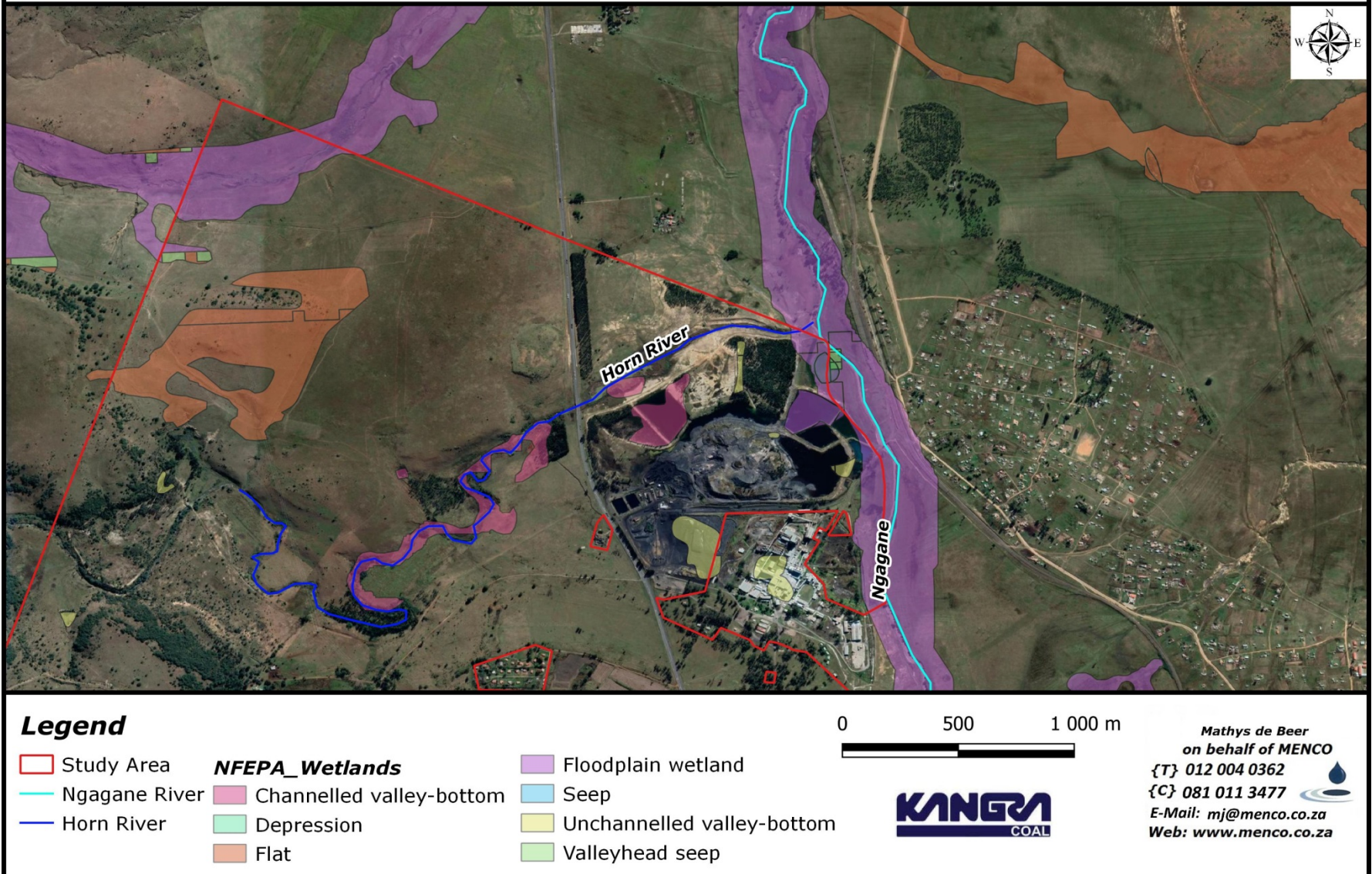


Figure 5-3: NFEPA Wetlands



5.3 IHAS SCORES

The habitat assessment (IHAS) assesses the potential that the biotopes have to provide adequate habitat for colonization by various macro-invertebrates. According to (McMillan, 1998) the following parameters give a good indication to the habitat quality:

- <55%: *habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.*
- 55%-65%: *habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.*
- >65%: *habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.*

The Index of Habitat Integrity scores (%) for the in-stream and riparian zone components as devised by (Kleynhans & Louw, 2007) are indicated in **Table 5-4**

Table 5-4: Habitat Integrity Index Classes

Class	Description	Score (%)
A	Unmodified, natural	90 – 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the assumption is that ecosystem functioning is essentially unchanged.	80 – 89
C	Moderately modified. A loss of change in natural habitat and biota has occurred, but basic ecosystem functioning appears predominately unchanged.	60 – 79
D	Largely modified. A loss of natural habitat and biota and a reduction in basic ecosystem functioning is assumed to have occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and ecosystem functioning is extensive.	20 – 39
F	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst cases, the basic ecosystem functioning has been destroyed.	0 - 19

(Kleynhans & Louw, 2007)

5.4 ECOSTATUS DETERMINATION

The ecological status (*EcoStatus*) of a river refers to its overall condition or health, i.e. the totality of the features and characteristics of the river and its riparian areas, which manifests in its ability to support a natural array of species. This ability relates directly to the capacity of the system to provide a variety of goods and services.

For this report, data was collected primarily on habitat integrity and the biological response indicators as shown in **Figure 5-4**. The outcome of this overall assessment will be referred to as the *EcoStatus* and comprises six indicators namely:

- *Instream Habitat Integrity,*
- *Riparian Zone Habitat Integrity,*
- *Riparian Vegetation Integrity,*
- *Fish Assemblage Integrity,*
- *Macro-invertebrate Integrity, and*
- *Water Quality (diatoms).*

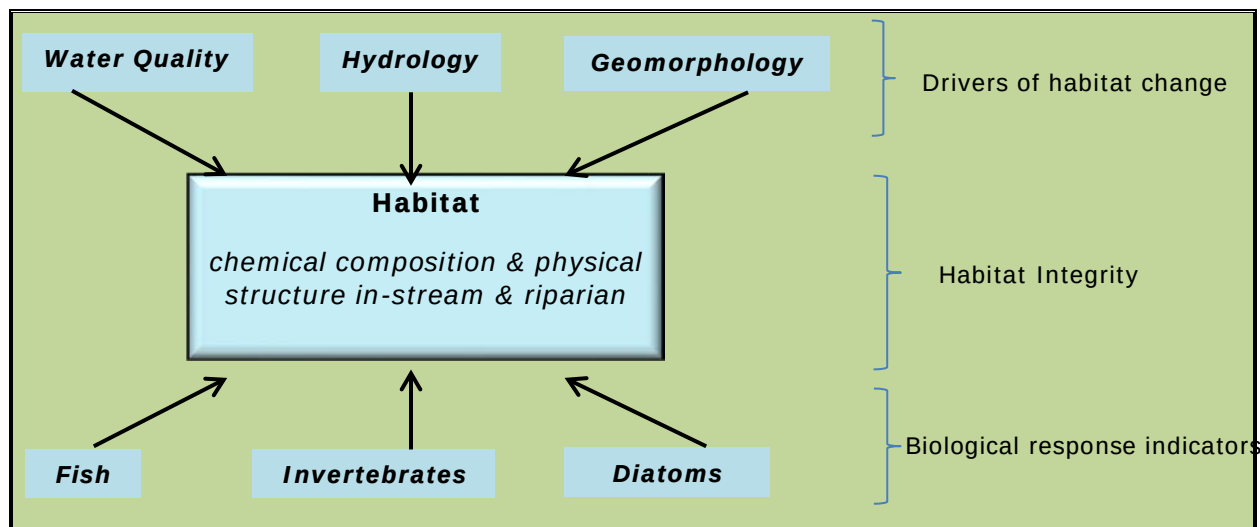


Figure 5-4: Ecological Status Response Indicators

The ecological importance and sensitivity (EI&S) provides an indication from an ecological perspective of whether a river should receive a high level of protection or not. The following EI&S categories can be assigned to a river:

Table 5-5: EcoStatus Indices

EI&S Category	Description
<i>Very High</i>	A high or very high EI&S indicates that there is strong ecological motivation for awarding a high level of protection to the associated river, and such rivers should ideally be maintained in a natural or good river health category
<i>High</i>	
<i>Moderate</i>	A low/marginal or moderate EI&S denotes that a river has relatively lower conservation value and that such a catchment is more suited to development than one where a river has a higher EI&S.
<i>Low/Marginal</i>	

A river health categorisation is used to provide a simplified user-friendly key to a much more intricate and complex process of assessing the *EcoStatus* of a river. Each river health category relates to a level of ecosystem health, which in turn relates to the potential of the river to support a particular range of ecosystem services. The river health categories and their relation



to the water resource classification system as proposed by the Department of Water Affairs and Forestry are presented in the table below.

Table 5-6: River Health Categorisation & Water Resource Classification System

Category	Description	Proposed Class	Description
Natural	No or negligible modification of instream and riparian habitats and biota.	Natural	Human activity has caused no or minimal changes to the historically natural structure and functioning of biological communities, hydrological characteristics, chemical concentrations and the bed, banks and channel of the resource.
Good	Ecosystem essentially in good state; biodiversity largely intact.	Moderately used or impacted	Resource conditions are slightly to moderately altered from the Natural class due to the impact of human activity and water use.
Fair	Sensitive species may be lost, with tolerant or opportunistic species dominating	Heavily used or impacted	Resource conditions are significantly changed from the Natural class due to human activity and water use, but are nonetheless ecologically sustainable.
Poor	Mainly tolerant species present or alien species invasion; disrupted population dynamics; species are often diseased.	Unacceptably degraded resources	Due to over-exploitation, these rivers are already in a state that is ecologically unsustainable.

(Department of Water Affairs and Forestry, 2004)

6 HABITAT ASSESSMENT

All the sites are described in terms of the Invertebrate Habitat Assessment System (IHAS). In depth descriptions of each site is provided in **Table 6-1** below. The overall habitat integrity of the sites can be classified as largely natural to Good with a few modifications such as previous River diversions which has alternated the flow of the Horn River for an extended period. This mainly indicates that resource conditions are slightly too moderately altered from the Natural class due to the impact of human activity and water use. This category of habitat integrity provides a moderately used habitat for aquatic species and can be classified as having a moderately High Ecological Importance and Sensitivity factor. The decant which confluences with the Horn River has been active for an extended time period with physio-chemical alterations expected to affect the overall habitat integrity of the downstream Horn River. The physio-chemical alterations within the Horn River have resulted in a darkish brown turbidity and subsequent water coloration within the river system. The confluence at the Ngagane River changed to a murkier grey brown coloration as it enters the river system with no differences in water coloration observed when comparing the Ngagane US and Ngagane DS sites. No indications of any visible water quality changes would tend to indicate that the Horn River has very little physio-chemical impacts on the habitat integrity of the Ngagane River.

Table 6-1: Physical Habitat Descriptions of the Monitoring Sites

Site	Photos	Characteristics
Horn US		This site is situated within the Horn River approximately 300 m upstream of the decant point. This site is considered as an important upstream reference site. It should be noted that this site has been moved closer to the decant site due to access constraints further upstream. This site had various deeper water sections which could not be analysed for SASS5 purposes. The river substrate was mostly associated with mud with limited GSM also present. Aquatic and marginal vegetation were mostly restricted to the riverbanks which constituted the main area used for SASS5 purposes. Trampling from cattle at several areas close to the river bank was also observed which increased bank erosion.
Horn DS1		This site is situated approximately 200m downstream of the decant point also situated within the Horn River. This site is situated just upstream of a bridge at the N11 road. The substrate at this site was dominated by mud with overhanging trees and aquatic vegetation mostly located around the river banks. The river also meanders into several meandering channels creating deeper back water sections within the river system. The river is highly associated with wetland/lentic conditions. This site is not considered as the most ideal sampling point due to a lack of available sampling biotopes.

Horn DS2		This site is located approximately 700 m downstream of the Horn DS 1 site also located within the Horn River. This site is clearly impaired by several erosion channels which contribute to additional AMD. The river has a deeper section at the outflow of the upstream dam with shallower sections being located within the downstream bio-monitoring cross section. Steep banks occur around the river edge with vegetation being restricted to reedbed with some aquatic vegetation occurring in isolated patches. Although stones in and out of current were present the surface of these stones were covered with a ferric oxide layer which restricted the presence of benthic aquatic macro invertebrates to some extent. A narrow river channel of 1.5m – 2 m was present at this site.
Ngagane US		The site is located within the Ngagane River approximately 100m upstream of the confluence with the Horn River. This site is considered as an important reference site. Gentle slopes forms around the river channel with steep embankments also present. Some marginal vegetation and aquatic vegetation were present around the river banks but was however restricted. The River channel was also fairly deep which restricted sampling procedures to the river edges. The substrate largely consisted of mud with a few areas close to the river banks containing gravel as well as sand.

Ngagane DS		The site is located within the Ngagane River approximately 140m downstream of the confluence with the Horn River and represents an important comparative site when taking the impact of the Horn River into account. High flows were to a large extent observed with aquatic and marginal vegetation being mostly restricted to the Rivers edge. Overhanging trees with roots dissecting the stream channel has also resulted in bank erosion with natural forming tannins also occurring saturated around the rivers edge. A variety of fish and frog species were also sampled at this site. A slightly shallower back water channel has also been observed next to the eastern riverbank.
PCD		The Pollution Control Dam is situated on site to treat mine waste water before it is discharged into the Horn River. The PCD is situated approximately 50 m upstream of the Horn River. A dirt road is situated in between the PCD and wetland system. Severe erosion channels between the road and wetland system has been observed which suggests that water is leaching through the built road from the opposite side. Seeing as the water quality associated with the PCD has several increased spikes in chemical parameters it is important to ensure that no leaching from the PCD occurs.

Decant		The acidic decant along the railway line between the Jacaroo Park residential complex and the Portion 19 (Remaining Extent) of the farm Ballengeich 3299 HS mining area is regarded as a major diffuse contributor of pollution. No direct changes in water quality is however visually observed at the inlet of the decant site. A high presence of dissolved salts has been observed by means of crystallised white precipitate layers along the outer edges of the decant zone. The same ferric oxide precipitate observed at the Horn DS2 site is also prevalent throughout the outer reaches of its flow channel.
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7 SURFACE WATER ASSESSMENT

During the extent of the site visit seven (7) sites were assessed for surface water purposes. These sites were specifically selected to track and relate any water quality changes within the aquatic ecosystem associated with the Horn and Ngagane River and strongly relates to the on-going AMD and old decant and potential effects it has on the receiving water ways. Three surface water sites within the Horn River were selected while 2 sites were selected within the Ngagane River. The decant point as well as the PCD were also assessed for surface water purposes. All of the applicable surface water samples were analysed by Waterlab which is an accredited SANAS 5667 laboratory. As part of the assimilative capacity determination in-situ data was also obtained at various localities within the Horn and Ngagane River.

The following surface water qualities were measured during the sampling process during the site visit: Water temperature, Electrical Conductivity, pH values and Dissolved Oxygen. The *in-situ* data is only an indication of what the applicable variables were at the time of study and may differ from the laboratory results in **Appendix A**.

pH Values:

The pH of natural waters is determined by both geological and atmospheric influences, as well as by biological activities. Most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6 to 8, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (*Department of Water Affairs and Forestry, 1996a*).

Temperature:

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (*Department of Water Affairs and Forestry, 1996*). Temperature affects the rate of development, reproductive periods and emergence time of organisms (*Department of water Affairs and Forestry, 2006*).

Electrical Conductivity:

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current (*Department of Water Affairs and Forestry, 1996*). This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge (*Department of Water Affairs and Forestry, 1996a*). Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently they do not affect the EC (*Department of Water Affairs and Forestry, 1996*). Electrical conductivity (EC) is a rapid and useful surrogate measure of the

Total Dissolved Solids (TDS) concentration of waters with a low organic content (*Department of Water Affairs and Forestry, 1996*).

Dissolved Oxygen:

The maintenance of adequate dissolved oxygen (DO) is critical for the functioning of aquatic ecosystems since it is required for the respiration of all aerobic organisms (*Department of Water Affairs and Forestry, 1996*). Therefore, DO concentration provides a useful measure of the health of an ecosystem. The median guideline for DO for the protection of aquatic biota is > 5 mg/l (*Kempster, et al., 1980*). Certain oxygen-consuming chemical effluents may reduce oxygen levels in water but the most common anthropogenic causes of low oxygen levels are organically enriched effluents and eutrophication (*Davies & Day, 1998*).

The in-situ data clearly indicates that the EC values for the Decant and PCD has exceeded the RWQO values to a significant extent and could have potential devastating effects on aquatic ecosystems should the applicable parameter levels directly reach the Horn River. When taking the water quality data of each of the applicable sampling localities within the Horn River into account it was observed that the in-situ data at the Horn DS2 site had the lowest pH level as well as the highest EC level. The pH level is considered to only be slightly non-compliant to the aquatic RQO's and somewhat improves to 6.5 before its confluence with the Ngagane River. The EC value at the Horn DS2 site has increased from the 2022 assessment (44) to 114 during the current assessment. Considering the wet season, it is expected that an increase in EC levels might be probable particularly due to additional nutrients being released from the wetland system and dam just upstream of this site. The EC levels have gradually improved to 75 before its confluence with the Ngagane River.

A similar conductivity and EC has been obtained for the PCD which is expected considering the functionality of the PCD. The pH at the decant has however slightly improved from 2.6 to 3.3 during the current assessment which could possibly be attributed to increased clean surface water-runoff related to recent precipitation events. The conductivity has however considerably increased. It should be noted that in comparison the Horn US site also has a comparatively high EC when being compared to the downstream Horn River sites. The Ngagane River on the other hand obtained very similar (highly compliant) pH as well as EC levels for both the upstream and downstream sites indicative that there are no significant impacts on the Ngagane river from an in-situ data perspective. Please refer to **Figure 7-1** and **Figure 7-2** for in-situ data comparisons.

**Table 7-1: Water quality analyses**

Variables	Sample Identification								
Sites	Decant	Horn US	Horn DS1	Horn DS2	Ngagane US	Ngagane DS	PCD	Ngagane RQO's	RWQO
pH	3.3	7.6	7.1	6.3	7.4	7.3	2.6	6.5 - 9	6.5 - 9
EC	735	80.6	87.7	115	36.2	34.7	500		<70
TDS	7260	204	268	288	298	252	4796	<350	<520
T Alkalinity	<5	56	56	24	66	72	<5		
Cl	168	7	9	12	13	11	29		<163
SO ₄	4379	300	334	509	69	88	3036		<324
DO	8.7	9.4	8.8	7.2	8.8	8.8	8.9		>5
Na	1006	21	29	51	33	37	261		<115
K	36	2.5	2.9	3.3	2.1	2.3	8.6		<50
Ca	531	61	66	85	14	16	414		<108
Mg	511	51	57	75	12	10	281		<51
Al	0.568	<0.100	<0.100	0.148	0.498	0.582	151	<0.105	<0.2
Fe	8.83	<0.025	<0.025	0.042	0.167	0.237	57	<0.1	<1.0
Fe 2+	0.146	<0.025	<0.025	<0.025	0.062	0.082	0.462		
Fe 3+	8.68	<0.025	<0.025	<0.025	0.132	0.155	56		
Mn	4.22	0.735	0.882	1.84	0.132	0.136	16	<0.15	<1.0

The water quality results obtained during the current assessment indicate that there are minimal non-compliances associated with the Ngagane River with only Aluminium levels being slightly non-compliant to the aquatic RQO limits. Taking the Horn River into account EC levels were considered to be non-compliant throughout the river system with a slight peak observed at the Horn DS2 site. Sulphate and Magnesium levels have increased to non-compliant levels at the two applicable downstream sites with a slightly elevated increase observed at the DS2 site.

Considering the significant spikes in Mg and Na levels obtained at the Decant it is highly possible that these increases are related to the confluence of the decant site. Highly non-compliant levels for these chemical parameters have also been observed at the PCD which could also attribute to increased levels within the Horn River. Excessive erosion channels with possible leaching from the PCD could directly impact the DS2 site especially considering the close proximity of these channels and PCD to the DS2 site. Additionally, a spike in manganese levels have also been observed at the DS2 site.

Exceedingly high chemical parameters were observed at the Decant and PCD which could have potential detrimental impacts on the water quality of the Horn River. Several erosion channels around the Horn River were observed as a result of long-term Acid Mine Drainage which has impacted the river system over an extended period. High TDS, SO₄, Na and Mg levels were observed at these sites which could be expected as these sites are associated with current and historic mine waste water. The water associated with the decant was observed to have flown at a steady rate. It is estimated that continual run-off from the decant will gradually decrease the water quality of the Horn River and subsequently the Ngagane River if the surface water flow is not prohibited. Kangra Coal is in the process of implementing a passive AMD treatment system at the site, comprising an Anoxic Limestone Drain (ALD), Successive Alkaline Producing System (SAPS), Oxidation/Sedimentation Pond, and Aerobic Wetland units, designed to treat AMD decant to within the GN 1873 Resource Quality Objectives before discharge to the Horn River.

With the River diversion being put in place several years ago diffuse pollution and AMD from the PCD could have significant impacts on the habitat conditions and water quality of the downstream Horn River.

A small weir was also identified close to the confluence with the Ngagane River. Control structures, such as weirs and barrages, constructed on a river will change the hydraulic regime of that river by increasing water depths and reducing velocities in the zones of developed backwater curves. This modified hydraulic regime impacts water quality due to changes in the transport and decay processes of pollutants along the rivers.

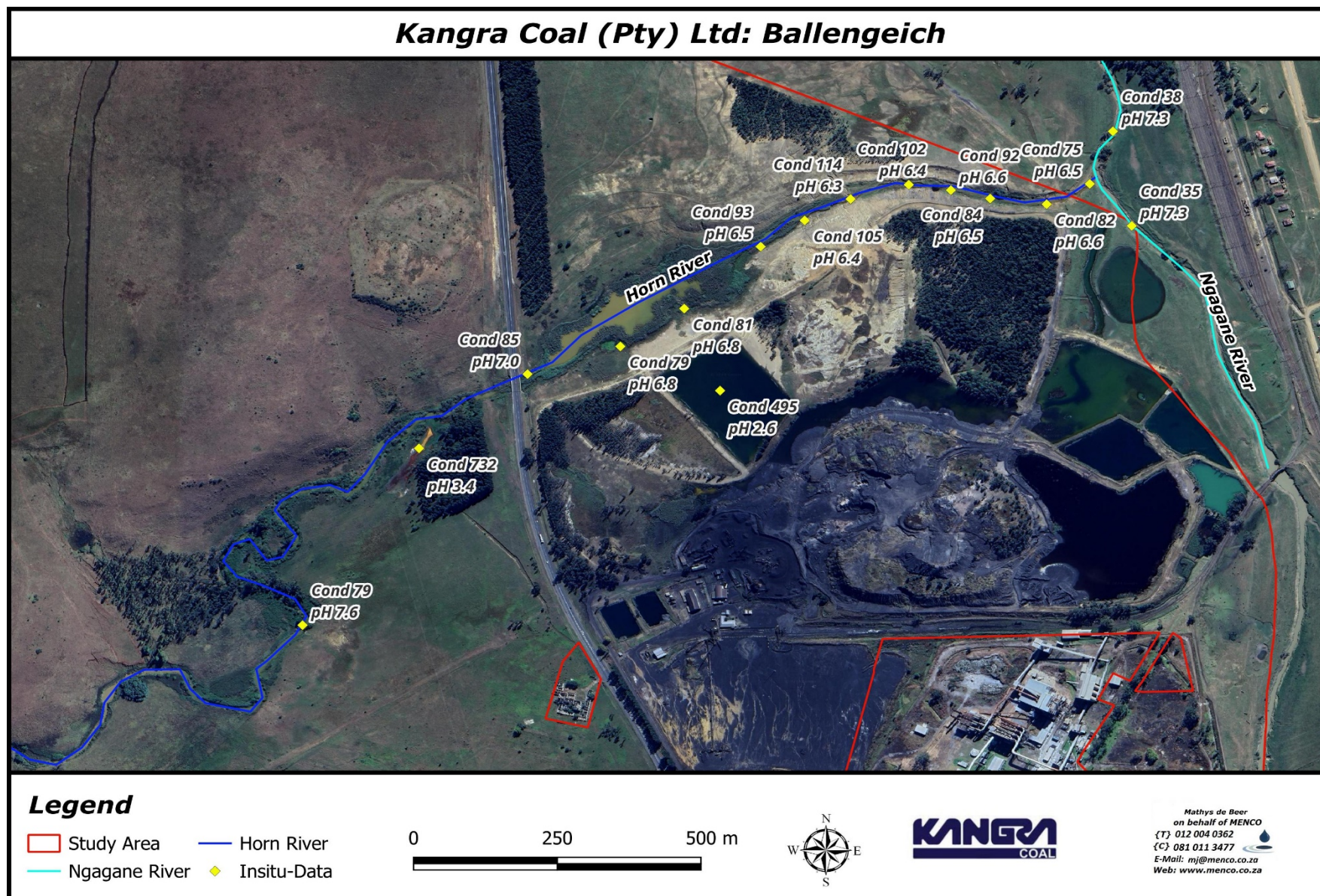


Figure 7-1: In-situ data sites (2023)

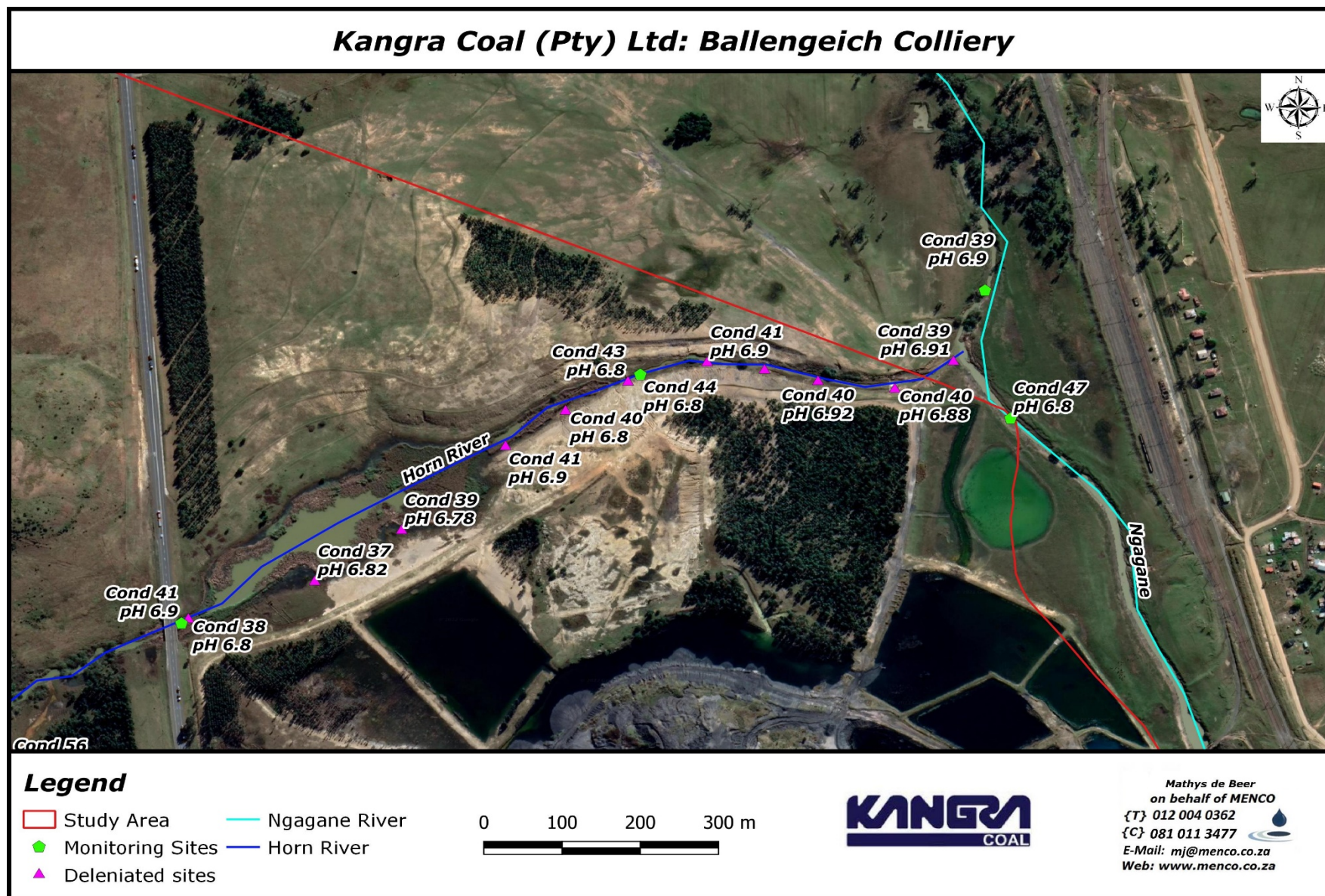


Figure 7-2: In-situ data sites (2022)



In accordance with GN 320 (Regulation 8) requirements, the surface water quality results obtained during the November 2023 assessment are formally assessed below against the applicable GN 1873 (March 2022) Resource Quality Objectives (RQOs) for the V31F (Horn River) and V31K (Ngagane River) catchments. Monitoring sites are designated as Compliant (C), Non-Compliant (NC) or Not Applicable (N/A) for each key parameter. Results in bold italics indicate exceedances of the applicable RQO.

Table 7-2: GN 320 / GN 1873 Surface Water Quality Compliance Assessment – November 2023

Parameter	RQO (V31F / V31K) mg/L	Decant	PCD	Horn US	Horn DS1	Horn DS2	Ngagane US	Ngagane DS
pH	6.5–9.0	3.3 NC	2.6 NC	7.6 C	7.1 C	6.3 NC	7.4 C	7.3 C
EC (mS/m)	≤70	735 NC	500 NC	80.6 NC	87.7 NC	115 NC	36.2 C	34.7 C
TDS (mg/L)	≤350	7260 NC	4796 NC	204 C	268 C	288 C	298 C	252 C
SO ₄ (mg/L)	≤165 / ≤200	4379 NC	3036 NC	300 NC	334 NC	509 NC	69 C	88 C
Fe (mg/L)	≤0.1	8.83 NC	57 NC	<0.025 C	<0.025 C	0.042 C	0.167 NC	0.237 NC
Mn (mg/L)	≤0.15	4.22 NC	16 NC	0.735 NC	0.882 NC	1.84 NC	0.132 C	0.136 C
Al (mg/L)	≤0.105	0.568 NC	151 NC	<0.1 C	<0.1 C	0.148 NC	0.498 NC	0.582 NC
Cl (mg/L)	≤120	168 NC	29 C	7 C	9 C	12 C	13 C	11 C
Na (mg/L)	≤115	1006 NC	261 NC	21 C	29 C	51 C	33 C	37 C
DO (mg/L)	>5	8.7 C	8.9 C	9.4 C	8.8 C	7.2 C	8.8 C	8.8 C

C = Compliant with GN 1873 RQO; NC = Non-Compliant with GN 1873 RQO. Highlighted cells (NC) indicate exceedances. RQO values: 95th percentile for all parameters except nutrients. Horn River (V31F) and Ngagane River (V31K) share the same RQO limits for most parameters, with the exception of SO₄ (≤165 mg/L for V31F; ≤200 mg/L for V31K).



8 AQUATIC ASSESSMENT

It has been found that significant differences between SASS Scores and taxa numbers are obtained between different SASS operators. In addition it was found that ASPT scores are more consistent measures for indicating river health during temporal assessments in a given reach of a river (*Dickens & Graham, 2002*). This method has proven over years that it is the most consistent in classifying the ecological reserve.

An investigation into the aquatic invertebrate composition of a stream gives a decent indication of the short-term biological (biotic) integrity of the system. The SASS5 sheets as compiled during this assessment are included in the report and the ASPT and SASS scores are presented for each stream and river assessed below.

Compared to the reference score, based on the definition of Present State Classes in terms of SASS5 scores as presented in (*Dickens & Graham, 2002*), the streams associated with the project area have produced varied results. A PES of a Health Class D was determined for the Ngagane River while the obtained results for the sites located within the Ngagane River produced a Health Class D/E.

It should be noted that the PES199 classification originally rated the Horn River as a Health Class C. This classification has deteriorated to a Health Class E according to the PES2018 River classification. The deterioration in Health Class is highly associated with continual external impacts including mining activities as well as agriculture which has resulted in a gradual deterioration in habitat availability, habitat integrity as well as water quality within the quaternary catchment. Similarly, the PES Health Class rating for the Ngagane River has deteriorated from a Class B to a Class C.

The current Health Class obtained for the Horn River (Health Class D/E) is thus slightly in an improved state when being compared to the PES2018 and slightly in a deteriorated state when being compared to the Default catchment Class (Class D). The current Health Class obtained for the Ngagane River (Health Class D) is thus slightly in an impaired state when being compared to the PES2018 and in a comparable state when being compared to the Default catchment Class (Class D).

Taking the ASPT scores into account during the assessment, together with the SASS, IHAS and Water quality data the aquatic ecosystem were evaluated and the current PES for each aquatic ecosystem could be obtained. The graph below presents each rivers score and an average score for all the sites was obtained for comparison.



Figure 8-1 indicates an overall trend that the SASS5 as well as the ASPT results have slightly deteriorated since 2022 for each of the applicable monitoring sites. It should also be noted that the Horn US site has been moved closer to the decant site due to access constraints further upstream. The original upstream site was deemed as a very favourable site with a wide variety of biotopes available for sampling purposes which justified the high SASS5 and ASPT scores. The new upstream site was not deemed as an ideal monitoring site due to a lack of available biotopes as well as deep water channels which constituted a lower overall aquatic score.

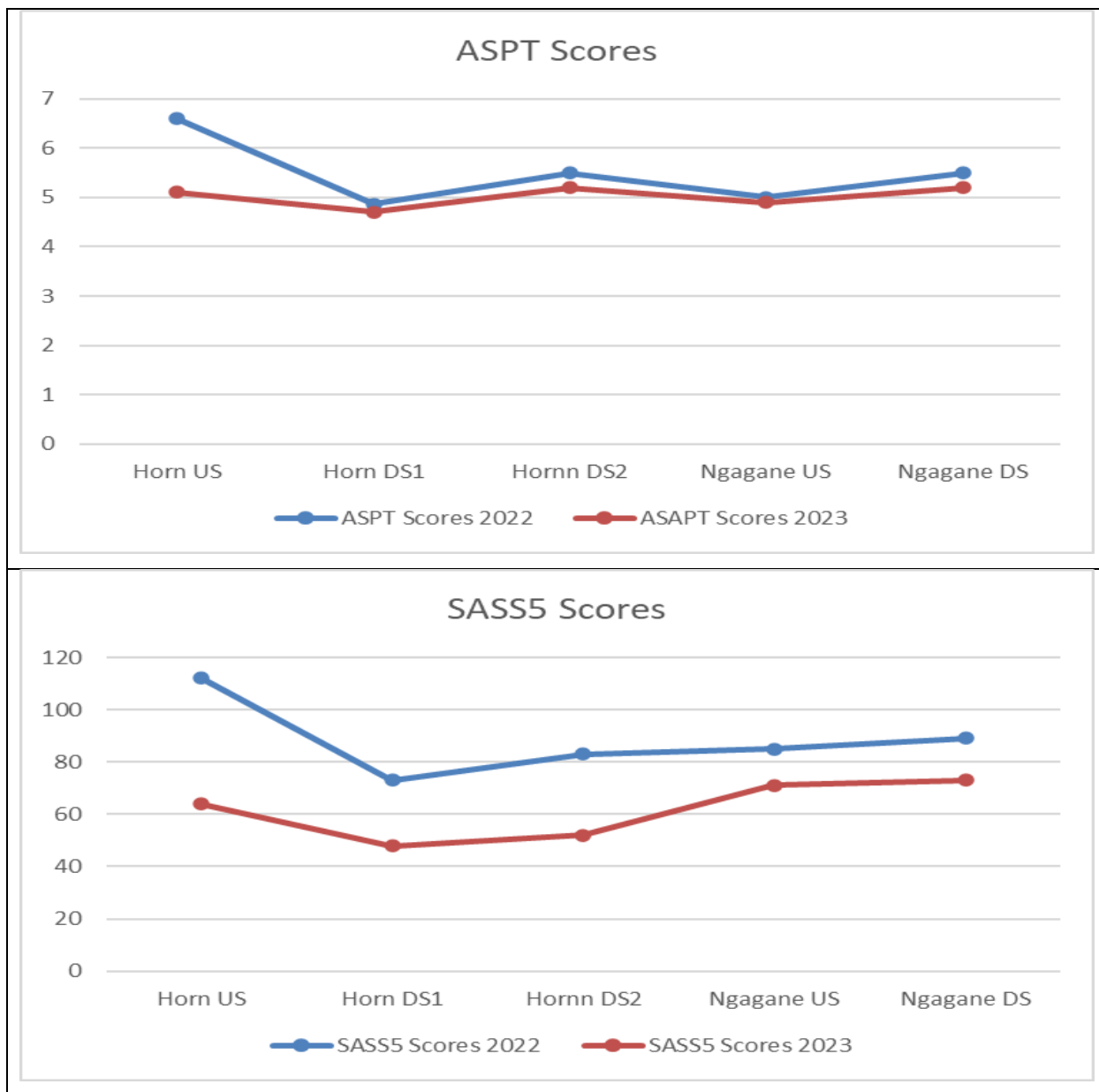


Figure 8-1: 2022/2023 Season Assessment PES Comparisons

**Table 8-1: Bio-monitoring results**

Sites	SASS5	ASPT	IHAS	Health Class
June 2022				
Ngagane US	85	5	62	C
Ngagane DS	89	5.5	76	C
Horn US	112	6.6	82	B
Horn DS1	73	4.87	58	D
Horn DS2	83	5.5	72	C
Sites	SASS5	ASPT	IHAS	Health Class
November 2023				
Ngagane US	71	4.9	58	D
Ngagane DS	73	5.2	66	D
Horn US	64	5.1	52	D / E
Horn DS1	48	4.7	54	D / E
Horn DS2	52	5.2	58	D / E

Taking the current bio monitoring results into account it should be noted that there were several habitat restrictions and limitations which affected the scores of the overall bio monitoring results. The Ngagane US site was not suited as an ideal monitoring location but had to be used for monitoring purposes due to a lack of access further upstream. The site was dissected by a rather deep river channel which restricted aquatic macro-invertebrate sampling to the river edges. Strong flowing conditions were also present within the river which affected the species diversity further downstream. The restrictions in habitat biotopes are supported by a reduced ASPT and SASS5 score which is justifiable with reduced IHAS scores being obtained throughout the sites.

Several long-term impacts on the river system have resulted in the REC aquatic scores obtained within the Ngagane River to decrease gradually over time with one of the biggest drivers being pollution from activities within the domestic, industrial, mining and agriculture sectors. Another key driver of changes in aquatic ecosystems is invasive alien species. The infestation of riparian areas by alien vegetation can cause significant change in the health of river ecosystems. Alien fish species also have a significant impact on the aquatic ecosystem.



Largemouth bass (*Micropterus salmoides*) and Common carp (*Cyprinus carpio*) are both common in the rivers of the District.

The sediment toxicity results **section 9** indicated a high toxic hazard for the decant and downstream Horn River. The high toxicity levels reduce natural aquatic and marginal vegetation plant growth abilities and is also considered to be a serious habitat barrier for several aquatic macro invertebrate species such as Benthic aquatic macroinvertebrates which are highly dependent on substrate soils within river systems for survival.

Impaired bio monitoring results were obtained at the Horn DS2 site with a Health Class D/E being attained. The overall aquatic scores have deteriorated since 2022 which could be attributed to impaired habitat conditions as well as physio-chemical barriers. Increased surface water flow during the current wet summer period has resulted in a considerable absence in Hemiptera specimen which prefer stagnant water systems. These aquatic specimens are normally found within vegetated cover during increased flow rates. Due to a considerable loss in available bank vegetation cover these species have most likely moved further downstream. The conditions at this site were largely associated with lentic characteristics with wetland conditions largely occurring. The substrate was also dominated by a thick layer of mud with vegetation available for sampling being restricted to mostly reed bed vegetation. The natural flow dynamics and characteristic from the Horn US site has been slightly compromised by the river diversion which was constructed many years ago and as a result impacted the aquatic habitat integrity at this specific site.

A orange ferric iron precipitate has been observed at the Horn DS2 site on most of the submerged rocks as well as several areas next to the river bank. As a result, this creates a smothering effect on most of these surfaces which subsequently decreases the diversity of aquatic macro invertebrates found, especially benthic species which are normally found directly on or underneath rocks. From visual observations being made very few benthic species were sampled at this site.

The current bio monitoring results indicate that Ballengeich has very little to no impact on the current aquatic macro invertebrate communities related to the Ngagane River and more specifically the V31K quaternary catchment. Compared to the Ngangane US site the aquatic scores have remained very similar at the downstream site. More direct impacts can however be observed on the Horn River with AMD impacting the aquatic indices. It should however be noted that upstream reference conditions indicate that external impact sources also impact the Horn River on various scales.

8.1 SENSITIVE SPECIES

Of the families identified during the 2022 dry season assessment 5 species were recorded in 5 families that were sensitive to pollution (SASS score >7). The five families identified include **Crustacea; Ephemeroptera; Odonata; Hemiptera; Coleoptera**. It should be noted that most of the applicable sensitive species were sampled at the Horn US site. The species recorded are presented below.

Specie	Common Name	Characteristics	Picture
<i>Baetidae >2sp</i>	Mayflies (12 QV)	- Gills under abdomen, - Usually three tail Filaments, - Dart actively from stone to stone, - Light sand to dark brown colour, - Size of 3 – 28mm.	
<i>Aeshnidae</i>	Hawkers & Emperors (8 QV)	- Long, tapering bodies with large eyes, and thin antennae. - Swims in short bursts or walks on surfaces. - Green, brown or black of colour. - Size of 3mm – 6cm.	
<i>Naucoridae</i>	Creeping water bugs (7 QV)	- Oval, slightly fat bodies, with exceptionally broad heads. - Forelegs adapted for holding prey, - Move around in fast half creeping fashion and stings when handled carelessly. - Brown or green of colour	
<i>Atyidae</i>	Freshwater Prawns (8 Qv)	- Among vegetation and edges of streams - Jumps when disturbed or surprised - Five pairs of legs - Small pinchers on first two pairs of legs	

Elmidae	Riffle beetles (8Qv)	- Sharp claws on feet - Fast streams at stones or solid substrate - Walking/crawling whilst clinging to substrate - Very slow moving - Some species with red toes	
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Figure 8-2: Sensitive Species Aquatic Life Recorded

9 TOXICOLOGICAL ASSESSMENT

Table 9-1: Toxicity Analyses

Results		Horn US	Decant	Horn DS
Heterocypsis inconspicua (Ostreocod) (A)	Date test performed	2023.11.23	2023.11.23	2023.11.23
	*144hour inhibition (-) / stimulation (+) (%)	-11	N/A	N/A
	144hour mortality rate (% relative to control)	-10	-100	-100
	Description	no lethal/sub-lethal hazard	S.D.O.T.H	S.D.O.T.H
Phytolacca (seed germination) (A)	Date test performed	2023.11.24	2023.11.24	2023.11.24
	*72hour inhibition (-) / stimulation (+) (%)	1	-70	-14
	72hour Germination success (% relative to control)	-11	-41	0
	Description	S.D.O.T.H	S.D.O.T.H	no lethal/sub-lethal hazard
Overall classification - Hazard class		Class II - Slight lethal hazard	Class IV - High lethal/sub-lethal hazard	Class IV - High lethal hazard
Weight (%)		50	83	50
* = The sub-lethal toxicity interpretation relies on the inhibition/stimulation result of this test. The lethal toxicity interpretation relies on mortalities and germination success S.D.O.T.H = Some degree of toxicity hazard, refer to overall hazard classification Weight (%) = relative toxicity levels (out of 100%), higher values indicate that more of the individual tests indicated higher toxicity levels				
Site	Hazard classification		Percentage Effect	
Horn US	II	☹	A statistically significant (P<0.05) PE is reached in at least one test, but the effect level is below 50%	
Decant	IV	☠☠	The 100% effect is reached or exceeded in at least one test	
Horn DS2				

Three (3) sediment samples were obtained throughout the study area and analysed for toxicological purposes which included two (2) sampling sites within the Horn River as well as an additional sampling site at various sections of the decant channel. Toxicological assessments were conducted in order to detect the Ecological Effect Potential by measuring the various toxicity mixtures obtained within the soil mixture. Percentage effects in the form of Phyto seeds were also analysed in order to establish the capability of plant seed growth

within the affected soil body. It should be noted that three separate samples were obtained at each sampling site in order to establish an aggregate sample.

Sediment sample Horn US showed a slight lethal environmental toxicity hazard (Class II) based on the 11% phytotox germination inhibition effect noted following testing. Sediment samples Decant and Horn DS2 were allocated a Hazard Class IV (high lethal and/or sub-lethal environmental toxicity hazard) based on the 100% ostracod (*H. incongruens*) mortalities (lethal) for both samples, together with the 70% phytotox growth inhibition effect (sub-lethal) and the 41% phytotox germination inhibition effect (lethal) noted following testing for sample Decant.

When comparing the toxicity results it could be observed that the sediment toxicity of the Horn River it is observed that the upstream site's soil toxicity is already slightly impaired obtaining a Class II (slight lethal hazard). Considering the lentic conditions associated with the Horn River this class could be justified as reference conditions considering the soils stagnant nature in conjunction with an influx in nutrients typically associated with the streams hydro geomorphological characteristics. The decant site as well as the Horn DS2 site has a hazard Class rating IV (high lethal/sub-lethal hazard) which could have detrimental impacts on the soil characteristics of the aquatic ecosystem.

The decant site in particular has a 70% phytotox growth inhibition effect meaning that the effected soils will have a severe effect in delaying seed germination as well as plant growth inhibition effects. A 100% mortality rate for Ostracods at both the decant as well as the Horn DS site indicate severe toxic stress conditions for invertebrates in general which would affect a large array of aquatic macro invertebrates as well.

10 ECOLOGICAL STATUS

Align with the River Health Programme (RHP), Menco used the indices, or composite indicators to report on the current state, the cause of change, the desired state and make informed recommendations for achieving the required health class. The Present Ecological Status (PES) that was obtained by Menco is comparable to the DWS and RHP data with slight differences notable.

The in-stream and riparian habitats in the V31G and V31K catchments show an acceptable to deteriorated state, with the general condition being fair in catchment. Biological communities also reflect a slightly impaired health status with physio-chemical, soil and habitat modifications contributing to localised impacts on invertebrates.

Table 10-1: Overall Eco Status of Ngagane River

Water Quality	SASS5	IHAS	Health Class
			Class D: Largely Impacted
Good	D	D	

Table 10-2: Overall Status of the Horn River

Water Quality	SASS5	IHAS	Toxicity	Health Class
				Class D/E: Largely to Severely Impacted
Fair	D/E	D	Class IV	

The desired ecological state is important to have an idea of what is achievable and what is not. It also provides resource managers with directions for making decisions and implementing management actions. Some management action is discussed in **Section 11**.

The health Class rating for the Ngagane River is rated as a Health Class D which is slightly in an impaired state when being compared to the SANBI PES and in an comparable state when

being compared to the catchment PES. Strong flowing conditions in conjunction with deeper water channels at the upstream site contributed to alterations within the aquatic indices while biotope limitations also had a localised impact. No clear impacts stemming from the Horn River were observed within any of the applicable aquatic indices.

The health Class rating for the Horn River is rated as a Health Class D/E which is slightly in an impaired state when being compared to the catchment PES and in a comparable state when being compared to the SANBI PES. Impacts from the AMD as well as decant was observed throughout several areas of the Horn River which to an extent affected the physio-chemical characteristics, habitat integrity as well as invertebrate toxic stress conditions.

It is important that Kangra Coal aim to ensure that the current Health Class D is maintained for the Ngagane River or improved to a Health Class C. Kangra should at all times ensure that the aquatic scores obtained within the Ngagane River are similar for both the upstream and downstream sites. It is not expected that the Ngagane River will improve to a Health Class B within the upcoming bio monitoring events as the Ngagane River is impacted by several upstream impact sources.

It is important that Kangra Coal ensures that the AMD from the PCD as well as the run-off water from old decant is maintained and does not increase the water quality parameters as well as soil toxicity of the Horn River. The passive wetland system should be constructed as soon as possible to ensure that baseline upstream conditions are re-established further downstream.

11 MANNAGEMENT ACTIONS AND MITIGATION MEASURES

Some management actions that could be implemented by Kangra Coal in the overall protection and Conservation of the Horn River and Ngagane River include:

- *Bio-monitoring indices used in the River Health Programme are good indicators of the ecological state of rivers and can therefore flag problem areas where corrective measures are required. It's therefore recommended that bi-annual bio-monitoring continues.*
- *Restore and rehabilitate channel morphology and riparian vegetation. There was a definite lack of riparian vegetation around several areas of the Horn River on-site.*
- *Stabilise bank erosion; these erosion channels should be rehabilitated and re-vegetated especially at the Horn DS 2 and Ngagane US sites.*
- *Clear alien vegetation from riparian zones and catchment;*
- *Ensure compliance to water quality objectives set for the catchment and aquatic ecosystems as well as to the applicable WUL.*
- *Identify and control sources of pollution that are reducing water quality; Kangra Coal is in the process of implementing a passive AMD treatment train (ALD → SAPS → Oxidation Pond → Aerobic Wetland) designed to a capacity of 1,000 m³/day, which will capture and treat AMD from the artesian decant point and discharge treated effluent to the Horn River within GN 1873 RQO compliance limits.*
- *Taking the high toxicity class into account, it is highly recommended that a soil rehabilitation assessment be conducted within the upcoming dry season, particularly within the sediment deposition planes within the Horn River. Toxic soils should be removed and revegetated in order to improve toxicity levels.*
- *Several water quality parameters of the PCD were also considered as exceeding the RQO's to a significant extent. It is critically important that Kangra Coal ensures that the water within the PCD is contained and the dam properly lined to ensure that waste water does not leach into the Horn River as it could have potential devastating impacts on the receiving environment.*
- *It is important that Kangra Coal aim to ensure that the current Health Class D is maintained for the Ngagane River or improved to a Health Class C. Kangra should at all times ensure that the aquatic scores obtained within the Ngagane River are similar for both the upstream and downstream sites.*

12 RECOMMENDATIONS AND CONCLUSIONS

The following recommendations and management actions should be taken into consideration for Kangra Coal:

- It is recommended that the Water Quality Guidelines for Aquatic Ecosystems as well as the V31G and V31K RQO's are incorporated within the Monitoring Programme and assessed on a continual (possibly monthly) basis. These water quality values are used by the DWS in water quality management as the primary source of reference information and decisions support required for the management and protection of aquatic ecosystems.
- It is recommended that Kangra Coal continue with the implementation of their action plan towards improving the water quality and aquatic ecosystem conditions. Once the WUL is obtained WUL water quality limits should be adhered to in order to ensure environmental sustainability.
- It is recommended that aquatic bio monitoring assessments be conducted on a bi-annual basis so that an aquatic data base could be obtained for comparative purposes. This data base will also be beneficial for comparing aquatic data during seasonal periods as well as the potential impacts from the AMD and decant. The data will establish a comprehensive database which will assist in making more informed recommendations towards to activities.
- Ensure that compliance to Environmental Authorisation and Law be practiced at all times and that all aspects be reported, which may in any way potentially compromise the integrity of the aquatic (Wetland, rivers and tributaries) system of Ngagane and Horn Rivers.
- It is recommended that the management actions and mitigation measures listed in **section 11** be implemented to ensure that the overall protection and Conservation of the Horn River and Ngagane River are maintained.
- The current assessment, in conjunction with the assimilative capacity assessment, confirms the necessity for the passive AMD treatment system currently being developed by Kangra Coal (passive treatment train: ALD → SAPS → Oxidation Pond → Aerobic Wetland; 1,000 m³/day). Implementation of this system is the primary recommendation arising from this assessment in order to reduce AMD loading to the Horn River and progressively improve the Health Class status of the downstream receiving environment.

In conclusion it was found that the old decant as well as AMD emanating from the colliery has localised impacts on the downstream Horn River. No direct impacts on the aquatic ecosystem

Health of the Ngagane River has been observed as environmental indices produced similar aquatic results for both the upstream and downstream aquatic sites.

The assimilative capacity assessment conducted in 2022 indicated that AMD will have a more significant impact on the receiving Horn River during the wet summer season which proved to have been the case as a slight deterioration in water quality parameters, a decrease in aquatic species diversity as well as lethal toxic sediment results were obtained during the current assessment.

The health Class rating for the Ngagane River is rated as a Health Class D which is slightly in an impaired state when being compared to the SANBI PES and in a comparable state when being compared to the catchment PES. The health Class rating for the Horn River is rated as a Health Class D/E which is slightly in an impaired state when being compared to the catchment PES and in a comparable state when being compared to the SANBI PES.



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14 APPENDICES

Appendix A

SASS5 Accreditation

NATIONAL AQUATIC ECOSYSTEM HEALTH MONITORING PROGRAMME



Water and Sanitation



Water Research
Commission

CERTIFICATE OF ACCREDITATION

This is to certify that

Mathys de Beer

has met the requirements of the
River Health Programme as a SASS5 Practitioner



COMPETENCY IN THE FOLLOWING AREAS HAVE BEEN DEMONSTRATED:

UNDERSTANDING OF THE SCOPE AND APPLICATION OF THE SASS5 METHOD.

DEMONSTRATION OF THE CORRECT SAMPLING PROTOCOLS

DEMONSTRATION OF THE CORRECT SAMPLE PREPARATION PROTOCOLS

IDENTIFICATION OF AQUATIC MACROINVERTEBRATES

COMPETENCY IS VALID FOR 3 YEARS FROM CERTIFICATE DATE



NATIONAL SASS5 AUDITOR

7 April 2022

DATE