INKOMATI-USUTHU

CATCHMENT MANAGEMENT AGENCY

ANNUAL WATER QUALITY STATUS REPORT 2021/22

VISION

Sufficient, equitable and quality water resources for all in the Inkomati-Usuthu Water Management Area

MISSION

To efficiently manage water resources by empowering our stakeholders in our quest to contribute towards transformation by promoting equal access to water and protecting the environment

VALUES

Integrity

Batho Pele (Stakeholders Orientation)

Accountability

Diversity

Transparency

SLOGAN:

"INKOMATI-USUTHU CMA, YOUR PARTNER IN WATER MANAGEMENT"

ANNUAL WATER QUALITY STATUS REPORT WITHIN INKOMATI-USUTHU WMA

Compiled by : Ms Caroline Tlowana and Zandile Mkize

Editor(s) : Mr. Marcus Selepe (Manager: Resource Quality Monitoring Division)

: Dr T Sawunyama (Acting Executive: Water Resources Management)

Acknowledgements for Technical contributions:

Caroline Tlowana	(Senior Scientist)
Jonathan Maenetja	(Scientific Technician)
Sakhile Nkosi	(Scientific Technician)
Bongekile Mahlatsi	(Scientific Technician)
Tebatso Chiloane	(Scientific Technician)
Mbalenhle Dhlamini	(Scientific Technician)
Nkululeko Nkala	(Scientific Technician)
Naledi Sekatane	(Intern)
Zandile Mkize	(Intern)

EXECUTIVE SUMMARY

Chapter 3 of the NWA prescribes the protection of water resources through resource-directed measures including the determination of the management classification, Resource Quality Objectives, and the Reserve of significant water resources. These are measures which together are intended to ensure the protection of the water resource whereas the Source Directed Control measures are intended to regulate and control the impacts of land-based activities by ensuring pollution prevention and remedying the effects of pollution on water resources. It is further required that the protection of water resources is balanced with the use of water as a factor of production to enable socio-economic growth and development.

The challenges affecting water quality in the Inkomati-Usuthu WMA have always been mainly due to industrial and mining activities and the poor state of water services authorities' sewage infrastructure. Pollution of the resource is caused due to contamination of sewage (e.g., from overflows, spills and leakages or by discharge of untreated/partially treated sewage into the resource); and decanting of mining effluents or leachate into the water resources as well as solid waste especially nappies.

The microbial pollution remains a human health risk, especially to the vulnerable rural communities that at times must use the river water for domestic, religious, cultural, and recreational purposes. Deteriorating water quality on certain Ecological Water Requirements sites especially microbiological quality has largely been attributed to inadequate compliance, monitoring and enforcement, weak co-operative governance, absence of regulation and delays in the implementation of the waste discharge charge.

The surface water quality in the Inkomati-Usuthu WMA complied with the Resource Quality Objectives (RQOs), South African Target Water Quality Guideline limits (SATWQG) and International Water Quality Guideline limits (IWQG) for most of the monitored points and this showed that the water quality within the WMA is in a relatively fair to good state.

Table of Contents

ACRONYMS AND ABBREVIATIONS

NWA	National Water Act, Act 36 of 1998
IUCMA	Inkomati-Usuthu Catchment Management Agency.
IUWMA	Inkomati-Usuthu Water Management Area
RQOs	Resource Quality Objectives
RSA	Republic of South Africa
RDM	Resource Directed Measures
DWS	Department of Water and Sanitation.
WWTWs	Wastewater Treatment Works.
CFU	Colony-forming unit.
E. coli	*Escherichia coli*.
KNP	Kruger National Park.
EWR	Ecological Water Requirements
CME	Compliance Monitoring and Enforcement
SANAS	South African National Accreditation System
SDC	Source Directed Control
U/S	Up Stream
D/S	Down Stream
EC	Electrical Conductivity
mS/m	Milli Siemens per meter
µS/cm	Micro Siemens per centimetre
mg/l	milli-grams per liter
TWQG	Target Water Quality Guide
WMA	Water Management Area
SATWQG	South African Target Water Quality Guidelines
IWQG	International Water Quality Guidelines
PO_4	Phosphate
NO_3+NO_2	Nitrates and nitrites
pH	Acid base relation
SO_4	Sulphate
Sal	Salinity
NH_3	Ammonia

CHAPTER 1 INTRODUCTION AND BACKGROUND

1.1 Introduction

The Inkomati-Usuthu Catchment Management Agency (IUCMA) is the responsible authority within the jurisdiction of the Inkomati-Usuthu Water Management Area (WMA). The WMA is in the eastern part of the country and falls wholly within the Mpumalanga Provincial boundary as depicted in *Figure 1* below as WMA three (3) of the nine (9) demarcated WMAs. The Inkomati-Usuthu WMA comprises of four catchments namely Sabie Sand, Crocodile, Komati and Usuthu catchment and is also part of international basins called the Incomati River Basin and Maputo River Basin. The water resources in the area are strategically important for international obligations as well as inter-basin transfers for power generation. As an authority, the IUCMA is responsible for managing, controlling, protecting, and monitoring water resources in its area of responsibility.

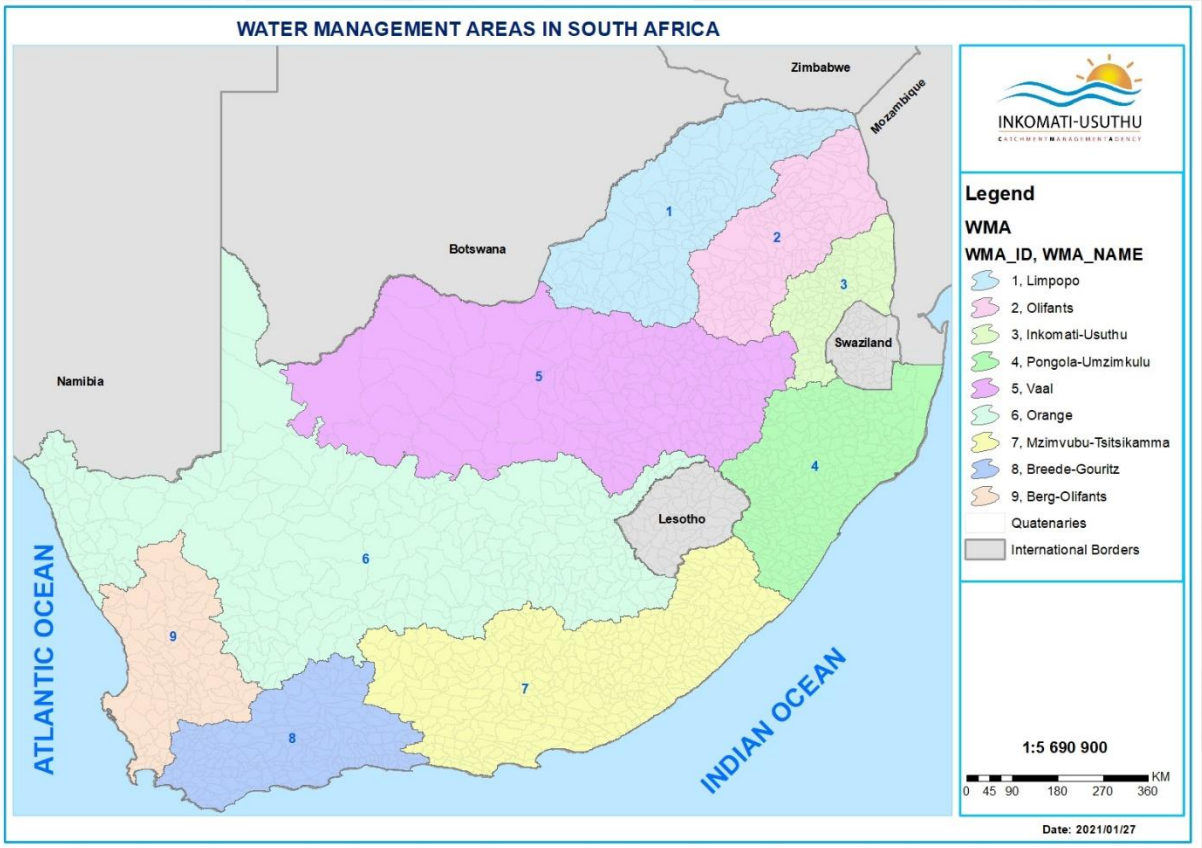


Figure 1: Map of South Africa indicating the nine WMA.

1.2 Background

National Water Act, Act 36 of 1998 (NWA) of South Africa Chapter 14: Requires the Minister to establish national monitoring systems for the collection of appropriate data and information that is adequate and responsive to the present and future challenges of efficient management of the country's water resources. The Inkomati-Usuthu Catchment Management Agency (IUCMA) conducts regional water quality monitoring in the Inkomati-Usuthu WMA which feeds into the national monitoring system. Water quality is vital as it determines fitness for uses and the protection of the health and integrity of aquatic ecosystems and is described as chemical, physical, and biological characteristics of water (DWS, 1996).

Surface water quality within Inkomati-Usuthu WMA is measured by means of physio-chemical, microbiological and eutrophication monitoring programme(s) conducted monthly through grab sampling and continuous monitoring technique(s). The samples are then submitted to a South African National Accreditation System (SANAS) accredited laboratory for analysis. The variables of concern differ from catchment to catchment and are based on the types of activities occurring within a specific catchment. Eutrophication monitoring information is conducted only in major dams within the WMA. Eutrophication is the process of excessive nutrient enrichment of waters that typically results in problems associated with macrophyte, algal or cyanobacterial growth.

Water quality is linked with water quantity, instream and riparian habitat and aquatic biota integrity, which are collectively referred to as “resource quality” in terms of the NWA. Resource quality needs to be maintained within certain pre-determined parameters to enable continuous sustainable economic growth and social development. The pre-determined parameters are Resource Directed Measures (RDM) represented by the Resource Management Class, Resources Quality Objectives (RQOs) and the Reserve. For this report, only Water Quality Component of the resource quality was assessed in relation to pre-determined parameters.

The RDM has been determined and gazetted within Inkomati-Usuthu WMA, except for Usuthu catchment. The comprehensive ecological Reserve determination study was completed in February 2006, however gazetted into law in July 2019 by government notice No. 998 and the classification and setting of the RQOs studies were completed in April 2015 and gazetted into law in December 2016 by government notice No. 1616, respectively. The water quality status and compliance within the WMA was evaluated against RQOs and where not available the Target Water Quality Guideline limits (TWQG) will be used. RQOs are intended to give effect to the management class and the ecological needs determined in the reserve to assist resource managers on the protection of the resource.

The major watercourses within Inkomati-Usuthu WMA form part of the Incomati and Maputo River Basins. Water quality conditions of the ten (10) major watercourses within Inkomati-Usuthu WMA are assessed as part of information and data sharing in terms of Interim Inco-Maputo Basin Agreement (IIMA) for co-operation on the protection and sustainable utilisation of these shared watercourses. Water quality compliance status of international obligation sites will be evaluated against the water quality guidelines resolution of the tripartite permanent technical committee on exchange of information and water quality.

The purpose of the report is to assess and report the water quality status, trends and compliance with the set standards/objectives in the water resource, in a manner that supports balanced decision making and planning to support sustainable development within the Inkomati Usuthu WMA.

1.3 Objectives

- To provide information on the status and trends in terms of the physio-chemical and microbial quality of surface water resources within the Inkomati Usuthu WMA.
- To determine the trophic status of major dams within the Inkomati Usuthu Water Management Area.
- To determine compliance status of applicable variables at Ecological Water Requirements (EWR) Sites and water quality priority Resource Units (RU) with Resource Quality Objectives (RQOs); and
- To determine water quality compliance status at International Obligation sites with the set values in terms of the Interim Inco-Maputo Agreement (IIMA).

CHAPTER 2 METHODOLOGY

2.1 Study Area

The physical, chemical and microbiological programme of water resources takes place within the jurisdiction of the Inkomati-Usuthu WMA and comprises of Sabie/Sand Catchment, Crocodile Catchment, Komati Catchment and Usuthu Catchment as illustrated in *Figure 2* below. The IUWMA is situated in the north-eastern part of South Africa in the Mpumalanga Province. It borders on Mozambique in the east and on eSwatini in the south-east. The water management area extends over several parallel river catchments which all drain in a general easterly direction, and flow together at the border with Mozambique or within Mozambique, to form the Incomati River which discharges into the Indian Ocean immediately North of Maputo at Villa Laisa, while the Usuthu River confluences with Pongola River to form the Maputo River which discharges into the Indian Ocean South of Maputo and is called Maputo basin.

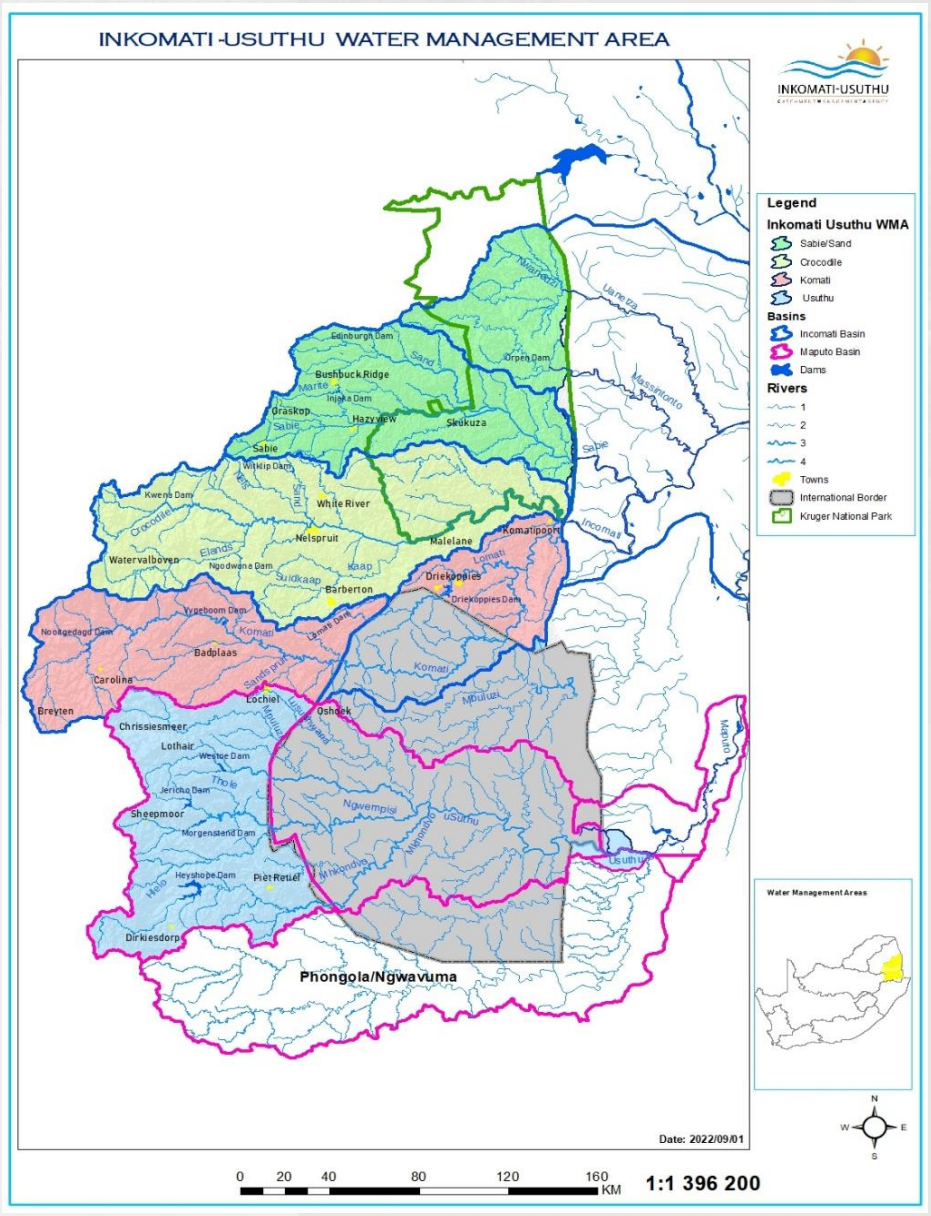


Figure 2: Inkomati-Usuthu Water Management Area

2.2 Materials and Methods

2.2.1 Grab sampling technique

Monthly physio-chemical and microbiological samples were taken using grab sample technique. Sampling bottles were marked with the site code, date and time of collection using a permanent marker. Some of the samples were taken on bridges using a bucket and bailer. The bucket was rinsed before collecting the sample and filling the sampling bottles.

One (1) litre physio-chemical sample bottles were rinsed three times before they were filled. The 300ml microbial sample collecting bottles were not rinsed since they were sterilized, ample air space was left in the sample bottle to facilitate mixing by shaking.

Both physio-chemical and microbial water quality samples were stored in two separate cooler boxes and preserved with ice packs or cubes. The samples were then submitted to a SANAS accredited laboratory for analysis and microbiological samples were delivered within 12 hours to the Laboratory.

Figure 3: Water quality samples taken at Komati River using the bailer and the bucket.

Figure 4: IUCMA official taking water quality chemical sample at tributary of Seekoeispruit.

2.2.2 Continuous monitoring technique

Five water quality probes are installed within the WMA for continuous water quality monitoring. The parameters that are measured in continuous monitoring stations are actual conductivity (µS/cm), temperature (˚C) and salinity (PSU) after every 3 hours. Actual conductivity data is transmitted to Zednet via network and other variables are downloaded through Win-Situ software.

Figure 5: IUCMA official downloading data from probe trough Win-Situ software at Komati River.

2.2.3 Eutrophication monitoring technique(s)

Monthly eutrophication samples were taken using either integrated sample with 5m hosepipe or subsurface grab sample techniques from major dams within the WMA.

Macro samples were taken by decanting water from the integrated sample or subsurface grab sample into the blue-top bottle washed with phosphate free soap and the samples were stored in cooler box with ice cubes. Samples for **identification of algae** were taken by decanting water from the integrated sample or subsurface grab sample into a small glass bottle with 2-4 drops of lugol preservative.

The **chlorophyll-a** samples were conducted using a filter unit, by unscrewing the top of the rinsed filter and carefully placing the filter paper inside the unit and screwing the top back. 250ml of the water from the integrated sample or subsurface grab sample is poured into the unit and water was drawn through the filter using a vacuum pump up to 500ml if possible. The total amount of water filtered was recorded. The filter was then opened gently, then the filter paper was carefully lifted and stored into a glass tube with ethanol.

Total suspended solids samples were taken using the same method as conducted for the Chlorophyll-a samples, but a weighed filter paper marked with a black dot was used and then stored in a petri dish.

All samples were clearly marked on a tag with the sample description, date, time, dam ID code, name of the resource and volume filtered. The samples are stored in a dark container. The samples and onsite monitoring report sheets were then submitted to the Department of Water and Sanitation laboratory at Resource Quality Information Services (RQIS) for analysis.

<u>The following onsite visual monitoring and measurements were conducted:</u>

- Estimated visual area on the total surface area covered by algal blooms or invasive water plants.
- Other observation potentially related to eutrophication i.e., Odour problems, fish kill, wind speed and direction.
- The secchi disc is used to determine the clarity by lowering the disc into the water until it is out of sight and record the depth reading on the marked rope.

The HydroNet system and Microsoft Excel were used to display and interpret the 12 months water quality data for the sites monitored.

The water quality status for compliance is represented by colour green and for non-compliance is represented by colour red throughout the report unless indicated otherwise. The data reported was collected over a period of 12 Months (January 2021- December 2021) within the Inkomati-Usuthu WMA.

CHAPTER 3 WATER QUALITY STATUS AND TRENDS IN THE WMA

3. 1. Sabie/ Sand Catchment

3.1.1 Introduction

The Sabie River originates in the upper reaches of the Sabie Town and passes through industries such as York Timber Sawmill and the defunct underground gold mines of the Transvaal Gold Mine Estate (TGME) are situated. The Sabie River further flows through Hazyview and Mkhuhlu and other residential areas before it enters the Kruger National Park, Mozambique, and the Indian Ocean respectively. The main tributaries of the Sabie River are Mac-Mac River, Klein Sabie River, Noord-Sand River, Bega River, Sand River and Marite River. The Sand River confluences with the Sabie River inside the Kruger National Park. There are four main dams in the Sabie Sand Catchment, namely: Inyaka Dam, Da-Gama Dam, Eidenburg Dam and Mahleve Dam. The catchment is dominated by trout farming, forestry at the upper reaches of the catchment and housing development such as guest houses, lodges and hotels. There are several wastewater treatment works, the majority of which are operated by municipalities. The middle reaches from Hazyview to the Kruger National Park are affected mostly by agriculture, eco-adventure tourism, irrigation, water abstraction and urban development while the lower reaches of the catchment are inside the Kruger National Park which is a protected area.

3.1.2 Water Quality Monitoring Points

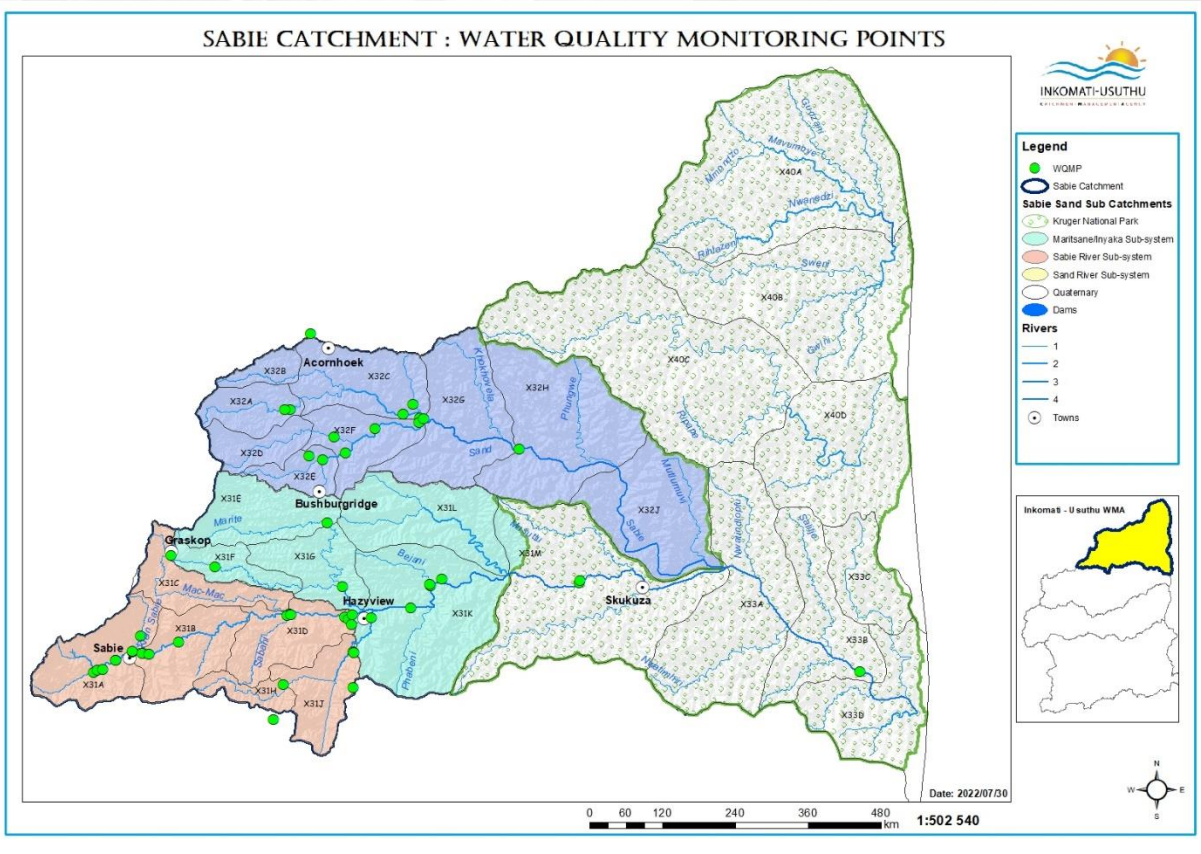


Figure 6: Water quality monitoring points in the Sabie Catchment

3.1.3 Water Quality Status, trends, and Discussion of Results

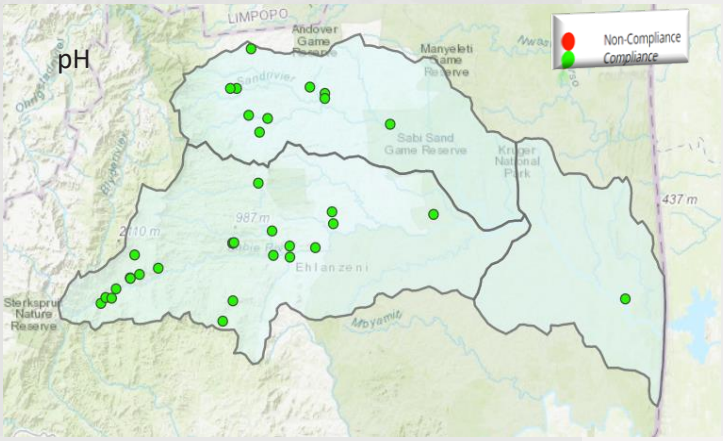
The water quality status and trends of the indicator parameters is compared with the Resource Quality Objectives (RQOs) published in a Government Gazette dated 30 December 2016 or the Target Water Quality Guideline limits (TWQG) where the RQOs were not available or set as tabulated below.

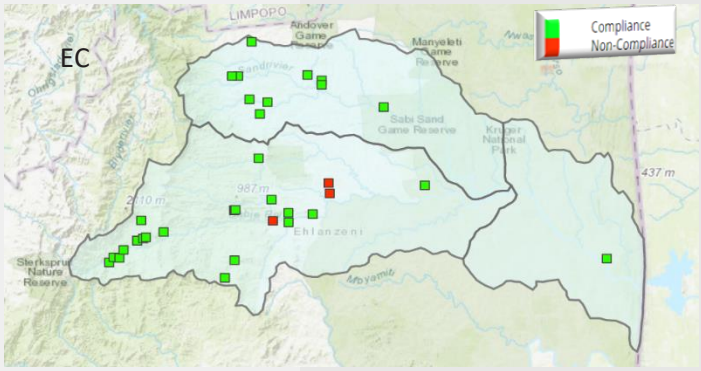
Table 1: TWQG and RQOs within Sabie/Sand Catchment

Variables/Parameters	Resource Quality Objectives		TWQG
	Sabie System	Sand System	
pH	6.5 - 8.0	6.5 – 8.8	6.5-8.5 (Recreation)
EC (mS/m)	30	55	40
Phosphate (mg/l)	0.015	0.125	N/A
Nitrates/Nitrites (NO_3 + NO_2) in mg/l)	N/A	N/A	6 (Domestic)
E. coli (cfu/100ml)	130	130	0

N/A=Not available

pH is a vital indicator of water that is changing chemically and measures how acidic/or basic the water is, ranging from 0 to 14. **pH** levels complied with the TWQG throughout the Sabie Sand catchment.





Electrical Conductivity (EC) complied with RQOs except Langspruit downstream of Hazyview WWTW, the Bega River and Ngwenyameni River downstream of Mkhuhlu settlement.

Figure 7*: Water quality status within Sabie/Sand Catchment showing acidity & alkalinity (pH) and Salts (EC) concentrations.*

Salinity

Salinity is a measure of the total concentration of all dissolved salts in water. *Figure 8* indicates the salinity (PSU) measured in continuous monitoring at Sabie River (March -December 2021). The trend indicates that the salt concentration is in a steady state.

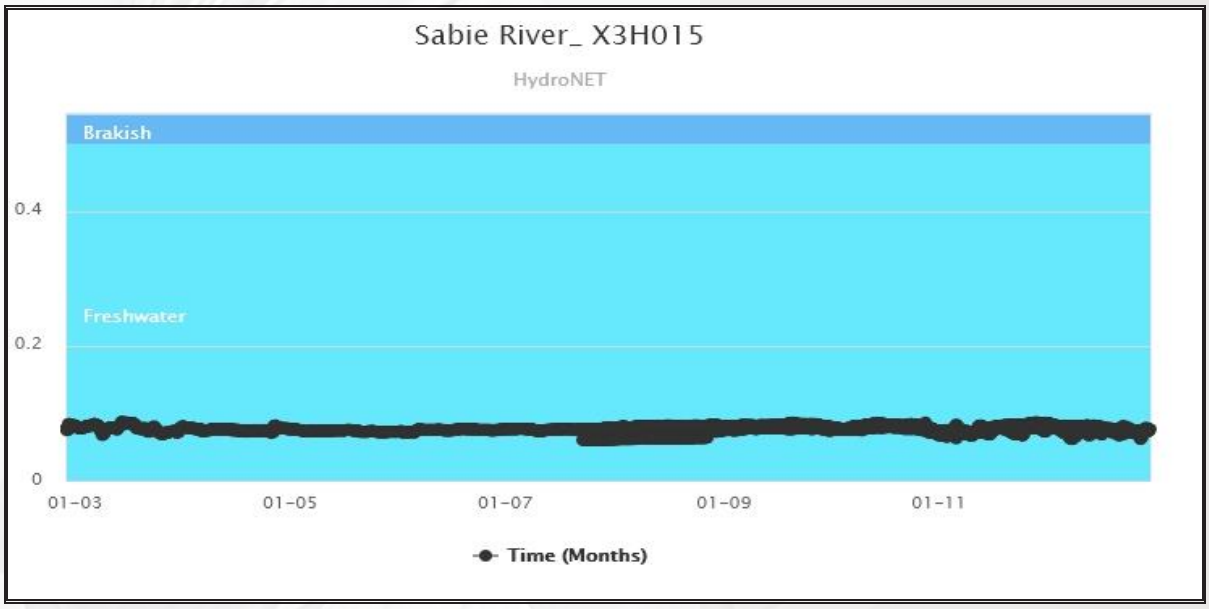
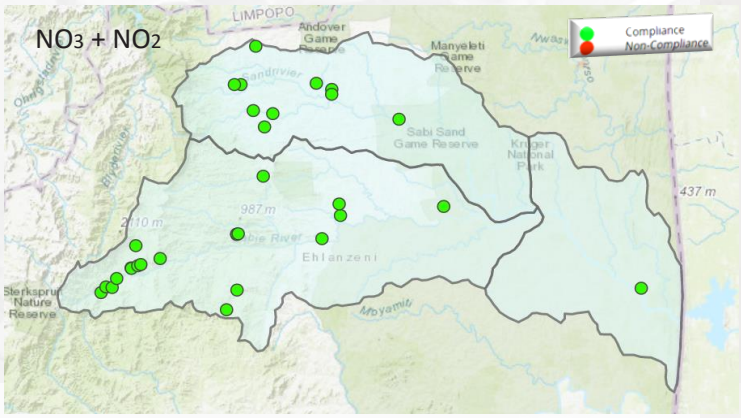
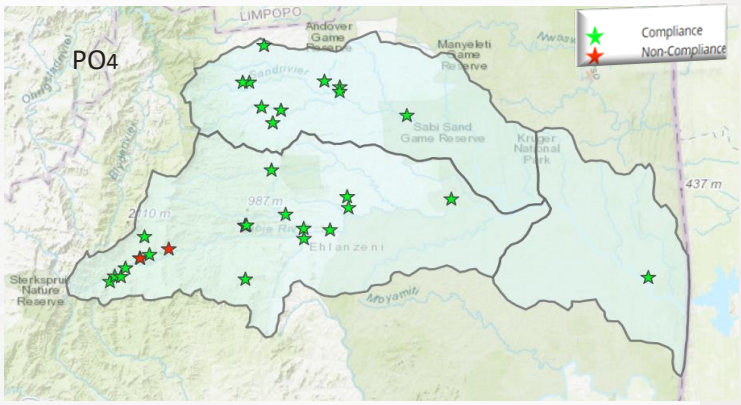


Figure 8: Salinity trend chart at Sabie River gauging station (X3H015)



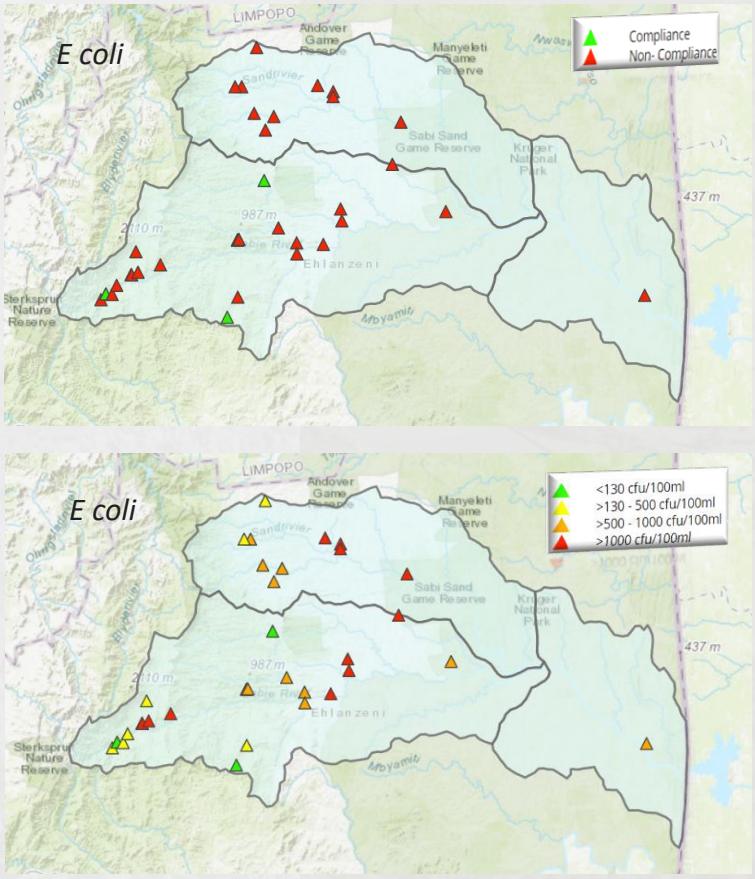


Nitrates/Nitrites concentrations complied with the TWQG throughout the sites monitored in the catchment.

Phosphate indicated compliance with the RQOs for most sites within Sabie/Sand sub-catchment except for Klein Sabie and Sabie River D/S of Sabie WWTWs which indicated non-compliance.

Nutrients are required in water resource; however excessive amount can lead to eutrophication process which is harmful to fish and other aquatic life.

Figure 9: Water quality status within Sabie/Sand Catchment Nutrients (NO_3+NO_2 and PO_4) concentrations.



E. coli counts in the Sabie/Sand Catchment indicated noncompliance with the set RQOs of 130 (cfu/100ml) except for Lone Greek River, Inyaka Dam and Da-Gama Dam which showed compliance with the set RQOs. High levels of microbial concentration greater than (>) 1 000 (cfu/100ml) arises from urban and rural impacts from the Sabie, Hazyview, Mukhuhlu and Thulamahashe areas including effluent from WWTWs and its associated infrastructure. Whereas other areas have not reached an alarming stage as the coliform counts are still below 1000

Figure 10: Water quality status within Sabie/Sand Catchment showing Microbial (E coli) concentrations.

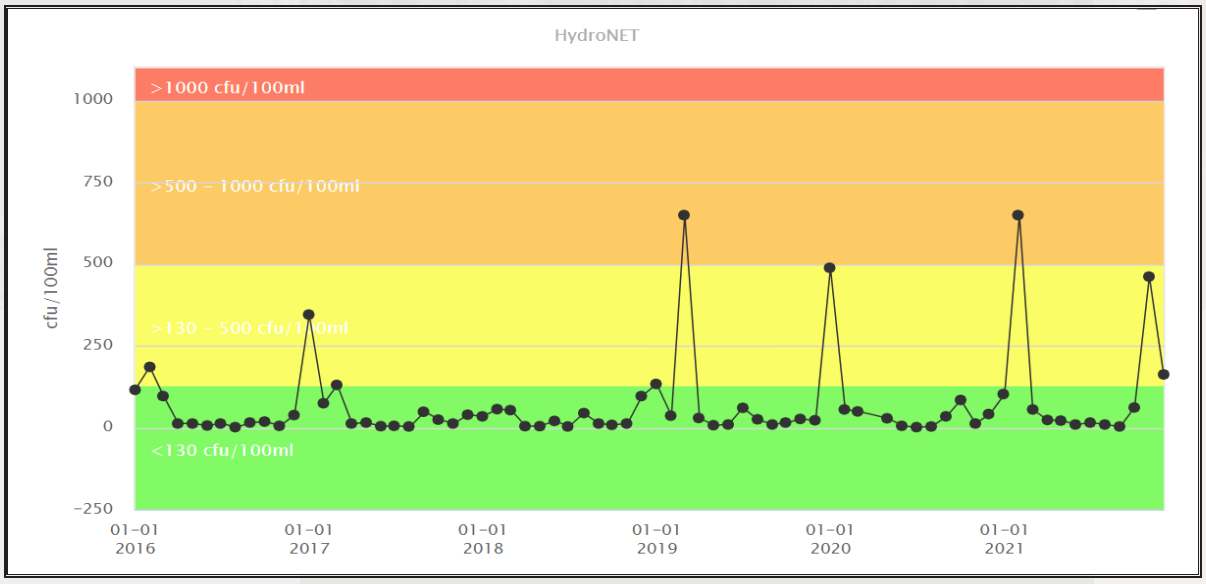


Chart indicating microbial (E coli) concentrations trends (Jan 2016-Dec 2021) at Mac-Mac River

E. coli in water is a strong indicator of sewage or animal waste contamination in water bodies. The microbial pollution remains a human health risk, especially to the vulnerable rural communities that at times must use the river water for domestic, religious, cultural, and recreational purposes. The trend in the Mac-Mac complied for most of the times with few spikes in the reported period.

3.2. Crocodile Catchment

3.2.1 Introduction

The Crocodile River catchment originates near Dullstroom, where it flows into the Kwena Dam and eastwards through Nelspruit and confluences with the Komati River before entering Mozambique at the Lebombo Border Gate. The Elands River and Kaap River are two large tributaries of the Crocodile River system. The other smaller tributaries of the Crocodile River include the Lunsklip River, Nels River, Houtbosloop, Gladdespruit, White River and Besterspruit. The Significant Dams include the Kwena Dam, Ngodwana Dam, Witklip Dam, Klipkoppie Dam, Longmere Dam & Primkop Dam. The Crocodile River Catchment is dominated by agricultural activities (dry land, and irrigated cultivation), forestry, rural and urban settlements. The middle region of the Crocodile River is characterized by increased urbanization. The river flows through the major towns of Nelspruit, Kaapmuiden and Malelane as well as commercial farming activities (sugar cane, fruit orchards, and vegetables) which are important characteristics of this catchment. There are also mining activities in the Kaap River and the Sappi Mill in the Elands River sub-catchment. Other activities that existed in the catchment but have since closed are, Manganese Metal Corporation, Papas Quarry and Assmang Chrome. Illegal sand mining is posing a severe water quality problem in the middle regions of the Crocodile River catchment area around Ka-Nyamazane area.

3.2.2 Water Quality Monitoring Points

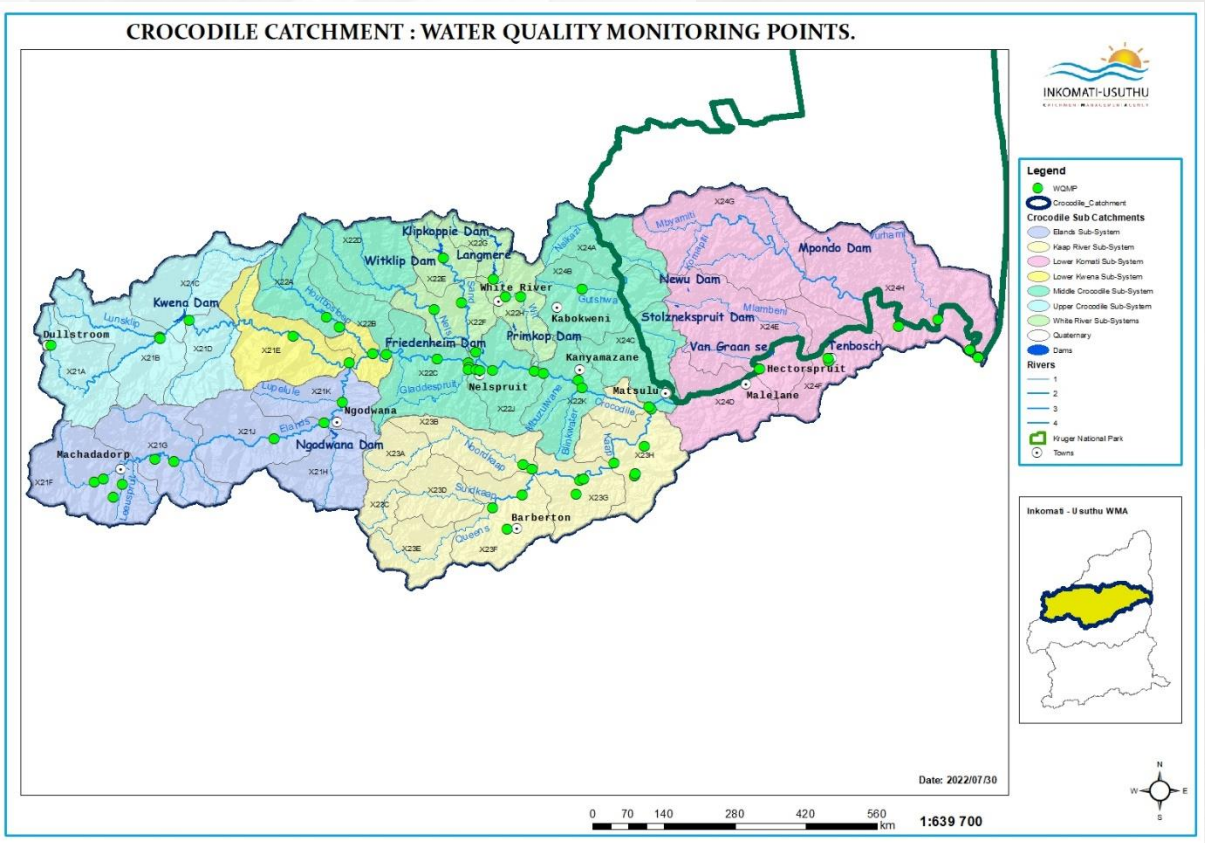


Figure 11: Water quality monitoring points in the Crocodile Catchment.

3.2.3 Water Quality Status, trends, and Discussion of Results

The compliance of the indicator parameters is compared with the Resource Quality Objectives published in a Government Gazette dated 30 December 2016 or the Target Water Quality Guideline limits (TWQG) where the RQOs were not available or set as tabulated below.

Table 2: TWQG and RQOs within Crocodile Catchment

Variables/Parameters	RQOS	TWQG
pH	6.5 – 8.0	6.5 - 8.5
Electrical Conductivity (mS/m)	30 and 55	40
Phosphate (mg/l)	0.015, 0.025, 0.075 & 0.125	0.025
E coli (cfu/100ml)	120 and 130	130
Ammonia (NH_3) in mg/l	-	1 (Domestic)
Sulphate	-	30 (Industry)
Arsenic (As) in mg/l	0.02	-
Manganese (Mn) in mg/l	0.18	-
Chromium (Cr) VI in mg/l	0.014	-

N/A=Not available

Chromium (Cr) VI

Cr (VI) is monitored at Leeuspruit to assess the impact from Assmang Chrome on the water resource, Cr (VI) complied with the RQOs of 0.014 (mg/l) throughout the reporting period (Jan-Dec 2021), except for December 2021 as encircled below in *Figure 12*.

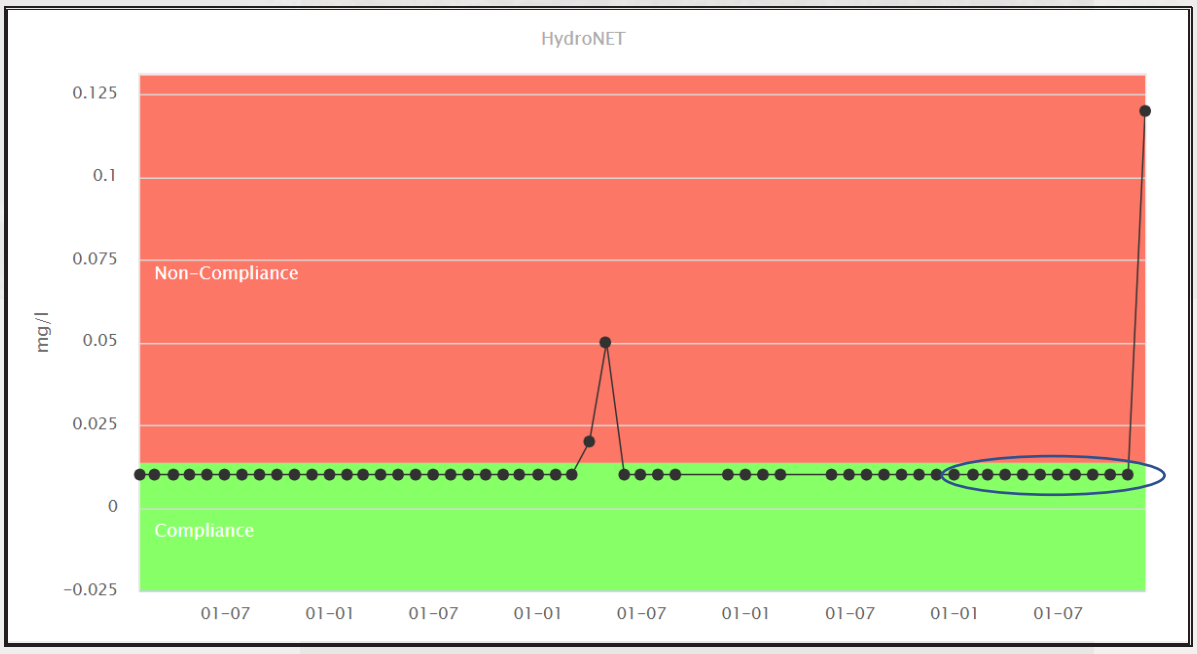
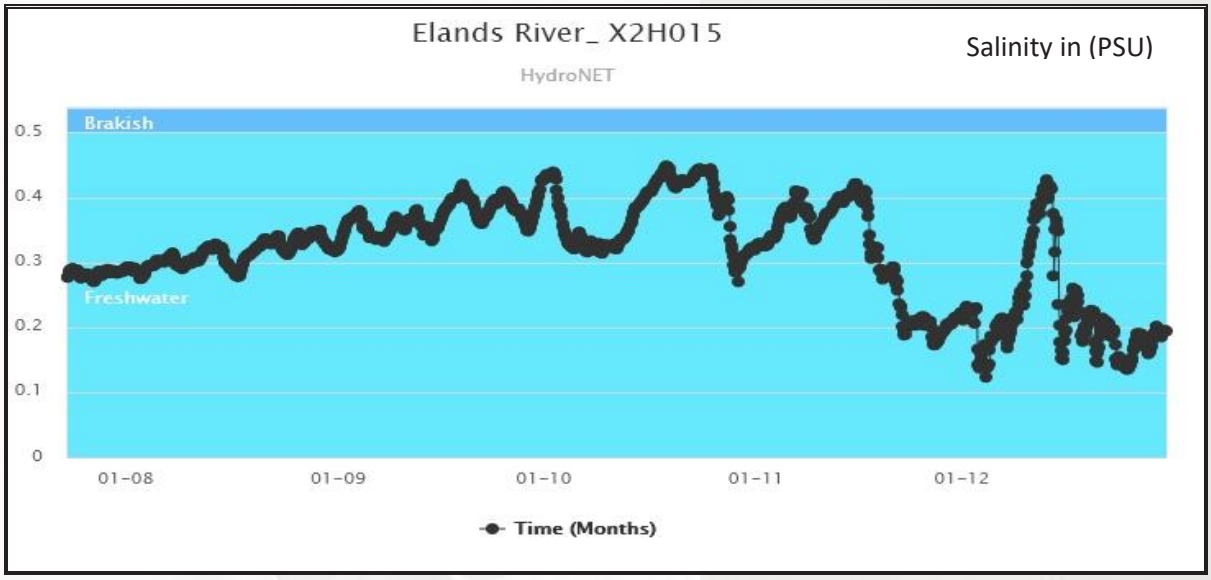
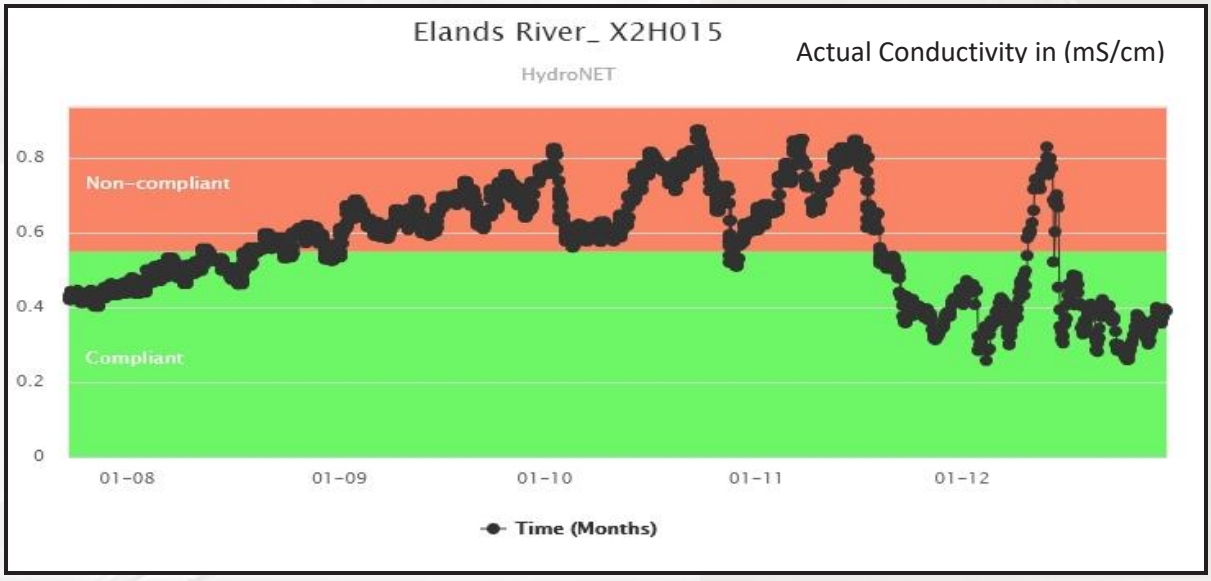


Figure 12: Chromium (VI) trend chart at Leeuspruit

Below are the charts indicating the salinity (PSU), actual conductivity (µS/cm) and temperature (˚C) that are measured in continuous monitoring at Lindenau station on Elands River ranging from 1 August 2021 to 31 December 2021.





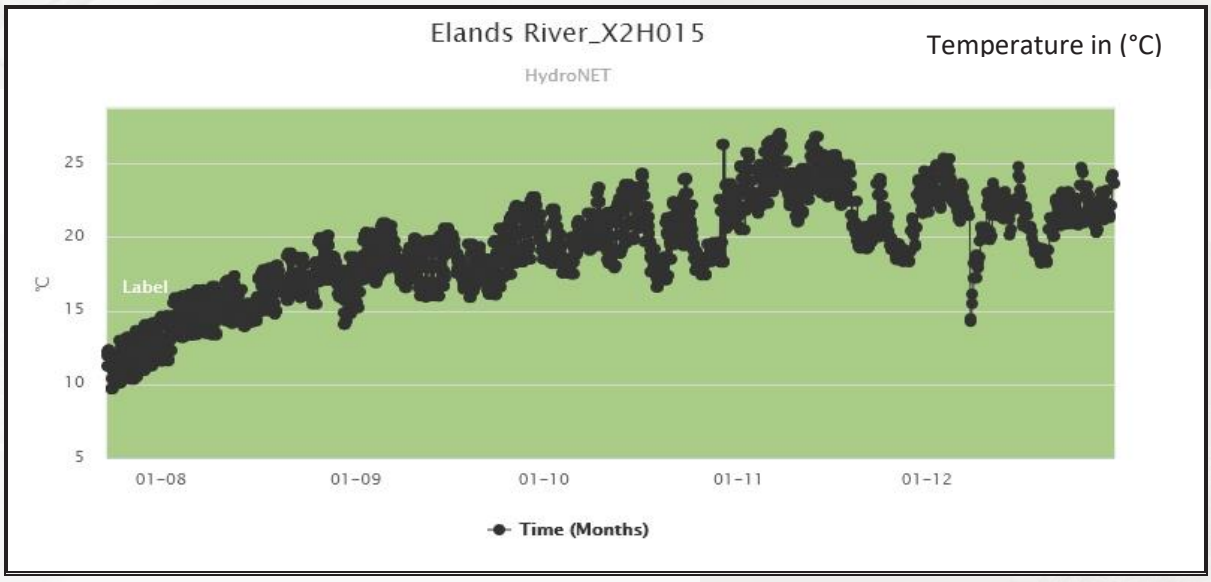


Figure 13: Salinity, EC and Temperature trend charts at Elands River gauging station (X2H015)

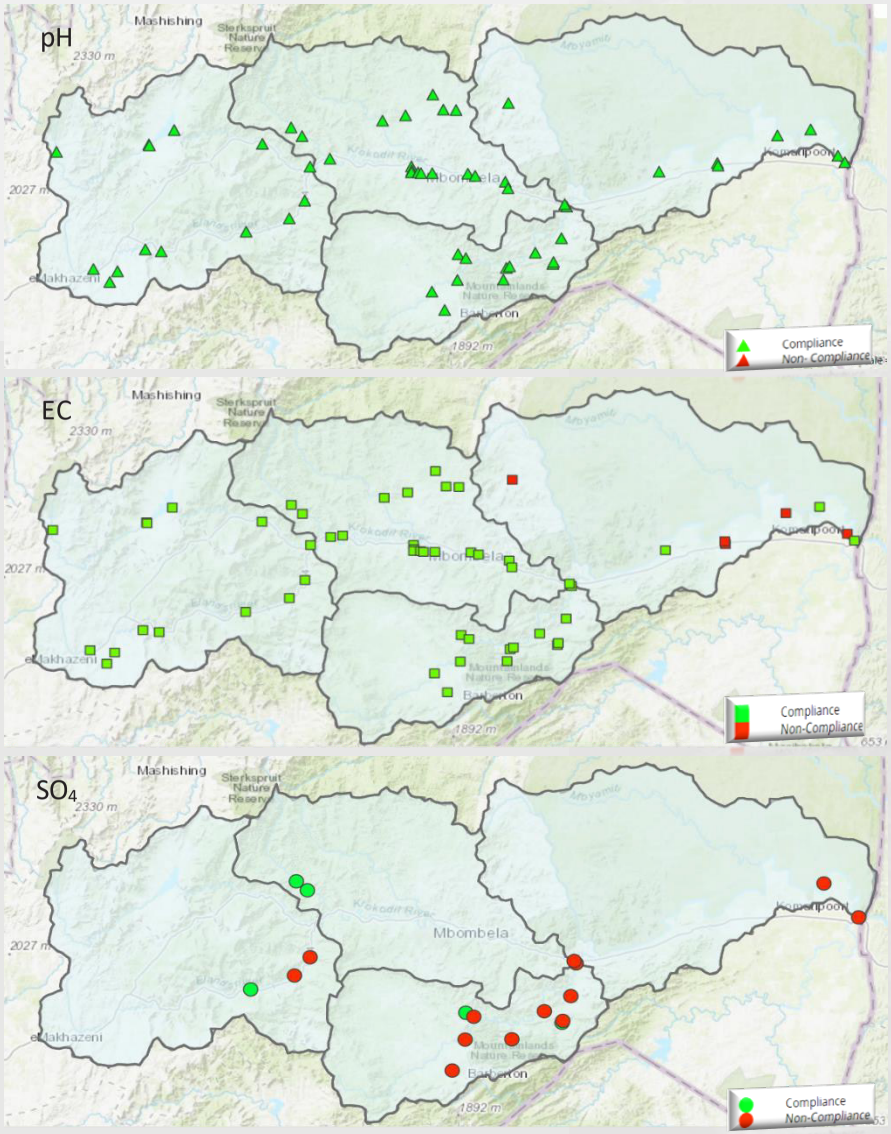


Figure 14: Water quality status within Crocodile Catchment showing acidity or basicity (pH) and salts (EC and SO_4) concentrations.

pH

pH is a vital indicator of water that is changing chemically and measures how acidic/or basic the water is, ranging from 0 to 14. The pH levels complied with the TWQG throughout the Crocodile Catchment.

Electrical Conductivity (EC)

The electrical conductivity is an indicator of the estimated levels of dissolved salts in water. Electrical Conductivity within Crocodile Catchment complied with the RQOs (Aquatic Ecosystem drivers), except Gutshwa River downstream of Kabokweni WWTW, tributary of Crocodile River at Tenbosch, Hectorspruit upstream and downstream of Hectorspruit WWTWs and the tributary of Crocodile River downstream of Komati WWTW. The high level of EC may be due to presence of inorganic dissolved solids such as chloride, phosphate, and nitrate arising from industrial effluent, WWTWs, stormwater runoff from formal /informal settlements and agricultural runoff.

Sulphate (SO_4)

The average sulphate concentration within the Crocodile Catchment indicated non-compliance with TWQG (Industry: category one) of 30 (mg/l) except for Elands River at Hemlock upstream of Sappi's Ngodwana Mill, Houtbosloop River, Noordkaap upstream of Consort Mine and the tributary of Kimberley Creek in the Kaap River System.

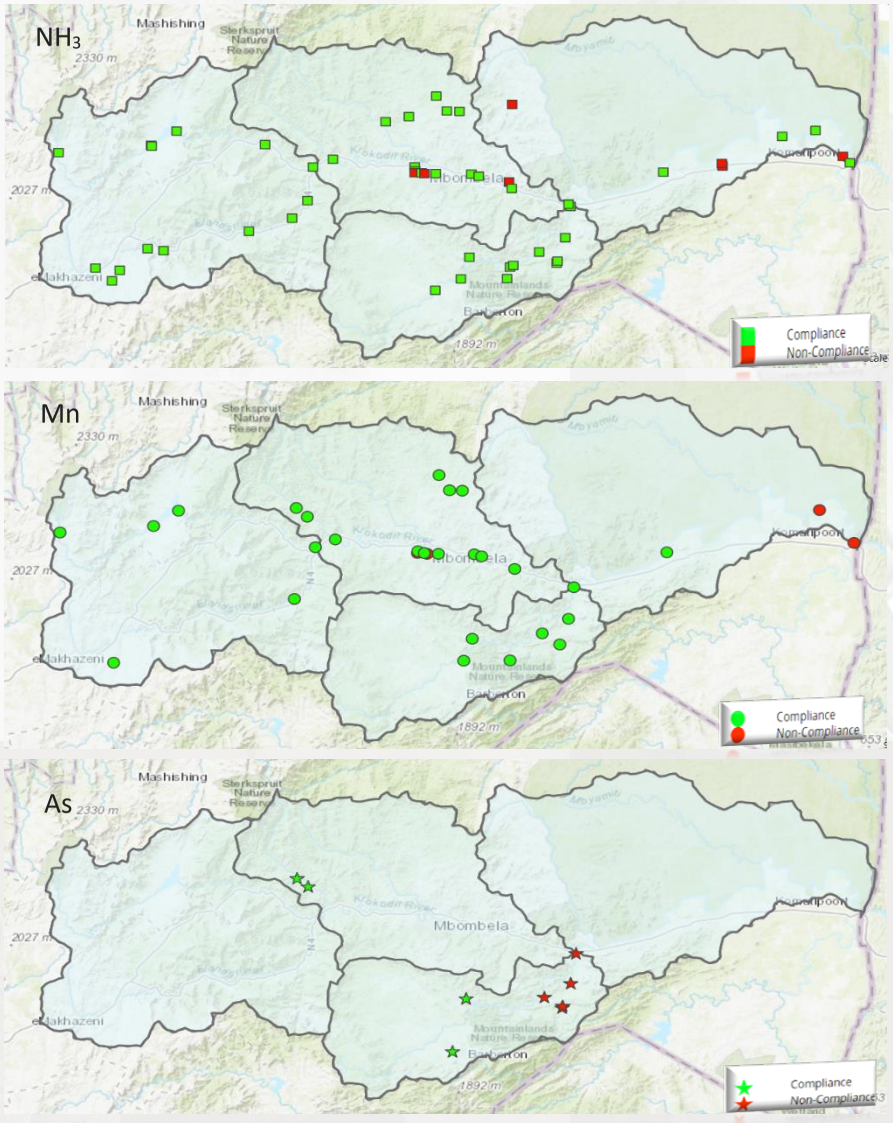


Figure 15: Water quality status within Crocodile Catchment showing toxic substances (NH_3, Mn and As) concentrations.

Ammonia (NH_3)

Ammonia is formed from the decomposition of nitrogenous organic material (plants or animals) in surface water and if found in relative abundance, it can be highly toxic to fish and other aquatic life. Ammonia within the Crocodile Catchment indicated compliance with TWQG (Domestic) of 1 (mg/l), except the tributaries of Crocodile River, namely the Gladdespruit, Besterspruit, KaNyamazane Stream, Hectorspruit as well as unnamed tributary downstream of Komatipoort WWTWs and the tributary of Gutshwa River downstream of Kabokweni WWTW.

Manganese (Mn)

Manganese complied with the RQOs of 0.18 (mg/l) within Crocodile Catchment, except for four points Gladdespruit and Besterspruit in middle Crocodile Catchment and an unnamed tributary of Crocodile River downstream of Komatipoort WWTWs and Crocodile River at Komatipoort in the lower Crocodile Catchment. The mineral manganese can be found naturally in the environment (surface water) or as a result of land use activities such as mining and industrial discharges.

Arsenic (As)

Arsenic is a toxic metalloids mainly found in gold mining areas and also a naturally occurring element. Arsenic complied with the RQOs of 0.02 (mg/l) within the Houtbosloop, Noordkaap, tributary of Queens, however indicated non-compliance within the Louws Creek and its tributaries as well as Kaap River after confluence with Louws Creek. The impact are attributed to gold mine activities in the area as well as illegal gold mining within Louws Creek and its tributaries.

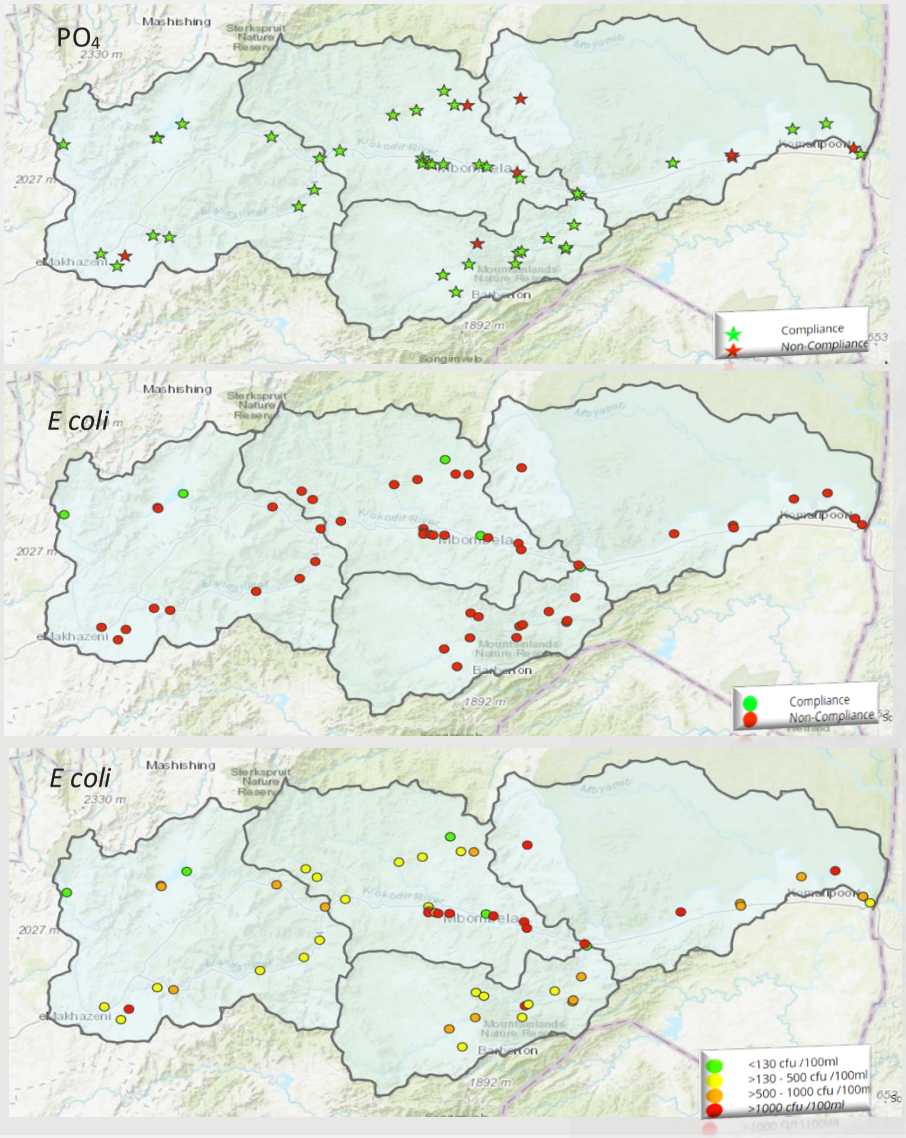


Figure 16: Water quality status within Crocodile Catchment showing nutrients (PO_4) and microbiological (E coli).

Phosphate (PO_4)

Phosphates enter surface water from human and animal feacal waste, effluent discharges and fertilizers runoff. Phosphate concentrations in the Crocodile Catchment complied with the RQOs for most of the time except for points downstream of Emthonjeni, White River, Komatipoort, New Consort and Kabokweni WWTWs, downstream & upstream of Hectorspruit WWTWs as well as the Kanyamazane stream. The impacts are attributed by effluent discharges from WWTWs and illegal dumping of solid waste.

Escherichia coli (E. coli)

E. coli counts in the Crocodile Catchment show elevated counts which from time to time exceeded the set RQOs of 130 (cfu/100ml). The red colour shows non-compoliance while the green shows compliance. The non-compliance from the upper, middle and lower parts of the Crocodile River and its tributaries are due to contamination from human faecal material and/or animals. Only four (4) points in the catchments complied with the RQO of 130 (cfu/100ml) Crocodile River at headwater, Kwena Dam, Langmere Dam and Crocodile River at Karino .

This map shows extent of noncompliance by showing less than 1 000 cfu/100ml in orange colour while greater than 1 000 cfu/100ml is shown in red. High level of microbial concentration greater than(>) 1 000 (cfu/100ml) arises from extensive urban and rural impacts from the Nelspruit, White River, Barberton, Malelane, Hectorspruit and Komatipoort including effluent from WWTWs and its associated infrastructure which discharge effluent into the Crocodile River and its tributaries. Meanwhile, the other areas have not reached an alarming stage as the *E. coli* counts are below 1000 (cfu/100ml).

3.3. Komati Catchment

3.3.1 Introduction

The Komati River originates from the outflow of the Nooitgedacht dam next to Carolina, Mpumalanga province. The catchment of the Nooitgedacht dam includes the Boesmanspruit, Vaalwaterspruit and the Witkloofspruit tributaries that feed directly into the dam. The most unique feature of the Komati River is that it starts in South Africa and flows through eSwatini in a North-easterly direction and comes back to South Africa at the Mananga Border Gate. It then confluences with the Crocodile River (one of its main tributaries) at Komatipoort before it enters Mozambique where it confluences with the Sabie River which is another one of its main tributaries. After entering Mozambique, the Komati River is referred to as the Incomati River and flows into the Indian Ocean at Maputo Bay. From source to mouth, the length of the Inkomati River is 480 kilometers. The catchment is dominated by coal mining in the upper reaches of the catchment and irrigation agriculture in the lower reaches of the catchment. There are also WWTWs the majority of which are operated by municipalities. For the purposes of this report the Komati River upstream of eSwatini will be referred to as Upper Komati and downstream of eSwatini, will be referred to as Lower Komati.

3.3.2 Water Quality Monitoring Points

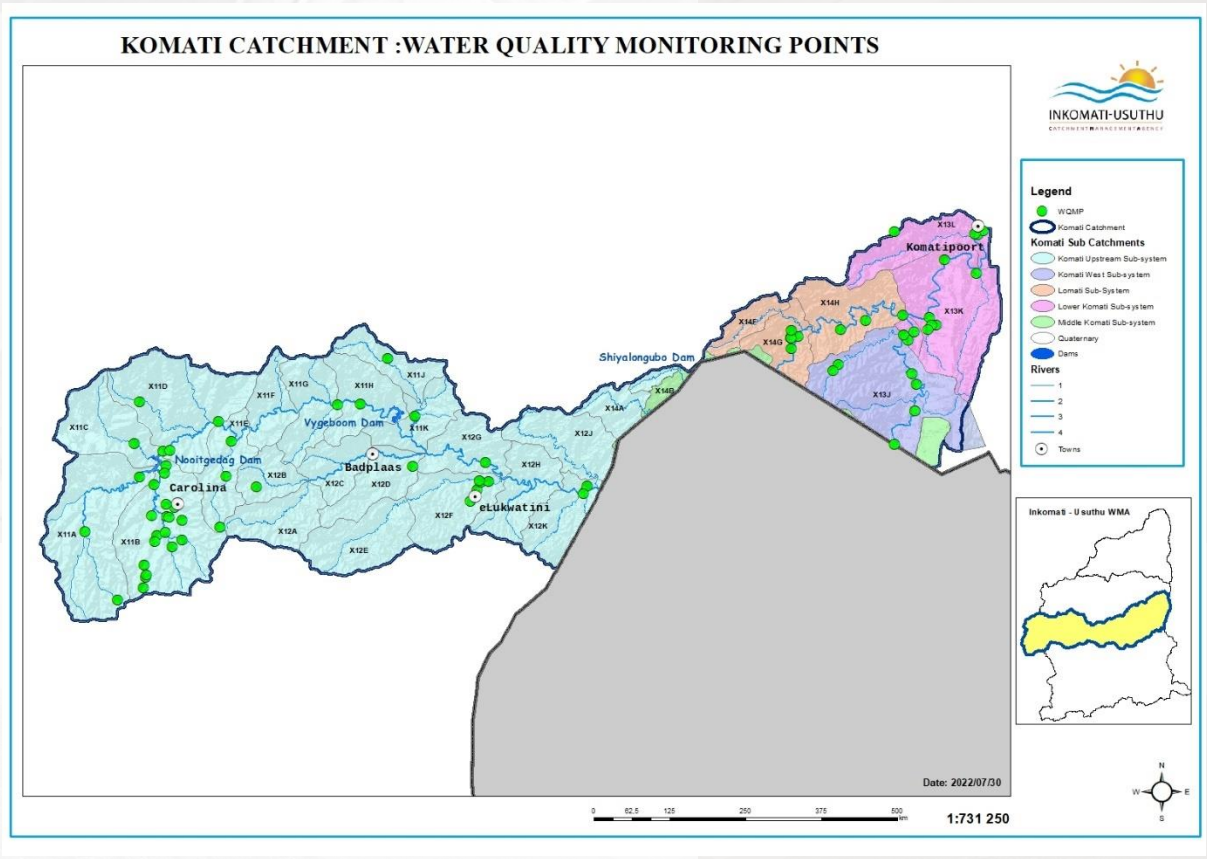


Figure 17: Water quality Monitoring points in the Komati Catchment.

3.3.3 Water Quality Status, trends, and Discussion of Results

The compliance of the indicator parameters is compared with the Resource Quality Objectives published in a Government Gazette dated 30 December 2016 or the Target Water Quality Guideline limits (TWQG) where the RQOs were not available or set as tabulated below.

Table 3: TWQG and RQOs within Komati Catchment

Variables/Parameters	RQOs	TWQG
pH	6.5 - 8.0	6.5 - 8.5
Electrical Conductivity (mS/m)	30, 40, 50, 55 & 85	40
Phosphate (mg/l)	0.02	0.025
E coli (cfu/100ml)	130	130
Ammonia (NH_3) in mg/l	-	1 (Domestic)
Sulphate	30 and 80	30 (Industry category 1)
Nickel	-	0.2 (Agriculture: Irrigation)

N/A=Not available

Nickel

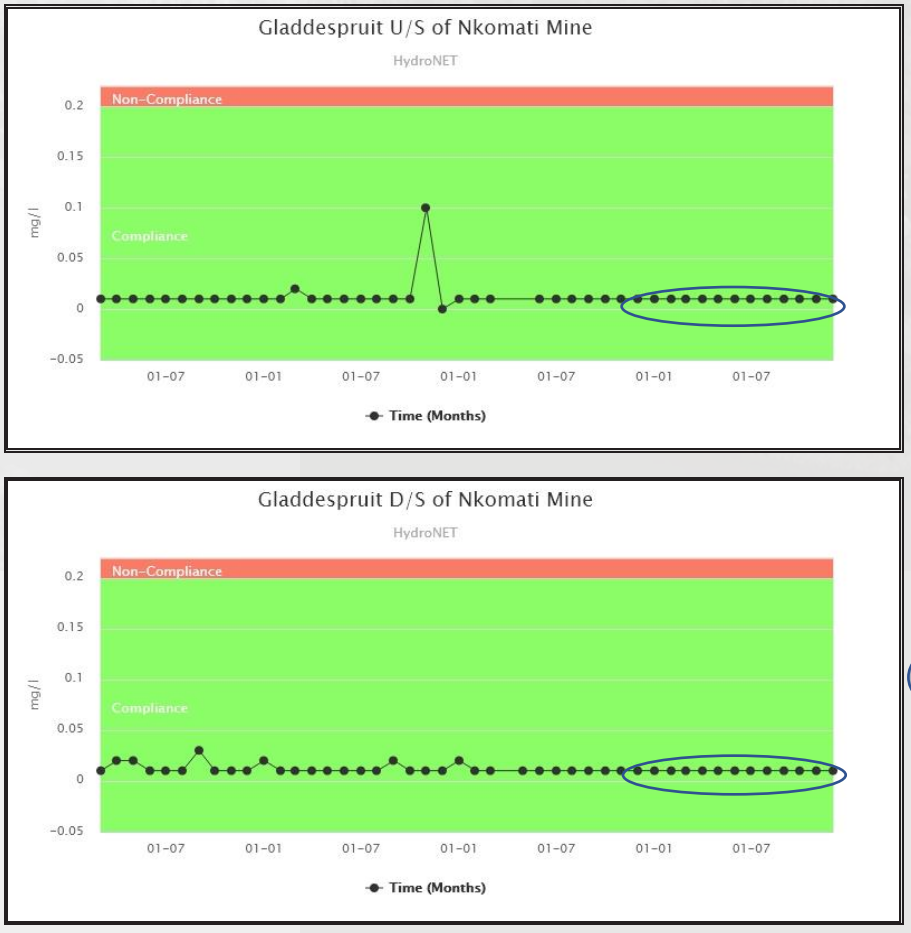


Figure 18: Nikel trend charts at Gladdespruit (US and DS of Nkomati Mine).

Nickel is found naturally in surface water and can also directly be emitted from various industries through discharge in surface waters. Nickel complied with TWQG in the Gladdespruit throughout the reporting period as encircled in *figure 18*

Salinity

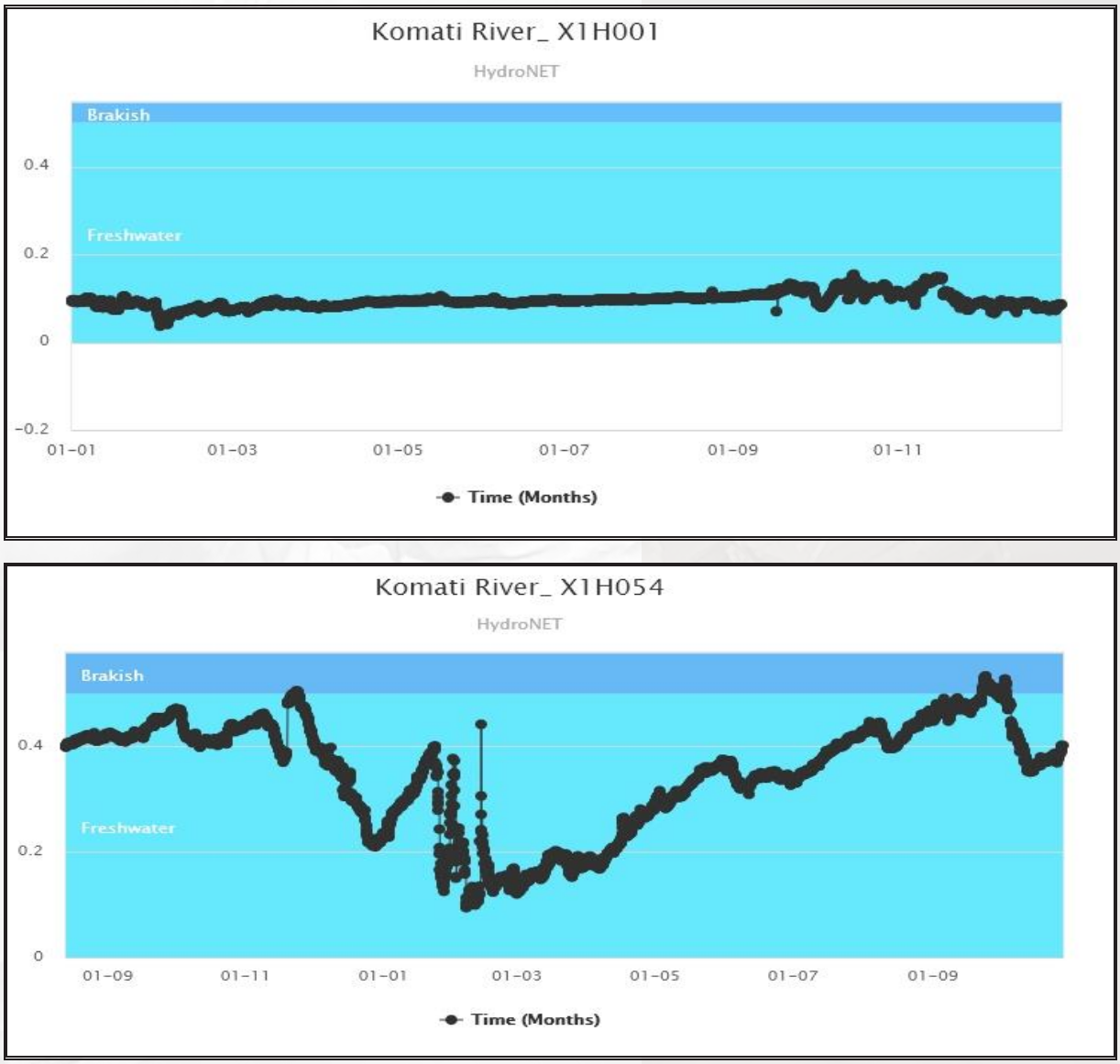
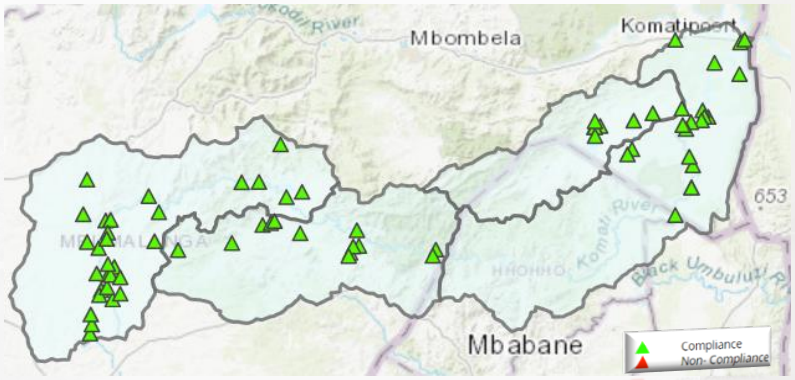


Figure 19: Salinity (PSU) trend charts at Komati River gauging stations (X1H001 and X1H054)

pH



pH is a vital indicator of water that is changing chemically and measures how acidic/or basic the water is, ranging from 0 to 14. **pH** concentrations complied with the TWQG throughout the catchment.

Figure 20: Water quality status within Komati Catchment showing pH concentrations.

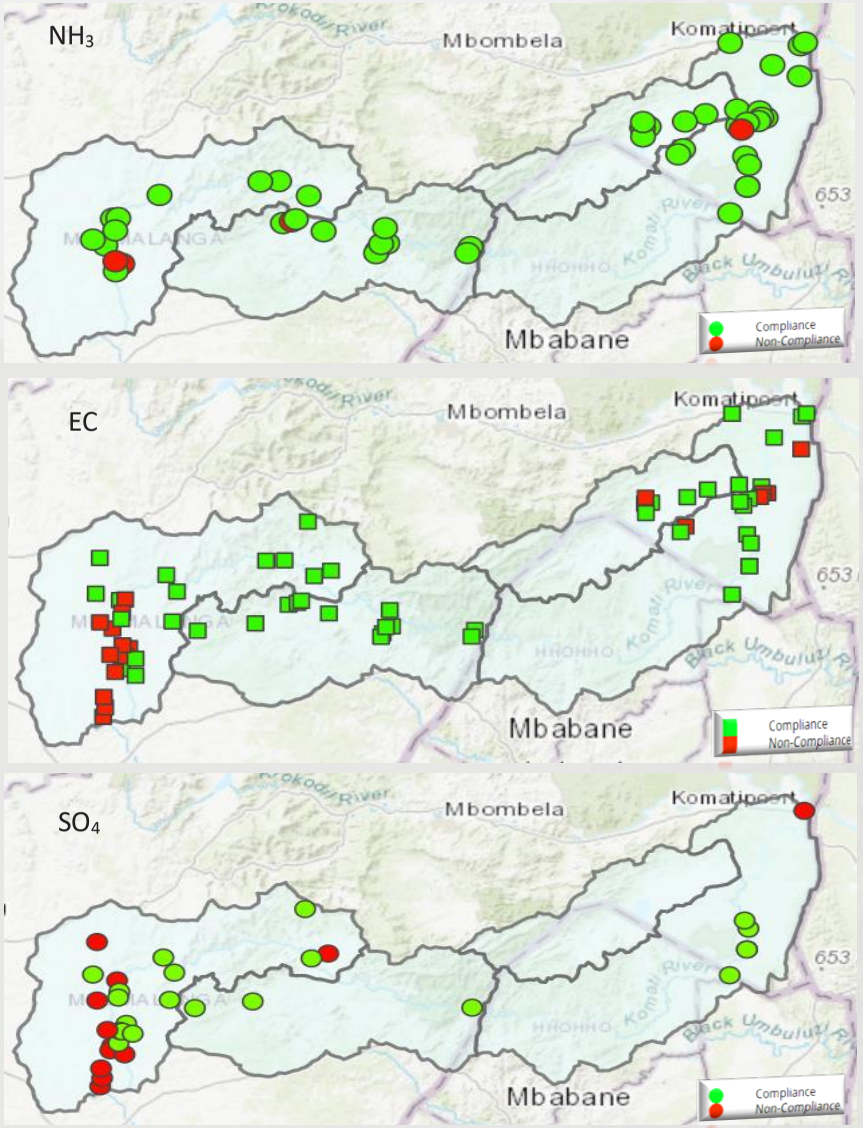


Figure 21: Water quality status within Komati Catchment showing NH_3, EC and SO_4 concentrations.

Ammonia (NH_3)

Ammonia within the Komati Catchment indicated compliance with TWQG (Domestic) of 1 (mg/l), except for the tributary of Boesmaspruit (ustream and downstream of Carolina WWTWs), Tributary of Seekoeispruit (downstream of Badplaas Sewer pump station) and Tributary of Komati River (downstream of Tonga Hospital WWTWs).

Electrical Conductivity (EC)

Electrical Conductivity was compliant at most monitoring points with the RQOs (Aquatic Ecosystem drivers) set within the Komati Catchment. There were a few points where the EC did not comply with the set RQOs in the Upper Komati sub-catchment especially on the Boesmanspruit which is dominated by coal mines. In the Lower Komati sub catchment mainly dominated by agricultural activities, there were also a few monitoring points where EC did not comply with the set RQOs. The high level of EC is due to presence of dissolved solids arising from mining activities, effluent from WWTWs, stormwater runoff from formal /informal settlements areas and agricultural runoff within the Catchment.

Sulphate (SO_4)

Sulphate concentration showed non-compliance with the RQOs limit within priority resource units or the TWQG limits in the Boesmanspriut, Witkloofspruit and Gladdespruit. These priority resource unit is dominated by coal mines and the high levels of sulphates are mostly attributed to active mines and defunct mines some of which are decanting.

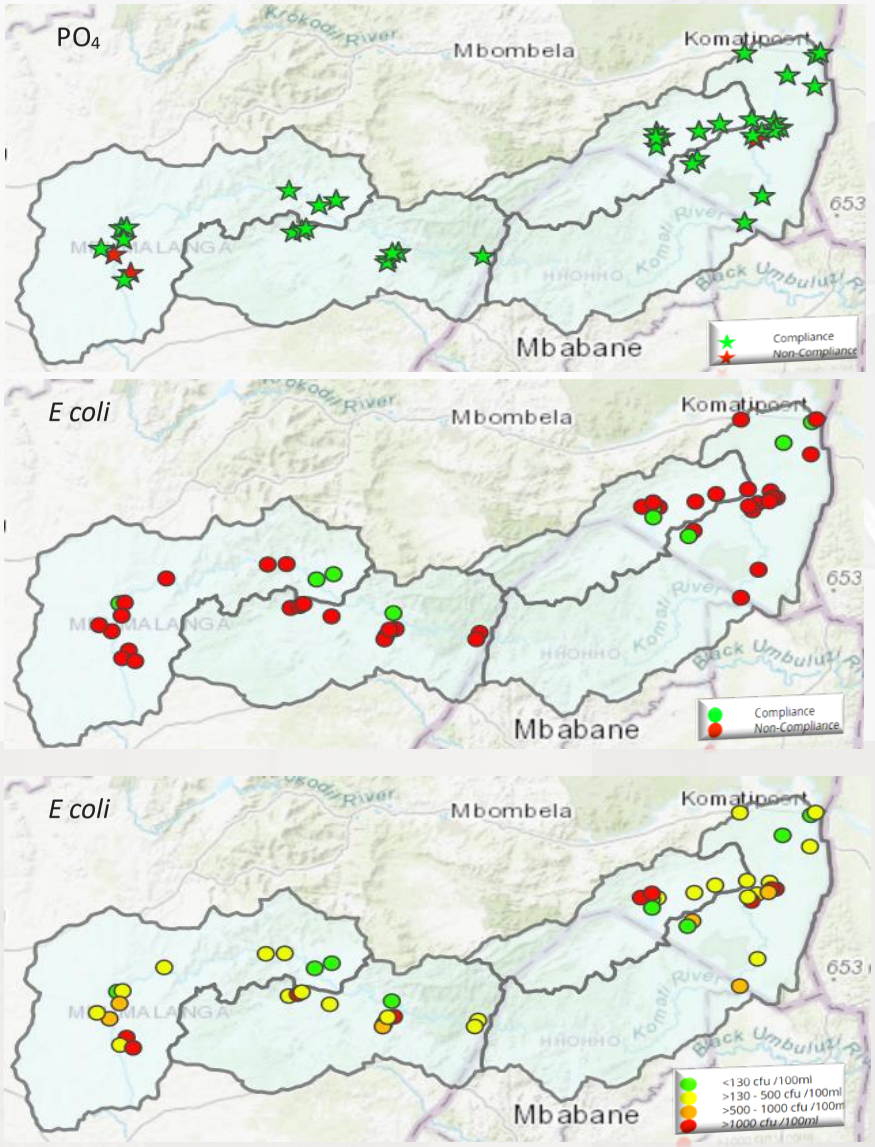


Figure 22: Water quality status within Komati Catchment showing microbiological (E. coli) and nutrients (PO_4) concentrations.

Phosphate (PO_4)

Phosphate showed compliance with the RQOs for most of the points within Komati Catchment, except for three points. The two points are in upper Komati sub catchment on tributary of Boesmanspruit upstream and downstream of Carolina WWTWs and the other point is in lower Komati sub catchment on tributary of Komati River downstream of Tonga Hospital WWTWs. The impacts are attributed to effluent discharges from WWTWs and illegal dumping of solid waste materials.

Escherichia coli (E. coli)

The red colour shows non-compoliance while the green shows compliance. ***E. coli*** counts in the Komati Catchment complied with the RQO of 130 (cfu/100ml) for few points mostly the Major Dams and Komati River at Tjakastad . The other sites in Carolina, Badplaas and Elukwatini areas within the upper Komati sub catchment and KaMatsamo, Tonga, Skoonplaas, KaMaqhekeza and Buffelspuit settlement within lower Komati sub catchment showed elevated *E. coli* counts which did not comply with the set RQOs due to contamination of human faecal material and/or other animals.

This map shows extent of noncompliance by showing less than 1 000 cfu/100ml in orange colour while greater than 1 000 cfu/100ml is shown in red. The high level of microbial concentration > 1 000 (cfu/100ml) arises from extensive urban and rural impacts from Carolina Badplaas, Elukwatini Tonga, Skoonplaas, KaMaqhekeza and Buffelspuit, Driekoppies areas including WWTWs and its associated infrastructure which discharge effluent into the Komati River and its tributaries. Meanwhile, other areas have not reached an alarming stage as *E. coli* counts for most of the points are still below 1 000 (cfu/100 ml).

3.4. Usuthu Catchment

3.4.1 Introduction

The headwaters of the Usutu River emerge from the highlands of Amsterdam, Mpumalanga province, flow through the Kingdom of eSwatini and then Republic of Mozambique before entering the Indian Ocean. The Usuthu Catchment is unique from the other three catchments due to the short distance from the headwaters to the border with eSwatini. Consequently, it has independent rivers that start at the source and flow directly into a neighbouring country before confluence with the main stem. While the main stem is the Usuthu River, the other tributaries confluence with the Usuthu River in eSwatini. These tributaries are the Lusushwana, Mpuluzi, bordering the Usuthu River to the North, and Sandspruit immediately south of the Usuthu River, followed by the Ngwempisi, Hlelo and Assegai consecutively to the south.

The major activities in the catchment include forestry, mining, agricultural activities and municipal wastewater treatment works. The Usuthu catchment is characterised by large transfers out of the catchment (and out of the WMA) to the Vaal and Olifants Water Management Areas mainly for cooling purposes at ESKOM power stations but also for other economically important activities. Four large dams in the Usuthu support these transfers, namely, Heyshope, Morgenstond, Westoe and Jericho dams. Pollution of these strategic water resources will significantly impact on power generation and the economy of the country at large.

3.4.2 Water Quality Monitoring Points

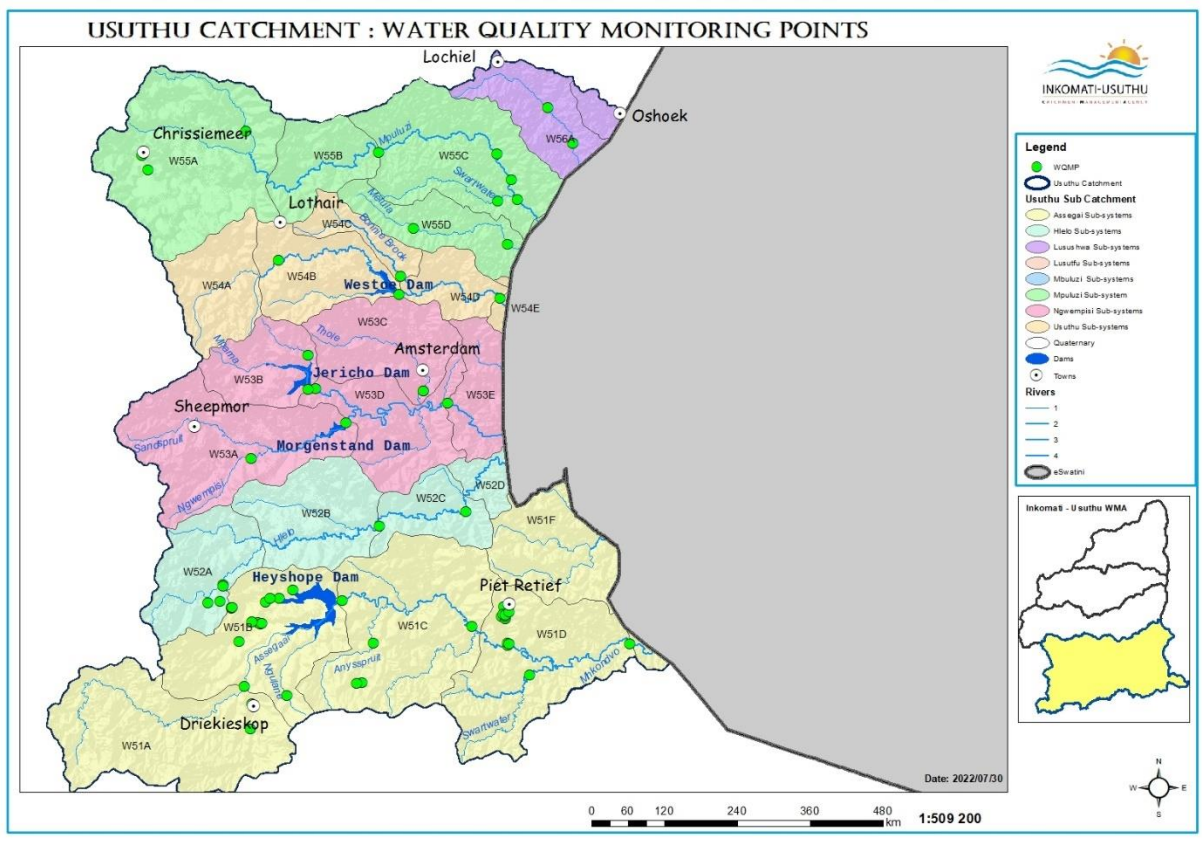


Figure 23: Water quality monitoring points in the Usuthu Catchment

3.4.3 Water Quality Status, trends, and Discussion of Results

The RQO are currently not determined for the Usuthu Catchment. Thus, the South African Target Water Quality Guidelines (SATWQG) were used to benchmark the water quality data for all variables. The compliance of the indicator parameters was compared with the Target Water Quality Guideline Limits (TWQG) as indicated in **Table 4**.

Table 4: Target Water Quality Guideline

Variables/Parameters	TWQG
E. coli (cfu/100ml)	130 (Recreation: full contact)
Electrical Conductivity (mS/m)	40
Phosphate (mg/l)	0.025
pH	6.5-8.5
Nitrates/Nitrites (mg/l)	6 (Domestic)
Manganese (mg/l)	0.18 (Aquatic ecosystem)
Ammonia (mg/l)	1 (Domestic)
Sulphate (mg/l)	30 (Industry Category 1)

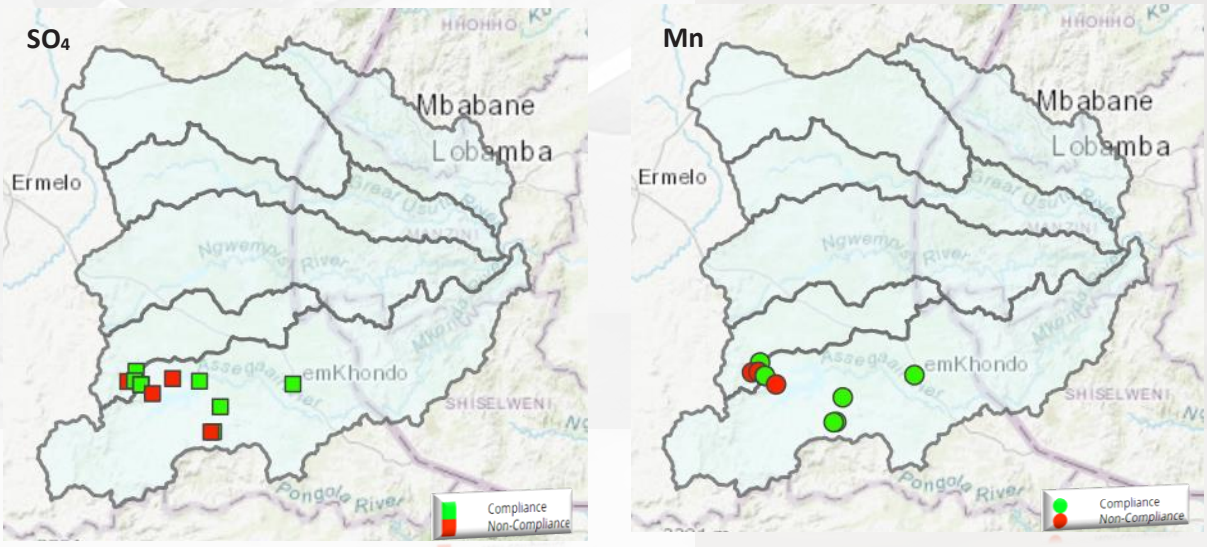


Figure 24 : Water quality status within Usuthu Catchment showing SO_4 and Mn concentrations

Sulphate and manganese are monitored to assess the impact of coal mining activities in the upper Assegaai River and Hlelo River sub-systems in the Usuthu Catchment. SO_4 indicated compliance with the TWQG for Industry of 30 (mg/l) except for 4 sites which indicated non-compliance as shown in *figure 24* and Mn indicated compliance with aquatic ecosystem of 0.18 (mg/l) throughout the reporting period except for 4 sites which exceeded the set TWQG.

The compliance status is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

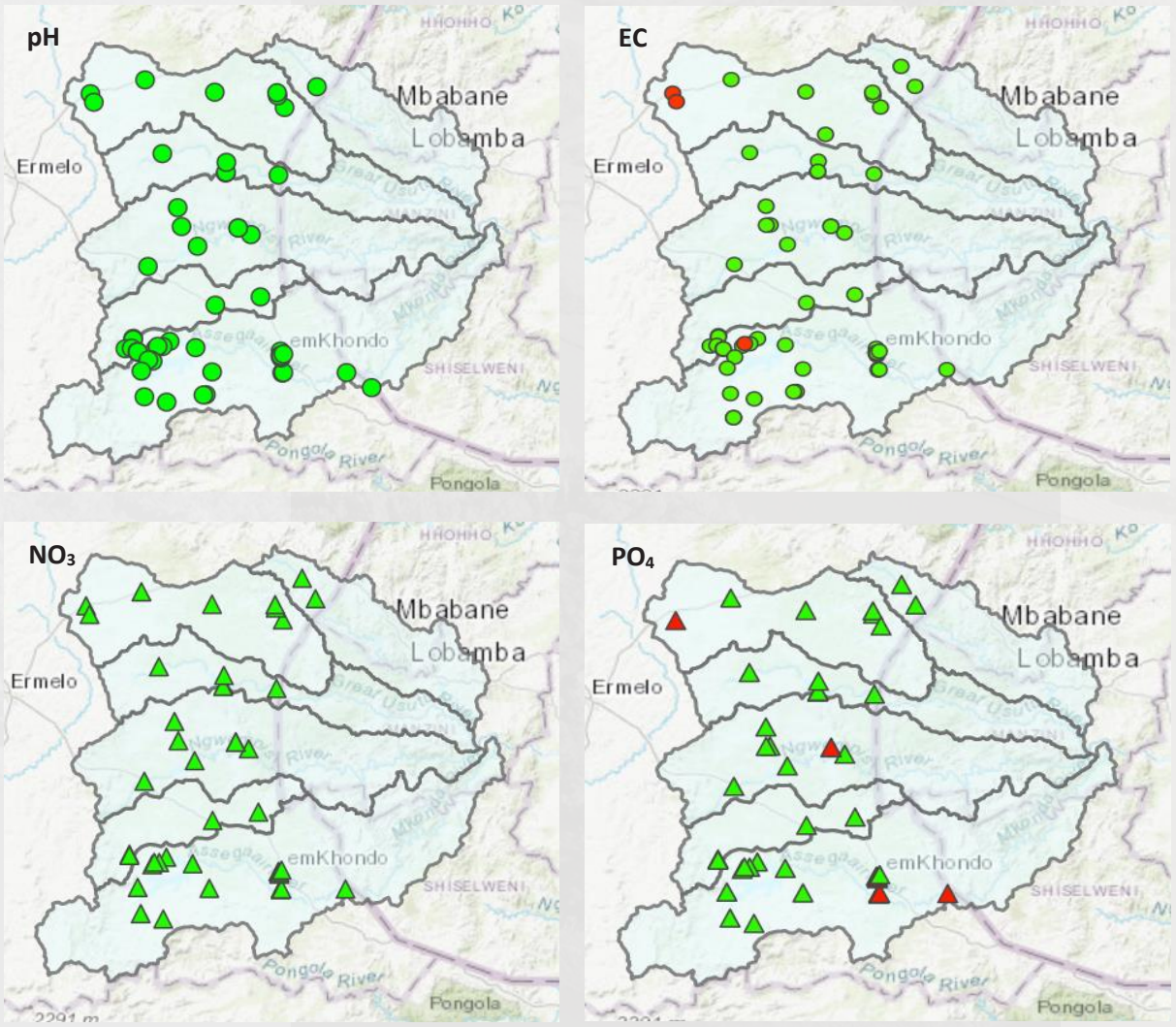


Figure 25 : Water quality status in Usuthu Catchment showing pH, EC, PO_4 and NO_3 concentrations

As shown in *Figure 25* **pH** complied with the TWQG limit throughout the reporting period and **EC** complied with the TWQG limits within the Usuthu Catchment except for downstream of Chrissiessmeer WWTWs, Egude River, tributary of Klipmisselspruit and Klipmisselspruit downstream of WWTW.

As shown in *Figure 25* **Nitrates and Phosphate** concentrations complied with the TWQG throughout the reporting period in the catchment, except for nine (9) points that indicated non-compliance for phosphate which are downstream of the WWTW as well as Klipmisselspruit and its tributaries.

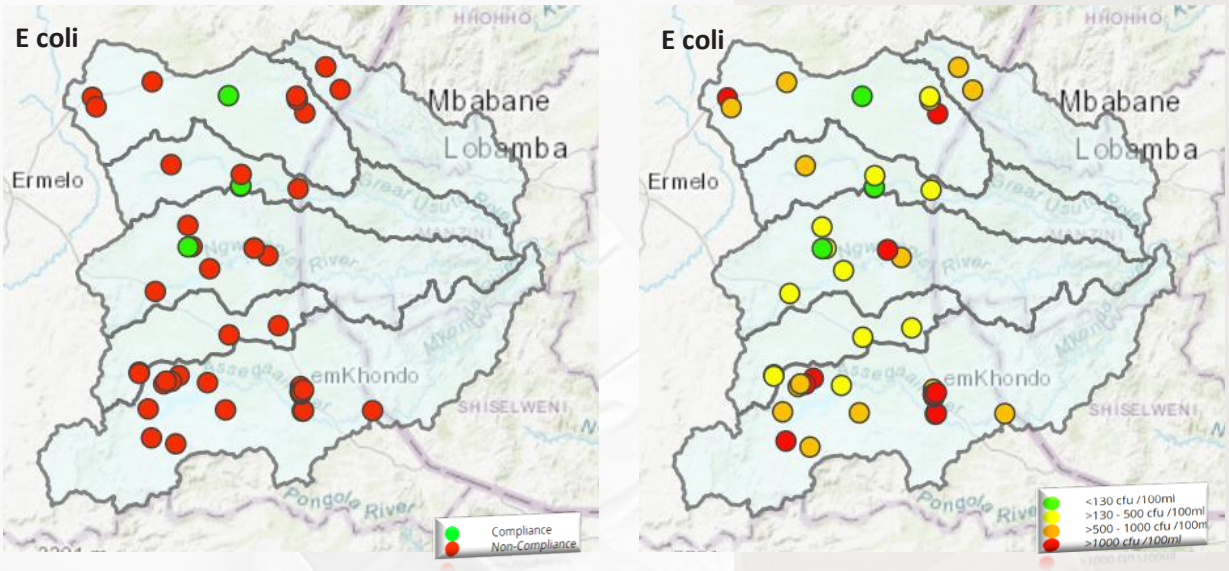


Figure 26 : Water quality status within Usuthu Catchment showing microbial (*E coli*) concentrations.

Escherichia coli counts did not comply with the TWQG limits of 130 (cfu/100ml). The non-compliance can mostly be attributed to the WWTW which discharge untreated or partially treated wastewater into the streams, overflowing sewer pump stations, non-point sources such as illegal waste dumping. The high level of microbial concentration greater than (>)1 000 (cfu/100ml) arises from residential area impacts. Whereas most of the areas have not reached an alarming stage as *E. coli* counts for most of the points are still below 1 000 (cfu/100 ml).

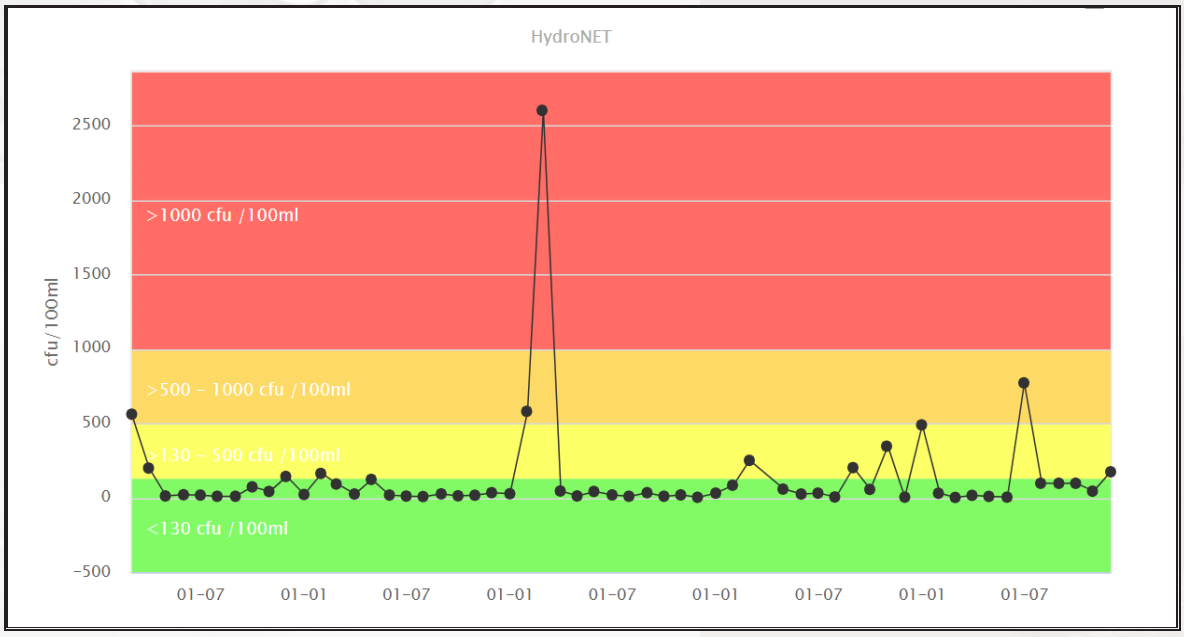


*Chart indicating microbial (E coli) concentration s trends (*March*2017-Dec 2021) in the Usuthu River*

CHAPTER 4 EUTROPHICATION STATUS

4.1 Introduction

Eutrophication is the process of nutrient enrichment of waters which results in the stimulation of an array of symptomatic changes, amongst which increased production of algae and aquatic macrophytes, deterioration of water quality and other symptomatic changes found to be undesirable and to interfere with water users (DWAF, 2002).

Eutrophication is a natural process resulting from the accumulation or overabundance of nutrients in bodies of water, particularly nitrogen and phosphorus compounds (Van Ginkel, 2011; Bol et al., 2018). However, human activities and related water pollution impacts such leaching from fertilized agricultural regions, erosion, nitrogen deposits from atmospheric pollution, sewage and industrial waste have been reported to accelerate the extent of eutrophication (Van Ginkel, 2011). This results in the intense development of eutrophication symptoms including blooms of blue-green algae (i.e. Cyanobacteria, Figure 1), which causes the reduction of water quality and clarity, an outbreak of alien aquatic plants such as water hyacinth (Moran, 2006), degradation of recreational opportunities, health risks to people and animals and thus, an increase in water treatment expenses.

Ten (10) major dams within the WMA are monitored as part of the National Eutrophication Monitoring Programme (NEMP) for 01 April 2021. The list of trophic status classes and criterion used to assign the trophic status are given in **Table *5*** and **Table 6** below.

Table 5: Trophic status classes used for assessment of dams in South Africa

1. **Oligotrophic**	low in nutrients and not productive in terms of aquatic and animal plant life;
2. **Mesotrophic**	intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life and showing emerging signs of water quality problems;
3. **Eutrophic**	rich in nutrients, very productive in terms of aquatic animal and plant life and showing increasing signs of water quality problems; and
4. **Hypertrophic**	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous.

Table 6: Criterion used to assign trophic status for the dams and lakes in South Africa

Statistic	**Unit**	**Current trophic status**			
Median annual Chl *a*	µg/l	0<x<10	10<x<20	20<x<30	>30
		Oligotrophic (low)	Mesotrophic (Moderate)	Eutrophic (significant)	Hypertrophic (serious)
% of time Chl a> 30µg/l	%	0	0<x<8	8<x<50	>50
		Negligible	Moderate	Significant	Serious
Potential for algal and plant productivity					
Median annual Total Phosphorus (TP)	mg/l	x<0.015	0.015<x<0.047	0.047<x<0.130	>0.130
		Negligible	Moderate	Significant	Serious

4.2 Trophic status

The trophic status is the level of Eutrophication within the water source. The trophic status helps us in determining the level of algal growth within the specific source. Shown below in *Figure 27* are the results of each impoundment monitored through the NEMP. Within the 10 impoundments monitored 9 falls under the Oligotrophic status, thus meaning they are low in nutrients with negligible for potential for plant and algal productivity. Jericho impoundment merely makes it to the Mesotrophic status which entails an intermediate level of nutrients and moderate potential for plant and algal productivity, as well as emerging signs of water quality issues.

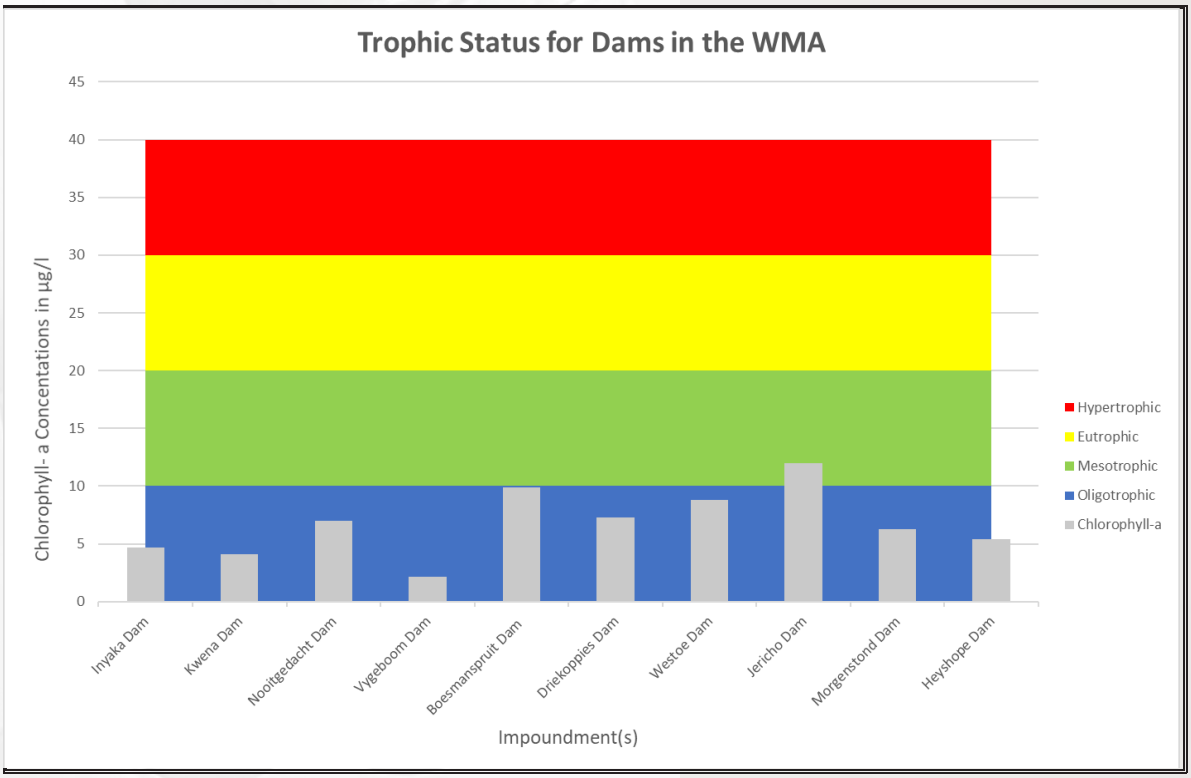
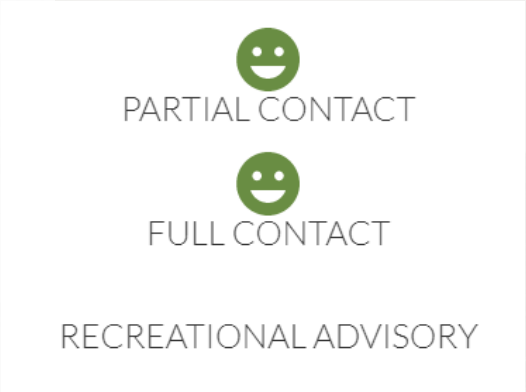


Figure 27 : The trophic status of the impoundments with Inkomati - Usuthu WMA.

Based on the trophic status, it was safe to undertake recreational activities that required both full and/or partial contact at Boesmanspruit Dam as illustrated in *Figure 28* during the reported period.

Figure 28: A photo of Boesmanspruit Dam



CHAPTER 5 RESOURCE DIRECTED MEASURES

5.1 Introduction

Resource Directed Measures (RDM) are tools developed to manage water quality, water quantity and aquatic ecosystems for the protection of water resources by setting objectives for the desired condition of resources. The ecological Reserve is one of the components of **Reserve** within the framework of resource directed measures which also consist of the **Management Class** (MC) and **Resource Quality Objectives** (RQOs) for protection of water resources to ensure sustainable development and use of water resource. RDM provide descriptive and numerical goals for the state of the resource, while the Source Directed Controls (SDC) specify the criteria for controlling impacts.

Classification process sets a class in which the water resource must be managed (DWS, 2011), while Reserve and RQOs are prescribed based on the management class sets. RQOs capture the ecological Reserve into measurable conditions which should be adhered to in the receiving water resource in terms of resource quality. In the Inkomati Usuthu WMA, Classes and RQOs are determined within the X primary drainage region of Komati (X1), Crocodile (X2), Sabie-Sand (X3) and (X4) and gazetted into law in December 2016 by government notice No. 1616. The comprehensive ecological Reserve determination study was also completed in February 2006, however gazetted into law in July 2019 by government notice No. 998.

Resource quality objectives (RQOs) are numerical or narrative descriptors of quality, quantity, habitat, and biotic conditions that need to be met to achieve the required management scenario and are defined for each resource units (RU) for every integrated Units of Analysis (IUA). RU are the portrayal of catchments using units which are relatively homogenous on an ecological basis and IUAs represent a homogenous catchment area of similar impacts. Every IUA is classed in terms of the extent of permissible utilisation and protection and constitutes respective catchment configuration. The catchment configuration consists of several biophysical nodes representing river reaches. Within these river reaches Ecological water requirements (EWR) sites are established.

Although the RQOs have four key components of aquatic ecosystem (quality, quantity, habitat, and biota) to ensure that the structure and the function is protected, this report will only focus on water quality component. Monitoring of RQOs is required to determine compliance/or achievement of the numerical or narrative descriptors of water quality set to achieve the required management scenario.

Water quality monitoring was conducted within the WMA, and the purpose of this chapter is to assess compliance/or achievement of RQOs at specified Ecological Water Requirements site(s) and water quality priority resource units within the specified reaches. Note that where there is more than one monitoring site on the same river reach within the water quality (WQ) priority resource units the downstream monitoring site is used for reporting. It should be noted that it is not a single water user responsibility for the achievement/or compliance of the RQO in a resource unit but rather an aggregate impact of all water users within the RU. Consequently, the RQOs do not form part of the licence conditions.

Non-compliance/or achievement RQO should not be seen as a failure of key Performance Area, rather effective management of water resource moving towards the direction of the RQO not away from it. In situations where the RQO is persistently not achieved, it needs to be addressed progressively over realistic period, to allow users to adjust their activities, to allow water resource managers to apply successful SDC that are guided by RDM which may require amendment of regulation(s)/condition(s). For example, attaching appropriate conditions of use to licenses.

5.2 Ecological Water Requirements (EWR) Sites Compliance Status

5.2.1 Sabie Sand Catchment

The data reported was collected over a period of a year from January 2021- December 2021 and was statistically analysed using percentiles and average as tabulated below in **Table *7***. The Sabie/Sand catchment comprises of eight (8) Ecological Water Requirements (EWR) sites across the catchment as presented in *Figure 29*.

Table 7: Water Quality Variables

Classified Water quality variables	Indicator Variables	Statistical analysis of data
System variables	Turbidity	95 percentiles
Salts	Electrical Conductivity	95 percentiles
Nutrients	Phosphate	50 percentiles
Microbial	*E coli*	95 percentiles

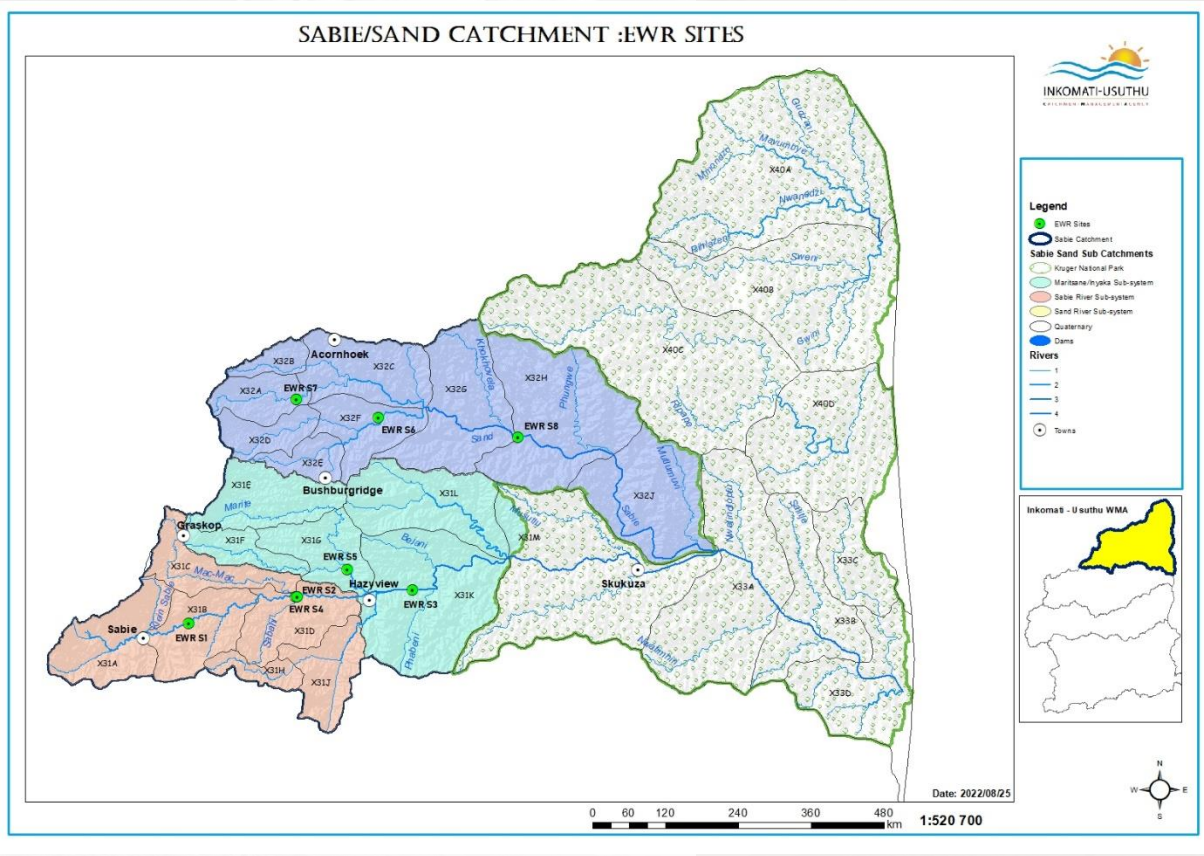


Figure 29 : Map showing Ecological Water Requirement sites within Sabie/Sand Catchment

The compliance status of each EWR site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in **Table 8** below.

Table 8: EWR Sites compliance status

Resource Units	EWR Site	Turbidity (NTU)		EC (mS/m)		PO_4 (mg/l)		*E coli* (cfu/100ml)	
		RQO	Results	RQOs	Results	RQOs	Results	RQOs	Results
MRU Sabie A: (Sabie River)	EWR S-1	NR	**74.15**	30	**12.78**	0.015	**0.015**	130	**>2420**
MRU Sabie A: (Sabie River)	EWR S-2	NR	**153.33**	30	**59.79**	0.015	**<0.010**	130	**>2420**
MRU Sabie B: (Sabie River)	EWR S-3	NA	**83.94**	30	**12.54**	0.015	**<0.010**	130	**>2420**
MRU Mac A: (Mac Mac River)	EWR S-4	NA	**19.71**	40*	**13.81**	0.025*	**<0.010**	130*	**545**
MRU Mar A: (Marite River)	EWR S-5	NR	**34.7**	30	**10.51**	0.015	**<0.010**	130	**>2420**
MRU Mut A: (Mutlumuvi River)	EWR S-6	NR	**640.30**	55	**10.52**	0.015	**0.011**	130	**>2420**
MRU Sand A: (Grootsand River)	EWR S-7	NA	**35.45**	42	**14.38**	0.125	**<0.010**	130	**1846**
MRU Sand B: (Sand River)	EWR S-8	NR	**77.625**	40*	**45.68**	0.125	**0.017**	130	**>2420**

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Table 9: Compliance status of monitoring sites per reach within WQ Priority Resources Units: Compliance (Green) or non-compliance (Red)

WQ Priority RU	River reach and Resource Name	Turbidity (NTU)		EC (mS/m)		PO_4 (mg/l)		*E-coli* (cfu/100ml)	
		RQO	Results	RQOs	Results	RQOs	Results	RQOs	Results
RU S6	X31J-00774 (Noorsand River)	NA	**VA**	30	**30.92**	0.025	**0.011**	130	**>2420**
RU S9	X31K-00713 (Bejani River)	NA	**VA**	30	**60.15**	0.025	**0.010**	130	**>2420**
MRU Sabie C	X33B-00804 (Sabie River)	NA	**80.13**	42	**69.37**	0.125	**0.011**	130	**1509**

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Discussion of results

Ecological Water Requirements Sites

Year 2021 compliance percentage of EWR sites within the Sabie/Sand catchments with the water quality numerical RQOs are as follows: Electrical Conductivity (87.5%), phosphate (100%) and *E coli* (0%). Compliance percentage showed improvement in terms of PO_4 and remained constant for EC and deteriorated for *E coli* compared to 2020 as illustrated in *Figure 30.*

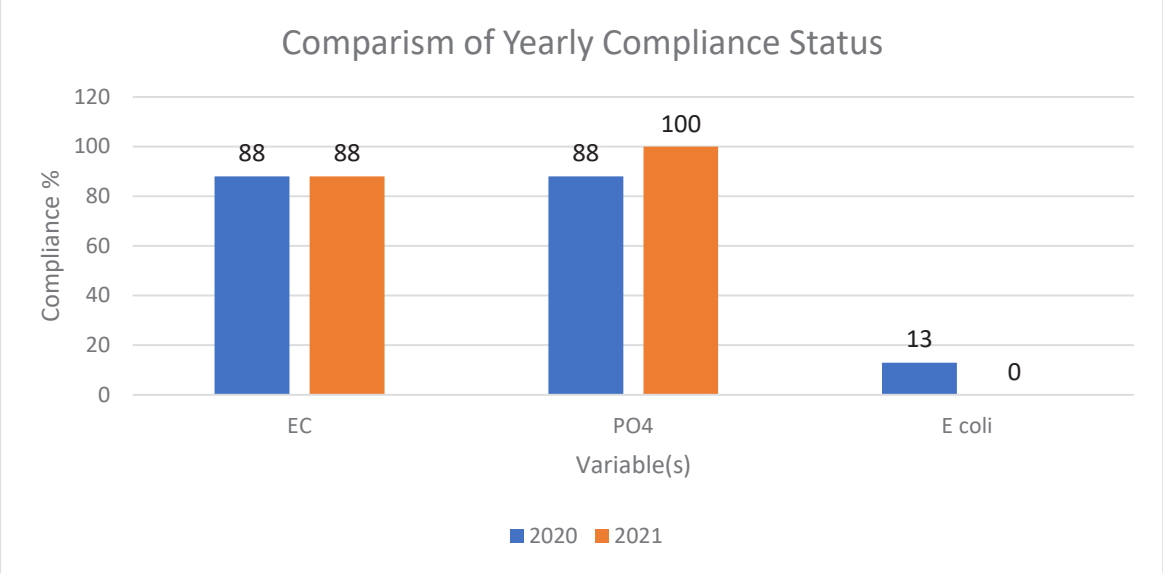


Figure 30 : Compliance percentage of EWR Sites within Sabie Sand Catchment

5.2.2 Crocodile Catchment

The data reported was collected over a period of a year from January 2021- December 2021 and was statistically analysed using percentiles and average as tabulated below in **Table 10**. The Crocodile catchment comprises of nine (9) EWR sites across the catchment as presented in *Figure 31*.

Table 10: Water Quality Variables

Classified Water quality variables	Indicator Variables	Statistical analysis of data
System variables	pH	5 and 95 percentiles
	Turbidity (TUR)	95 percentiles
	Temperature (Temp)	95 percentiles
Salts	Electrical Conductivity (EC)	95 percentiles
Nutrients	Phosphate (**PO_4**)	50 percentiles
	Total Inorganic Nitrogen (TIN)	95 percentiles
Microbial	*Escherichia coli (E coli)*	95 percentiles
Toxic	Manganese (Mn)	95 percentiles
	Cyanide (Cn)	
	Chromium VI (Cr VI)	
	Cyanide (Cn)	
	Arsenic (As)	

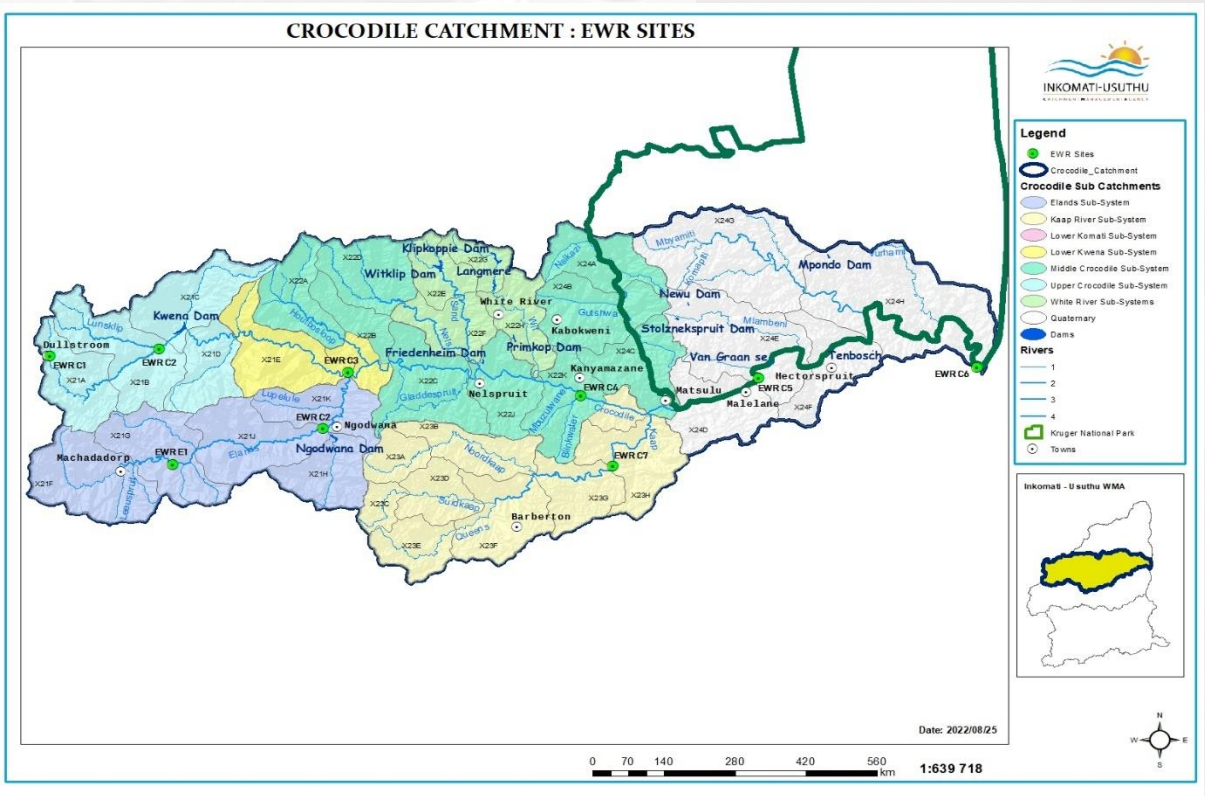


Figure 31: Map showing Ecological Water Requirement sites within Crocodile Catchment.

The compliance status of each EWR site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in **Table 11** below.

Table 11: EWR Sites compliance status

Variable	Results ROQs Ecospecs	Resources Units							
		MRU CROC A Crocodile River		MRU CROC B Crocodile River	MRU ELAN A Elands River	MRU ELAN B Elands River	MRU CROC D Crocodile River	MRU CROC E Crocodile River		MRU KAAP A Kaap River
		EWR-C1	EWR-C2	EWR-C3	EWR-E1	EWR-E2	EWR-C4	EWR-C5	EWR-C6	EWR-C7
Temp (°C)	RQO	Not more than 2 °C from baseline (Aquatic Ecosystem driver)								
	Results	21.9	22.2	23.3	23.2	24.2	27.3	27.8	29.3	27.3
Turbidity (NTU)	RQO	NA (Aquatic Ecosystems driver)								
	Results	5.1	45.3	207.8	194.9	323.8	1007.4	117.7	109.1	49.9
EC (mS/m)	RQO	30	30	30	30	55	70	70	70	200
	Results	37.5	13.0	12.4	20.5	86.9	49.2	69.7	99.7	69.3
PO_4 (mg/l)	RQO	0.015	0.025	0.015	0.025	0.015	0.125	0.075	0.125	0.125
	Results	<0.010	<0.010	<0.010	0.014	<0.010	0.100	0.050	0.04	0.03
TIN (mg/l)	RQO	NR	NR	NR	NR	NR	NR	NR	NR	< 4
	Results	NR	NR	NR	NR	NR	NR	NR	NR	1
E-coli (cfu/100 ml)	RQO	120	130	130	130	130	130	130	130	130
	Results	125	1278	1664	>2420	1181	>2420	>2420	1628	990
Cn(mg/l)	RQO	NR	NR	NR	NR	NR	NR	NR	0.04	0.004
	Results	NR	NR	NR	NR	NR	NR	NR	VA	<0.007
As (mg/l)	RQO	NR	NR	NR	NR	NR	NR	NR	0.02	0.020
	Results	NR	NR	NR	NR	NR	NR	NR	VA	0.053

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Table 12: Compliance status of monitoring sites per reach within WQ Priority Resources Units: Compliance (Green) or non-compliance (Red)

WQ Priority RU: River reach (Resource Name)	Turbidity		pH		EC (mS/m)		PO_4 (mg/l)		*E coli* (cfu/100ml)		*Mn(mg/l)*		As(mg/l)		Cn (mg/l)		Cr VI (mg/l)	
	RQO	Results	RQO	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results
MRU Elan A: X21F-01046 (Elands River)	NR		6.5 - 8	7.6-7.9	30	29.5	0.025	<0.010	130	411	0.18	VA	0.020	NR	0.004	NR	0.014	VA
RU C7: X21F-01100 (Leeuspruit)	NR		6.5 - 8	7.5-8.2	30	28.2	0.025	0.086	130	>2420	0.18	VA	0.020	NR	0.004	NR	0.014	VA
MRU Elan B: X21J-01013 (Elands River)	NA	VA	6.5-8.5*	7.3-8.1	55	18.6	0.025	<0.010	130*	1328	0.18	VA	0.020	NR	0.004	NR	0.014	VA
MRU Elan B: X21K-00997 (Elands River)	NA	VA	6.5-8.5*	7.5-8.3	55	71.0	0.025	<0.010	130*	1485	0.18	VA	0.020	NR	0.004	NR	0.014	NR
MRU Croc C: X22B-00888 (Crocodile River)	NA	VA	6.5-8.5*	7.5-8.1	55	29.0	0.025	<0.010	130	2042	0.18	0.014	0.020	VA	0.004	VA	0.014	NR
MRU Croc C: X22J-00993 (Crocodile River)	NA	VA	6.5-8.5*	7.2-8.1	55	133.5	0.025	<0.010	130	>2420	0.18	0.029	0.020	NR	0.004	NR	0.014	NR
MRU Croc C: X22J-00958 (Crocodile River)	NA	VA	6.5-8.5*	7.3-7.9	55	75.6	0.025	0.006	130	>2420	0.18	0.104	0.020	NR	0.004	NR	0.014	NR
MRU Croc C: X22K-00981 (Crocodile River)	NA	VA	6.5-8.5*	7.4-7.9	55	63.7	0.025	0.076	130	>2420	0.18	0.282	0.020	NR	0.004	NR	0.014	NR
RU C12: X22C-01004 (Gladdespruit)	NA	VA	6.5-8.5*	7.1-7.9	40*	28.4	0.02*	0.012	130*	>2420	0.18	1.671	0.020	NR	0.004	NR	0.014	NR
RU C14: X22H-00836 (White River)	NR		6.5-8.5*	7.4-8.0	55	39.9	0.125	0.005	130	398	0.18	0.136	0.020	NR	0.004	NR	0.014	NR
RU C17: X23C-01098 Suidkaap River)	NR		6.5-8.5*	7.4-8.2	30	21.3	0.075	0.019	130	664	NR		0.02	NR	0.004	NR	0.014	NR
RU C17: X23E-01154 (Queens River)	NR		6.5-8.5*	7.6-8.2	30	51.8	0.075	0.007	130	2181	0.18	VA	0.02	VA	0.004	VA	0.014	NR

WQ Priority RU: River reach (Resource Name)	Turbidity		pH		EC (mS/m)		PO_4 (mg/l)		*E coli* (cfu/100ml)		*Mn(mg/l)*		As(mg/l)		Cn (mg/l)		Cr VI (mg/l)	
	RQO	Results	RQO	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results	RQOs	Results
RU C17: X23F-01120 (Suidkaap River)	NR		**6.5-8.5***	7.0-8.0	**30**	68.0	**0.075**	0.087	**130**	1866	**0.18**	0.319	**0.02**	VA	**0.004**	<0.007	0.014	NR
MRU Croc D: X24C-01033 (Crocodile River)	**NA**	**VA**	**6.5-8.5***	7.6-8.5	**85**	44.0	**0.125**	0.064	**130**	>2420	**0.18***	0.073	**0.01***	0.010	NR		NR	
RU C19: X24B-00903 (Gutshwa River)	**NA**	**VA**	**6.5-8.5***	7.5-7.9	**55**	107.5	**0.125**	0.800	**130**	>2420	**0.18**	NR	**0.020**	NR	**0.004**	NR	0.014	NR

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Discussion of results

Ecological Water Requirements Sites

Year 2021 compliance percentage of EWR sites within the Crocodile catchments with the water quality numerical RQOs are as follows: Electrical Conductivity (77.7%), phosphate (100%), *E coli* (0%), TIN (100%), As (0%) and Cn (100%). Compliance percentage showed consistency in terms of EC, TIN, Cn, As and PO_4 and indicated deterioration for *E. coli* as illustrated in *Figure 32*.

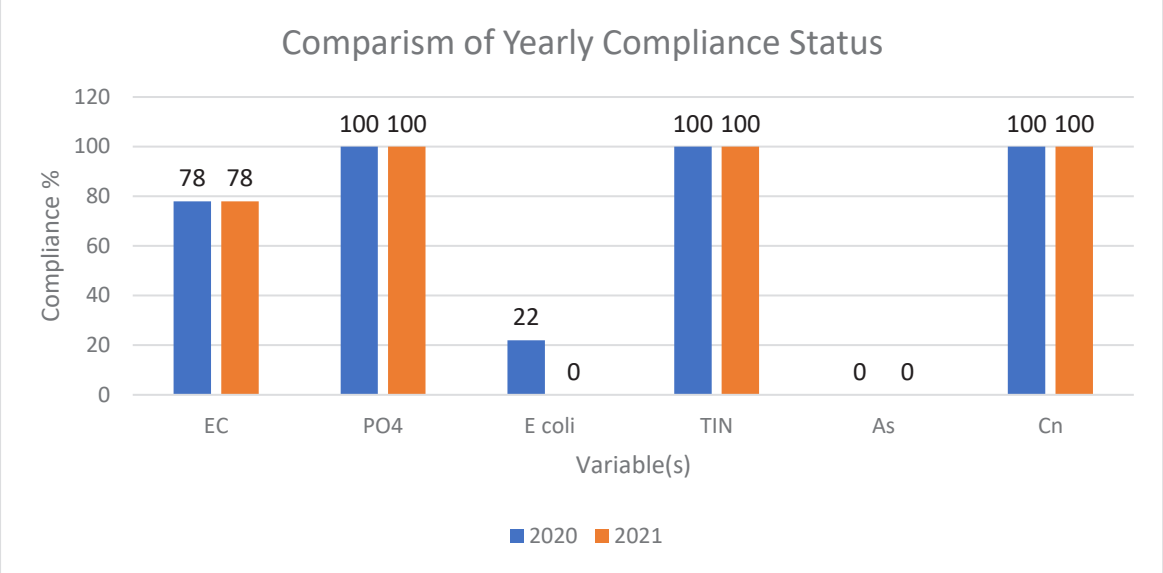


Figure 32: Compliance percentage of EWR Sites within Crocodile Catchment

5.2.3 Komati Catchment

The data reported was collected over a period of a year from January 2021- December 2021 and was statistically analysed using percentiles and average as tabulated below in **Table 13**. The Komati catchment comprises of six (6) Ecological Water Requirements (EWR) sites across the catchment as presented in *Figure 33*.

Table 13: Water Quality Variables

Classified Water quality variables	Indicator Variables	Statistical analysis of data
System	pH	5 and 95 percentiles
Salts	Electrical Conductivity	95 percentiles
Nutrients	Orthophosphate	50 percentiles
Microbial	*E coli*	95 percentiles

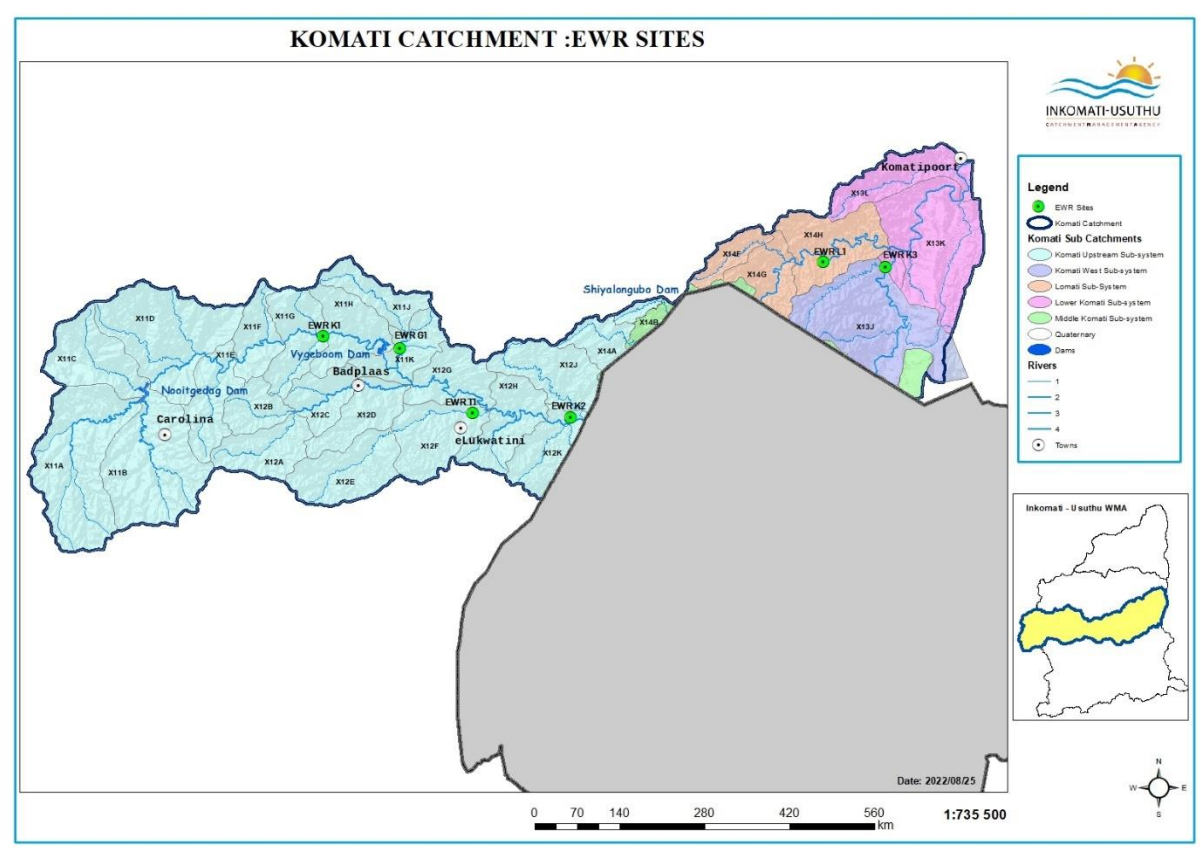


Figure 33 : Map showing Ecological Water Requirement sites within Komati Catchment.

The compliance status of each EWR site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in **Table 14** below.

Table 14: EWR Sites compliance status

Resource Units	EWR Site	Turbidity (NTU)		EC (mS/m)		PO_4 (mg/l)		TIN		*E coli* (cfu/100ml)	
		RQO	Results	RQOs	Results	RQOs	Results	RQO	Results	RQOs	Results
MRU Komati B: (Komati River)	EWR K-1	NR	**108.51**	50	**19.425**	0.02	**0.010**	**NR**		**130***	**1180**
MRU Komati G: (Glaaddespruit River)	EWR G-1	NA	**32.23**	40*	**19.42**	0.02	**0.010**	**NR**		**130***	**185**
MRU Komati C: (Komati River)	EWR K-2	NA	**17.90**	55	**20.57**	0.02	**0.023**	**NR**		130	**1488**
MRU Komati T: (Teewaterspruit River)	EWR T-1	NA	**43.45**	40*	**25.96**	0.125	**0.061**	**NR**		130	**>2420**
MRU Komati M: (Lomati River)	EWR L-1	NA	**40.18**	30	**24.41**	0.015	**0.010**	1	**VA**	130	**1203**
MRU Komati D: (Komati River)	EWR K-3	**NR**	**433.25**	85	**75.81**	0.125	**0.010**	1	**VA**	130	**1120**

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Table 15: Compliance status of monitoring sites per reach within WQ Priority Resources Units: Compliance (Green) or non-compliance (Red)

WQ Priority RU	River reach and Resource Name	pH		Temperature		Turbidity (NTU)		Sulphate (mg/l)		EC (mS/m)		PO_4 (mg/l)		*E-coli* (cfu/100ml)	
		RQO	Results	RQO	Results	RQOs	Results	RQOS	Results	RQOs	Results	RQOs	Results	RQOs	Results
RU K1	X11A-01248 (Vaalwaterspruit)	8.0-8.8	**8.15**	NR		NR		30	**245.00**	30	**87.1**	0.025	**0.016**	130	**>2420**
	X11A-01295 (Vaalwaterspruit)	8.0-8.8	**7.85**	NR		NR		30	**1272.00**	30	**198.51**	0.025	**VA**	130	**VA**
RU K2	X11B-01370 (Boesmanspruit)	8.0-8.8	**7.79**	NR		NR		80	**350.40**	30	**73.56**	0.025	**VA**	130	**VA**
	X11B-01361 (Tributory of Boesmanspruit)	8.0-8.8	**7.85**	NR		NR		80	**VA**	30	**13.08**	0.025	**VA**	130	**VA**
	X11B-01272 (Boesmanspruit)	8.0-8.8	**7.85**	NR		NR		80	**135.95**	30	**49.35**	0.025	**0.085**	130	**>2420**
RU-K3	X11C-00147 (Witkloofspruit)	8.0-8.8	**7.89**	NR		NR		30	**176.95**	30	**60.62**	NR		NR	
	X11D-01129 (Klein Komati River)	8.0-8.8	**7.85**	NR		NR		30	**51.73**	30	**18.01**	NR		NR	
RU-K4	X11E-01237 (Swartspruit)	6.5-8.5*	**7.01**	NR		NA	**VA**	30	**24.37**	40*	**15.36**	NR		NR	
MRU Komati E	X13K-01038 (Komati River)	6.5-8.5*	**7.7-8.4**	**Not more than 2 °C from baseline.**	VA	NA	**VA**	NR		85	**68.36**	0.125	**0.010**	130	**352**
	X13L-00995 (Komati River)	6.5-8.5*	**7.4-8.4**		VA	NA	**110.13**	30*	**46.81**	85	**93**	0.125	**0.013**	130	**809**

NA: Not available NR: Not Required VA: Variable Not Analysed TWQR*: Strictest limit from Targeted Water Quality Guideline

Discussion of results

Ecological Water Requirements Sites

Year 2021 compliance percentage of EWR sites within the Komati catchments with the water quality numerical RQOs are as follows: Electrical Conductivity (100%), phosphate (100%) and *E coli* (0%) and TIN (100%). Compliance percentage showed improvement in terms of PO_4 and indicated consistency for EC, TIN and *E-coli* as illustrated in *Figure 34*.

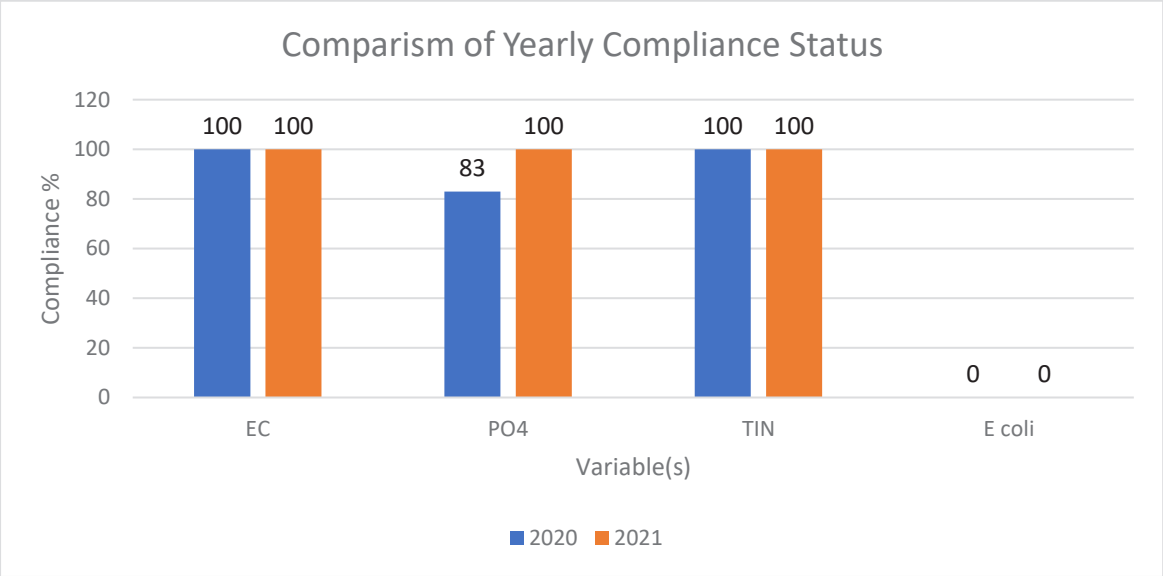
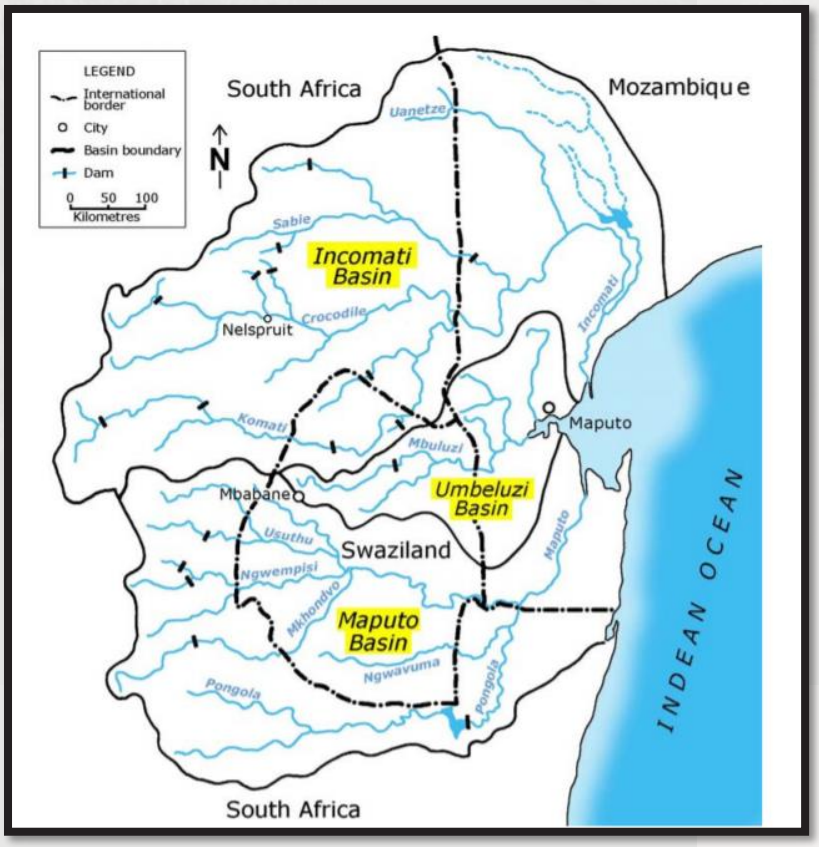


Figure 34 : Compliance percentage of EWR Sites within Komati Catchment

CHAPTER 6: WATER QUALITY STATUS OF INCOMATI-MAPUTO WATERCOURSES

6.1 Introduction

The Inkomati-Usuthu water management area falls within two river basins namely Incomati River Basin and Maputo River Basin (insert). The Incomati River Basin is located in the eastern region of southern Africa and is shared by South Africa, eSwatini and Mozambique. The basin is 480 kilometres long, with drainage basin 50,000 square kilometres in size. The headwater of Maputo River Basin originates in South Africa, Usuthu River in Mpumalanga province, and flows easterly through eSwatini and the River is called Great Usuthu or Lusutfu, where it enters the Republic of Mozambique after confluence with Pongola River and it's called Maputo River flowing into the estuary in Maputo Bay. The 13 km gorge (Valley) forms the boundary between Kingdom of eSwatini and Republic of South Africa and approximately twenty kilometres forms the border between South Africa (province of KwaZulu-Natal) and the Republic of Mozambique. The land area of the Maputo River basin is about 30 000 km^2.



Water is used by forest plantations and for domestic and industrial use, while irrigation is the major water user in both basins. The government of the Republic of Moçambique, the Republic of South Africa (RSA) and the Kingdom of eSwatini have been collaborating in the exchange of information, agreements on sharing of water, and in joint studies that are of mutual interest and benefit. These initiatives have been done through the Tripartite Permanent Technical Committee (TPTC), which was formally established on 17 February 1983. The TPTC is responsible for providing advice to the shared watercourse States on equitable utilisation and management of the shared waters. It was identified in the Interim IncoMaputo Agreement (IIMA), (August 2002) that a "Comprehensive Agreement" is required for the watercourse states to participate more effectively in the utilisation, development and protection of the shared waters. The purpose of this chapter is to share water quality compliance status of the major watercourses within the basins which falls within the Inkomati Usuthu WMA, South Africa.

6.2 International Water Quality Monitoring Points

The catchment comprises of ten (10) international obligation (IO) sites across the WMA as presented in *Figure 35*.

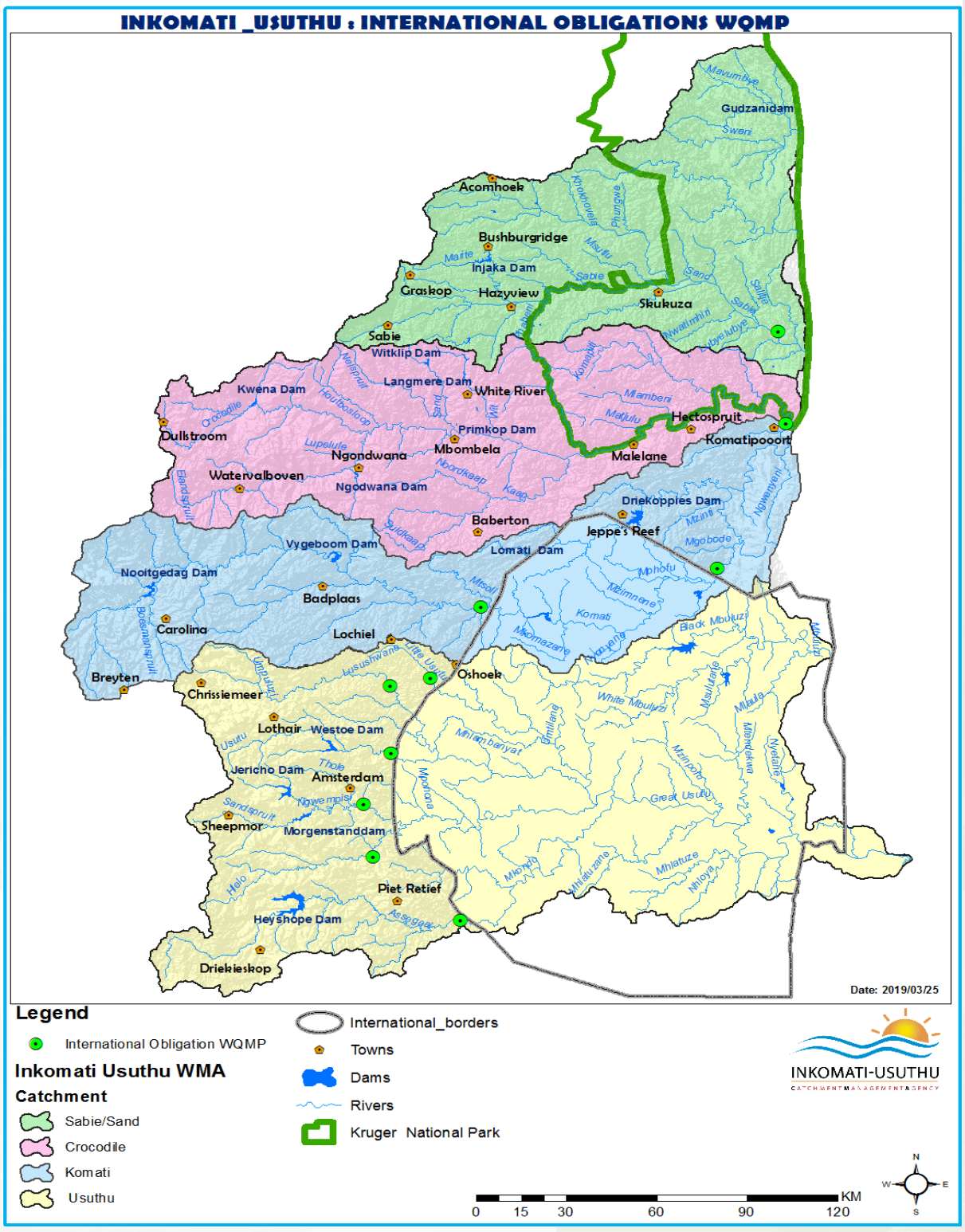


Figure 35 : International Obligation water quality monitoring points in the Inkomati-Usuthu WMA

6.3 International Water Quality Guideline limits

The average data reported was collected over a period of a year from January 2021- December 2021. The compliance of the indicator parameters is compared with the water quality guidelines as per the Interim IncoMaputo Agreement (IIMA), tabulated below.

Table 16: International Water Quality Guideline limits

Variables/Parameters	International Water Quality Guidelines Limits
Total Coliforms (TC) in cfu/100ml	10 000
Faecal coliforms (FC) in cfu/100ml)	2 000
Faecal Streptococci (FS) in cfu/100ml)	1 000
Electrical Conductivity (EC) in mS/m)	150
Sulphate (SO_4) in mg/l)	250
Phosphate (PO_4) in (mg/l)	2
pH	6.5-8.5
Nitrates (NO_3) in mg/l	50
Ammonia (NH_3) in mg/l	1
Copper (Cu) in mg/l	0.02
Iron (Fe) in mg/l	N/A
Manganese (Mn) in mg/l	0.3
Biological Oxygen Demand (BOD) in mg/l	<5
Chemical Oxygen Demand (COD) in mg/l	10
Chloride (Cl) in mg/l	250
Fluoride (F) in mg/l	0.75
Potassium (K) mg/l	50
Sodium (Na) in mg/l	200
Turbidity (TUR) in NTU	5
Dissolved Oxygen (DO) in %	>75

6.4 Water Quality Status

The compliance status of each IO site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

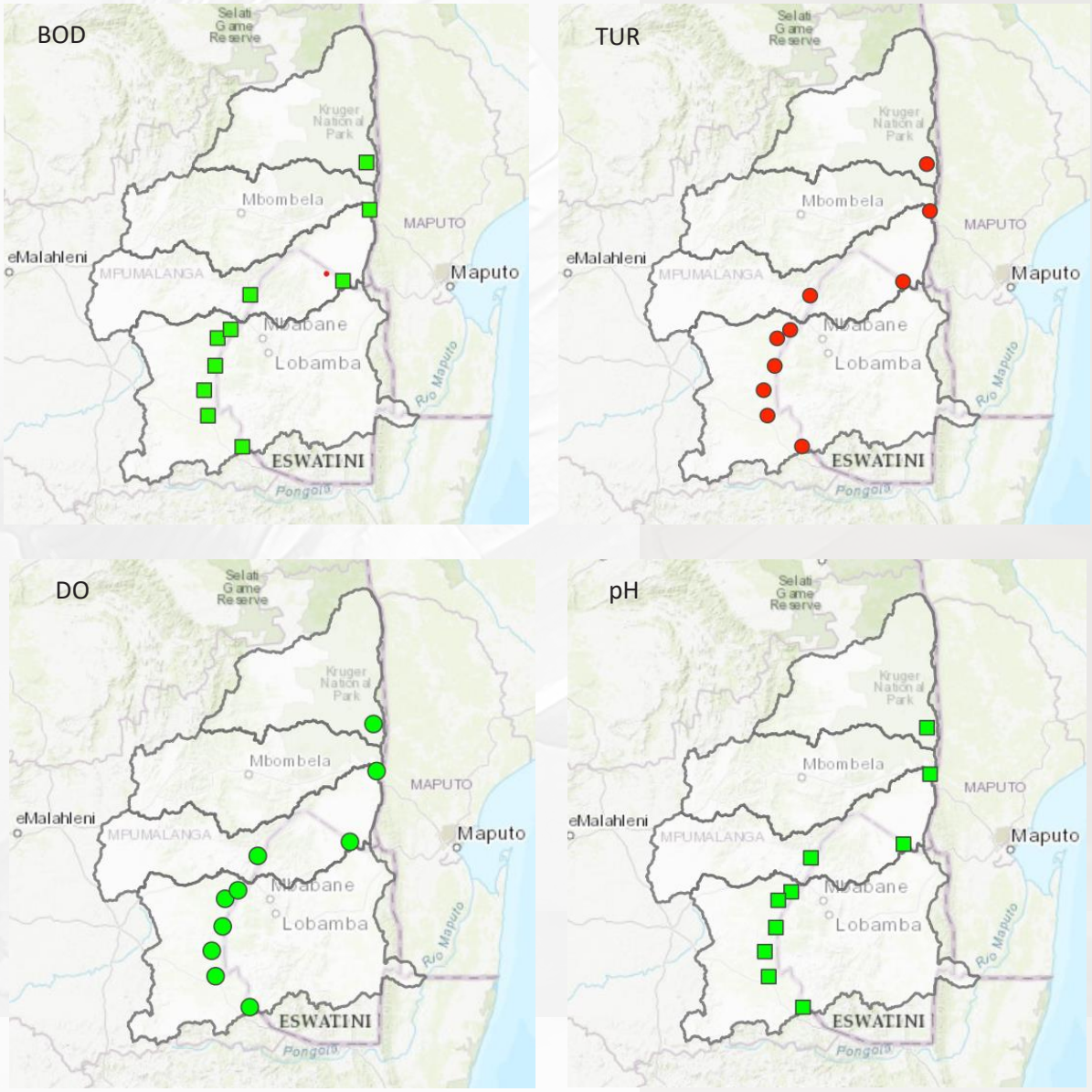


Figure 36 : Maps showing water quality status for international obligation site (s)

Discussion of Results

All variables as shown in *Figure 36* complied with the international water quality guidelines limit as per the IIMA. The RSA therefore complied with the water quality limits discharged (allowed to flow) into the Republic of Mozambique and Kingdom of eSwatini as per the international obligation agreement throughout the reporting period, except for turbidity which indicated non-compliance at all international Obligation sites within the basin due to the stringent turbidity limit and the high flows that result in soil erosion as well as illegal sand mining.

.

The compliance status of each IO site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

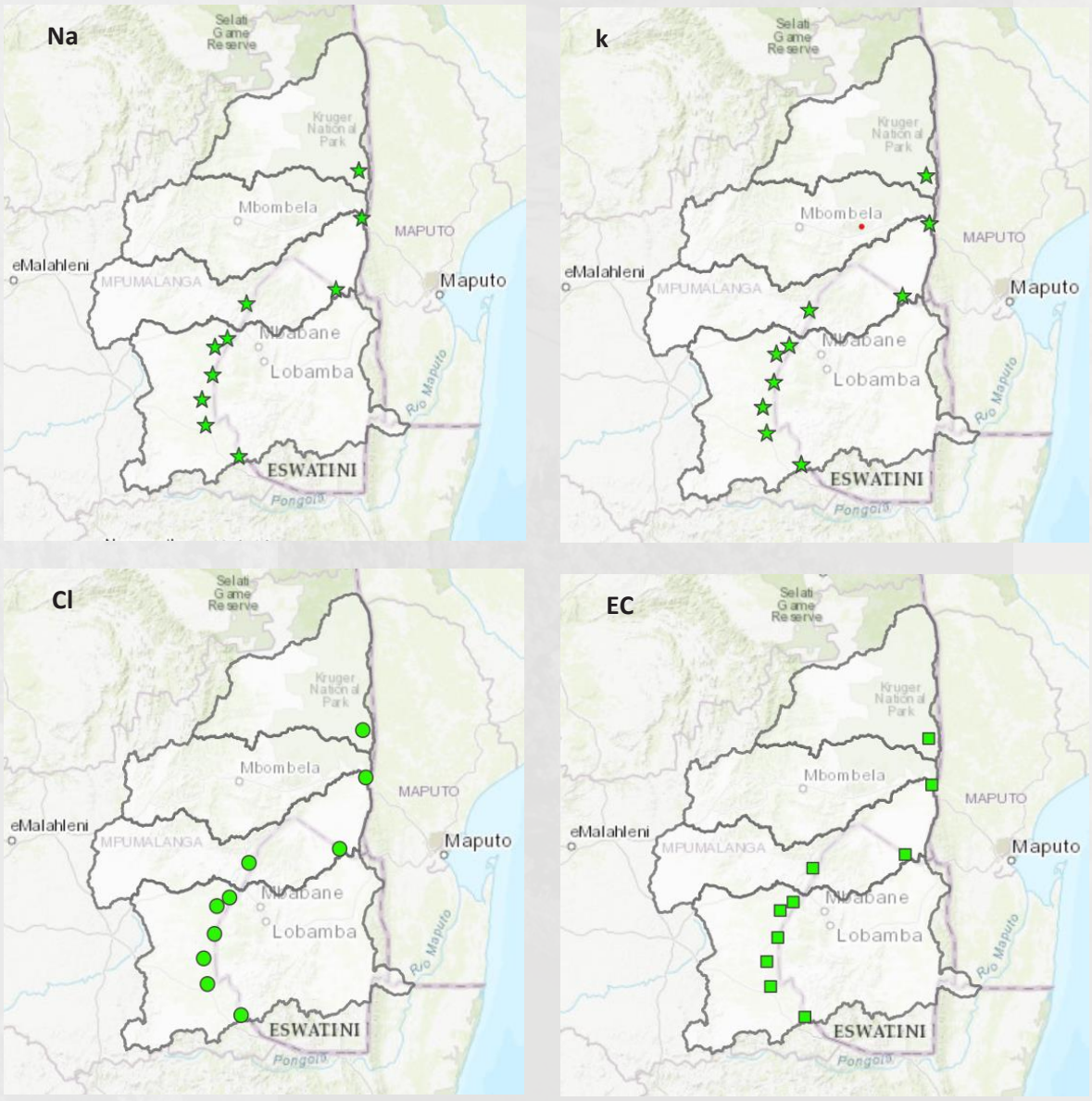


Figure 37: Maps showing water quality status for international obligation site(s)

Discussion of Results

All variables as shown in *Figure 37* complied with the international water quality guidelines limit as per the IIMA. The RSA therefore complied with the water quality limits discharged (allowed to flow) into the Republic of Mozambique and Kingdom of eSwatini as per the international obligation agreement throughout the reporting period.

The compliance status of each IO site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

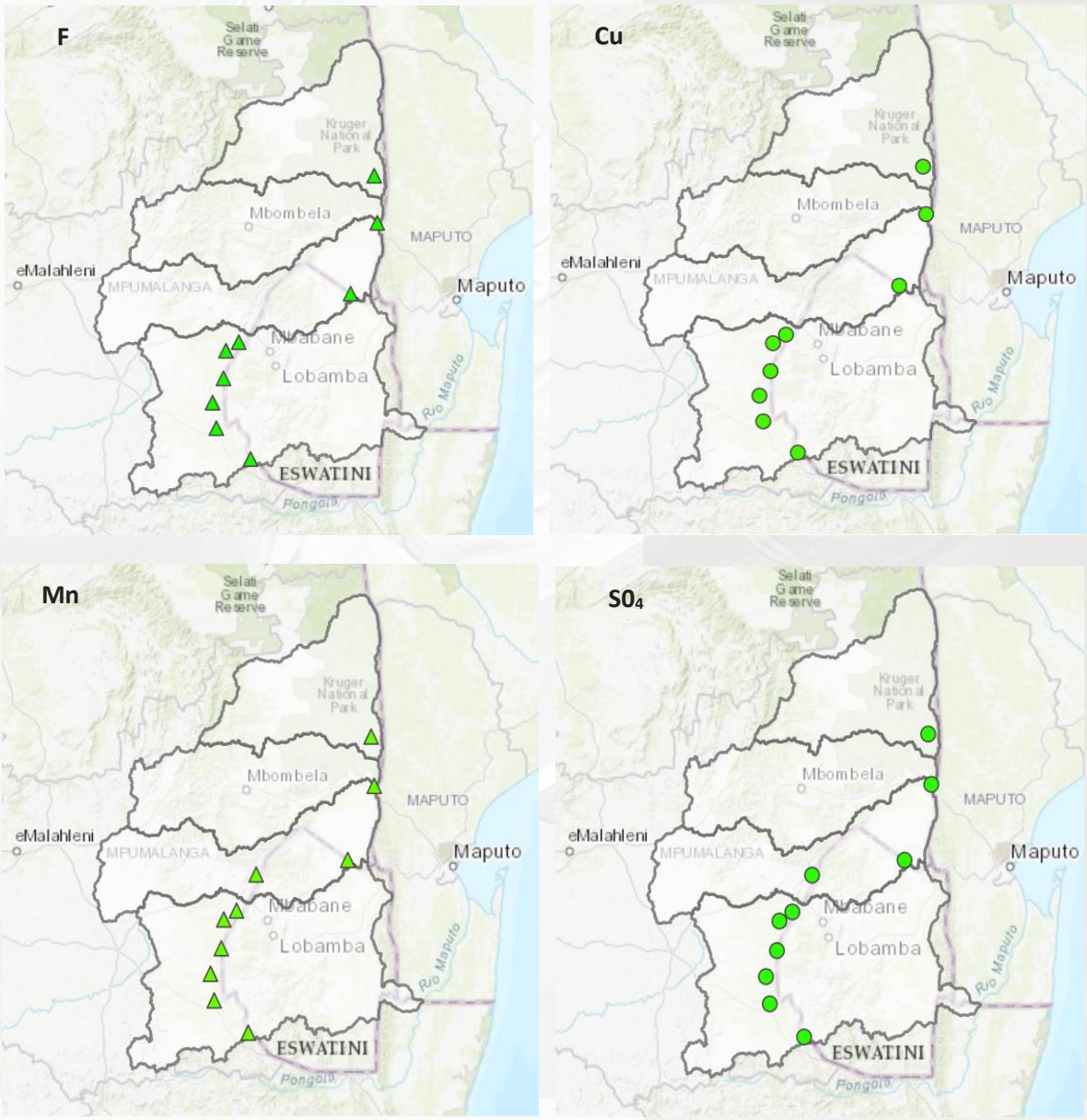


Figure 38: Maps showing water quality status for international obligation site(s)

Discussion of Results

All variables as shown in *Figure 38* complied with the international water quality guidelines limit as per the IIMA. The RSA therefore complied with the water quality limits discharged (allowed to flow) into the Republic of Mozambique and Kingdom of eSwatini as per the international obligation agreement throughout the reporting period.

The compliance status of each IO site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

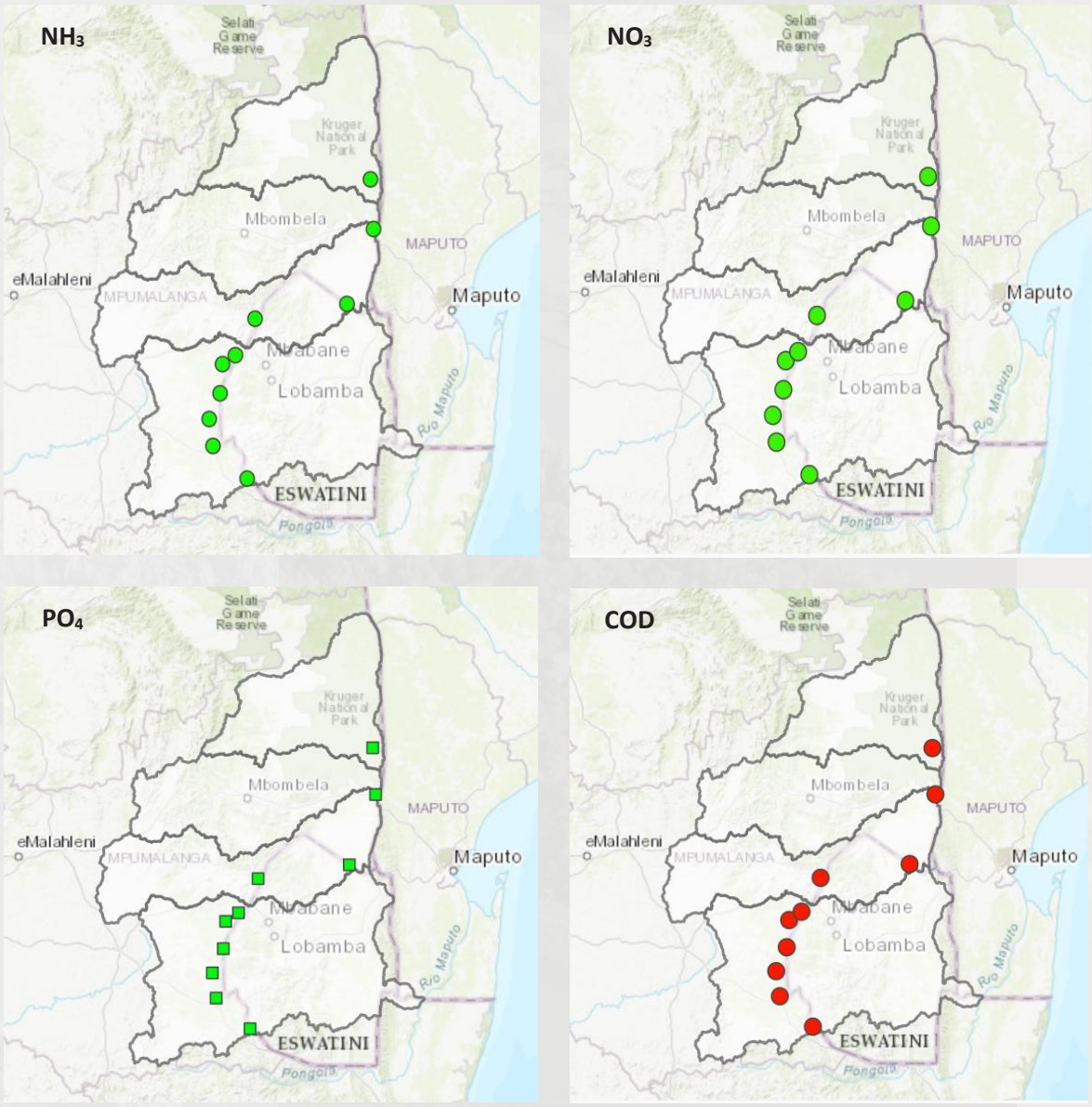


Figure 39: Maps showing water quality status for international obligation site(s)

Discussion of Results

All variables as shown in *Figure 39* complied with the international water quality guidelines limit as per the IIMA. The RSA therefore complied with the water quality limits discharged (allowed to flow) into the Republic of Mozambique and Kingdom of eSwatini as per the international obligation agreement throughout the reporting period, except for chemical oxygen demand which indicated non-compliance for at all international Obligation sites within the basin.

The compliance status of each IO site is indicated by colours: Compliance (Green) or non-compliance (Red) as indicated in the maps below.

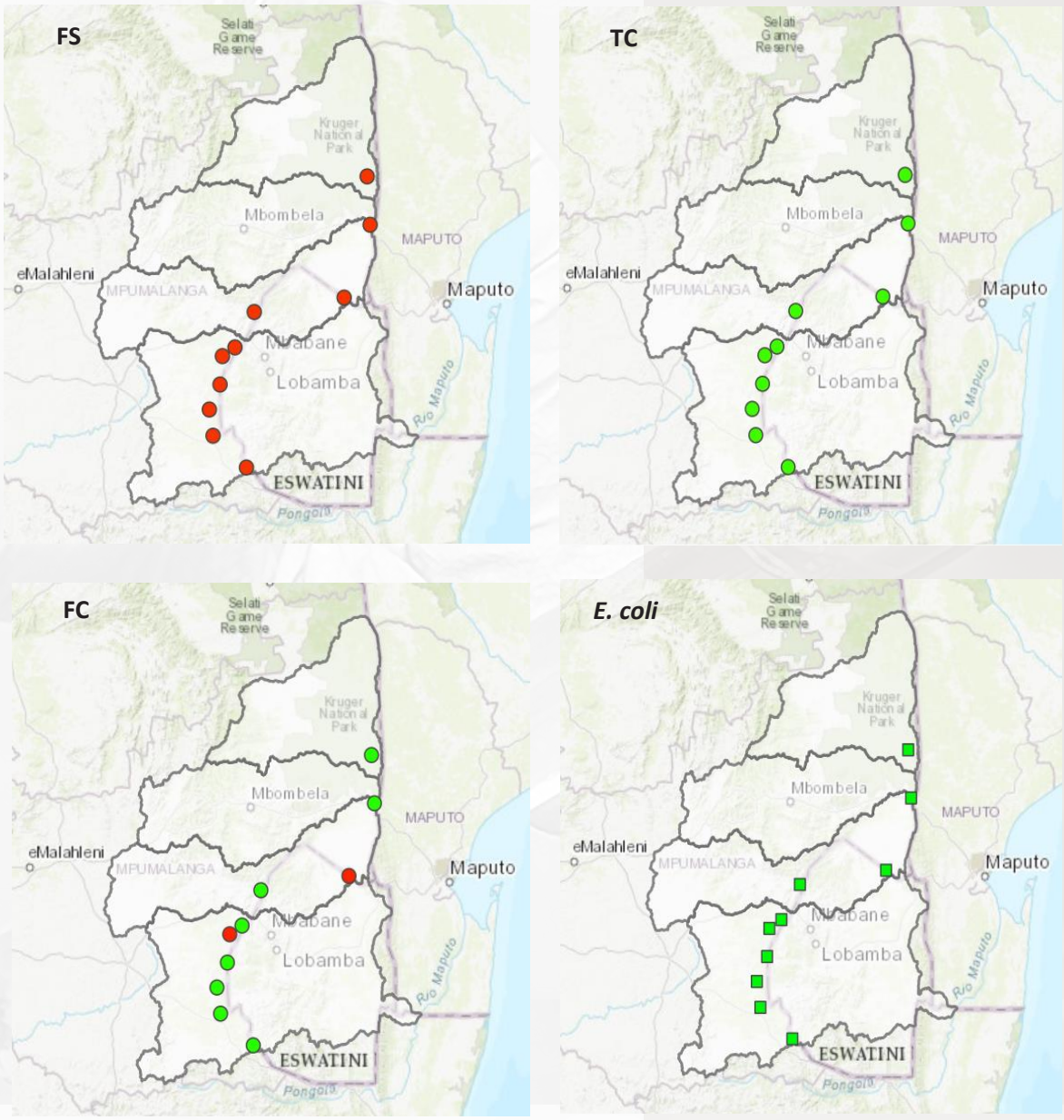


Figure 40: Maps showing water quality status for international obligation site(s)

Discussion of Results

All variables as shown in *Figure 40* complied with the international water quality guidelines limit as per the IIMA. The RSA therefore complied with the water quality limits discharged (allowed to flow) into the Republic of Mozambique and Kingdom of eSwatini as per the international obligation agreement throughout the reporting period, except for and total coliforms at Mpuluzi River and Komati River at Mananga boarder and *Faecal Streptococci* which indicated non-compliance at all international Obligation sites within the basin. Note that *E. coli* does not form part of the IIMA however reported for information purposes using 2 000 (cfu/100ml) as a limit.

CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Surface water quality in the Inkomati-Usuthu WMA complied with the RQOs, TWQG and IWQG limits for most of the monitored points and this showed that the water quality within the WMA is in a relatively good state. However, there are challenges with other variables in the water resources.

The presence of *E. coli* in water resource indicates that the water has been contaminated with human or animals faecal material and this is a challenge in the entire WMA. *Escherichia coli* contamination has a potential health risk for individuals who use water directly from the resource which may also lead to waterborne diseases for those people and is a threat for crop production, especially those crops eaten raw. There are challenges with microbial compliance on EWR sites and priority resource units as well within the WMA.

Electrical Conductivity and phosphate are not major causes for concern in the catchment. It is only in selected areas where the water quality status related to these parameters are punctuated by non-compliance. The Boesmanspruit, Gladdespruit, and Kaap River systems are being threatened by metal contamination especially manganese and arsenic as well high sulphates arising from mining activities (active mines, defunct mines and decanting mines).

Eutrophication status of the dams within the WMA were mostly oligotrophic (low levels of nutrients, with an average chlorophyll-a concentration of less than 10 ug/L). Based on the trophic status it was safe to undertake recreational activities within the water bodies during the period reported.

The Republic of South Africa complied with the international water quality limits discharged (allowed to flow) into Kingdom of eSwatini as well as Republic of Mozambique per the international agreement throughout the reporting period, except few variables and sites that indicated non-compliance.

7.2 Recommendations

It is recommended that the land use activities impacting on water resources quality be efficiently controlled through Source Directed Controls (SDC) as per the provision(s) of the National Water Act No 36 of 1998. SDC focus on managing the quality and quantity of water entering water resource with the primary purpose of ensuring that the water quality RQOs that have been set for the water resource are achieved. SDC include regulatory mechanisms such as water quality standards for wastewater, conditions in water use authorisations, wastewater discharges, pollution prevention, control of emergency incidents, best waste management practices and waste minimisation technologies. Additionally, progressive implementation of self-regulation is encouraged.

The authorisation of a water use related to water quality is an important tool for SDC and must consider the Class, Reserve and RQOs collectively referred as RDM before issuance of an authorisation. The purpose of water use authorisation is to ensure that water is used for the purpose(s) authorised only and enable water manager(s) to achieve their resource quality objectives (RQOs), and hence contribute to sustainable development. It is therefore critically important to implement the SDC and RDM in an integrated and structured manner to achieve a balance between protecting and utilising of water resources for the current and future generation.

BIBLIOGRAPHY

Department of Water and Sanitation (DWS). June 2013. National Water Resource Strategy. 2nd ed. Pretoria.

Department of Water and Sanitation. May 1996. South African Water Quality Guidelines Volume 8 Field Guide. 2nd ed. Pretoria.

Government Notice No. 1616, December 2016, Gazette, National Water Act, 1998(No 36 of 1998): Classes of Water Resources and Resource Quality Objectives for the Catchments of the Inkomati.

Government Notice No. 1616, December 2016, Gazette, National Water Act, 1998(No 36 of 1998): Classes of Water Resources and Resource Quality Objectives for the Catchments of the Inkomati.

Republic of South Africa. August 1998. National Water Act (Act 36 of 1998). Pretoria.

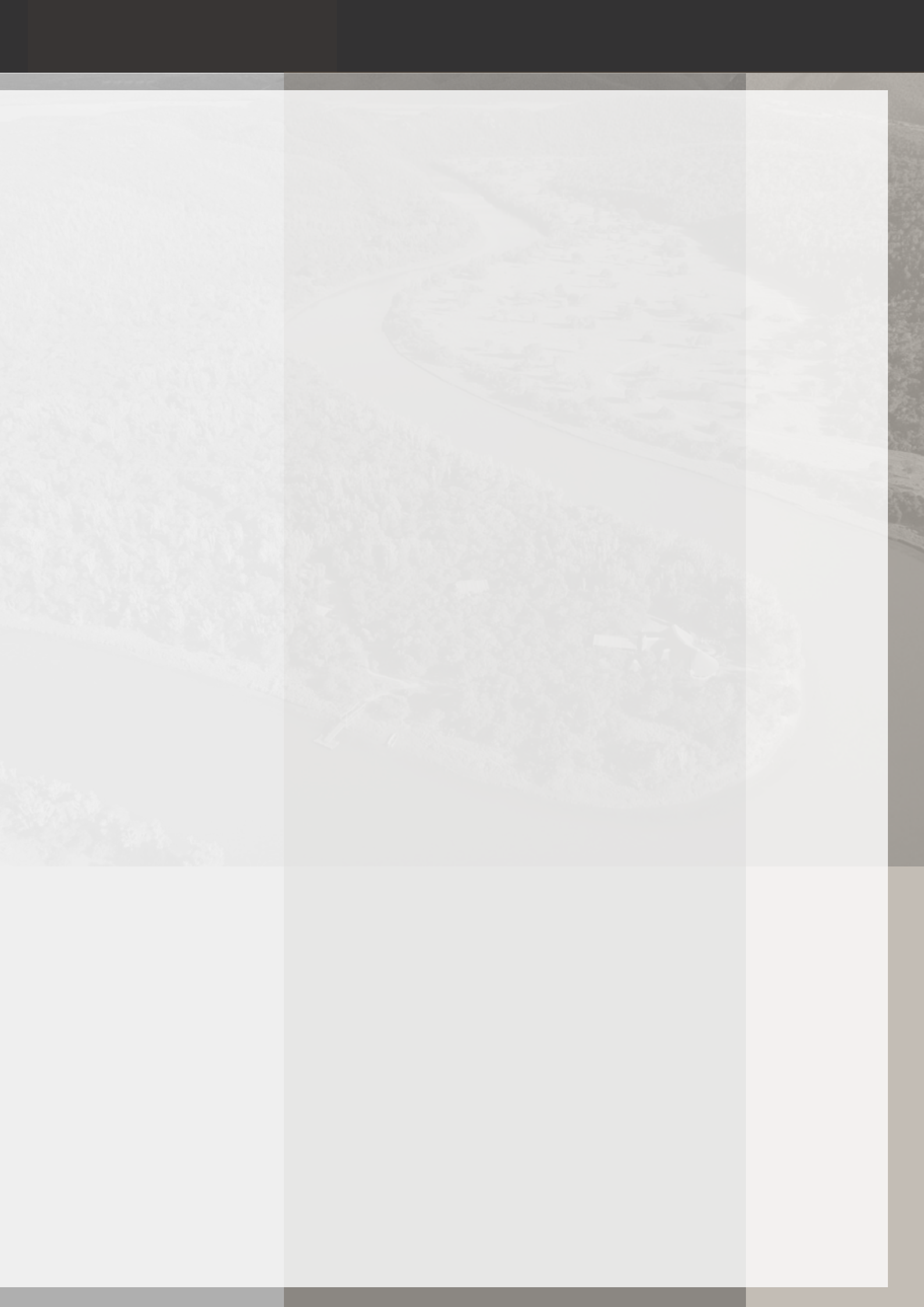
Republic of South Africa, Republic of Mozambique and Kingdom of ESwatini. August 2002. Co-operation on the Protection and Sustainable Utilisation of the Incomati and Maputo watercourses. Maputo.

DWAF, 2002. National Eutrophication Monitoring Programme –Implementation Manual, PRETORIA.

Van Ginkel, C. (2011). Eutrophication: Present reality and future challenges for South Africa. Water SA 37(5): 693–701.

Bol, R., Gruau, G., Mellander, P-E, Dupas, R., Bechmann, M., Skarbøvik, E., Bieroza, M., Djodjic, F., Glendell, M., Jordan, P., Van der Grift, B., Rode, M., Smolders, E., Verbeeck, M., Gu, S., Klumpp, E., Pohle, I., Fresne, M., and Gascuel-Odoux C. (2018). Challenges of Reducing Phosphorus Based Water Eutrophication in the Agricultural Landscapes of Northwest Europe. Frontiers in Marine Science 5: 276-292.

Moran, P. (2006). Water nutrients, plant nutrients, and indicators of biological control on water hyacinth at Texas field sites. Journal of Aquatic Plant Management 44: 109-114



INKOMATI-USUTHU

CATCHMENT MANAGEMENT AGENCY

Private bag X11214, Mbombela, 1200

Suite 801, The MAXSA Building,
13 Streak Street, Mbombela, 1200

013 753 9000

www.iucma.co.za

QR CODE FOR THE IUCMA WEBSITE