17 AWARD Tech Report Series

Municipal Support Initiative

The Role of Municipal Spatial Planning in Managing Water Quality Impacts

[Ba-Phalaborwa & Maruleng Local Municipalities]

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Abbreviations

AR4	Fourth Assessment Report of the IPCC
CEO	Chief Executive Officer
CMA	Catchment Management Agency
DEA	Department of Environmental Affairs
DM	District Municipality
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
INR	Institute for Natural Resources
IPCC	International Panel on Climate Change
IRHI	Index of Reservoir Habitat Impairment
IUA	Integrated Unit of Analysis
LTAS	Long-term Adaptation Scenarios
RDP	Reconstruction and Development Plan
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
SDF	Spatial Development Framework
SUDS	Sustainable Urban Drainage Systems
VIP	Ventilated Improved Pit latrine
WMS	Water Management System
WTW	Water Treatment Works
WUDS	Water Sensitive Urban Design
WWTW	Wastewater Treatment Works

1 Introduction

In terms of the Constitution (Schedule 4, Part B), Local Governments are responsible for land use planning and management. As landuse activities directly impact on the environment, Local Government must consider the impacts of land uses on environment, including the resultant runoff water quantity and quality. The consequences of non- or poor management are impacts on our riverine systems and potential negative impacts on human settlements downstream. Land use planning is also set to have an impact on whether climate change scenarios will be experienced as server or not.

Since municipalities span the full surface area of river catchments, it is important they are able to understand the importance of land use decisions on the catchment as a system. Furthermore, it is upon them to plan and monitor so that the system is not adversely affected by poor land use decisions. For example, Local Governments are responsible for stormwater management; as such they are responsible to ensure the quality of the stormwater resulting from the land use activities, and reaching the rivers or water resource body, does not degrade the quality of the resource.

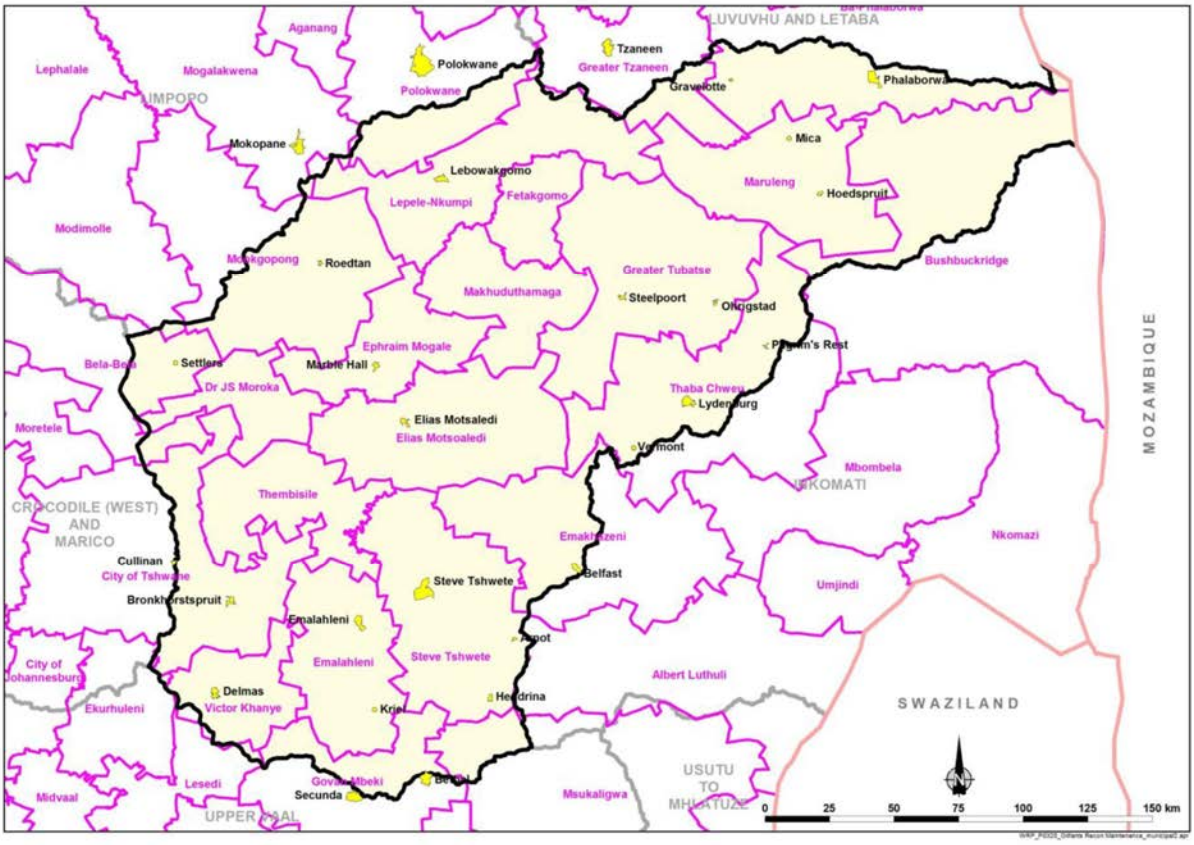

Figure 1: Local municipalities included in the Olifants Catchment (source WRP Consulting)

In order to manage the water resources of the country, both in terms of quality and quantity, a series of Resource Quality Objectives (RQOs) have been determined for various reaches of the rivers and resources of South Africa. The RQOs provide a set of targets and thresholds against which to manage the water resources, i.e. a volume of flow and level of acceptable pollution of the water resources at different locations. Water users and discharges, including stormwater runoff, must be managed in such a way that the national standards are met, i.e. that the pollution load reaching the water resource does not exceed the threshold set.

The Ba-Phalaborwa Local Municipality is currently updating their Spatial Development Framework (SDF) and together with Maruleng Local Municipality (both part of Mopani District Municipality) requires advice on how to respond to resource management challenges in their land use planning process. The scope of this work includes consideration of land use impacts to water quality, as well as water related risks (flooding, drought and pollution) as a result of climate change in the area, identification of pollution hotspots, applicable legislation to manage the pollution, spatial planning recommendations along riverine zones, and various mitigation recommendations.

1.1 Purpose of this report

This report sets out to outline the impacts of land use on water quality, especially taking into consideration the effects of climate change and specifically within the study area. The report is also one in a series aimed at assisting local government in the managing water from a spatial planning perspective.

The report identifies the applicable legislation for managing land uses, and land use planning practices that should be considered during the SDF process taking into consideration the impact of landuse on the RQOs. The report further outlines the resource quality objectives that fall within the study area before identifying the pollution issues and hotspots within the project area.

1.2 Introduction to the Mopani DM, Ba-Phalaborwa & Maruleng LM

1.2.1 Mopani District Municipality

Mopani District Municipality (DM) is situated in the north-eastern part of the Limpopo Province, in South Africa. It is bordered in the east by Mozambique, in the north, by Vhembe District Municipality through Thulamela and Makhado Municipalities, in the south, by Mpumalanga province through Ehlanzeni District Municipality (Bushbuckridge, Thaba - Chweu and Greater Tubatse) and, to the west, by Capricorn District Municipality (Molemole, Polokwane and Lepelle - Nkumpi), in the south-west, by Sekhukhune District Municipality (Fetakgomo).

The district spans a total area of 2,001,100 ha (20,011 km^2), inclusive of a portion of Kruger National Park from Olifants to Tshingwedzi camps or Lepelle to Tshingwedzi Rivers. There are 16 urban areas (towns and townships), 354 villages (rural settlements) and a total of 125 Wards. Ba-Phalaborwa and Maruleng are two of the local municipalities serviced by the Mopani District Municipality.

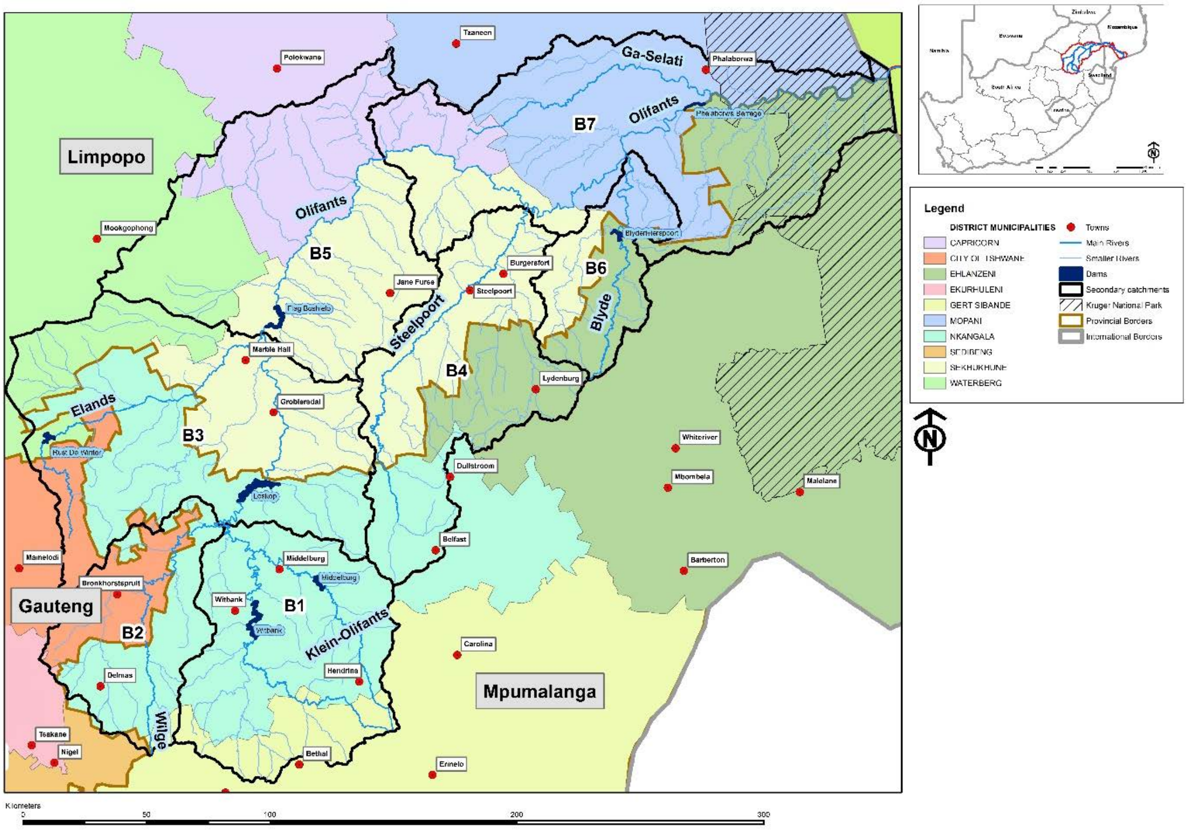

Figure 2: District municipalities within the Olifants Catchment

The key water resources in the Mopani DM consist of:

- Lower Olifants River from where it enters the Mopani DM near Ga-Mametsa up to the outflow from the DM and Kruger National Park at Olifants Gorge,
- Blyde River from downstream of the Blyderivierpoort Dam up to its confluence with the Olifants River,
- Selati River from its origin to its confluence with the Olifants River at Phalaborwa,
- Various smaller tributaries such as the Makhutswi and Klaserie rivers, and
- Letaba River which forms part of the northern border of the DM up to its confluence with the lower Olifants River in the Kruger National Park *(although the Letaba is not part of the Olifants (East) catchment, the principles of this report still apply)*.
- The impoundments in the study area includes the Phalaborwa Barrage, Klaserie Dam (previously called Jan-Wassenaar Dam), and some smaller farm dams.

1.2.2 Ba-Phalaborwa Local Municipality

Ba-Phalaborwa Local Municipality (LM) is situated in the north-eastern part of South Africa, in the Mopani District of the Limpopo Province. It is one of the five local municipalities in the Mopani District. The municipality has a geographic area of 746,200ha) (7,462km$^{2)}$, with private farms covering a large proportion of the area, as well as tribal land that is under the control of traditional leaders (namely, Ba-Phalaborwa Traditional Authority, Maseke Traditional Authority, Selwane Traditional Authority and Majeje Traditional Authority).

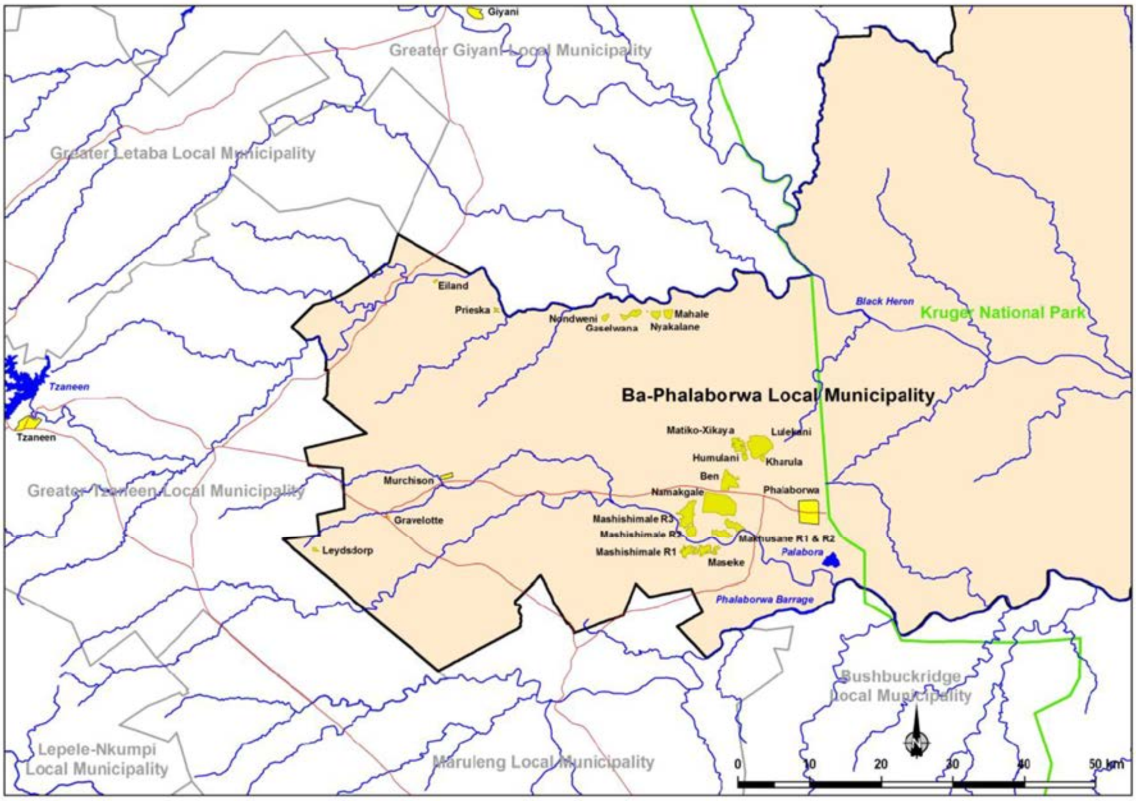

Figure 3: Ba-Phalaborwa Municipality showing high density residential including industrial and commercial areas (source: WRP consulting)

The other areas are proclaimed towns of Namakgale, Lulekani and Gravelotte. Farms constitute 27% of the total municipal area. Most of the farms in Ba-Phalaborwa belong to private owners and are used for game and citrus farming. Ba-Phalaborwa serves as a convenient gateway to the Kruger National Park and the Greater Limpopo Transfrontier Park through the Mozambique (Masingir-Xai-Xai) Channel. There are several mines operating within the municipal area.

Water is mainly supplied by Lepelle Northern Water at 334.94 c/kl (2015). Phalaborwa is supplied from the Phalaborwa Barrage with the remaining schemes relying on boreholes and springs. Ba-Phalaborwa LM is supplied by eight reservoirs that are owned and managed by Lepelle Northern Water; these reservoirs supply BPM Town, Namakgale, Lulekani, Benfarm and Mashishimale.

Water schemes (Water Infrastructure Status & Intervention Plans, DWS, 2012)

1. Phalaborwa / Namakgale / Lulekani RWS
2. Murchison WS
3. Gravelotte WS
4. Leydsdorp local WS
5. Eiland supply
6. Prieska supply

1.2.3 Maruleng Local Municipality

The Maruleng Local Municipality (LM) is situated in the south-eastern quadrant of the Limpopo Province within the Mopani District Municipal Area of Jurisdiction. The municipal area extends over 324,699ha (3,246.99km^2).

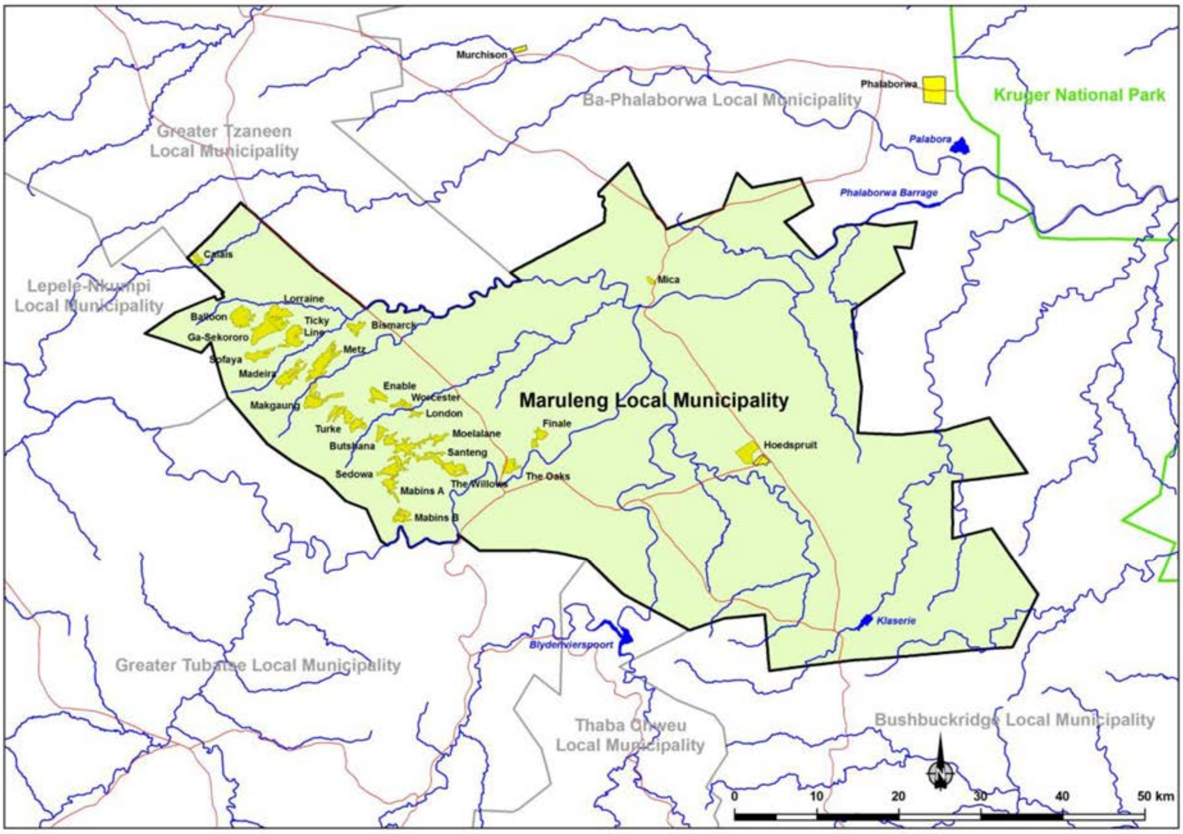

Figure 4: Maruleng Municipality showing high density residential including industrial and commercial areas

The Maruleng LM is bordered by the Kruger National Park to the east, the Ba-Phalaborwa and Tzaneen Local Municipalities to the north, the Lepelle Nkumpi Local Municipality to the west, and the Tubatse Local Municipality and Bushbuckridge Local Municipality to the south.

Agriculture, especially commercial agriculture, is a key economic driver and employment generator in Maruleng LM. The area exports mango and citrus, but other crops such as vegetables are becoming increasingly important. Maize is also cultivated by both commercial and subsistence farmers. There are other agricultural activities such as livestock which focuses on cattle, goats and poultry, as well as game farms and marula fruit.

The Maruleng Local Municipality is characterised by low rainfall. This results in limited water resources culminating in severe water shortages and drought conditions. Only 9% of the population have access to RDP standard water sources. The Municipality also provide free basic water (6000 litres per household per month).

Hoedspruit town is supplied by the Air Force base at Drakensig. The rest of the areas in Maruleng are supplied by boreholes.

Water schemes (Water Infrastructure Status & Intervention Plans, DWS, 2012)

1. Hoedspruit / Kampersrus WS
2. Mametje Sekororo Raw Water Scheme
3. Maruleng individual WS

Lack of access to basic sanitation services has created significant environmental and health problems. The fact that most villages in the municipality do not have RDP level sanitation constitutes a major risk in terms of ground water pollution. The main types of sanitary systems used in the municipality are water borne sewerage (flush toilets), septic tanks, ventilated improved Pit latrines (VIP), French drains and ordinary pit latrines or no basic services at all.

1.3 Why it is important for municipalities to manage impacts to water quality

Water is life. All living organisms need to water to live. We need water to grow crops to produce food to eat; we need water to drink, to cook, to clean; we need water to generate electricity; we need water to manufacture products e.g. clothing, bricks, buildings, paper, etc. In order to use the water, and to sustain the ecosystems the produce the goods and services we use to survive, requires the water to be of a suitable quality, or we can't use it and the environment can't survive. While the environment and the receiving water resources can tolerate some pollution, the accumulation of pollutants throughout the system can reach a threshold that the water resources and the environment can no longer tolerate. As the landuse activities of the catchment change and develop, this results in increased impacts to the water resources e.g. through increased runoff (quantity) and increased pollution loads (quality). It is therefore important to manage the levels of pollution or impacts reaching the water resources in order to prevent the threshold being reached. This includes managing the impacts of land use activities. Resource Quality objectives (RQOs) are the management targets set for water resources in order to prevent the threshold being reached. As effects of climate change are starting to be noticed, it is ever more pertinent to manage and mitigate the impacts to water resources in order to prevent water becoming a more scarce resource.

Poor quality or contaminated water requires treatment before it can be used. If the water is significantly contaminated it will require expensive and complex treatment before it can be used e.g. for drinking, irrigation, processing and manufacture. This increases the cost of the water and increases demand on other resources e.g. electricity in order to treat the water.

1.4 Water quality

1.4.1 Water Quality Allocation Plan - Translating in-river RWQOs to catchments targets

Translating the in-river RWQOs to water quality targets for different pollution sources, requires the development of a Water Quality Allocation Plan (DWAF, 2003, Rossouw et al, 2008). The inputs to a Water Quality Allocation Plan are the RWQOs for each river reach or management unit, and the outputs of the plan are the waste loads that are allocated to different waste producing sectors and/or individual sources.

The development of sectoral or source specific implementation plans are not components of a Water Quality Allocation Plan and it is normally left to the sector or an individual source to show what measures they would implement to meet the requirements of the load allocated to them. For example, in the Selati River there are several sources of waste. These include background loads from the catchment, and loads from the mines, urban stormwater runoff, WWTWs, etc.

In the Water Quality Allocation Plan all the sources need to be accounted for, and the allocation of waste loads must be done so that the in-river RWQOs are met. If the sum of all the waste loads exceed the in-river RWQO, then waste loads allocated to different sources need to be reduced. It is prudent not to allocate all the waste loads to meeting the in-river RWQOs and to keep some in reserve for future developments in the catchment. Alternatively, when future developments take place, a re-allocation of waste loads can be done (as one would do when re-allocating water quantity to different users) or the new development can "purchase" waste loads from other users.

As the effluent discharge from different land uses is governed by different legislation, it is important that the overall Water Quality Allocation Plan be compiled in an integrated manner considering all sources of pollution.

It is recommended *that a Water Quality Allocation Plan be developed that accounts for the pollution loads from all the sources in the lower Olifants River, in order to determine the allowable waste loads from WWTWs and urban stormwater runoff sources, in order to ensure the RQOs are achieved.*

1.4.2 Monitoring

The old adage that you cannot manage what you do not measure still holds true. There is an urgent need for the local authorities to initiate and strengthened monitoring in their urban areas, and to strengthen and consolidate information management systems. Adaptive management of urban stormwater is based upon the support of monitoring networks and systems. This objective includes building capacity in urban pollution management through education, training, and knowledge transfer.

1.4.2.1 Compliance monitoring

The low Green Drop scores for monitoring is an indication that monitoring data is not submitted to DWS, either because monitoring is done but the results are not submitted, or no monitoring is being done. The Local Municipalities cannot improve operations at their respective wastewater treatment works if they don't monitor their effluent discharge volumes and quality, and compare these to their water use licence conditions. At the very least, effluent discharge monitoring should be conducted as specified in water use licence conditions, and the results reported to the Green Drop system.

1.4.2.2 Urban catchment monitoring

Local Municipalities cannot manage the impacts on receiving rivers of dry-weather flow, and stormwater runoff, unless they start to monitor the quantity and quality in their urban streams and rivers. A good strategy is to start with simple monitoring (see suggestions below) and to expand this as the need for better data arises, and as resources (funding and skilled staff) becomes available.

Visual monitoring - ***It is recommended** that a visual monitoring system be designed to visually inspect urban streams and rivers for indicators of water pollution, and where necessary, report incidents and initiate remediation measures.* ***It is recommended** that a fixed-point network be designed with visual monitoring at key points in the system.* An example of a Visual Assessment form is included in Annexure B. No specific training is required and the programme can be expanded to include simple in-situ measurements.

Urban stream water quality monitoring – ***It is recommended** that an urban stream water quality monitoring programme be designed to monitor the quality of key urban streams.* The constituents to be monitored should at least include in situ measurements of water temperature, pH, electrical conductivity, and water clarity. A hand-held field instrument to measure these constituents is fairly inexpensive (< R10 000). The ideal would be to also monitor dissolved oxygen as a measure of fitness for aquatic ecosystems and the organic load but such an instrument is expensive (> R40 000). Water samples should be collected and analysed for the constituents listed in the tTable follows.

Table 1: Constituents recommended for an urban stream water quality monitoring programme

Constituent	Motivation
Physical properties	
Suspended sediment concentration	The total suspended solids (TSS) concentration is a measure of the amount of material suspended in water. It affects the clarity of water, can smother habitats when it settles out, can affect the water temperature which is detrimental to temperature sensitive organisms, and pollutants can adhere onto the suspended particles. It can also block irrigation equipment and at very high concentrations, smother fish. SS has been identified as a concern in the RQO project (DWA).
Turbidity	Is a measure of the light-scattering ability of water and is indicative of the concentration of suspended matter in the water. Affects water clarity and temperature (see effects of TSS for impacts).
Electrical conductivity	Indicates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. The effects of the TDS are governed by the constituent inorganic salts and it affects the metabolism of organisms. Secondary effects include those on water chemistry, which in turn affect the fate and impact on the aquatic environment of other chemical constituents or contaminants.
Ph	The pH value is a measure of the hydrogen ion activity in a water body which is indicative of the acidity or alkalinity of a water body
Nutrients	
Ammonium-nitrogen	Ammonium can be present in solution as the free, un-ionised form (NH_3) or in the ionised form as ammonium ion (NH_4^+). The toxicity of ammonia to aquatic organisms is directly related to the concentration of the un-ionised form (NH3) and is affected by water temperature and pH. The ammonium ion contributes to eutrophication. High ammonium is an indication of sewage pollution.
Nitrate-nitrogen	Nitrates are naturally present in aquatic ecosystems. High nitrate concentrations could negatively impact an aquatic ecosystem's health because high concentrations can stimulate excessive growth of aquatic plants and algae.
Ortho-phosphate	Phosphates occur in aquatic environments in numerous organic and inorganic dissolved forms. High concentrations can stimulate excessive growth of aquatic plants and algae.
Organic	
Chemical oxygen demand	COD indirectly measures the amount of organic compounds and consequently pollutants present in a water body that consume oxygen when it decomposes. High COD is indicative of pollution with domestic or industrial wastewater.
Human health	
Faecal coliforms or e coli	Faecal coliforms are primarily used as an indicator of faecal pollution and are mainly used for the assessment of faecal pollution from wastewater. Used to assess risk to recreational water users.

Metals can be added to detect the impacts of mining and industrial pollution.

Water samples should be analysed at a chemical laboratory and Lepelle Northern Water probably has a good laboratory at the Phalaborwa WTW.

Water samples should initially be collected at a monthly frequency provided there is flowing water at the stream/river sampling points.

Water quality data should be stored in a secure database and the chemical analysis results should be compared to urban quality guidelines to assess the risk to aquatic ecosystems and human health.

It is further recommended that good international practices as described in the Department of Water (2009) and Smith et al (1989) be used to design the water quality monitoring programmes:

- Develop the goals and objectives. Realistic, affordable and sustainable objectives need to be set by the key role players.
- Detailed list of monitoring points – consolidate sampling points of different organisations. There is a need to consolidate monitoring point in order to eliminate overlaps or duplicate points and if needed, add monitoring points at locations of interest.
- Confirm statistical design criteria. The data collected must be able to satisfy the information requirements for the different role players and the need to detect trends at a predefined level of confidence.
- The provisional list of variables needs to be motivated and linked to the set goals and objectives.
- Identify water testing laboratory. Currently different laboratories are used by the different monitoring parties and the results are not always comparable. It has been proposed that one laboratory be used for both the bacteriological analysis as well as the other constituents.
- Confirm appropriate analysis methods for the final list of variables taking into account the laboratory detection limits and typical concentrations encountered in the lower Olifants River catchment.
- Obtain quotes for the analysis of the different variables from different laboratories. This is required in order to budget for the implementation of the sampling programme.
- Confirm sample submission procedures and results transmission from the laboratory to the coordinator.
- Recommend field samplers and training/qualification requirements. People need to be identified that will collect the samples on a regular basis. To promote confidence in the data, it is important that the water samples be taken consistently in the correct method and therefore the field samplers must at least have some basic training in sampling techniques. This is also a quality control measure.
- Develop a draft, initial sampling schedule that needs to be reviewed and if necessary, updated on an annual basis. This is crucial as the samplers need to plan their activities around the sampling schedule and all their other, work related responsibilities.
- Develop a route map for sampling. A route map will enable the samplers to plan their sampling so that the bacteriological samples can reach the laboratory within the prescribed time limits. It may not be possible for one person to do all the sampling on one day and coordination within the sampling group is essential and again linked to the sampling schedule.
- Confirm field sampling and measurement procedures to ensure that all the samplers use the same methods and procedures.

- Identify sampling equipment and field measurement instruments to ensure that all the equipment is available or if not, can be acquired prior to the implementation phase of the project.
- Confirm sample preservation needs for the chemical samples (if required) and sample transport procedures to ensure that the water samples collected are viable for analysis and that the result are trustworthy.
- Develop appropriate quality control / quality assurance procedures to promote confidence in the data and to prevent samplers from taking shortcuts.
- Recommend a data storage/retrieval and management system. Ideally all the key role players should be able to retrieve the data as and when needed.
- Recommend appropriate data analysis procedures and display options.
- Compile a budget for the programme. A budget should include the running costs of the samplers, equipment required for sampling, water sample analysis costs, data management and project coordination costs.
- Programme coordination. Not only should the programme be coordinated to ensure that the objectives of all the key role-players are met, but supervision of the programme is crucial to ensure that it runs smoothly and in a sustainable manner.

1.4.3 Urban & peri-urban water quality guidelines

The term "water quality" describes the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of aquatic ecosystems. Many of these properties are controlled or influenced by constituents that are either dissolved or suspended in water.

It is recommended that initially the water quality of the Mopani DM be evaluated from two perspectives, each of which makes use of a different indicator derived from Department of Water and Sanitation guidelines. These perspectives acknowledge the dual importance and inter-dependence of people and the freshwater environment.

i. Public health (recreational use) - Microbiological data (E.coli) should be used to evaluate the suitability of urban and peri-urban waters for intermediate contact recreational use. The guideline stipulates that samples should not exceed 1000 indicator organisms per 100 ml. Although referred to as recreational, this includes domestic use e.g. washing in rivers, bathing and water for cooking/cleaning.

ii. Ecosystem health – It is recommended that the guidelines to protect the aquatic ecosystems be based on dissolved oxygen, and nutrients, electrical conductivity, and total suspended solids. It is recommended that consideration be given to adopting the guidelines used by the City of Cape Town for evaluating their inland waters (Anchor Environmental Consultants et al., 2012).

2 Concluding remarks

Water quality in the Mopani DM would be affected by the increase in water temperature that would affect the growth and/or decay rates of aquatic flora and organisms, and by an increase in rainfall intensity and probably flash floods that could affect existing pollution control dams. The current stormwater management requires review and integration into the land use planning process to ensure improved management especially of water quality reaching the receiving water sources.

Monitoring of water quality in urban areas is the responsibility of local authorities and there is an urgent need for the two LAs to implement monitoring of their wastewater discharges, and the quality of urban and peri-urban streams and rivers. Similarly, it is the responsibility of the LMs to ensure their discharge, especially stormwater, does not exceed the RQOs.

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Annexure A: Resource quality objectives

SUMMARY OF THE RQOS FOR THE SITES WITHIN THE BA-PHALABORWA AND MARULENG LOCAL MUNICIPAL AREAS, EXCLUDING KRUGER NATIONAL PARK

Municipality	Integrated Unit of Analysis (IUA)	Water Resource Class for IUA	Biophysical Node Name	Quaternary Catchment	Co-ordinates		River Name / description of point	Ecological Category to be maintained	Natural MAR (million m^3/a)	EWR as % of natural MAR)
Maruleng Local Municipality	10 Lower Olifants	II	HN87	B60J	-24,458611	30,8275	Sandspruit, including Rietspruit and Qunduhlu	B	-	-
			EWR site - 12 (88)	B60J			Blyde	B	383.7	27.9
			HN89	B60J	-24,31388889	30,85594444	Blyde (confluence with Olifants)	C	385.7	16.13
	10 Lower Olifants	II	EWR site - 11 (96)	B71H, J	24°18'25.90"S	30°47'9.90"E	Olifants (confluence with Blyde) (Upstream confluence)	D	1321.8	11.2 (D)
	10 Lower Olifants	II	HN97	B72A			Makhutswi, including Moungwane and Malomanye	C	38.0	12.89

			HN98	B72C			Olifants (outlet - outlet of IUA10)	C	1755.5	18.07
Ba-Phalaborwa Local Municipality	11 Ga-Selati River	III	HN99	B72E	-24,091944	30,275278	Ngwabatse (confluence with Ga-Selati)	D	25.7	9.05
			HN100	B72G	-24,123889	30,353611	Ga-Selati (outlet of quaternary)	C	13.5	19.59
			EWR site - 14a (101)	B72H	23°59'29.40"S	30°40'60.00"E	Ga-Selati *(2km down Mica road bridge)*	C	52.2	19.59
			HN102	B72J			Molatle (confluence with Ga-Selati)	B	11.4	16.67
	11 Ga-Selati River	III	EWR site - 14b (103)	B72K	24° 1'21.00"S	31° 8'48.00"E	Ga-Selati *(Phalaborwa Mine)*	D	72.7	11.99 (D)
	11 Ga-Selati River	III	HN104	B72K	-24,034167	31,123611	Ga-Selati (outlet of quaternary - outlet of UIA11)	D	72.7	11.95 (D)

Both	12 Lower Olifants within Kruger National Park	II	EWR site 13 (105)	B72D	24° 7'36.00"S	31° 1'1.00"E	Olifants *(Downstream of Blyde confluence)*	C	1760.7	11.36

RWQOS FOR SPECIFIC SITES: **QUANTITY** – THESE ARE APPLICABLE TO ONLY CERTAIN RQO SITES

Municipality	**Integrated Unit of Analysis (IUA)**	**Biophysical Node Name**	**Ecological Category to be maintained**	**Water Quantity**						
				Compo-nent	**Sub Compo-nent**	**RQO**	**Indicator/ measure**	**Numerical Limits**		
Maruleng Local Municipality	10 Lower Olifants	EWR site - 11 (96)	D	Quantity	Low and High Flows	Low flows must support the ecosystem structure and function. High flows must be maintained for ecosystem functioning.	EWR maintenance low and high flows and drought flows: Olifants EWR11 in B71J VMAR = $1321.9 \times 10^6 m^3$ PES=D category	Maintenance low flows (m3/s) (Percentile) Oct 2.959 (80) Nov 4.420 (80) Dec 5.358 (80) Jan 6.468 (80) Feb 8.217 (80) Mar 7.345 (80) Apr 6.450 (80) May 5.095 (80) Jun 4.139 (80) Jul 3.396 (80) Aug 2.886 (80) Sep 2.623 (80)	Drought flows (m3/s) (Percentile) 1.576 (99) 2.353 (99) 2.853 (99) 3.444 (99) 4.376 (99) 3.911 (99) 3.434 (99) 2.713 (99) 2.204 (99) 1.808 (99) 1.537 (99) 1.397 (99)	Freshets (m3/s) (Percentile) 0.340 (99) 1.713 (99) 2.760 (99) 1.426 (99) 5.091 (99) 1.426 (99) 0.701 (99)

	10 Lower Olifants	HN97	C	Quantity	Low Flows	Low flows must be maintained to provide for basic human needs.	EWR maintenance low and drought flows: Makhutsi River in B72A VMAR = 38.01x10^6m^3 PES=C category	Maintenance low flows (m^3/s) (Percentile) Oct 0.130 (50) Nov 0.144 (50) Dec 0.173 (50) Jan 0.258 (50) Feb 0.435 (50) Mar 0.415 (50) Apr 0.330 (50) May 0.236 (50) Jun 0.206 (50) Jul 0.179 (70) Aug 0.159 (60) Sep 0.142 (50)	Drought flows (m^3/s) (Percentile) 0.000 0.004 (99) 0.004 (99) 0.004 (99) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	
		HN98	C	Quantity	Low and High Flows	Low flows must be maintained so that they provide for the ecosystem. High flows must provide for the ecosystem.	EWR maintenance low and high flows and drought flows: Olifants in B72C VMAR = 1755.5x10^6m^3 PES=C category	Maintenance low flows (m^3/s) (Percentile) Oct 5.645 (60) Nov 8.016 (70) Dec 9.747 (70) Jan 11.956 (70) Feb 15.848 (70) Mar 14.484 (70) Apr 13.039 (60) May 10.333 (60) Jun 8.401 (60) Jul 6.783 (60) Aug 5.729 (70) Sep 5.194 (60)	Drought flows (m^3/s) (Percentile) 2.148 (99) 2.978 (99) 3.573 (99) 4.341 (99) 5.713 (99) 5.219 (99) 4.724 (99) 3.777 (99) 3.112 (99) 2.543 (99) 2.177 (99) 1.997 (99)	Freshets (m^3/s) (Percentile) 0.654 (99) 3.383 (99) 5.806 (90) 3.425 (99) 12.616 (90) 3.425 (99) 1.824 (99)

Ba-Phalaborwa Local Municipality	11 Ga-Selati River	EWR site - 14b (103)	D	Quantity	Low Flows	Low flows are important for the maintenance of the ecosystem.	EWR maintenance low and drought flows: Ga-Selati EWR14b in B72K VMAR = $72.74x10^6m^3$ PES=D category	Maintenance low flows (m^3/s) (Percentile) Oct 0.122 (70) Nov 0.138 (60) Dec 0.192 (60) Jan 0.350 (50) Feb 0.744 (60) Mar 0.608 (50) Apr 0.378 (70) May 0.200 (70) Jun 0.178 (70) Jul 0.156 (70) Aug 0.141 (70) Sep 0.132 (7)	Drought flows (m^3/s) (Percentile) 0.001 (99) 0.001 (99) 0.001 (99) 0.001 (99) 0.003 (99) 0.003 (99) 0.002 (99) 0.001 (99) 0.001 (99) 0.001 (99) 0.001 (99)	
	11 Ga-Selati River	HN104	D	Quantity	Low Flows	Low flows are important for the maintenance of the ecosystem.	EWR maintenance low and drought flows: Ga-Selati EWR14b in B72K VMAR = 72.74x106m3 PES=D category	Maintenance low flows (m^3/s) (Percentile) Oct 0.122 (60) Nov 0.138 (60) Dec 0.192 (60) Jan 0.350 (50) Feb 0.744 (60) Mar 0.608 (50) Apr 0.378 (70) May 0.200 (60) Jun 0.178 (70) Jul 0.156 (70) Aug 0.141 (70) Sep 0.132 (70)	Drought flows (m^3/s) (Percentile) 0.001 (99) 0.001 (99) 0.001 (99) 0.001 (99) 0.003 (99) 0.003 (99) 0.002 (99) 0.001 (99) 0.001 (99) 0.001 (99) 0.001(99)	

Both	12 Lower Olifants within Kruger National Park	EWR site 13 (105)	C	Quantity	Low and High Flows	Low flows must be improved to maintain ecosystem structure and function. High flows must be maintained to support ecosystem structure and function.	EWR maintenance low and high flows and drought flows: Olifants EWR13 in B72B VMAR = 1762.2x106m3 PES=C category	Maintenance low flows (m^3/s) (Percentile) Oct 3.940 (70) Nov 5.592 (70) Dec 6.802 (80) Jan 8.351 (70) Feb 10.994 (70) Mar 10.125 (70) Apr 9.105 (70) May 7.209 (70) Jun 5.860 (70) Jul 4.732 (70) Aug 3.998 (70) Sep 3.625 (70)	Drought flows (m^3/s) (Percentile) 2.149 (99) 2.979 (99) 3.576 (99) 4.347 (99) 5.683 (99) 5.231 (99) 4.729 (99) 3.778 (99) 3.112 (99) 2.544 (99) 2.179 (99) 1.999 (99)	Freshets (m^3/s) (Percentile) 0.598 (99) 3.093 (99) 5.317 (90) 3.141 (99) 11.515 (90) 3.141 (99) 1.665 (99)

RWQOS FOR SPECIFIC SITES: **QUALITY** THESE ARE ONLY DETERMINED FOR CERTAIN SITES.

Municipality	Integrated Unit of Analysis (IUA)	Biophysical Node Name	Ecological Category to be maintained	Water Quality				
				Compo-nent	Sub Component	RQO	Indicator/ Measure	Numerical Limits
Ba-Phalaborwa Local Municipality	11 Ga-Selati River	EWR site - 14b (103)	D	Quality	Salts	Salts should be improved to support the ecosystem.	Electrical conductivity*	≤ 111 mS/m
					System Variables	Sedimentation must not excessively impact on habitat state.	Suspended solids*	≤ 50.0 mg/L
					Toxins	Toxicity must not pose a threat to local users.	F* Al* As* Cd hard* Cr(VI)* Cu hard* Hg* Mn* Pb hard* Se* Zn* Chorine* Endosulfan* Atrazine*	≤ 2.50 mg/L ≤ 0.105 mg/L ≤ 0.095 mg/L ≤ 3.0 µg/L ≤ 121 µg/L ≤ 6.0 µg/L ≤ 0.97 µg/L ≤ 0.990 mg/L ≤ 9.5 µg/L ≤ 0.022 mg/L ≤ 25.2 µg/L ≤ 3.1 µg/L free Cl ≤ 0.13 µg/L ≤ 78.5 µg/L

	11 Ga- Selati River	HN104	D	Quality	Salts	Salts should be improved to support the ecosystem.	Electrical conductivity* Sulphates*	≤ 111 mS/m ≤ 500 mg/L
					System Variables	Sedimentation must not excessively impact on habitat state.	Alkalinity* Turbidity* Temperatures* Dissolved oxygen*	≥ 60 mg/L $CaCO_3$ ≤ 10 NTU ≤ abs(dev from ambient) 4.0 ≥ 6.5 mg/L O_2
					Toxins	Toxicity must not pose a threat to local users.	F* Al* As* Cd hard* Cr(VI)* Cu hard* Hg* Mn* Pb hard* Se* Zn* Chorine* Endosulfan* Atrazine*	≤ 2.50 mg/L ≤ 0.105 mg/L ≤ 0.095 mg/L ≤ 3.0 µg/L ≤ 121 µg/L ≤ 6.0 µg/L ≤ 0.97 µg/L ≤ 0.990 mg/L ≤ 9.5 µg/L ≤ 0.022 mg/L ≤ 25.2 µg/L ≤ 3.1 µg/L free Cl ≤ 0.13 µg/L ≤ 78.5 µg/L
Both	12 Lower Olifants within Kruger National Park	EWR site 13 (105)	C	Quality	System Variables	Sediment concentrations should not reach levels where instream sedimentation excessively impacts on the instream habitat or where suspended sediments negatively impact on fitness for use for water institutions.	Suspended solids*	≤ 25.0 mg/L

RWQOS FOR SPECIFIC SITES: **BIOTA** – THESE ARE ONLY DETERMINED FOR SPECIFIC SITES.

Municipality	Integrated Unit of Analysis (IUA)	Biophysical Node Name	Ecological Category to be maintained	Instream Habitat and Biota		Riparian zone habitat	
				RQO	Numerical Limits	RQO	Numerical Limits
Ba-Phalaborwa Local Municipality	11 Ga-Selati River	EWR site - 14b (103)	D	Instream habitat must be in a largely modified or better condition. Instream biological assemblages must be in a largely modified or better condition. Low and high flows must be suitable to maintain the river habitat and ecosystem condition. Water quality: Toxicity must not pose a threat to local users and the ecosystem	Instream Habitat Integrity category: ≥ D (≥ 42) Fish ecological category: ≥ D (≥ 42) Macro-invertebrate ecological category: ≥ D (≥ 42) Instream Ecostatus category: ≥ D (≥ 42) Hydrological category: ≥ D (≥ 42) Water Quality category: ≥ D (≥ 42)	The riparian zone must be in a largely modified or better condition. Riparian vegetation must be in a better than largely modified condition Low and high flows must be in a largely modified or better condition.	Riparian Zone Habitat Integrity category ≥ D (≥ 42) Riparian ecostatus category: ≥ C/D (≥ 58) Hydrological category ≥ D (≥ 42)
Both	12 Lower Olifants within Kruger National Park	EWR site 13 (105)	C	Instream habitat must be in a moderately modified or better condition to support ecosystem processes. Instream biological assemblages must be in a moderately modified or better condition. The habitat requirements of species of special	Instream Habitat Integrity category: ≥ C (≥ 62) Fish ecological category category: ≥ C (≥ 62) Macro-invertebrate ecological category category: ≥ C (≥ 62) Instream Ecostatus category: ≥ C (≥ 62) Suitable instream habitat	The riparian zone must be in a better than moderately modified condition. Riparian vegetation must be in a close to natural condition.	Riparian Zone Habitat Integrity category ≥ B/C (≥ 78) Riparian ecostatus category: ≥ B (≥ 82) Hydrological category ≥ C (≥ 62)

				ecological importance must be provided for to ensure viable and sustainable populations. Low and high flows must be suitable to maintain the river habitat and ecosystem condition. Water quality: Sediment concentrations must not reach levels where instream sedimentation excessively impacts on the instream habitat or where suspended sediments negatively impact on fitness for use for water institutions.	conditions for > 5 Hippopotami Habitat for a minimum of 45 aquatic bird species. Hydrological category: ≥ C (≥ 62) Water Quality category: ≥ C (≥ 62)	Low and high flows must be in a moderately modified condition.	

ANNEXURE B: Example of a visual assessment form

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Berg River Water Quality Sampling
Visual assessment of the Berg River

Sampling point			
Date		Time	
Sampler name			

Weather conditions (check one per category)

Air temperature		Cold (< 10°C)	Cool (10-20°C)	Warm (20-30°C)	Hot (>30°C)
Percentage cloud cover		0-25%	25-50%	50-75%	75-100%
Number of days since last rain		(Within last 7 days)			
Wind	None	Light	Moderate	Strong	Gale force

River state (check one per category)

Water clarity	Clear	Slightly muddy	Moderately muddy	Very muddy	
Colour	Colourless/clear	Tea coloured	Green	Brown	
Flow	Still/Calm	Slow flowing	Moderate flowing	Fast flowing	
Algae on rocks		None visible	Some visible	Lots visible	
Foam		None visible	Some visible	Lots visible	
Oily sheen		None visible	Some visible	Lots visible	
Odour	No smell	Fishy	Rotten eggs	Musty	Chlorine

Solid waste in the river (from 30m upstream to 30m downstream of the sampling site) (check one per category)

Category	**Examples**			
Plastics	Packaging, bags, wrapping, polystyrene blocks or pellets, bottles, crates, straws, straps, ropes, nets.	None	Some	Lots
Paper	Packaging, wrappers, newspapers, fliers, cardboard, food containers	None	Some	Lots
Metal	Cans, foil, bottle tops, number plates	None	Some	Lots
Glass	Bottles, broken windows	None	Some	Lots
Garden refuse	Grass cuttings, leaves, branches	None	Some	Lots
Building rubble	Bricks, planks, lumps of concrete	None	Some	Lots
Fabric	Old clothing, rags	None	Some	Lots
Animals	Animal carcasses, skeletons	None	Some	Lots
Automotive	Oil, tyres, rubber	None	Some	Lots

In-situ measurements

Water temperature	°C	
Electrical conductivity	µS/cm mS/m	
TDS	mg/l	
pH		
Dissolved oxygen	mg/l	
Dissolved oxygen	% saturation	
Clarity tube	cm	

Notes

Office use only Data captured

Person		Date	

AWARD is a non-profit organisation specialising in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

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About USAID: RESILIM-O

USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year programme, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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