

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS (WP11387)

WATER QUALITY RESOURCE QUALITY OBJECTIVES

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Water Quality Resource Quality Objectives

Patsy Scherman

- Background to setting WQ RQOs
- Approach and Principles
- High Priority EWR site
- High Priority WQ site

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BACKGROUND PREPARATION FOR RQO DEVELOPMENT

- Water quality Status Quo
- Identify preliminary water quality hot spots
- Prepare for November 2022 TTG meeting
- At TTG and follow up meetings:**
 - ID wq role players, including non-ecological e.g. irrigation, settlements
 - Identify indicators linked to **driving variables** associated with indicator **wq role players**, e.g. elevated **phosphate** associated with **nutrients** linked to **stock-watering**
 - Identify **pollution priority areas** and / or **priority protection areas**

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WATER QUALITY HOTSPOTS: W5

RU	SQ reach	River name	WQ role players	WQ driving variables	WQ notes
W51-3	W51-D02044	Assegal	Urban impacts, Piet Retief WWTWs	Nutrients, salts, toxics, <i>E. coli</i> / coliforms	Klipmissebuit drains into this SQ and is highly impacted by urban impacts: Indal Coal Mine Siding, industries and Piet Retief WWTWs
W51-4	W51-F01986	Biesbokspruit	Cultivation; wood-processing	Toxics, nutrients, salts	Wood-processing plant
W51-4	W51-F02019	Biesbokspruit	Industries (Woodchem + PG Bloon and Impact), saw mills, residential settlements	Toxics, nutrients, salts, <i>E. coli</i> / coliforms	
W53-3	W53-C01679	Thole	Urban impacts; WWTW; cultivation	Toxics, nutrients, salts, <i>E. coli</i> / coliforms	
W55-1	W55-C01395	Mputuzi	Erosion (sand-mining); Residential settlements and WWTWs at lower end of SQ - oxidation ponds systems overflow into rivers	Turbidity, toxics, nutrients, salts	
Christiesmeer Lake within W51B, e.g. inputs such as W55A-Q1423; Majosi se Vlei			Residential settlements and overflowing WWTWs	Nutrients, salts, <i>E. coli</i> / coliforms	
Tributaries flowing into Heyshope Dam (Northern part of the Dam) within W51A e.g. W51A-02082, Assegal River, and W51B, e.g. W51B-02101, Ngulame River			Residential settlements; WWTWs and coal mines.	Toxics, nutrients, salts, <i>E. coli</i> / coliforms	Mining activities

WQ impact ratings: 3; Serious

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PRINCIPLES: WATER QUALITY RQOs (1)

- If EcoSpecs not available from an EWR study, wq guidelines are used (linked to a level of protection, e.g. TWQR, rather than a TEC).
- WQ RQOs IMMEDIATELY applicable = ONLY where monitoring data are available.
- Monitoring recommendations and provisional RQOs are set for identified driving variables for which RQOs are *not immediately* applicable, but for which a database needs to be developed.
- Once an adequate dataset has been produced, evaluate the provisional RQOs provided and update the RQOs for the driving variables.
- Numerical and narrative RQOs are prepared using all existing data sources for identified monitoring points, and for *driving variables ONLY* for High Priority WQ sites, and for *ALL variables* for High Priority EWR sites.

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PRINCIPLES: WATER QUALITY RQOs (2)

- Note that Reserve data available as A-F categories were converted to Ideal to Tolerable categories (required for water quality gazettement purposes), as follows:

Categories A and A/B: **Ideal**
Categories B, B/C and C: **Acceptable**
Categories C/D and D: **Tolerable**
- Values used for setting RQOs were linked to standard DWS methods and procedures, data format from WMS and DWAF (2008). Note data confidence.
- Monitoring data to be collected for measurement against RQOs that are immediately applicable and to be gazetted, should be collected from the monitoring sites as identified in the water quality Reserve documentation, if possible.

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PRINCIPLES: WATER QUALITY RQOs (3)

- Microbial compliance targets: as in NMMP (new risk guidelines) - set below each WWTW, town and large settlement.

Water use attribute	Potential Health Risk		
	Low	Medium	High
Drinking untreated water	0	1-10	> 10
Drinking water after limited treatment *	< 2 000	2 000 – 20 000	> 20 000
Full or partial contact	< 600	600 – 2 000	> 2 000
Irrigation of crops to be eaten raw	< 1 000	1 000 – 4 000	> 4 000

* The guideline value refers to raw water before treatment; although water should be used for drinking only AFTER limited treatment has taken place. Limited treatment refers to treatment that is NOT conventional. Conventional treatment includes all flocculation, sedimentation, filtration and disinfection.

- Toxics: Broad numerical guidelines for toxics are not suitable for areas where specific information on toxics are not available, or where the identity of contaminants are not known. Where no data, biotic response and biological monitoring are used to indicate toxicity.

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HIGH PRIORITY EWR SITES

EWR site	Present state EC	Water quality categories	
		Drivers of WQ state	WQ TEC
EWR MA1	B	Elevated turbidities and salts; small increase in nutrient levels.	B
EWR NS1	B	Elevated turbidities and salts; small increase in nutrient levels.	B
EWR WM1	B	Elevated turbidities and salts; small increase in nutrient levels.	B
EWR BM1	B/C	Elevated intermittent sulphates (upstream mining) and salts.	B/C
EWR MK1	C/D	Elevated intermittent sulphates and salts, presumably from upstream coal mining. Toxics and elevated nutrients and turbidities. A WQ priority area in upstream SQW, with impacts being from the high risk Mkuze WWTW.	Immediate: C/D; 58.3% (prevent deterioration). Short-term (5 yrs): C; 68.8% Long-term (10 yrs): B/C; 79.4%.
EWR UP1	A/B	Elevated turbidity.	A/B
EWR AS1	B/C	Elevated nutrient levels, with some evidence of toxics.	B/C
EWR NGL	B	Elevated turbidity and small toxics input expected. Urban impacts from Amsterdam.	B

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MKUZE: Improvement through non flow-related interventions

- Improvement in the management and quality of discharges from the Mkuze WWTW.
- Improvement in the management and quality of discharges from coal-mining facilities upstream. An appropriate strategy must be developed to deal with the problem of mine decant, especially from closed and abandoned mines. It is difficult to predict what level of improvement can be achieved, and it is unlikely that salts can be moved from the current 95th percentile of 275 mS/m to that of 85 mS/m for a D Category in the short term.
- Improvement in land management and controlled use of biocides and fertilizers; reducing sedimentation and toxics released into the system.
- Reported high silt loads in the system must be verified, considered and addressed. DWS (2020) proposes that a strategy/action plan needs to be developed to achieve this. This study must include the question of the role of silt in the Mkuze swamps (capacity of the swamps to absorb this silt) and the impacts of phosphates associated with the silt.
- Draw up a detailed water quality management strategy be drawn up for the Mkuze catchment to contain the potential water quality threats.

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HIGH PRIORITY EWR SITE – W2: Black Mfolozi River, BM1

- RQOs and TPCs (Thresholds of Probable Concern, or 'red flags') must be set for all variables.
- Use PAI, WQ table summary table, and DWAF (2008) and WQ ecosystem guidelines to set RQOs and TPCs

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EWR site: Black Mfolozi, BM1

River	Black Mfolozi	Water Quality Monitoring Points	
EWR Site	BM1	PES	RC
Parameter / units		PES value	Benchmark tables (DWAF, 2008) W2H028 (WMS W22_102857, n=29, 2014-2018).
Inorganic salt ions (mg/L)	Sulphate as SO ₄	234.8 99 th percentile	Rating for PAI / Comment
	Sodium as Na	35.13	
	Magnesium as Mg	22.7	
	Calcium as Ca	65.34	
	Chloride as Cl	26.25	
Electrical conductivity	Potassium as K	5.48	Due to elevated sulphate levels
Nutrients (mg/L)	mSm	58.18	
	SRP-P	0.01	1
	TIN-N	0.1	0
Physical variables	pH (5 th and 95 th % tiles)	7.5 + 8.3	1
	Temperature (°C)	-	1. Largely natural temperature range expected. 0.5. Largely natural oxygen range expected.
	Dissolved oxygen (mg/L)	-	
	Turbidity (NTU)	-	1. Some localized erosion at the site due to land-use.
	Chl-a: phytoplankton (ug/L)	-	
Response variable	Macroinvertebrate score (MIRA)	81.2%	B/C
	SASS score	185	
	ASPT score	6.3	
Toxics (mg/L)	Diatoms	SP=17 (n=1)	Indicates Very Good water quality
	Fish score (FRAI)	75.9%	
	Ammonia (as N)	0.005	
	Fluoride (F)	0.58	
	Overall site classification (from PAI table)		B/C (81.8%)

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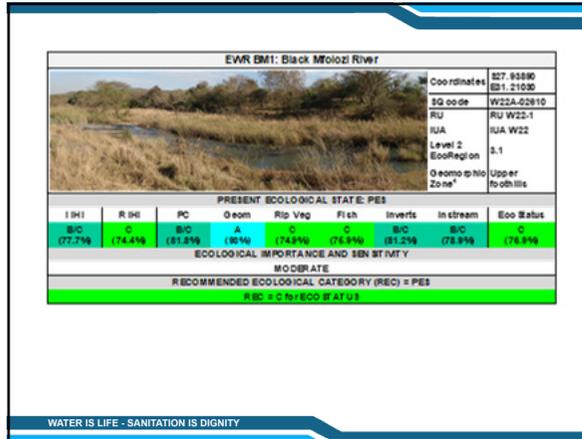
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The assessment is of moderate confidence as recent data could not be sourced. Diatom results indicate Good water quality (category A/B for diatoms). Despite the good water quality state, intermittent high sulphate levels moved the assessment from a B to B/C category. It is assumed upstream mining is responsible for intermittent increases.

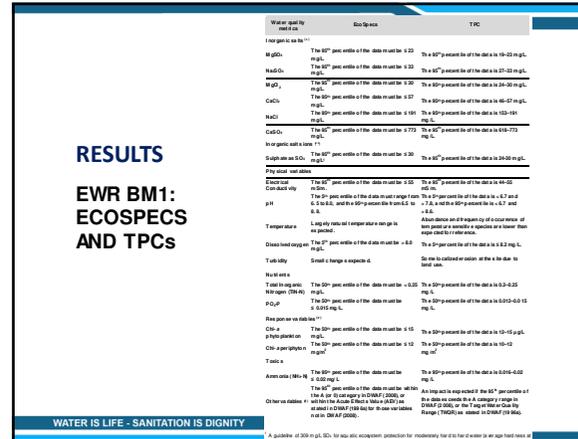
Metric	Rating	Threshold	Comp	Overall	Adjusted	Adjusted
pH	2.00	2	0.00	50.00	50.00	50.00
Salts	2.00	2	0.00	50.00	50.00	50.00
Nutrients	2.00	2	0.00	50.00	50.00	50.00
Water Temperature	2.00	2	0.00	50.00	50.00	50.00
Water clarity	2.00	2	0.00	50.00	50.00	50.00
Dissolved oxygen	2.00	2	0.00	50.00	50.00	50.00
Diagrams	2.00	2	0.00	50.00	50.00	50.00
Toxics	2.00	2	0.00	50.00	50.00	50.00
PAI MODIFICATION RATING WITH THRESHOLD APPLIED						
	0.00		MEAN CONF =	3.21		
CALCULATED PAI MODIFICATION RATING WITHOUT THRESHOLD AND WITH DIATOM WEIGHTS						
	0.00					
CALCULATED PAI RATING WITHOUT THRESHOLD AND BASED ON ADJUSTED RESULTS						
	0.00					
FINAL PAI MODIFICATION RATING						
	0.00					
P-C CATEGORY		P-C CATEGORY				
B/B	B/C	REVIEW % & CATEGORY (2018)				

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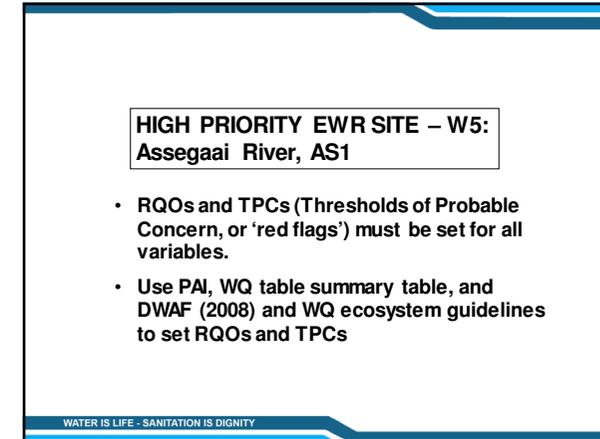
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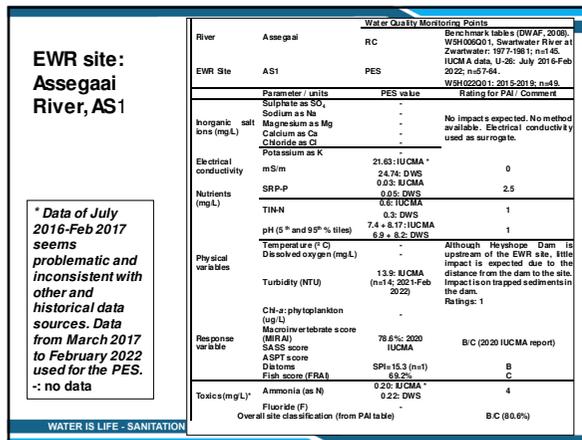
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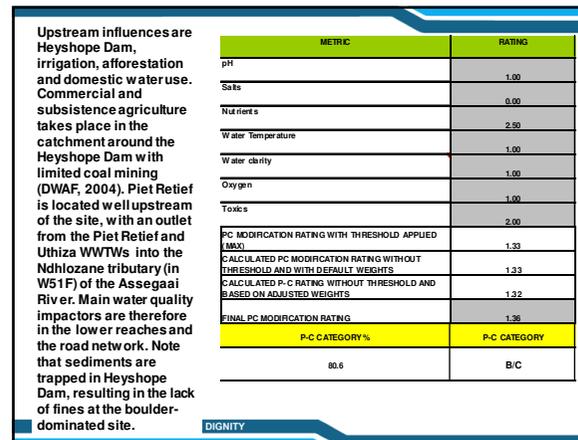
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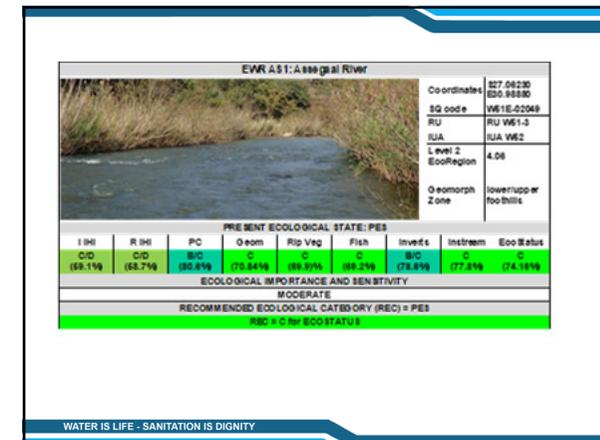
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RESULTS: EWR AS1 - ECOSPECS AND TPCs

Water quality variable	Ecospice	TPC
Inorganic salts **		
MgSO ₄	The 50 th percentile of the data must be ≤ 16 mg/L.	The 50 th percentile of the data is 13.6 mg/L.
Na ₂ SO ₄	The 50 th percentile of the data must be ≤ 20 mg/L.	The 50 th percentile of the data is 16.0 mg/L.
MgCl ₂	The 50 th percentile of the data must be ≤ 12 mg/L.	The 50 th percentile of the data is 10.0 mg/L.
CaCl ₂	The 50 th percentile of the data must be ≤ 21 mg/L.	The 50 th percentile of the data is 17.0 mg/L.
NaCl	The 50 th percentile of the data must be ≤ 45 mg/L.	The 50 th percentile of the data is 36.0 mg/L.
CO ₃ CO ₃	The 50 th percentile of the data must be ≤ 281 mg/L.	The 50 th percentile of the data is 280-281 mg/L.
Physical variables		
Electrical Conductivity	The 50 th percentile of the data must be ≤ 20 mS/m.	The 50 th percentile of the data is 24.0 mS/m.
pH	The 2 nd percentile of the data must range from 6.5 to 8.0, and the 98 th percentile from 6.5 to 8.0.	The 2 nd percentile of the data is < 6.7 and > 7.8, and the 98 th percentile is < 6.7 and > 8.4.
Temperature	Large natural temperature range is expected.	Some temperature sensitive species at lower abundance and frequency of occurrence than expected for reference.
Dissolved oxygen	The 5 th percentile of the data must be > 7.0 mg/L.	
Turbidity	Small changes expected.	Medium within current range (median: 11.0 NTU).
Nutrients		
Total Inorganic Nitrogen (TIN)	The 50 th percentile of the data must be ≤ 0.7 mg/L.	The 50 th percentile of the data is 0.6-0.7 mg/L.
PO ₄ -P	The 50 th percentile of the data must be ≤ 0.035 mg/L.	The 50 th percentile of the data is 0.03-0.035 mg/L.
Response variables **		
Chlorophyllation	The 50 th percentile of the data must be ≤ 20 mg/L.	The 50 th percentile of the data is 16-20 mg/L.
Chlorophyll	The 50 th percentile of the data must be ≤ 0.3 mg/L.	The 50 th percentile of the data is 0.2-0.3 mg/L.
Toxic		
Arsenite (AsO ₃ -As)	The 50 th percentile of the data must be ≤ 0.02 mg/L.	The 50 th percentile of the data is 0.018-0.02 mg/L.
Other variables **	The 50 th percentile of the data must be within the A (or B) category in DWAF (2006), or within the Asset Ethics Value (AEV) as stated in DWAF (1996a) for those variables not in DWAF (2006).	An intent is expected if the 50 th percentile of the data exceeds the category range in DWAF (2006), or the Target Water Quality Range (TWQR) as used in DWAF (1996a).

(*) Inorganic salts only to be generated when the TPC for Electrical Conductivity is exceeded or salt pollution is expected, should a tool for generating salts be available.

(**) Low confidence. Ecospice and TPC boundaries may need adjusting as data becomes available.

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**HIGH PRIORITY WQ SITES
- set for the RU; highlighting
priority areas**

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EXAMPLE: RU W51-1: STREAMS UPSTREAM HEYSHOPE DAM

Source: No detailed water quality assessment conducted. PESEIS data (DWS, 2014) and literature sources (e.g. DWS, 2020; DWAF, 1996a-e; data sources e.g. NCMP data) were used.

Model: N/A

Users: Settlements; WWTWs; mining.

Water quality issues: Toxics, nutrients, salts, *E. coli*/ faecal coliforms.

Narrative ROO	Numerical ROO
Ensure that salts stay within Ideal limits.	90 th percentile of the data must be less than 15 mS/m (Eskom wq requirements; Heyshope Dam: driven).
Ensure that nutrient levels are within Acceptable limits.	50 th percentile of the data must be less than 0.015 mg/L PO ₄ -P (Aquatic ecosystems: driven).
Ensure that toxics are within Ideal limits or A categories.	90 th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2006).

Water use attribute	Potential Health Risk		
	Low	Medium	High
	Faecal coliform or <i>E. coli</i> counts/100 ml		
Drinking untreated water	0	1-10	> 10
Drinking water after limited treatment †	< 2 000	2 000 – 20 000	> 20 000
Full or partial contact	< 600	600 – 2 000	> 2 000
Irrigation of crops to be eaten raw	< 1 000	1 000 – 4 000	> 4 000

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GENERAL NOTES

- Ecology is the main “user” at stretches containing EWR sites. Remember Chapter 3, NWA:

SUSTAINABLE UTILISATION = LONG-TERM BALANCE BETWEEN USE AND PROTECTION OF WATER RESOURCES

- Information on other users was “checked” at these river stretches.
- Driving user at sites = often ecological protection. Suitable if wq data is linked to the maintenance or reaching of a particular water quality category, which is part of a specific EC, catchment configuration and Water Resource Class.
- RQOs for driving variables set accordingly.

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