Determination of Water Resource Classes and Associated Resource Quality Objectives for the Berg Catchment (WP10987)

December 2018

Revision: Final

Outline of Resource Quality Objectives Report

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Bold type indicates this Report.

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17	RDM/WMA9/00/CON/CLA/0718	Final Project Close Out Report.

List of Abbreviations

DWA	*(Previous) Department of Water Affairs*
DWAF	*(Previous) Department of Water Affairs and Forestry*
DWS	*Department of Water and Sanitation*
EC	*Ecological Category (A to E based on Kleynhans et al, 1996)*
EIS	*Ecological Importance and Sensitivity*
EWR	*Ecological Water Requirements*
GRU	*Groundwater Resource Unit*
IUA	*Integrated Unit of Analysis*
NFEPA	*National Freshwater Ecosystem Priority Area*
NL	*Numerical Limit*
nMAR	*Natural Mean Annual Runoff*
NWA	*National Water Act*
PES	*Present Ecological Status*
REC	*Recommended Ecological Condition*
RQOs	*Resource Quality Objectives*
RU	*Resource Unit*
TEC	*Targeted Ecological Condition*
TPC	*Threshold of probable concern*
WMA	*Water Management Area*
WRC	*Water Resource Classes*
WRCS	*Water Resources Classification System*

Executive Summary

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation has commissioned a study to determine Water Resource Classes and Resource Quality Objectives (RQOs) for all significant water resources in the Berg Catchment in line with Section 12 of the NWA which established a Water Resources Classification System (WRCS) that is formally prescribed by Regulations 810 dated 17 September 2010.

The Water Resources Classification procedure have been completed in the Berg Catchment and the determination of the RQOs follows on from this process. The 7-step procedure established by the Department of Water and Sanitation (DWS) (formally the Department of Water Affairs) in 2011 (DWA, 2011) is being applied to determine the Resource Quality Objectives (RQOs) for river, estuary, wetland, dam and groundwater resources in the Berg Catchment. These procedural steps to determine RQOs in the Berg Catchment include the following:

- Step 1. Delineate the Integrated Units of Analysis (IUAs) and define the Resource Units (RUs)
- Step 2. Establish a vision for the catchment and key elements for the IUAs
- Step 3. Prioritise and select preliminary Resource Units for RQO determination
- Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change
- Step 5. Develop draft RQOs and Numerical Limits
- Step 6. Agree Resource Units, RQOs and Numerical Limits with stakeholders
- Step 7. Finalise and Gazette RQOs.

In terms of the RQO determination process, Step 1 (Delineation), Step 2 (Visioning) have been completed as part of the Classification phase of this study. Step 3 (Prioritisation) involved the iterative process of prioritizing Resource Units using the RU prioritization tool and it is documented in the Resource Units Prioritization Report (DWS, 2018). Step 4 (Evaluation), documented in the Evaluation of Resource Units Report (DWS, 21018), entailed the selection of sub-components for RQO determination, and the selection of indicators for monitoring and propose the direction of change.

This report documents the approach adopted and the outcomes of the implementation of Step 5 (Outline) of the RQO determination procedure. Step 5 comprises the proposed draft ROQs and numerical limits (NL) for the significant water resources in the Berg Catchment that have been developed. RQOs are narrative statements, but sometimes provide broad quantitative descriptions of the water resource. Numerical limits translate the narrative RQOs into numerical values, where appropriate, and which can be monitored and assessed for compliance.

The components for which RQOs and NLs were provided for each priorities RU include:

- Quantity.
- Quality
- Habitat.
- Biota.

There are key limitations and uncertainties which may influence the confidence of the outcomes of the RQOs and numerical limits process. These are briefly discussed for each significant water resource in this Outline Report.

The next step of the RQO determination process, Sub-step 5.8, involves the confidence assessment in both the RQOs and in the process followed in determining the narrative statements. The confidence in the RQOs is dependent on the accuracy of information used in the process. The assessment of confidence was undertaken for the processes applied and associated outputs at both the catchment and Resource Unit scale. These will however be presented in a separate Confidence Report along with recommendations for monitoring of the RQOs and a draft monitoring program which will be presented in the RQOs Monitoring Report.

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1 Introduction

1.1 Background

Chapter 3 of the National Water Act (NWA) lays down a series of measures which are together intended to ensure protection of the water resources. In accordance with these measures, the Department of Water and Sanitation (DWS) in line with Section 12 of the NWA, established a Water Resources Classification System (WRCS) that is formally prescribed by Regulations 810 dated 17 September 2010. The WRCS provides guidelines and procedures for determining Water Resource Classes, Reserve and Resource Quality Objectives.

Section 13 of the NWA states that "as soon as reasonable practicable after the Minister prescribed a system for classifying water resources, the Minister must, subject to subsection (4), by notice in the gazette, determine for all or part of every significant water resource-

a) A class in accordance with the prescribed classification system; and

b) Resource quality objectives based on the class determined in terms of paragraph (a)."

The Chief Directorate: Water Ecosystem has therefore commissioned a study to determine Water Resource Classes (WRCs) and associated Resource Quality Objectives (RQOs) for all significant water resources in the Berg / Olifants-Doring Water Management Area (WMA) that lie outside the Olifants-Doring section of the WMA. This includes the area of the former Berg WMA (i.e. former WMA 19)

With the Classification phase of this study completed, the current next phase of the study comprises the 7-step procedure (DWA, 2011) towards determination of RQOs for all significant water resources in the Berg Catchment.

Previous RQO studies were reviewed to determine an approach for the current study. Reports of relevant previous studies that are referred to are the RQO determination reports for the Crocodile (West), Marico, Mokolo and Matlabas catchments (DWS, 2015), for the Olifants WMA (DWS, 2014) and the Upper Vaal WMA (DWS, 2014).

1.2 Scope of this phase of the study

The main objective of this study is to determine Resource Quality Objectives (RQOs) for all significant water resources in the Berg Catchment that must give effect to the Water Resources Classes that have been determined in the previous phase of the study and are describe in the Evaluation of Scenarios Report. To this end, the 7-step process for determining RQOs, described in DWA (2011) and depicted in Figure 1-1, is being implemented.

Once gazetting has been finalised, implementation, monitoring and review would then follow.

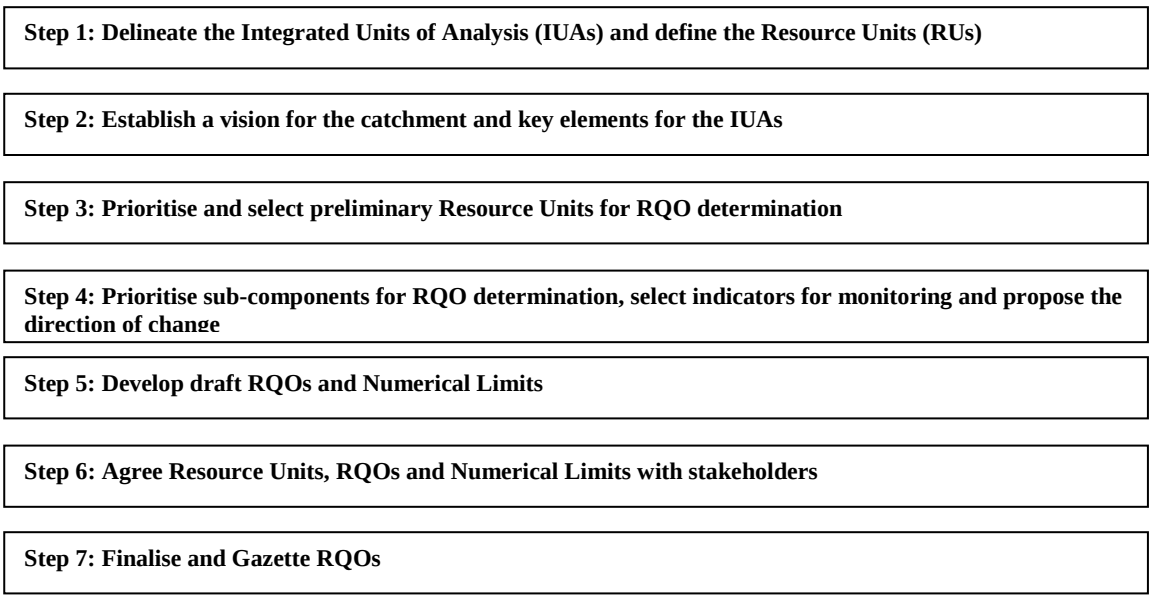

Figure 1-1: The seven-step process for RQO determination (DWA, 2011)

In terms of the RQO process outlined above, Step 1 (Delineation), Step 2 (Visioning) have been completed as part of the Classification phase of this study. Step 3 (Prioritisation) involved the iterative process of prioritizing Resource Units using the RU prioritization tool and it is documented in the Resource Units Prioritization Report (DWS, 2018). Step 4 (Evaluation), documented in the Evaluation of Resource Units Report (DWS, 21018), entailed the selection of sub-components for RQO determination, and the selection of indicators for monitoring and propose the direction of change.

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1.3 Study Area

The study area covers all significant water resources of the Berg Catchment. The Berg River is the largest catchment in the Study Area, which also includes a number of smaller catchments such as the Diep, Kuils, Eerste, Lourens, Sir Lowry's, Steenbras, as well as various small catchments on the Cape Peninsula and along the West Coast. The study area includes secondary catchments G1 and G2 and G40A.

During the Classification phase of the study, resource units for rivers, wetlands, dams, groundwater and estuaries as well as a total of 12 Integrated Units of Analysis (IUAs) were delineated in the Berg Catchment.

The IUAs approximate socio-economic boundaries, delineated to facilitate the integration of ecological and socio-economic aspects required for the evaluation of scenarios during the Classification phase of the study (DWS, 2017). The delineation of the Resource Units and the IUAs is described in the *Resource Unit and Integrated Units of Analysis Delineation Report* (DWS, 2016b).

A visioning exercise for the catchment was undertaken with key stakeholders in the Classification phase of the study. The purpose of the visioning exercise was to articulate the aspirations of the various stakeholders for the future of the catchment. The stakeholders highlighted the key water resource issues relevant to their respective sectors, including issues relating to policy and legislation, resources, administration, capacity/empowerment and technology, and then presented their critical considerations for determining the water resource class.

The details and outcomes of the visioning exercise are documented in the *Evaluation of Scenarios Report* (DWS, 2018). The Evaluation of Scenarios report also describes the approach to determining the final recommended water resource classes for the individual IUAs and resource units of the Berg Catchment that took into account the trade-offs between environmental requirements and the benefits from ecosystem good services and attribute (EGSAs) with user requirements particularly in terms of water availability and the cost of alternative supply.

1.4 Recommended Water Resource Classes

Based on the evaluation of scenarios the recommended water resource class is based on the REC scenario but considering only the baseflow conditions as minimum with the flood EWRs being met on average and not necessarily every year. This is essentially the same recommended EWR scenario as previously considered for the implementation of the Berg River Dam and for the feasibility study for the Voëlvlei Augmentation Scheme.

Hence while this scenario does result in a historical firm yield (HFY) less than the present condition and for the scenarios with no environmental constraint it represents the best trade-off of environmental and ecological conditions, particularly recognising the importance of maintaining flow to the Berg River Estuary, for mitigating the water quality risk and recreational use of the Berg River. It is also important to note that an improved ecological condition, particularly for the Berg River estuary can be achieved if additional measures are taken to improve the water quality of the Berg River, and similarly for the other critical estuaries in the Berg Catchment.

The recommended water resources classes for each IUA are defined in terms of the following:

Class I	**Natural** – minimal impact of humans, natural water quality and safe for most uses.
Class II	**Moderately used/impacted** – slightly altered from natural due to human activity
Class III	**Heavily used/impacted** – significant change from natural due to human activity

The recommended water resource Class is based largely on the number of river and estuary nodes with the different ecological conditions in each IUA and are presented in Table 1-1 and shown in Figure 1-2.

Table 1-1 Recommended class for IUAs

IUA Name	IUA Code	Recommended Class
Upper Berg	D8	II
Middle Berg	D9	III
Berg Tributaries	C5	II
Lower Berg	B4	III
Berg Estuary	A1	II
Langebaan	A2	II
West Coast	A3	III
Diep	D10	III
Peninsula	E11	II
Cape Flats	E12	III
Eerste	D6	III
Sir Lowry's	D7	II

The recommended water resource class also takes into consideration critical water resource areas such as the strategic water source areas (SWSA) which cover a large portion of the upper reaches of some of the IUAs including the Upper Berg IUA and the area covered by the Table Mountain National Park (TMNP) which makes up more than half of the Peninsula IUA. These areas should receive additional protection while the remained of the IUA is located in a heavily impacted urban or rural area. The location of some of these critical resource areas are shown in Figure 1.3. and it is important that these critical water resource areas are provided further protection.

It was proposed that these SWSA and existing protected areas be given a sperate water resource class, i.e. a class I and indicating that these should be maintained in as near natural condition as possible, but this was not possible in terms of the guidelines and approach recommended for determine the water resource classes as these needed to be defined according to existing hydrological boundaries which were at quaternary catchments scale.

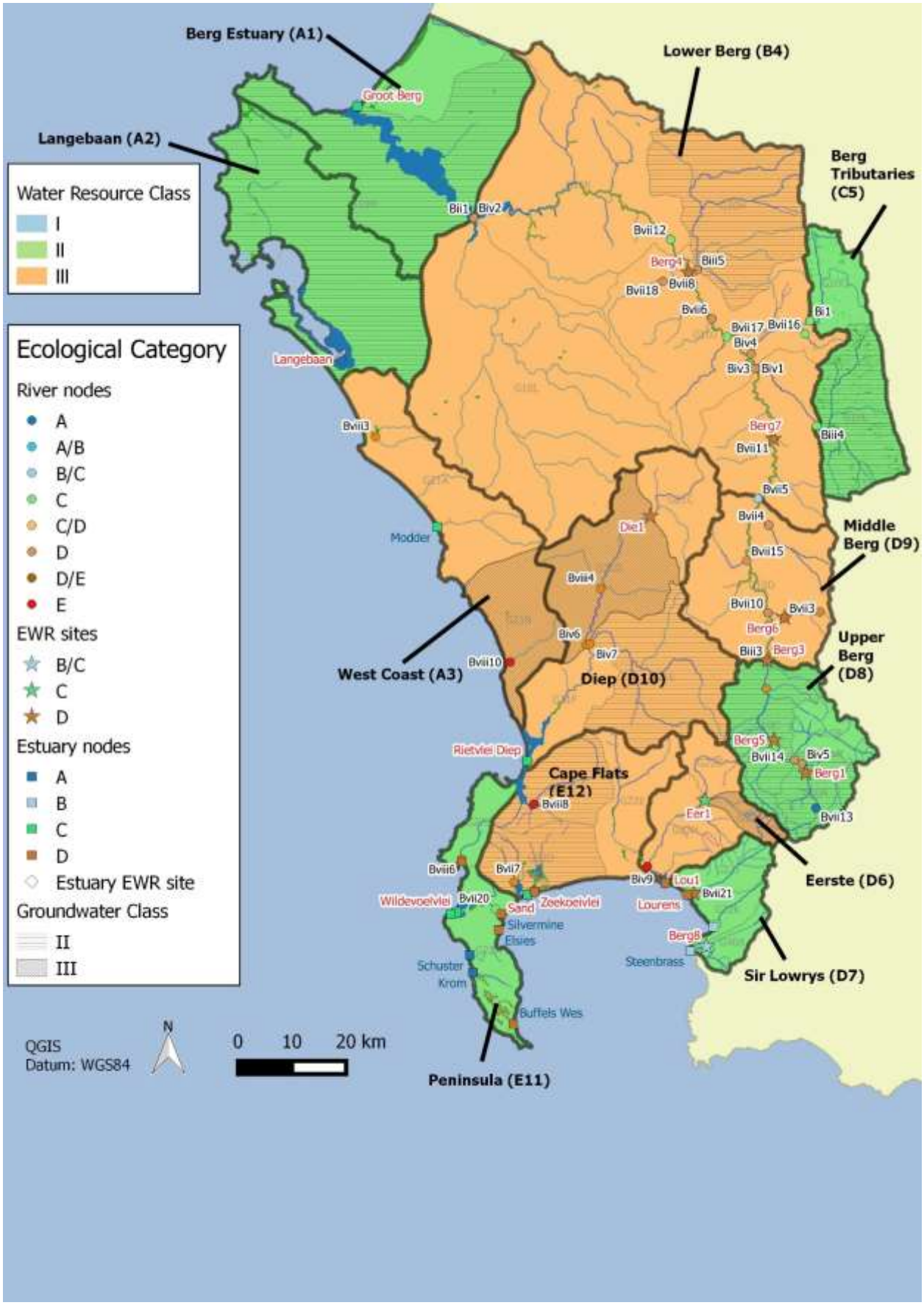

Figure 1-2 Map showing target ecological conditions, recommended water resource classes and resulting groundwater stress levels based on the future development scenario considered for the Berg catchment.

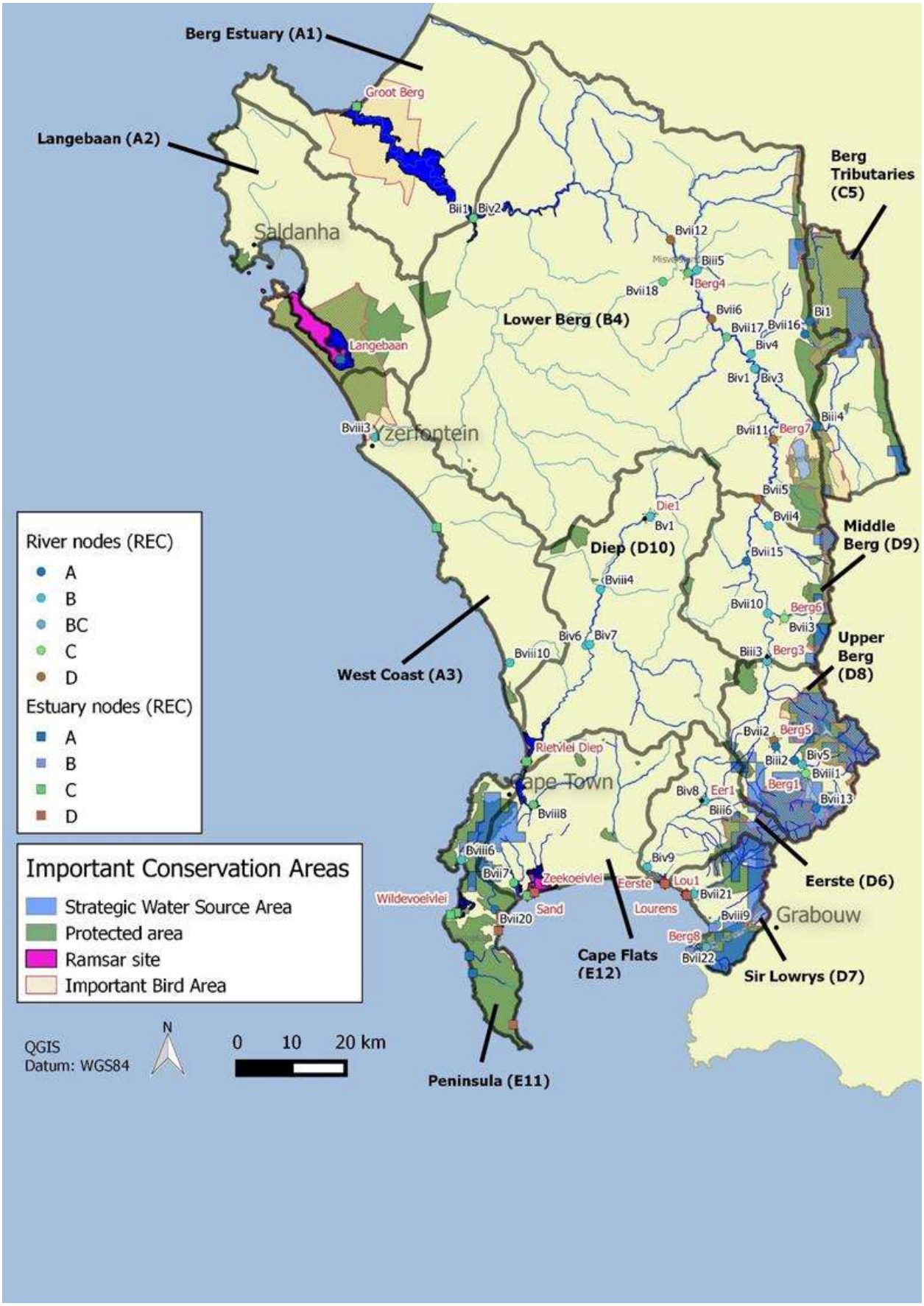

Figure 1-3 Map of the Study Area showing the strategic water source areas and protected areas used to define individual resource units within each IUA for the final recommended water resource class.

1.5 Prioritisation of Resource Units

The prioritized RUs for determining RQOs have been identified using the following criteria:

- All river RUs in the Berg Catchment irrespective of their scores
- All estuaries in the Berg Catchment irrespective of their scores. However, none of the river outlets in the catchment were prioritised
- Dams determined from prioritisation process with a priority weighting of > 0.6
- Wetlands RUs as determined from the prioritisation process
- Groundwater RUs scoring >40 in the scoring system and designated as a priority "3".

The prioritisation approach is resource-specific, for example enabling different areas to be prioritised for surface water and groundwater. This is necessary, given that the criteria for each differ.

However, in certain circumstances, the RQO for one resource may require the RQO of another resource to be developed to support it. These likely interactions have also been considered in terms of determining the final list of prioritised RUs and will also be reflected in the proposed RQOs for different RUs.

The final list of priority resource units is given in Table 1-2 and the priority RUs are mapped in Figure 1.4.

Table 1-2 Summary of results of the prioritisation process for the Berg Catchment

IUA	Prioritised Resource Units (RUs) for which detailed RQOs were developed				
	River Node	Estuary Name	Dam Name	Wetland Resource Units	Groundwater Resource Unit
D8 Upper Berg	Bviii1 Bvii13 Biii3		Berg River Dam Wemmershoek Dam	Strategic Water Source Wetlands_SEEP	G10A G10B
D9 Middle Berg	Bvii5 Bviii11 Bvii3			West Coast Shale Renosterveld FLOODPLAIN (Berg)	
C5 Berg Tributaries	Biii4 Bi1			Strategic Water Source Wetlands_SEEP	G10E
B4 Lower Berg	Bvii12 Bvii6		Voëlvlei Dam Misverstand Weir	Northwest Sandstone Fynbos SEEP (Boesmans River) West Coast Shale Renosterveld FLOODPLAIN (Berg) West Coast Shale Renosterveld DEPRESSION (Koekispan and Kiekoesvlei)	G10J G21B
A1 Berg Estuary		Berg (Groot)		Southwestern Shale Fynbos UNCHANNELED VALLEY BOTTOM (Berg)	
A2 Langebaan		Langebaan		Salt marsh SEEP (Geelbek)	
A3 West Coast				Southwest Sand Fynbos DEPRESSION (Yzerfontein)	G10L G10M
D10 Diep	Bv1 Biv6	Rietvlei/ Diep		Southwest Sand Fynbos FLOODPLAIN (Rietvlei) and Dune Strandveld FLOODPLAIN (Rielvlei) SEEP and DEPRESSION (Riverlands)	G21D
E11 Peninsula	Bviii6 Bvii20	Wildevöelvlei		Sand Fynbos DEPRESSION (Wildvoelvlei: open water) Sand Fynbos DEPRESSION (Seasonal) Sand Fynbos DEPRESSION (Pick n Pay Reedbeds) Strategic Water Source Wetlands _FLAT	

IUA	Prioritised Resource Units (RUs) for which detailed RQOs were developed				
	River Node	**Estuary Name**	**Dam Name**	**Wetland Resource Units**	**Groundwater Resource Unit**
E12 Cape Flats	Bvii7	Zandvlei		DEPRESSION (Zeekoeivlei main water body and seasonal wetlands) DEPRESSION (Rondevlei main water body and seasonal wetlands) FLOODPLAIN (Nooiensfontein) DEPRESSION (Blouvlei) DEPRESSION (Princessvlei) DUNE SLACK (Phillipi: Denel)	G22C G22D G22E
D6 Eerste	Biii6 Biv8	Eerste		Strategic Water Source Wetlands_SEEP	
D7 Sir Lowry's	Bvii22 Bvii21 Bviii9	Lourens	Steenbras Reservoir Steenbras Upper Dam	Strategic Water Source Wetlands_SEEP	
TOTAL	**20**	**7**	**6**	**24**	**11**

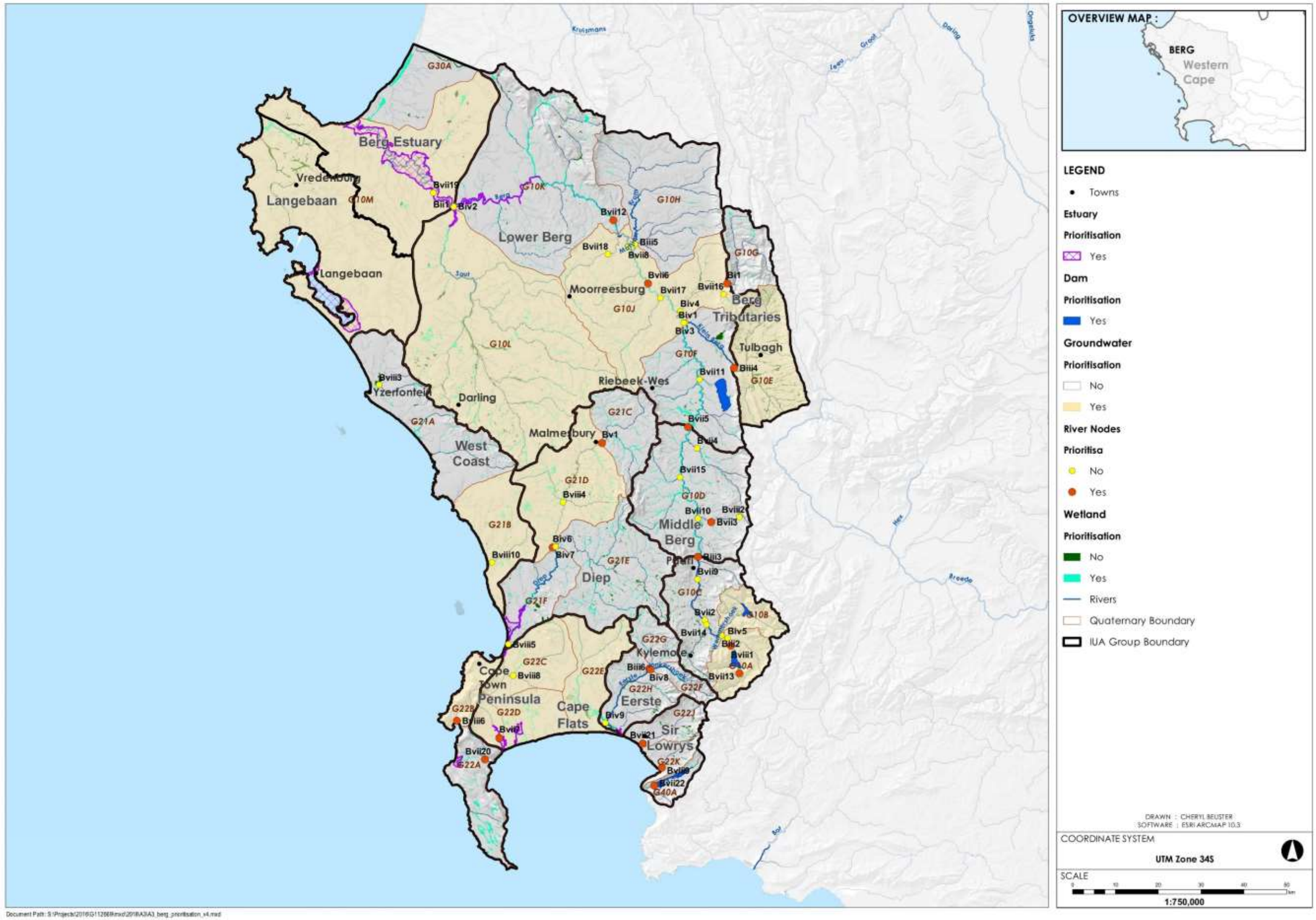

Figure 1.4 Summary of results of the prioritisation process for the Berg IUAs

1.6 Evaluation of Resource Units

The specific components for which RQOs should be developed for each of the prioritise resource units (RUs) were determined using the recommended RU Evaluation Tool developed by DWS (DWA, 2011). The Resource Evaluation tool is a decision support tool for the prioritisation process, which serves two main functions:

i. Determine the level of threat posed to each of the sub-components by activities in the catchment
ii. Identify which sub-components should be protected in order to support water resource dependent activities and/or maintain the integrity and ecological functioning of the water resource (DWS< 2011:57)

The information from the resource Evaluation Tool is then used to prioritise sub-components of the RQOs.

A total of 49 sub-components were selected for RQO determination using the RU Evaluation tool) including:

- 12 sub-components were selected to represent river resources from 20 prioritised RUs.
- 13 sub-components were selected to represent estuaries resources from 7 prioritised RUs.
- 9 sub-components were selected to represent dam resources from 6 prioritised RUs.
- 9 sub-components were selected to represent wetlands resources from 24 prioritised RUs.
- 6 sub-components were selected to represent groundwater resources from 11 prioritised RUs.

The final list of selected Sub-components for each resource unit type are given in Table 1-3.

Table 1-3 Summary of sub-component prioritisation selection for the Berg Catchment

Component	Sub-component	Rivers	Estuaries	Dams	Wetlands	Ground water
Quantity	Abstraction					X
	High flows	X	X	X	X	
	Low flows	X	X	X		X
	Discharge					X
	Hydroperiod				X	
Quality	Nutrients	X	X	X	X	X
	Salts	X		X		X
	System variables (temperature, salinity, oxygen, pH, turbidity	X	X	X		
	Toxins	X	X	X		
	Pathogens	X	X	X	X	X
Habitat	Ecological Condition	X				
	Geomorphology	X			X	
	Sedimentary processes		X			
	Mouth state		X			
	Vegetation / Riparian Vegetation	X			X	
Biota	Fish	X	X	X		
	Frogs				X	
	Invertebrates	X	X			
	Micro-algae		X			
	Macrophytes		X			
	Phytoplankton			X	X	
	Birds		X			
	Benthic algae				X	
	Totals	**12**	**13**	**9**	**9**	**6**

2 Approach

2.1 Resource Quality Objectives process overview

For the determination and implementation of RQOs, a seven-step procedure was established (DWA, 2011). This process is interlinked with the Water Resources Classification process and forms part of an Adaptive Management Cycle that is used as an improved water resources management practice. Overall the Adaptive Management Cycle consists of delineating the resource units (RU), setting a vision for the catchment, identifying priority RUs, selecting and evaluate the RUs for the specific RQO components and sub-components, drafting the RQOs and numerical limits, agree these with the stakeholders to finalise and Gazette the RQOs, and finally moving to implementing, monitoring and reviewing before restarting the process for corrections and improvements.

Ideally the RQOs should be set for each Resource Unit, as per the Water Resource Classification System recommendations. In reality however, due to the large number of Resource Units, it is necessary to prioritise and select the most important Resource Units for which RQO should then be determined. In terms of the seven step RQO determination process, Step 1 (Delineation) and Step 2 (Visioning) have been explained and completed as part of the Classification phase of this study (Figure 2-1). The Step 3 of the Procedure to Determine and Implement Resource Quality Objectives (DWA, 2011) purpose is to select and prioritise preliminary Resource Units using the RU prioritisation tool for RQO determination. The evaluation of the RU priority ratings for selection are then done (Step 4), and the RQOs and numerical limits are drafted (Step 5). These will then be discussed and agreed at the stakeholder engagement workshops (Step 6). This process will allow to select at least one RU to represent each IUA that will then be monitored after the gazetting of the RQOs (Step 7).

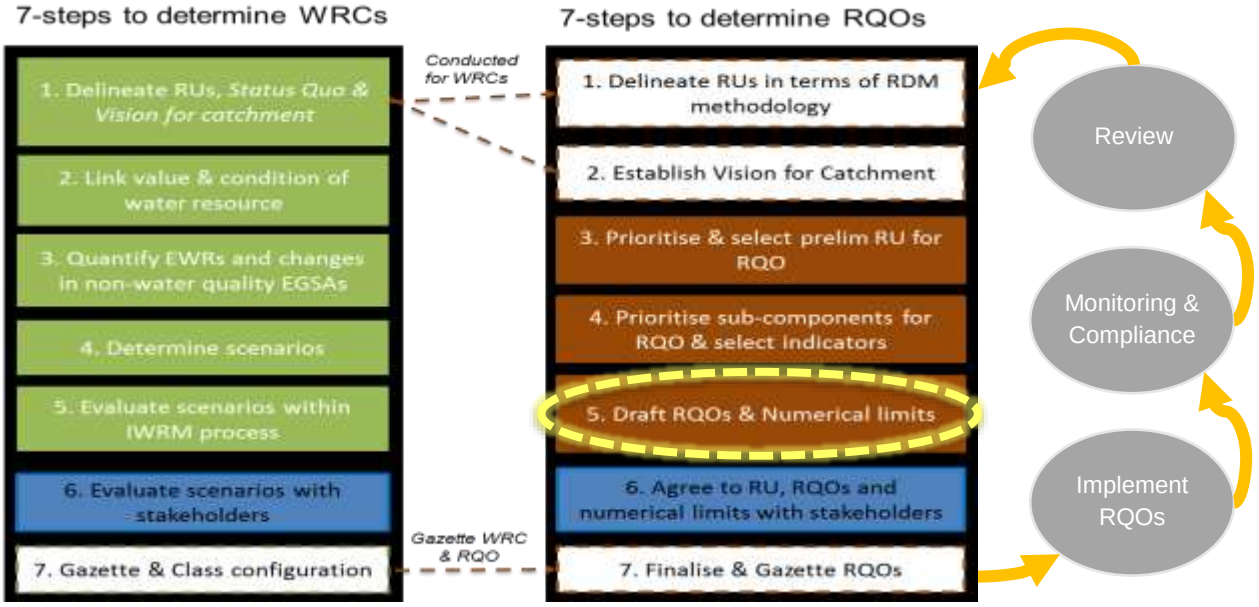

Figure 2-1 Integration of the seven-step processes for WRC determination and the RQO determination (DWA, 2011), incorporating the three additional steps to implement the Adaptive Management Cycle

Management, monitoring and compliance are the three additional steps of the Adaptive Management Cycle to be implemented after the RQO process. This introduces a continual learning and improvement procedure which allows changes to be made to continually align the RQOs with the vision for the catchment. The changes, if needed, will indicate that the measures in place to protect the water resource are not sufficient to comply with the RQOs set, or alternatively that the RQOs are not realistic, and need to be corrected or adapted accordingly.

2.2 Resource Quality Objectives and numerical limits overview

Based on the prioritisation of sub-components undertaken in Step 4 (Evaluation), Step 5 (Outline) focuses on developing of Resource Quality of Objectives and proposing Numerical Limits, where applicable, for rivers, estuaries, dams, wetlands and groundwater in the Berg catchment. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance.

A few sub-steps are followed during Step 5. These are briefly enumerated below:

1. Carry over sub-component and indicator information from the Resource Unit Evaluation Tool
2. Extract available data to determine the present state for selected sub-components and indicators
3. Assess the suitability of the data
4. Where necessary, collect data to determine the Present State for selected indicators
5. Determine the level at which to set RQOs
6. Set appropriate draft RQOs
7. Set appropriate draft Numerical Limits in line with the draft RQO
8. Determine confidence in the RQOs and process

2.3 Stakeholder Engagement and Review of Draft RQOs

The draft RQOs were first determined and incorporated into a draft RQO Outline Report. This was then circulated to the individual members of the Project Management Committee (PMC) and the Project Steering Committee (PSC). The draft RQOs were then presented to the PSC at a PSC Workshop held on the 6th November 2018. A follow-on workshop just with representatives of the Municipal Sector was also held on the 7th November 2018.

All comments received on the draft Outline Report as well as form the PSC and Municipal sector workshop have now been incorporated into the final RQO Outliner Report and will also be including the draft Gazetting Template.

A draft Gazette template has also been prepared and will be distributed for final comment from the PSC and other stakeholders before this can then be submitted through the formal Gazetting Process by DWS. A final project report will also be prepared that includes any additional comments and recommendations on the process.

3 Results

3.1 River RQOs and numerical limits

Two different levels of numerical and descriptive RQOs have been written for rivers. Hydrological and ecological condition RQOs have been written for all RUs as these were generated as part of the *Scenarios Evaluation Report* for determining the recommended water resource classes. In addition to this, water quality, geomorphology, riparian vegetation, invertebrates and fish RQOs have been written for the top twenty priority river resource units.

3.1.1 Critical Components and Subcomponents of River ROQs

The RU evaluation tool for rivers was used to prioritise RQO sub-components that may be important to users and the environment and to select indicators for which RQOs and Numerical Limits should be developed.

Table 3-1 indicates what kinds of RQOs have been written for each RU based on the evaluation of RUs.

Table 3-1 RQO components and sub-components for each Resource Unit in the Berg WMA

IUA	Quat	River	Node code	Rank	Quantity	Quality					Habitat		Biota		
					Hydrology	Nutrients	Salts	System variables	Toxins	Pathogens	Ecological condition	Geomorphology	Fish	Riparian vegetation	Invertebrates
Upper Berg	G10A	Berg	Bvii13	1	x	x	x	x	x	x	x	x	x	x	x
	G10A	Berg	Bviii1	1	x	x	x	x	x	x	x	x	x	x	x
	G10A	Franschoek	Biv5	3	x						x				
	G10B	Wemmershoek	Biii2	3	x						x				
	G10C	Dwars	Bvii14	4	x						x				
	G10C	Berg	Bvii2	4	x						x				
	G10C	Berg	Biii3	2	x	x	x	x	x	x	x	x	x	x	x
Middle Berg	G10C	Pombers	Bviii11	1	x	x	x	x	x	x	x	x	x	x	x
	G10D	Kromme	Bvii3	2	x	x	x	x	x	x	x	x	x	x	x
	G10D	Berg	Bvii10	5	x						x				
	G10D	Doring	Bvii15	5	x						x				
	G10D	Kompanjies	Bvii4	5	x						x				
	G10D	Berg	Bvii5	1	x	x	x	x	x	x	x	x	x	x	x
Berg Tributaries	G10E	Klein Berg	Biii4	2	x	x	x	x	x	x	x	x	x	x	x
	G10G	Vier-en-Twintig	Bi1	2	x	x	x	x	x	x	x	x	x	x	x
Lower Berg	G10F	Berg	Bvii11	4	x						x				
	G10J	Klein-Berg	Biv3	4	x						x				
	G10J	Berg	Biv1	4	x						x				
	G10J	Leeu	Bvii16	4	x						x				
	G10H	Krom	-	4	x						x				
	G10J	Vier-en-twintig	Biv4	5	x						x				
	G10J	Sandspruit	Bvii17	5	x						x				
	G10J	Berg	Bvii6	2	x	x	x	x	x	x	x	x	x	x	x
	G10J	Matjies	Biii5	5	x						x				
	G10J	Berg	Bvii8	4	x						x				
	G10J	Moreesburg Spruit	Bvii18	4	x						x				

IUA	Quat	River	Node code	Rank	Quantity	Quality					Habitat		Biota		
					Hydrology	Nutrients	Salts	System variables	Toxins	Pathogens	Ecological condition	Geomorphology	Fish	Riparian vegetation	Invertebrates
	G10K	Berg	Bvii12	1	x	x	x	x	x	x	x	x	x	x	x
	G10L	Sout	Bii1	5	x						x				
	G10L	Berg	Biv2	4	x						x				
	G21B	Sout	Bviii10	3	x						x				
Berg Estuary	G10M		Bvii19	5	x						x				
West coast	G21A		Bviii3	3	x						x				
Diep	G21C	Riebecks	-	3	x						x				
	G21D	Diep	Bv1	2	x	x	x	x	x	x	x	x	x	x	x
	G21D	Swart	Bviii4	3	x						x				
	G21D	Diep	Biv6	2	x	x	x	x	x	x	x	x	x	x	x
	G21E	Mosselbank	Biv7	3	x						x				
	G21F	Diep	Bviii5	5	x						x				
Cape Flats	G22C	Elsieskraal	Bviii8	3	x						x				
	G22D	Keysers	Bvii7	2	x	x	x	x	x	x	x	x	x	x	x
	G22E	Kuils River	-	3	x						x				
Peninsula	G22B	Hout Bay	Bviii6	1	x	x	x	x	x	x	x	x	x	x	x
	G22A	Silvermine	Bvii20	2	x	x	x	x	x	x	x	x	x	x	x
Eerste	G22F	Jonkershoek	Biii6	1	x	x	x	x	x	x	x	x	x	x	x
	G22G	Klippies	Biv8	2	x	x	x	x	x	x	x	x	x	x	x
	G22H	Kuils	Biv9	3	x						x				
Sir Lowrys	G22J	Lourens	Bvii21	1	x	x	x	x	x	x	x	x	x	x	x
	G22K	Sir Lowry's Pass	Bviii9	1	x	x	x	x	x	x	x	x	x	x	x
	G40A	Steenbras	Bvii22	1	x	x	x	x	x	x		x	x	x	x

The content of the RQOs is sourced from multiple sources but has been presented in the same formatted as much as possible and within the limits of the data. The studies used to source the data for the high priority RUs have been written at different times in the past and so the content is not the same between studies. Cognisance is also given to the fact that RQOs need to be meaningful but also implementable by the Department, who are all trained in assessing river condition using the Ecostatus modules developed by Neels Kleynhans, amongst other things (GAI, Rowntree *et al.* 2013; VEGRAI, Kleynhans et al. 2007; MIRAI, Thirion 2007; FRAI, Kleynhans 2008). For this reason, condition scores for different river attributes calculated using the Ecostatus modules are also included as RQOs. Additional recommendations for the monitoring of the RQOs is given in the *RQO Monitoring Report.*

In the detailed RQO tables given below, a number of critical component where identified but currently there is no data available that would enable a numerical limit or threshold of potential concern to be determined with any level of confidence. These components have been included but are currently greyed out and will not be included in the recommended RQOs to be gazetted as additional monitoring is required to determine the numerical limits.

3.1.2 Priority River RUs for the Berg Catchment

The top twenty high priority RUs in the Berg catchment where detailed RQOs for hydrology, water quality, geomorphology, riparian vegetation, Invertebrates and fish will be written are shown in Table 3-2. This list of priority RUs was presented to the DWS regional office to evaluate in terms of a realistic list of possible resource units that could potentially be monitored. Hence the proposed RUs are in line with DWS current monitoring plans.

Table 3-2 Top twenty prioritised River RUs for which it is recommended RQOs be developed

IUA	Quat	Node	Description and Reason for Priority	River	Priority Ranking Score
Peninsula	G22B	Bviii6	At EWR site. Existing EWR site just upstream of inflow into Hout Bay. One of two strongly flowing perennial rivers on the Peninsula that has three reservoirs important for water supply to the city of Cape Town. The upper reaches are conserved in the Oranjekloof Nature Reserve where Ghost Frogs breed.	Hout Bay	0.75
Steenbras	G40A	Bvii22	At EWR 8, u/s of estuary mouth - B/C. The Steenbras River is impounded by two reservoirs that supply water to the City of Cape Town, and receive Inter Basin Transfers from other reservoirs. This site is important to maintain baseflows downstream of the reservoirs for the river and as inflow into the estuary.	Steenbras	0.73
Upper Berg	G10A	Bviii1	D/s of Berg River dam at EWR 1 – C. This site is already monitored by the DWS REMP programme and also was part of the Berg River Monitoring Programme. The gauge records E-flows released from the Berg River Dam.	Berg	0.71
Eerste	G22F	Biii6	At EWR Eer1. Important for quality of river flows through Stellenbosch. Also, to sustain flows during the dry season currently abstracted by the Stellenbosch Municipality upstream in Jonkershoek Nature Reserve. This site represents one of the few urban rivers in good condition, an example that should be exemplified.	Jonkershoek	0.66
Lourens	G22J	Bvii21	At EWR Lou1. This river is one of the major rivers that drain through the Cape Flats, starting through expensive farmland, then again representing one of the few urban rivers in good condition, as it flows through Somerset West. This river is a Protected Natural Environment (PNE). The gauge at this site records flows important as outflow through the estuary into False Bay.	Lourens	0.62
Sir Lowrys	G22K	Bviii9	Cumulative at outlet G22K. Flows through an expensive residential development and the historic town of Sir Lowry's Pass village, important economically and socially respectively. This river is one of the few rivers that still flows perennially through the Cape Flats that support important wetland habitat.	Sir Lowry's Pass	0.56
Upper Berg	G10A	Bvii13	Gauge. Outlet of IUA. Upstream of Berg River dam, this gauge records important inflows into the dam that are used to adjust the EWR releases made downstream of the dam into the Berg River. This area is now an important conservation area and this river reach is one of the few upper foothill rivers left in the Western Cape that is unregulated and in good condition.	Berg	0.55
Middle Berg	G10D	Bvii5	At gauging weir G1H036 and u/s of EWR 3 – D. Existing EWR site at Hermon. This site is important as it is located downstream of the towns of Paarl and Wellington and the gauge here records flows in the river prior to any releases being made from Voelvlei dam. It is also the conduit for releases made to sustain agriculture downstream. It is also a site already being monitored by the DWS REMP and the Berg River Monitoring Programme.	Berg	0.52
Lower Berg	G10K	Bvii12	3.5 km d/s of Misverstand reservoir, at EWR 5 – D. Existing EWR site that is gauged to record flows downstream of	Berg	0.52

IUA	Quat	Node	Description and Reason for Priority	River	Priority Ranking Score
			Misverstand that are important to sustain the Berg River estuary. It is also a site already being monitored by the DWS REMP and the Berg River Monitoring Programme.		
Middle Berg	G10C	Bviii11	At EWR 7 u/s of confluence with Kromme – C. Existing EWR site that is important to record flows and conditions in the Pombers River that receives water via Gawie se water, a canal that delivers water abstracted from the Upper Witte River in the Breede River Basin.	Pombers	0.51
Middle Berg	G10D	Bvii3	North of Wellington, G1H037, d/s EWR 6 – D. Existing EWR site that is important to record flows and conditions in the Kromme River that receives water via Gawie se water, a canal that delivers water abstracted from the Upper Witte River in the Breede River Basin.	Kromme	0.51
Berg Tribs	G10E	Biii4	At gauging weir G1H008. Location for diversion of inflows into Voelvlei Dam. This site is also located near the IUA outlet as it gathers flows from all these important tributaries.	Klein Berg	0.5
Upper Berg	G10C	Biii3	At gauging weir G1H020. This site is important as it records flows through the town of Paarl and downstream of water releases made from the Berg River Dam at the Skuifraam Supplement Scheme. It is also a site already being monitored by the DWS REMP and the Berg River Monitoring Programme.	Berg	0.49
Peninsula	G22A	Bvii20	Outlet of IUA. This is one of two perennially flowing rivers on the Peninsula and the entire catchment is situated in the Silvermine Nature Reserve, part of the Table Mountain National Park.	Silvermine	0.49
Cape Flats	G22D	Bvii7	At EWR site. This is an important tributary of the Diep River, the most important and largest river basin on the West Coast supporting a diverse range of agricultural practices.	Keysers	0.46
Eerste	G22G	Biv8	The Klippies is an important tributary of the Eerste River that flows through the informal settlement of Kayamandi. It is an existing DWS monitoring site.	Klippies	0.46
Diep	G21D	Bv1	Outlet of IUA and inflow to estuary. The Diep is the main river basin on the West Coast and the estuary supports major recreational and expensive residential property.	Diep	0.45
Berg Tribs	G10G	Bi1	At gauging weir G1H028, pristine wilderness 100%. Location for diversion of inflows into Voelvlei Dam.	Vier-en-Twintig	0.44
Lower Berg	G10J	Bvii6	D/s of EWR 4, above Misverstand Dam G1H013 – D. It is also a site already being monitored by the DWS REMP and the Berg River Monitoring Programme.	Berg	0.42
Diep	G21D	Biv6	At EWR Die1. This gauge downstream of the town of Malmesbury records flows and conditions that support the agricultural activities downstream and also the effect that the town and supporting industry are having on the water quality of this river.	Diep	0.42

3.1.3 Rating values used for determined water quality RQOs for Rivers

The water quality RQOs for rivers were determined based on consideration for current water quality categories for toxic substances as give in Table 3-3. Other water quality RQOs were determined based on DWS guidelines for the most sensitive user, e.g. for agricultural use, ecological importance, drinking water or recreation contact.

Table 3-3: Rating values and equivalent water quality categories for toxic substances (modified from DWAF, 2008)

	Category	Ideal	Acceptable		Tolerable		Unacceptable
Toxic substance (µg/l)	**Rating**	**0**	**1**	**2**	**3**	**4**	**5**
Aluminium		20	62.5	105	150	192.5	>192.5
Ammonia		15	43.75	72.5	100	128.75	>128.75
Arsenic		20	57.5	95	130	167.5	>167.5
Atrazine		19	48.75	78.5	100	129.75	>129.75
Cadmium soft*		0.2	0.7	1.2	1.8	2.3	>2.3
Cadmium mod**		0.2	0.95	1.7	2.8	3.55	>3.55
Cadmium hard***		0.3	1.625	2.95	5	6.325	>6.325
Chlorine (free)		0.4	1.75	3.1	5	6.35	>6.35
Chromium (III)		24	115	206	340	431	>431
Chromium (VI)		14	67.5	121	200	253.5	>253.5
Copper soft*		0.5	1.025	1.55	1.6	2.125	>2.125
Copper mod**		1.5	3.025	4.55	4.6	6.125	>6.125
Copper hard***		2.4	4.875	7.35	7.5	9.975	>9.975
Cyanide (free)		4	32.5	61	110	138.5	>138.5
Endosulfan		0.02	0.075	0.13	0.2	0.255	>0.255
Fluoride		1500	2510	3520	2540	3550	>3550
Lead soft*		0.5	1.625	2.75	4	5.125	>5.125
Lead mod**		1	3	5	7	9	>9
Lead hard***		2	5.75	9.5	13	16.75	>16.75
Mercury		0.08	0.525	0.97	1.7	2.145	>2.145
Phenol		60	200	340	500	640	>640

*For use in soft water (Hardness less than 60mg $CaCO_3$/l)

** For use in moderately hard water (Hardness between 60 – 119 mg $CaCO_3$/l)

***For use in hard water (Hardness greater than 120 mg $CaCO_3$/l)

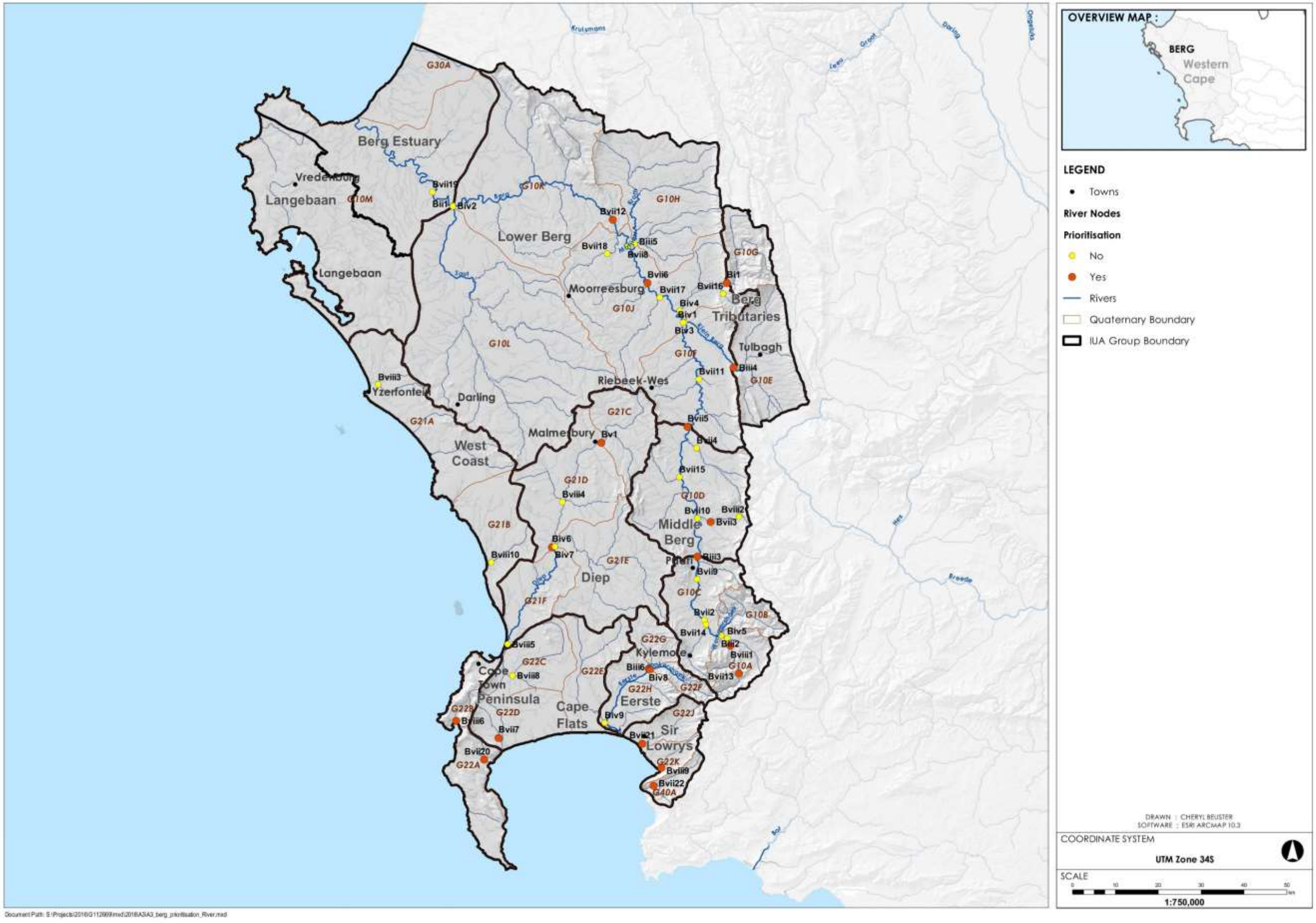

Figure 3-1 Priority River RUs for which draft RQOs have been developed in the Berg Catchment

3.1.4 River hydrological RQOs: all nodes

The Target Ecological Condition (TECs) and hydrological RQOs for all the nodes in the Berg WMA are provided in Table 3-4. It is important to note the REC is from the various reserve studies, while the TEC is derived from this study and in some cases may vary from the REC as it is either not possible to achieve the REC based on other demands or alternatively in some cases a slightly higher TEC is required to provide sufficient flow at this node to achieve the REC at downstream nodes that are linked.

Table 3-4 Annual and Monthly flow requirements at all river nodes in the G1 catchment

IUA	Node	River	REC	TEC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tot
UpperBerg	Bvii13	Berg		A	4.94	2.39	1.42	1.05	1.02	1.50	3.76	9.97	15.59	17.33	14.72	9.62	83.32
UpperBerg	Bviii1	Berg	C	B/C	3.10	2.03	1.30	0.75	0.61	0.74	2.02	4.54	14.06	19.04	9.94	7.31	65.44
UpperBerg	Biv5	Franschhoek		D	2.38	0.59	0.06	0.01	0.00	0.02	0.44	2.37	5.58	7.53	7.28	4.71	31.01
UpperBerg	Biii2	Wemmershoek		D	1.04	0.32	0.05	0.02	0.01	0.03	0.34	1.36	3.84	8.04	7.11	3.63	25.77
UpperBerg	Bvii14	Dwars		C	2.07	0.93	0.46	0.25	0.19	0.26	1.16	2.81	5.68	7.20	6.77	4.06	31.85
UpperBerg	Biii3	Berg		E	9.51	5.88	9.25	15.67	12.77	12.12	9.93	13.02	38.80	58.10	48.20	28.35	261.61
MiddleBerg	Bviii11	Pombers	C	D	0.55	0.46	0.44	0.44	0.40	0.42	0.43	0.54	0.66	0.83	0.86	0.64	6.67
MiddleBerg	Bvii3	Kromme	D	D/E	0.97	0.03	0.00	0.00	0.00	0.00	0.48	1.44	2.56	4.07	4.49	2.51	16.55
MiddleBerg	Bvii10	Berg		D	11.25	5.54	7.77	12.93	10.33	9.87	9.91	14.74	42.62	65.72	57.16	33.36	281.20
MiddleBerg	Bvii15	Doring		D	0.24	0.01	0.00	0.00	0.00	0.00	0.02	0.15	0.35	0.75	0.88	0.47	2.88
MiddleBerg	Bvii4	Kompanjies		D	1.18	0.05	0.00	0.00	0.00	0.00	0.23	1.23	2.63	4.78	5.38	2.85	18.33
MiddleBerg	Bvii5	Berg	D	C	14.18	3.66	2.51	4.04	2.31	2.40	8.11	16.88	47.87	78.22	72.66	41.56	294.38
BergTrib	Biii4	Klein Berg		C	6.45	3.41	2.35	1.42	1.19	1.32	1.75	4.66	8.05	12.06	15.45	10.97	69.09
BergTrib	Bi1	Vier-en-Twintig		B/C	0.76	3.90	1.37	0.38	0.43	0.84	2.44	0.80	2.59	6.56	7.14	4.11	31.32
BergTrib	Bvii16	Leeu		C	0.04	0.55	0.20	0.05	0.06	0.12	0.35	0.00	0.08	0.53	0.63	0.37	2.99
LowerBerg	Bvii11	Berg		C	9.54	3.15	2.51	3.13	2.31	2.40	4.51	11.17	39.95	72.02	67.95	35.06	253.69
LowerBerg	Biv1	Berg		D	21.46	7.16	8.25	10.29	8.17	8.51	11.85	16.26	46.76	85.82	86.89	49.41	360.83
LowerBerg	Biv3	Klein-Berg		D	3.84	4.32	2.55	1.48	1.22	1.37	1.95	1.39	3.27	9.91	15.77	10.12	57.19
LowerBerg	Biv4	Vier-en-twintig		D	3.42	3.92	0.53	0.07	0.21	0.58	2.70	1.61	4.25	11.26	13.97	8.98	51.50
LowerBerg	Bvii17	Sandspruit		C	0.87	0.42	0.09	0.03	0.02	0.02	0.09	0.49	0.87	1.73	2.20	1.35	8.19
LowerBerg	Bvii6	Berg	D	D	30.22	16.00	11.14	11.38	9.11	9.90	16.55	20.20	55.92	110.24	120.77	71.05	482.47
LowerBerg	Biii5	Matjies		D	1.49	0.63	0.51	0.04	0.02	0.05	0.66	2.56	4.58	6.11	6.73	3.47	26.85
LowerBerg	Bvii8	Berg		D	32.06	16.62	11.11	10.48	8.11	8.71	16.98	23.01	60.95	116.99	128.31	75.23	508.56
LowerBerg	Bvii18	Moreesburg Spruit		D	0.42	0.22	0.08	0.02	0.01	0.01	0.04	0.22	0.40	0.55	0.68	0.61	3.27
LowerBerg	Bvii12	Berg	D	D	29.94	13.23	6.90	6.91	7.41	8.18	11.16	19.90	59.62	116.02	129.02	74.17	482.44
LowerBerg	Bii1	Sout		D	0.93	0.43	0.33	0.02	0.02	0.03	0.45	1.65	2.75	3.42	3.67	1.93	15.65
LowerBerg	Biv2	Berg		D	30.28	12.12	3.59	1.58	1.48	1.63	8.68	20.53	61.49	119.93	133.49	76.41	471.21
LowerBerg	Bxi1	Berg	C	C	31.21	12.55	3.92	1.61	1.50	1.66	9.13	22.18	64.25	123.35	137.15	78.34	486.86

3.1.5 River RQOs for the Upper Berg IUA

The recommended River RQOs for the Upper Berg IUA are given in Table 3-5. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-5 RQOs and Numerical Limits for river's priority RUs in Upper Berg IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D8 Upper Berg	Berg River	Bvii13	Quantity	Hydrology	A	Observed flow.	Flows sufficient to maintain the river in an A category.	Table 3-6	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.025 mg/l PO_4-P	0.020 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/l TIN	0.56 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5 ≤ pH ≤ 7	5.5 ≤ pH ≤ 6.5
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 8 mg/l	9.2 mg/l DO
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	95%tile ≤ 130 cfu/100ml E coli / Faecal coliforms	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{50}	Sand particle size	0.860 > D_{50} > 0.275	0.860 < D_{50} < 0.275
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 62% = C category	< 58% = D category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >5%
						Indigenous riparian woody species		Cover 5-25%.	Cover < 5%
						Non-woody indigenous species		Cover 25-50%.	Cover < 20%
						Reeds		No reeds	Reeds present
						Exotic species	Lower zone cover abundance	Cover < 5%.	Cover > 10%
						Terrestrial woody species		Cover < 10%.	Cover > 20%
						Indigenous riparian woody species		Cover 25-60%	Cover < 20%
						Non-woody indigenous species		Cover 25-50%	Cover < 20%

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Reeds		No reeds	Reeds present
						Exotic species	Upper zone cover abundance	Cover < 10%.	Cover > 20%
						Terrestrial woody species		Cover </= 15%.	Cover >30%
						Indigenous riparian woody species		Cover 25-50%	Cover < 20%
						Non-woody indigenous species		Cover 40-70%.	Cover < 30%
			Biota	Fish		FRAI score	Fish condition	> 80% = B category	< 62% = C category
						Number of indigenous fish species.	Indigenous species richness	Three species present: *Sandelia capensis, Galaxia zebratus* and *Pseudobarbus burgi*	< 2 indigenous species
						Sandelia capensis		FROC = 5	*Sandelia capensis* absent for two consecutive surveys OR present at FROC of < 5.
						Galaxias zebratus		FROC = 5	*Galaxias zebratus* absent for two consecutive surveys OR present at FROC of < 5.
						Pseudobarbus burgi		FROC = 5	*Pseudobarbus burgi* absent for two consecutive surveys OR present at FROC of < 5.
						Exotic fish species		No increase in the number of exotic fish present: *Onchorhyncus mykiss* (FROC = 5)	More than 1 exotic fish species present.
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 78 % = B/C category	< 58% = C/D category
						SASS5 and ASPT score	SASS scores	SASS5 score >180, ASPT ≥ 7.2.	SASS5 scores < 162, ASPT < 6.5.
						Number of families	Diversity of invertebrate community	>/= 23 families, at an abundance of A to C.	<20 families. Any taxon (adult) with an abundance of 1.
D8 Upper Berg	Berg River	Bviii1	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in a C category.	Table 3-7	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.025 mg/l PO_4-P	0.020 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/l TIN	0.56 mg/l TIN

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5.0 ≥ pH ≤ 7.5	5.5 ≥ pH ≤ 7.0
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 8 mg/l	9.2 mg/l DO
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	95%tile ≤ 600 cfu/100ml E coli / Faecal coliforms	480 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{50}	Sand particle size	0.521 > D_{50} > 0.319	0.521 < D_{50} < 0.319
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 62% = C category	< 58% = D category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >1%
						Indigenous riparian woody species		Cover < 10%.	Cover >10%.
						Non-woody indigenous species		Cover 50-75%.	Cover < 30%
						Reeds		No reeds	Reeds present
						Exotic species	Lower zone cover abundance	Cover < 5%.	Cover > 15%.
						Terrestrial woody species		Cover < 10%.	Cover > 15%.
						Indigenous riparian woody species		Cover 50-75%.	Cover < 30%.
						Non-woody indigenous species		Cover 25-50%.	Cover < 20%
						Reeds		No reeds	Reeds present
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 62% = C category	> 58% = D category

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Number of indigenous fish species.	Indigenous species richness	One species present: *Sandelia capensis*	No indigenous species
						Sandelia capensis		FROC = 5	*Sandelia capensis* absent for two consecutive surveys OR present at FROC of < 5.
						Exotic fish species		No increase in the number of exotic fish present: *Micropterus dolomieu* (FROC = 5)	More than 1 exotic fish species present.
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62%= C category	< 58 % = D category
						SASS5 and ASPT score	SASS scores	SASS5 score >134, ASPT ≥ 6.1.	SASS5 scores < 120, ASPT < 5.5.
						Number of families	Diversity of invertebrate community	>/= 21 families, at an abundance of A to C.	<18 families. Any taxon (adult) with an abundance of 1.
D8 Upper Berg	Berg River	Biii3	Quantity	Hydrology	E	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-8	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in a Tolerable category for intermediate contact recreation.	95%tile ≤ 4000 cfu/100ml E coli / Faecal coliforms	3200 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size		
				Riparian		VEGRAI level 3 score.	Vegetation condition	> 38% = D/E category	< 22% = E/F category

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				vegetation		Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 58% C/D category	< 38% D/E category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	No data	
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

Figure 3.2 **Aerial view of Bvii13**

Table 3-6 **Bvii13: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: G1H076

```
Desktop Version 2, Generated on 02/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff:           Bvii13

Annual Flows (Mill. cu. m or index values):
MAR               =   84.848
S.Dev.            =   26.677
CV                =    0.314
Q75               =    0.980
Q75/MMF           =    0.139
BFI Index         =    0.351
CV(JJA+JFM) Index =    1.833

Ecological Category = A

Total IFR         =   41.016 (48.34 %MAR)
Maint. Lowflow    =   29.177 (34.39 %MAR)
Drought Lowflow   =    3.637 ( 4.29 %MAR)
Maint. Highflow   =   11.839 (13.95 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	5.006	3.762	0.751	3.209	0.000	0.440	3.649
Nov	2.415	1.778	0.736	2.041	0.000	0.073	2.115
Dec	1.429	1.715	1.201	1.149	0.000	0.000	1.149
Jan	1.065	1.473	1.384	0.771	0.000	0.000	0.771
Feb	1.035	1.416	1.368	0.640	0.000	0.000	0.640
Mar	1.528	1.820	1.191	0.695	0.000	0.000	0.695
Apr	3.853	4.035	1.047	1.107	0.170	0.000	1.107
May	10.210	7.126	0.698	2.328	0.429	2.022	4.350
Jun	16.035	10.635	0.663	3.706	0.659	3.153	6.859
Jul	17.661	8.978	0.508	4.569	0.803	4.160	8.729
Aug	14.893	5.724	0.384	4.707	0.826	0.664	5.371
Sep	9.718	6.300	0.648	4.255	0.750	1.327	5.582

Figure 3.3 **Upstream view of Bviii1**

Table 3-7 **Bviii1: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: G1H077

Desktop Version 2, Generated on 2/1/2010
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff : Bviii1

Annual Flows (Mill. cu. m or index values):

MAR	=	141.683
S.Dev.	=	50.536
CV	=	0.357
Q75	=	1.840
Q75/MMF	=	0.156
BFI Index	=	0.365
CV(JJA+JFM) Index	=	1.953

Ecological Category = C

Total IFR	=	44.062 (31.10 %MAR)
Maint. Lowflow	=	27.421 (19.35 %MAR)
Drought Lowflow	=	15.393 (10.86 %MAR)
Maint. Highflow	=	16.641 (11.75 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	9.032	6.161	0.682	2.143	1.339	0.000	2.143
Nov	4.717	3.094	0.656	1.293	0.778	0.544	1.837
Dec	3.021	3.061	1.013	1.071	0.429	0.544	1.615
Jan	1.969	2.539	1.290	0.803	0.429	0.000	0.803
Feb	2.072	2.954	1.426	0.726	0.387	0.000	0.726
Mar	2.253	2.589	1.149	0.803	0.429	0.000	0.803
Apr	7.393	6.733	0.911	1.296	0.778	0.778	2.074
May	18.743	13.292	0.709	2.679	1.339	0.000	2.679
Jun	27.047	22.802	0.843	4.147	2.074	4.666	8.813
Jul	26.597	14.813	0.557	4.285	2.143	10.109	14.395
Aug	23.807	14.179	0.596	4.285	2.679	0.000	4.285
Sep	15.033	8.348	0.555	3.888	2.592	0.000	3.888

Figure 3.4 **Upstream view of Biii3**

Table 3-8 **Biii3: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: G1H020

```
Desktop Version 2, Generated on 02/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =  418.079
S.Dev.            =  149.801
CV                =    0.358
Q75               =    5.050
Q75/MMF           =    0.145
BFI Index         =    0.361
CV(JJA+JFM) Index =    1.527

Ecological Category = D

Total IFR         =   92.242 (22.06 %MAR)
Maint. Lowflow    =   65.016 (15.55 %MAR)
Drought Lowflow   =   52.391 (12.53 %MAR)
Maint. Highflow   =   27.225 ( 6.51 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	25.784	13.520	0.524	5.803	1.612	0.000	5.803
Nov	12.937	8.895	0.688	2.080	1.560	0.000	2.080
Dec	6.813	6.046	0.887	1.612	1.612	0.000	1.612
Jan	4.478	4.092	0.914	1.612	1.612	1.721	3.333
Feb	3.887	3.377	0.869	1.456	1.456	0.000	1.456
Mar	5.119	5.235	1.022	1.612	1.612	0.000	1.612
Apr	14.294	16.467	1.152	4.368	1.560	4.454	8.822
May	42.007	33.171	0.790	8.382	1.612	0.000	8.382
Jun	76.793	56.596	0.737	9.776	9.776	10.525	20.301
Jul	92.003	53.749	0.584	10.102	10.102	10.525	20.627
Aug	83.787	38.098	0.455	10.102	10.102	0.000	10.102
Sep	50.178	32.029	0.638	8.112	9.776	0.000	8.112

3.1.6 River RQOs for the Middle Berg IUA

The recommended River RQOs for the Middle Berg IUA are given in Table 3-9. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-9 RQOs and Numerical Limits for river's priority RUs in Middle Berg IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D9 Middle Berg	Pombers River	Bviii11	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in a C category.	Table 3-10	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.025 mg/l PO_4-P	0.020 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/l TIN	0.56 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 8 mg/l	9.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	95%tile ≤ 600 cfu/100ml E coli / Faecal coliforms	480 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 38% D/E category	< 22% E/F category
						D_{16}, D_{50}, D_{84}	Sediment particle size		
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 22% = E category	< 18% = F category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	No data	
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 80% = B category	< 62% = C category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
D9 Middle Berg	Kromme River	Bvii3	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-11	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≤ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 8 mg/l	9.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 38% = D/E category	< 22 % = E/F category
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 18% = F category	< 18% = F category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species			
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 22% = E category	< 18% = F category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 78% = B/C category	< 58% = C/D category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
D9 Middl	Berg River	Bvil5	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-12	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an	Median ≤ 0.125 mg/l PO_4-P	0.100 mg/l PO_4-P

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Total inorganic nitrogen (TIN)	eutrophic condition or better.	Median ≤ 3.00 mg/l TIN	2.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		D_{50}	Sand particle size	$0.714 > D_{50} > 0.251$	$0.714 < D_{50} < 0.251$
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 52% = D category	< 38% = E category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >1%
						Indigenous riparian woody species		Cover 50-75%.	Cover < 30%.
						Non-woody indigenous species		Cover 15-25%.	Cover < 10%
						Reeds		No reeds	Reeds present
						Exotic species	Lower zone cover abundance	Cover < 5%.	Cover >15%.
						Terrestrial woody species		Cover < 10%.	Cover >15%.
						Indigenous riparian woody species		Cover 50-75%.	Cover < 40%.
						Non-woody indigenous species		Cover 15-25%.	Cover < 10%
						Reeds		No reeds	Reeds present
						Exotic species	Upper zone cover abundance	Cover < 10%.	Cover > 20%.
						Terrestrial woody species		Cover </= 15%.	Cover > 30%.

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Indigenous riparian woody species		Cover 50-75%.	Cover < 30%.
						Non-woody indigenous species		Cover 10-20%	Cover < 5%
			Biota	Fish		FRAI score	Fish condition	> 52% = D category	< 38% = E category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No increase in the number of exotic fish present: *Cyprinus carpio* (FROC = 5), *Tilapia sparrmanii, Clarias gariepinus, Gambusia affinis*	More than 4 exotic fish species present.
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62% = C category	< 58% = D category
						SASS5 and ASPT score	SASS scores	SASS5 score >90, ASPT ≥ 4.6.	SASS5 scores < 80, ASPT < 4.0.
						Number of families	Diversity of invertebrate community	>/= 18 families, at an abundance of A to C.	<13 families. Any taxon (adult) with an abundance of 1.

M Rountree

Figure 3.5 **Upstream view of Bviii11**

Table 3-10 **Bviii11: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 06/05/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Bviii

Annual Flows (Mill. cu. m or index values):
MAR               =    1.823
S.Dev.            =    0.970
CV                =    0.532
Q75               =    0.020
Q75/MMF           =    0.132
BFI Index         =    0.340
CV(JJA+JFM) Index =    1.645

Ecological Category = C

Total IFR         =    0.398 (21.82 %MAR)
Maint. Lowflow    =    0.226 (12.40 %MAR)
Drought Lowflow   =    0.222 (12.18 %MAR)
Maint. Highflow   =    0.172 ( 9.42 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.137	0.039	0.286	0.029	0.029	0.010	0.039
Nov	0.064	0.021	0.335	0.022	0.022	0.002	0.024
Dec	0.024	0.014	0.577	0.012	0.013	0.000	0.012
Jan	0.029	0.007	0.244	0.006	0.006	0.000	0.006
Feb	0.017	0.007	0.406	0.004	0.003	0.000	0.004
Mar	0.006	0.008	1.279	0.005	0.003	0.000	0.005
Apr	0.031	0.045	1.478	0.007	0.006	0.000	0.007
May	0.130	0.191	1.470	0.014	0.013	0.022	0.036
Jun	0.266	0.301	1.132	0.023	0.022	0.037	0.060
Jul	0.423	0.420	0.992	0.032	0.032	0.018	0.050
Aug	0.453	0.399	0.881	0.039	0.039	0.065	0.103
Sep	0.244	0.143	0.585	0.034	0.034	0.018	0.052

M Rountree

Figure 3.6 **Upstream view of Bvii3**

Table 3-11 **Bvii3: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 28/01/2010
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =   18.195
S.Dev.            =    9.190
CV                =    0.505
Q75               =    0.090
Q75/MMF           =    0.059
BFI Index         =    0.333
CV(JJA+JFM) Index =    2.622

Ecological Category = D

Total IFR         =    2.582 (14.19 %MAR)
Maint. Lowflow    =    1.104 ( 6.07 %MAR)
Drought Lowflow   =    1.103 ( 6.06 %MAR)
Maint. Highflow   =    1.478 ( 8.12 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.369	0.455	0.333	0.141	0.141	0.086	0.227
Nov	0.686	0.322	0.470	0.110	0.110	0.016	0.126
Dec	0.260	0.246	0.945	0.061	0.061	0.000	0.061
Jan	0.105	0.147	1.397	0.031	0.031	0.000	0.031
Feb	0.086	0.173	2.014	0.022	0.025	0.000	0.022
Mar	0.116	0.200	1.722	0.023	0.027	0.000	0.023
Apr	0.430	0.758	1.762	0.034	0.034	0.000	0.034
May	1.644	2.259	1.374	0.068	0.068	0.189	0.257
Jun	2.829	2.986	1.055	0.110	0.102	0.319	0.429
Jul	3.913	3.443	0.880	0.155	0.155	0.156	0.311
Aug	4.293	3.421	0.797	0.187	0.187	0.556	0.743
Sep	2.463	1.683	0.683	0.163	0.163	0.156	0.319

Figure 3.7 **Downstream view of Bvii5**

Table 3-12 **Bvii5: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 06/05/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem
Annual Flows (Mill. cu. m or index values):
MAR               =  534.333
S.Dev.            =  206.134
CV                =    0.386
Q75               =    6.130
Q75/MMF           =    0.138
BFI Index         =    0.361
CV(JJA+JFM) Index =    1.502

Ecological Category = D

Total IFR         =  117.891 (22.06 %MAR)
Maint. Lowflow    =   83.095 (15.55 %MAR)
Drought Lowflow   =   66.959 (12.53 %MAR)
Maint. Highflow   =   34.796 ( 6.51 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct  34.355  15.638   0.455    7.417   2.060     0.000     7.417
 Nov  16.953   9.961   0.588    2.658   1.994     0.000     2.658
 Dec   8.281   6.561   0.792    2.060   2.060     0.000     2.060
 Jan   6.109   4.474   0.732    2.060   2.060     2.199     4.260
 Feb   4.805   3.709   0.772    1.861   1.861     0.000     1.861
 Mar   5.447   5.647   1.037    2.060   2.060     0.000     2.060
 Apr  16.236  19.116   1.177    5.583   1.994     5.692    11.275
 May  50.471  44.376   0.879   10.713   2.060     0.000    10.713
 Jun  94.100  74.038   0.787   12.494  12.494    13.452    25.946
 Jul 119.135  77.176   0.648   12.911  12.911    13.452    26.363
 Aug 112.724  59.896   0.531   12.911  12.911     0.000    12.911
 Sep  65.718  40.141   0.611   10.368  12.494     0.000    10.368
```

3.1.7 River RQOs for the Berg Tributaries IUA

The recommended River RQOs for the Berg Tributaries IUA are given in Table 3-13. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-13 RQOs and Numerical Limits for river's priority RUs in Berg Tributaries IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
C5 Berg Tributaries	Klein Berg River	Biii4	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in an C category.	Table 3-14	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 62% = C category	< 58% = D category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 58% = C/D category	< 38% = D/E category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	No data	
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
C5 Berg Tributaries	Vier-en-twintig River	Bi1	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in a C category.	Table 3-15	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.025 mg/l PO_4-P	0.020 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/l TIN	0.56 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 30 mS/m EC	24 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5 ≥ pH ≤ 7	5.5 ≥ pH ≤ 6.5
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 8 mg/l	9.2 mg/l DO
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	95%tile ≤ 130 cfu/100ml E coli / Faecal coliforms	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 88% = A/B category	< 78% = B/C category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 88% = A/B category	< 78% = B/C category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 82% = B category	< 78% = C category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

Figure 3.8 **Aerial view of Biii4**

Table 3-14 **Biii4: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 19/01/2010
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =   84.212
S.Dev.            =   39.522
CV                =    0.469
Q75               =    1.010
Q75/MMF           =    0.144
BFI Index         =    0.370
CV(JJA+JFM) Index =    1.783

Ecological Category = C

Total IFR         =   18.663 (22.16 %MAR)
Maint. Lowflow    =   10.992 (13.05 %MAR)
Drought Lowflow   =    4.946 ( 5.87 %MAR)
Maint. Highflow   =    7.671 ( 9.11 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   7.837   4.093   0.522    1.422   0.710     0.638     2.059
 Nov   4.171   2.917   0.699    1.110   0.558     0.141     1.251
 Dec   2.505   2.577   1.029    0.754   0.240     0.000     0.754
 Jan   1.035   0.816   0.789    0.398   0.170     0.000     0.398
 Feb   0.836   0.898   1.075    0.305   0.090     0.000     0.305
 Mar   0.945   0.970   1.026    0.291   0.159     0.000     0.291
 Apr   1.734   1.767   1.019    0.338   0.180     0.000     0.338
 May   6.295   7.875   1.251    0.618   0.060     0.802     1.420
 Jun  11.601  10.191   0.878    1.002   0.506     1.516     2.518
 Jul  15.838  11.989   0.757    1.391   0.600     0.831     2.222
 Aug  18.636  15.377   0.825    1.744   0.867     2.913     4.657
 Sep  12.780   7.760   0.607    1.619   0.806     0.831     2.451
```

Figure 3.9U **Aerial view of Bi1**

Table 3-15 **Bi1: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 16/05/2018
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =  125.493
S.Dev.            =   43.831
CV                =    0.349
Q75               =    1.930
Q75/MMF           =    0.185
BFI Index         =    0.384
CV(JJA+JFM) Index =    1.544

Ecological Category = C

Total IFR         =   28.526 (22.73 %MAR)
Maint. Lowflow    =   17.724 (14.12 %MAR)
Drought Lowflow   =    8.976 ( 7.15 %MAR)
Maint. Highflow   =   10.801 ( 8.61 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   9.606   6.167   0.642    2.050   1.049     0.646     2.696
 Nov   6.039   5.406   0.895    1.631   0.842     0.217     1.848
 Dec   3.297   2.613   0.793    1.115   0.410     0.000     1.115
 Jan   1.826   1.201   0.657    0.731   0.396     0.000     0.731
 Feb   1.495   1.491   0.998    0.563   0.280     0.000     0.563
 Mar   2.034   2.336   1.148    0.573   0.318     0.000     0.573
 Apr   3.649   3.276   0.898    0.674   0.368     0.000     0.674
 May  10.697   9.469   0.885    1.128   0.593     1.298     2.426
 Jun  19.995  14.208   0.711    1.811   0.931     2.510     4.321
 Jul  25.031  14.596   0.583    2.358   1.202     3.886     6.244
 Aug  24.348  13.025   0.535    2.620   1.331     0.748     3.368
 Sep  17.476   9.550   0.546    2.470   1.257     1.497     3.966
```

3.1.8 River RQOs for the Lower Berg IUA

The recommended River RQOs for the Lower Berg UA are given in Table 3-16. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-16 RQOs and Numerical Limits for river's priority RUs in Lower Berg IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
B4 Lower Berg	Berg River	Bvii6	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-17	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for intermediate contact recreation.	95%tile ≤ 1000 cfu/100ml E coli / Faecal coliforms	800 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 68% = B/C category	< 62% = C/D category
						D_{50}	Sand particle size	0.576 > D_{50} > 0.349	0.576 < D_{50} < 0.349
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 42% = D category	< 38% = E category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >1%
						Indigenous riparian woody species		Cover 30-50%.	Cover < 20%
						Non-woody indigenous species		Cover 30-50%.	Cover < 20%

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Reeds		Cover 30-50%.	Cover < 20%
						Exotic species	Lower zone cover abundance	Cover < 5%.	Cover >15%.
						Terrestrial woody species		Cover < 10%.	Cover >15%.
						Indigenous riparian woody species		Cover 50-75%.	Cover < 30%.
						Non-woody indigenous species		Cover 5-10%.	None present
						Reeds		No reeds	Reeds present
						Exotic species	Upper zone cover abundance	Cover < 10%.	Cover > 20%.
						Terrestrial woody species		Cover </= 15%.	Cover > 30%.
						Indigenous riparian woody species		Cover 30-50%.	Cover < 20%
						Non-woody indigenous species		Cover 30-50%.	Cover < 20%
			Biota	Fish		FRAI score	Fish condition	> 18% = F category	< 18% = F category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No increase in the number of exotic fish present: Cyprinus carpio, *Oreochromis mossambicus, Tilapia sparrmanii, Micropterus punctulatus, Clarias gariepinus* and *Gambusia affinis.*	More than 6 exotic fish species present.
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 42% = D category	< 38% = E category
						SASS5 and ASPT score	SASS scores	SASS5 score >80, ASPT ≥ 5.0	SASS5 scores < 72, ASPT < 4.5.
						Number of families	Diversity of invertebrate community	>/= 15 families, at an abundance of A to C.	<13 families. Any taxon (adult) with an abundance of 1.
B4 Lower Berg	Berg River	Bvii12	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-18	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Water temperature	important for the maintenance of ecosystem health.	2°C difference from ambient	1.6 °C difference from ambient
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 68% = B/C category	< 62% = C/D category
						D_{50}	Sand particle size	0.860 > D_{50} > 0.275	0.860 < D_{50} < 0.275
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 42% = D category	< 38% = E category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >1%
						Indigenous riparian woody species		Cover 30-50%	Cover <20%.
						Non-woody indigenous species		Cover 50-75%.	Cover < 40%
						Reeds		Cover 15-25%.	Cover > 30%.
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	85% (B category)	C category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Exotic fish species		No increase in the number of exotic fish present: Cyprinus carpio, *Oreochromis mossambicus, Tilapia sparrmanii, Micropterus punctulatus, Clarias gariepinus* and *Gambusia affinis.*	More than 6 exotic fish species present.
				Invertebrates		MIRAI score	Macroinvertebrate condition	81.4% (B/C category)	C/D category
						SASS5 and ASPT score	SASS scores	SASS5 score >85, ASPT ≥ 4.2.	SASS5 scores < 76, ASPT < 3.8.
						Number of families	Diversity of invertebrate community	>/= 19 families, at an abundance of A to C.	<17 families. Any taxon (adult) with an abundance of 1.

Figure 3.10 **Downstream view of Bvii6**

Table 3-17 **Bvii6: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: G1H013.

```
Desktop Version 2, Generated on 19/01/2010
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =  860.679
S.Dev.            =  338.731
CV                =    0.394
Q75               =   10.400
Q75/MMF           =    0.145
BFI Index         =    0.365
CV(JJA+JFM) Index =    1.501

Ecological Category = D

Total IFR         =  177.839 (20.66 %MAR)
Maint. Lowflow    =  114.338 (13.28 %MAR)
Drought Lowflow   =   75.974 ( 8.83 %MAR)
Maint. Highflow   =   63.501 ( 7.38 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	63.466	27.054	0.426	13.079	9.026	2.496	15.575
Nov	33.168	19.362	0.584	7.615	4.966	0.000	7.615
Dec	15.614	11.970	0.767	4.789	2.789	0.000	4.789
Jan	9.494	6.374	0.671	4.000	2.158	0.000	4.000
Feb	7.578	6.167	0.814	4.136	2.282	0.000	4.136
Mar	8.989	8.913	0.992	3.974	2.158	0.000	3.974
Apr	23.512	25.088	1.067	5.475	3.311	2.496	7.971
May	75.763	70.685	0.933	7.342	4.737	6.418	13.760
Jun	139.856	108.265	0.774	12.148	8.353	6.418	18.565
Jul	184.420	121.447	0.659	15.579	10.842	33.196	48.775
Aug	184.669	109.775	0.594	18.579	13.026	12.479	31.057
Sep	114.152	60.769	0.532	17.623	12.326	0.000	17.623

Figure 3.11 **Upstream view of Bvii12**

Table 3-18 **Bvii12: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: G1H075.

```
Desktop Version 2, Generated on 19/01/2010
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           .\tem

Annual Flows (Mill. cu. m or index values):
MAR               =  901.794
S.Dev.            =  361.203
CV                =    0.401
Q75               =   10.690
Q75/MMF           =    0.142
BFI Index         =    0.363
CV(JJA+JFM) Index =    1.521

Ecological Category = D

Total IFR         =  217.490 (24.12 %MAR)
Maint. Lowflow    =  151.934 (16.85 %MAR)
Drought Lowflow   =   55.957 ( 6.21 %MAR)
Maint. Highflow   =   65.556 ( 7.27 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct  66.452  28.060   0.422   17.139   6.430     2.760    19.899
 Nov  34.601  19.751   0.571   10.132   3.651     0.000    10.132
 Dec  16.506  12.374   0.750    6.563   2.259     0.000     6.563
 Jan   9.600   6.439   0.671    5.580   1.860     0.000     5.580
 Feb   7.631   6.236   0.817    5.736   1.920     0.000     5.736
 Mar   9.077   9.115   1.004    5.553   1.833     0.000     5.553
 Apr  24.570  26.655   1.085    7.431   2.597     2.760    10.192
 May  79.796  76.616   0.960    9.885   3.561     0.000     9.885
 Jun 146.680 114.923   0.783   15.994   5.991    16.380    32.375
 Jul 193.018 130.011   0.674   20.407   7.732     6.480    26.887
 Aug 194.129 119.027   0.613   24.499   9.353    37.175    61.675
 Sep 119.731  64.595   0.539   23.014   8.769     0.000    23.014
```

3.1.9 River RQOs for the Diep IUA

The recommended River RQOs for the Diep IUA are given in Table 3-19. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-19 RQOs and Numerical Limits for river's priority RUs in Diep IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D10 Diep	Diep River	Bv1	Quantity	Hydrology	E	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-20	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an mesotrophic condition.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Diep River is naturally saline and should be maintained in its current status.	95%tile ≤ 450 mS/m EC	400 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	No data	
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	No data	
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	No data	
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
D10 Diep	Diep River	Biv6	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-21	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be improved to eutrophic conditions.	Median ≤ 0.125 mg/l PO_4-P	0.10 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 2.5 mg/l TIN	2.0 mg/l TIN
				Salts		Electrical conductivity (EC)	Diep River is naturally saline and should be maintained in its current status.	95%tile ≤ 350 mS/m EC	280 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 22% = E category	< 18% = F category
						D_{16}, D_{50}, D_{84}	Sediment particle size		
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 18% = F category	< 18% = F category

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 22% = E category	< 18% = F category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 22% = E category	< 18% = F category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

Figure 3.12 **Aerial view of Bv1**

Table 3-20 **Bv1: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 01/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :             Bv1
Annual Flows (Mill. cu. m or index values):
MAR                =   13.716
S.Dev.             =   12.523
CV                 =    0.913
Q75                =    0.090
Q75/MMF            =    0.079
BFI Index          =    0.328
CV(JJA+JFM) Index =    2.133

Ecological Category = D

Total IFR          =    1.911 (13.93 %MAR)
Maint. Lowflow     =    0.759 ( 5.54 %MAR)
Drought Lowflow    =    0.589 ( 4.29 %MAR)
Maint. Highflow    =    1.151 ( 8.39 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD       CV     Maint.  Drought    Maint.    Maint.
 Oct   0.654    0.276    0.422    0.079   0.079     0.026     0.106
 Nov   0.328    0.111    0.339    0.053   0.053     0.003     0.055
 Dec   0.155    0.053    0.345    0.029   0.029     0.000     0.029
 Jan   0.095    0.035    0.364    0.020   0.020     0.000     0.020
 Feb   0.075    0.034    0.454    0.017   0.017     0.000     0.017
 Mar   0.065    0.026    0.402    0.015   0.015     0.000     0.015
 Apr   0.273    0.873    3.200    0.021   0.020     0.000     0.021
 May   1.016    2.122    2.089    0.043   0.020     0.116     0.159
 Jun   2.513    4.709    1.874    0.090   0.030     0.294     0.385
 Jul   3.408    6.253    1.835    0.130   0.060     0.120     0.249
 Aug   3.673    5.394    1.468    0.157   0.140     0.473     0.630
 Sep   1.461    2.278    1.559    0.106   0.106     0.120     0.225
```

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Figure 3.13 **Downstream view of Biv6**

Table 3-21 **Biv6: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 01/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :            Biv6
Annual Flows (Mill. cu. m or index values):
MAR               =    9.300
S.Dev.            =    7.728
CV                =    0.831
Q75               =    0.080
Q75/MMF           =    0.103
BFI Index         =    0.358
CV(JJA+JFM) Index =    1.917

Ecological Category = D

Total IFR         =    1.326 (14.26 %MAR)
Maint. Lowflow    =    0.578 ( 6.22 %MAR)
Drought Lowflow   =    0.518 ( 5.56 %MAR)
Maint. Highflow   =    0.748 ( 8.04 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.727	0.358	0.492	0.073	0.073	0.044	0.117
Nov	0.327	0.149	0.455	0.051	0.051	0.004	0.055
Dec	0.133	0.055	0.416	0.026	0.026	0.000	0.026
Jan	0.087	0.039	0.447	0.019	0.019	0.000	0.019
Feb	0.071	0.037	0.514	0.016	0.016	0.000	0.016
Mar	0.062	0.029	0.479	0.014	0.014	0.000	0.014
Apr	0.182	0.447	2.455	0.017	0.016	0.000	0.017
May	0.654	1.104	1.689	0.032	0.024	0.073	0.104
Jun	1.655	2.515	1.520	0.063	0.024	0.192	0.256
Jul	2.043	2.793	1.367	0.084	0.072	0.277	0.361
Aug	2.049	2.919	1.424	0.096	0.096	0.053	0.149
Sep	1.310	1.026	0.783	0.087	0.087	0.105	0.192

3.1.10 River RQOs for the Peninsula IUA

The recommended River RQOs for the Peninsula IUA are given in Table 3-22. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-22 RQOs and Numerical Limits for river's priority RUs in Peninsula IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
E11 Peninsula	Hout Bay River	Bviii6	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-23	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an eutrophic condition or better.	Median ≤ 0.125 mg/l PO_4-P	0.100 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 2.50 mg/l TIN	2.00 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in a Tolerable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Acceptable, and then Ideal category for intermediate contact recreation.	95%tile ≤ 4000 cfu/100ml E coli / Faecal coliforms	3200 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 22% = E category	< 18% = F category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 18% = E/F category	< 18% = F category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 42% = D category	< 38% = E category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
E11 Peninsula	Silvermine River	Bvii20	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in a C category.	Table 3-24	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in its current state or better.	95%tile ≤ 350 mS/m EC	280 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for intermediate contact recreation. In the long term the aim should be to improve the river to an Acceptable category for full contact recreation.	95%tile ≤ 1000 cfu/100ml E coli / Faecal coliforms	800 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						VEGRAI level 3 score.		> 62% = C category	< 58% = D category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
				Riparian vegetation		Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 82% = B category	< 78 % = C category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62% = C category	< 58% = D category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

Figure 3.14 **Aerial view of Bviii6**

Table 3-23 **Bviii6: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 02/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Bviii

Annual Flows (Mill. cu. m or index values):
MAR               =   17.221
S.Dev.            =    8.003
CV                =    0.465
Q75               =    0.102
Q75/MMF           =    0.071
BFI Index         =    0.325
CV(JJA+JFM) Index =    1.328

Ecological Category = D

Total IFR         =    2.537 (14.73 %MAR)
Maint. Lowflow    =    1.248 ( 7.25 %MAR)
Drought Lowflow   =    1.140 ( 6.62 %MAR)
Maint. Highflow   =    1.289 ( 7.48 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.884	0.891	1.008	0.132	0.132	0.037	0.169
Nov	0.330	0.290	0.878	0.071	0.071	0.003	0.074
Dec	0.143	0.044	0.304	0.038	0.038	0.000	0.038
Jan	0.104	0.062	0.596	0.029	0.029	0.000	0.029
Feb	0.092	0.042	0.458	0.026	0.026	0.000	0.026
Mar	0.093	0.071	0.760	0.025	0.024	0.000	0.025
Apr	0.415	0.859	2.069	0.037	0.037	0.000	0.037
May	1.211	1.580	1.305	0.070	0.067	0.121	0.191
Jun	2.922	2.624	0.898	0.142	0.067	0.302	0.444
Jul	4.438	3.236	0.729	0.221	0.192	0.543	0.764
Aug	4.321	2.353	0.545	0.252	0.252	0.094	0.346
Sep	2.267	1.488	0.656	0.204	0.204	0.188	0.392

Figure 3.15 **Aerial view of Bvii20**

Table 3-24 **Bvii20: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 16/05/2018
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Bvii2

Annual Flows (Mill. cu. m or index values):
MAR               =    3.516
S.Dev.            =    2.363
CV                =    0.672
Q75               =    0.034
Q75/MMF           =    0.116
BFI Index         =    0.356
CV(JJA+JFM) Index =    1.331

Ecological Category = A

Total IFR         =    1.853 (52.70 %MAR)
Maint. Lowflow    =    1.415 (40.23 %MAR)
Drought Lowflow   =    0.242 ( 6.90 %MAR)
Maint. Highflow   =    0.439 (12.47 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.220	0.163	0.739	0.167	0.030	0.017	0.184
Nov	0.103	0.051	0.496	0.105	0.020	0.002	0.107
Dec	0.049	0.011	0.225	0.053	0.012	0.000	0.053
Jan	0.034	0.010	0.283	0.035	0.009	0.000	0.035
Feb	0.028	0.007	0.235	0.029	0.008	0.000	0.029
Mar	0.027	0.010	0.367	0.027	0.006	0.000	0.027
Apr	0.079	0.164	2.091	0.037	0.009	0.000	0.037
May	0.217	0.317	1.461	0.069	0.014	0.036	0.105
Jun	0.498	0.557	1.120	0.138	0.015	0.088	0.225
Jul	0.854	0.930	1.088	0.235	0.028	0.053	0.288
Aug	0.917	0.825	0.900	0.287	0.049	0.191	0.478
Sep	0.490	0.428	0.874	0.233	0.041	0.053	0.286

3.1.11 River RQOs for the Cape Flats IUA

The recommended River RQOs for the Cape Flats IUA are given in Table 3-25. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-25 RQOs and Numerical Limits for river's priority RUs in Cape Flats IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
E12 Cape Flats	Keysers River	Bvii7	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-26	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be improved to an eutrophic condition or better.	Median ≤ 0.125 mg/l PO_4-P	0.100 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 3.0 mg/l TIN	2.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 85 mS/m EC	68 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins			Toxicity levels must not pose a threat to aquatic ecosystems.	No data	
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in a Tolerable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Acceptable, and then Ideal category for intermediate contact recreation.	95%tile ≤ 4000 cfu/100ml E coli / Faecal coliforms	3200 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 38% = D/E category	< 22% = E/F category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous riparian woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 62% = C category	< 58% = D category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	No data	
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

Figure 3.16 **Aerial view of Bvii7**

Table 3-26 **Bvii7: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 01/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff :           Bvii7
Annual Flows (Mill. cu. m or index values):
MAR               =    4.495
S.Dev.            =    2.711
CV                =    0.603
Q75               =    0.037
Q75/MMF           =    0.099
BFI Index         =    0.345
CV(JJA+JFM) Index =    1.250

Ecological Category = D

Total IFR         =    0.672 (14.95 %MAR)
Maint. Lowflow    =    0.348 ( 7.74 %MAR)
Drought Lowflow   =    0.312 ( 6.94 %MAR)
Maint. Highflow   =    0.324 ( 7.21 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.264	0.222	0.843	0.038	0.038	0.012	0.050
Nov	0.113	0.071	0.628	0.024	0.024	0.001	0.025
Dec	0.053	0.011	0.214	0.014	0.014	0.000	0.014
Jan	0.038	0.012	0.316	0.011	0.011	0.000	0.011
Feb	0.032	0.007	0.233	0.009	0.009	0.000	0.009
Mar	0.031	0.013	0.416	0.009	0.007	0.000	0.009
Apr	0.101	0.215	2.121	0.012	0.012	0.000	0.012
May	0.284	0.402	1.416	0.019	0.018	0.027	0.046
Jun	0.673	0.703	1.045	0.035	0.019	0.068	0.103
Jul	1.124	1.083	0.964	0.056	0.039	0.139	0.196
Aug	1.164	0.903	0.776	0.066	0.066	0.026	0.092
Sep	0.619	0.486	0.785	0.054	0.054	0.051	0.106

3.1.12 River RQOs for the Eerste IUA

The recommended River RQOs for the Eerste IUA are given in Table 3-27. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-27 RQOs and Numerical Limits for river's priority RUs in Eerste IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D6 Eerste	Jonkershoek River	Biii6	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in an C category.	Table 3-28	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≥ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Ideal category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 62% = C category	< 58% = D category
						D_{16}, D_{50}, D_{84}	Sediment particle size		
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 62% = C category	< 58% = D category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 42% = D category	< 38% = E category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62% = C category	< 58% = D category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
D6 Eerste	Klippies River	Biv8	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-29	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be improved to an eutrophic condition or better.	Median ≤ 0.125 mg/l PO_4-P	0.10 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 3.0 mg/l TIN	2.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≤ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in a Tolerable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Acceptable, and then Ideal category for intermediate contact recreation.	95%tile ≤ 4000 cfu/100ml E coli / Faecal coliforms	3200 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 22% = E category	< 18% = F category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 18% = D/E category	< 18% = F category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62% = C category	< 58% = D category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

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Figure 3.17 **Upstream view of Biii6**

Table 3-28 **Biii6: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 01/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Biii6

Annual Flows (Mill. cu. m or index values):
MAR               =   36.582
S.Dev.            =    8.662
CV                =    0.237
Q75               =    0.590
Q75/MMF           =    0.194
BFI Index         =    0.378
CV(JJA+JFM) Index =    1.572

Ecological Category = C

Total IFR         =    8.276 (22.62 %MAR)
Maint. Lowflow    =    5.094 (13.92 %MAR)
Drought Lowflow   =    2.570 ( 7.03 %MAR)
Maint. Highflow   =    3.183 ( 8.70 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.243	1.318	0.406	0.639	0.326	0.245	0.883
Nov	1.983	0.891	0.449	0.543	0.278	0.067	0.610
Dec	1.032	0.696	0.675	0.349	0.182	0.000	0.349
Jan	0.554	0.508	0.916	0.200	0.107	0.000	0.200
Feb	0.408	0.455	1.116	0.142	0.070	0.000	0.142
Mar	0.456	0.656	1.438	0.126	0.050	0.000	0.126
Apr	1.423	1.522	1.069	0.186	0.070	0.000	0.186
May	3.591	2.279	0.635	0.335	0.175	0.454	0.789
Jun	5.890	3.076	0.522	0.522	0.268	0.747	1.269
Jul	6.666	2.728	0.409	0.645	0.329	1.052	1.697
Aug	6.460	2.033	0.315	0.714	0.363	0.206	0.920
Sep	4.875	1.697	0.348	0.693	0.353	0.412	1.104

Figure 3.18 **Aerial view of Biv8**

Table 3-29 **Biv8: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 01/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :            Biv8

Annual Flows (Mill. cu. m or index values):
MAR               =   14.918
S.Dev.            =    5.460
CV                =    0.366
Q75               =    0.330
Q75/MMF           =    0.265
BFI Index         =    0.435
CV(JJA+JFM) Index =    1.161

Ecological Category = D

Total IFR         =    2.323 (15.57 %MAR)
Maint. Lowflow    =    1.358 ( 9.10 %MAR)
Drought Lowflow   =    1.358 ( 9.10 %MAR)
Maint. Highflow   =    0.965 ( 6.47 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.893	0.584	0.309	0.164	0.164	0.146	0.310
Nov	1.357	0.359	0.265	0.156	0.156	0.066	0.221
Dec	0.792	0.238	0.301	0.135	0.135	0.000	0.135
Jan	0.417	0.142	0.341	0.091	0.091	0.000	0.091
Feb	0.259	0.086	0.332	0.064	0.064	0.000	0.064
Mar	0.215	0.126	0.586	0.054	0.054	0.000	0.054
Apr	0.385	0.655	1.700	0.058	0.058	0.000	0.058
May	0.922	0.972	1.054	0.077	0.077	0.081	0.158
Jun	1.856	1.885	1.016	0.111	0.111	0.182	0.294
Jul	2.168	1.446	0.667	0.133	0.133	0.100	0.232
Aug	2.379	1.286	0.541	0.153	0.153	0.291	0.443
Sep	2.276	1.113	0.489	0.163	0.163	0.100	0.263

3.1.13 River RQOs for the Sir Lowry's IUA

The recommended River RQOs for the Sir Lowry's IUA are given in Table 3-30. Note that the greyed-out indicators are ones that are recommended to be developed, but that currently there is insufficient observed data to provide RQOs for these parameters. These will not be included in the RQO template to be gazetted, but it is recommended that they be included in the monitoring and implementation plan for the RQOs so that in future numeric values and TPCs can be developed.

Table 3-30 RQOs and Numerical Limits for river's priority RUs in Sir Lowry's IUA

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D7 Sir Lowry's	Lourens River	Bvii21	Quantity	Hydrology	D	Observed flow.	Flows sufficient to maintain the river in a D category.	Table 3-31	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in a mesotrophic condition or better.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≤ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Ideal category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	> 42% = D category	< 38% = E category
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 42% = D category	< 38% = E category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 22 % = E category	< 18% = F category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 42% = D category	< 38% = E category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	
D7 Sir Lowry's	Sir Lowry's Pass River	Bviii9	Quantity	Hydrology	C	Observed flow.	Flows sufficient to maintain the river in a C category.	Table 3-32	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an mesotrophic condition.	Median ≤ 0.075 mg/l PO_4-P	0.060 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 1.75 mg/l TIN	1.40 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal state for all users and aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≤ pH ≤ 8.5	7 ≤ pH ≤ 8
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	Ammonia ≤ 0.073 mg/l (95%tile)	0.058 mg/l
						Atrazine		Atrazine ≤ 0.079 mg/l (95%tile)	0.063 mg/l

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Endosulfan		Endosulfan ≤ 0.0013 mg/l (95%tile)	0.001 mg/l
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for intermediate contact recreation. In the long term the aim should be to improve the river to an Ideal category for intermediate contact recreation.	95%tile ≤ 2500 cfu/100ml E coli / Faecal coliforms	2000 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score -	Geomorphological condition	No data	
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 42% = D category	< 38% = E category
						Exotic species	Marginal zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Lower zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
						Reeds		No data	
						Exotic species	Upper zone cover abundance	No data	
						Terrestrial woody species		No data	
						Indigenous woody species		No data	
						Non-woody indigenous species		No data	
			Biota	Fish		FRAI score	Fish condition	> 42% = D category	< 38% = E category
						Number of fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 62% = C category	< 58% = D category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D7 Sir Lowry's	Steenbras River	Bvii22	Quantity	Hydrology	B/C	Observed flow.	Flows sufficient to maintain the river in a B/C category.	Table 3-33	
			Quality	Nutrients		Phosphate (PO_4-P)	River nutrient levels must be maintained in an oligotrophic condition.	Median ≤ 0.025 mg/l PO_4-P	0.020 mg/l PO_4-P
						Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/l TIN	0.56 mg/l TIN
				Salts		Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95%tile ≤ 55 mS/m EC	44 mS/m EC
				System variables		pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5.0 ≥ pH ≤ 7.5	5.5 ≥ pH ≤ 7.0
						Water temperature		2°C difference from ambient water temperature	1.6 °C difference from ambient water temperature
						Dissolved oxygen		5%tile DO ≥ 6 mg/l	7.2 mg/l DO
				Toxins		Iron	Toxicity levels must not pose a threat to aquatic ecosystems.	95%tile ≤ 0.1 mg/l Fe	0.08 mg/l Fe
						Manganese		95%tile ≤ 0.18 mg/l Mn	0.15 mg/l Mn
				Pathogens		E coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	95%tile ≤ 165 cfu/100ml E coli / Faecal coliforms	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score	Geomorphological condition	> 82% = B category	< 78% = C category
						D_{16}, D_{50}, D_{84}	Sediment particle size	No data	
				Riparian vegetation		VEGRAI level 3 score.	Vegetation condition	> 78% = B/C category	< 62% = C/D category
						Exotic species	Marginal zone cover abundance	No exotic plant species.	Exotic species present
						Terrestrial woody species		No terrestrial woody species.	Cover >1%
						Indigenous riparian woody species		Cover < 10%.	Cover >10%.
						Non-woody indigenous species		Cover 30-50%.	Cover < 10%
						Reeds		Cover < 30%.	Cover > 40%.
						Exotic species	Lower zone cover abundance	Cover < 5%.	Cover >15%.
						Terrestrial woody species		Cover < 10%.	Cover >15%.
						Indigenous riparian woody species		Cover <20%.	Cover >20%.
						Non-woody indigenous species		Cover 30-50%.	Cover < 10%
						Reeds		Cover < 30%.	Cover > 40%.
						Exotic species	Upper zone cover abundance	Cover < 10%.	Cover > 20%.

IUA	River	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
						Terrestrial woody species		Cover </= 15%.	Cover > 20%.
						Indigenous riparian woody species		Cover < 70%.	Cover > 75%.
						Non-woody indigenous species		Cover 30-50%.	Cover < 10%
			Biota	Fish		FRAI score	Fish condition	> 52% = D category	< 38% = E category
						Number of indigenous fish species.	Indigenous species richness	No data	
						Genus species		No data	
						Exotic fish species		No data	
				Invertebrates		MIRAI score	Macroinvertebrate condition	> 92% = A category	< 88% = B category
						SASS5 and ASPT score	SASS scores	No data	
						Number of families	Diversity of invertebrate community	No data	

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Figure 3.19 **Upstream view of Bvii21**

Table 3-31 **Bvii21: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 06/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Bvii2

Annual Flows (Mill. cu. m or index values):
MAR               =   57.634
S.Dev.            =   14.974
CV                =    0.260
Q75               =    0.790
Q75/MMF           =    0.164
BFI Index         =    0.373
CV(JJA+JFM) Index =    1.583

Ecological Category = D

Total IFR         =    8.452 (14.67 %MAR)
Maint. Lowflow    =    4.092 ( 7.10 %MAR)
Drought Lowflow   =    4.092 ( 7.10 %MAR)
Maint. Highflow   =    4.360 ( 7.57 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	5.309	1.864	0.351	0.523	0.523	0.355	0.878
Nov	3.099	1.151	0.371	0.448	0.448	0.083	0.530
Dec	1.500	0.856	0.570	0.277	0.277	0.000	0.277
Jan	0.727	0.592	0.814	0.151	0.151	0.000	0.151
Feb	0.504	0.492	0.976	0.108	0.108	0.000	0.108
Mar	0.578	0.866	1.497	0.100	0.100	0.000	0.100
Apr	1.873	2.573	1.374	0.141	0.141	0.000	0.141
May	5.167	4.043	0.782	0.254	0.254	0.563	0.816
Jun	9.154	5.781	0.632	0.410	0.410	1.007	1.417
Jul	10.763	5.031	0.467	0.520	0.520	1.463	1.983
Aug	10.928	3.946	0.361	0.592	0.592	0.297	0.889
Sep	8.031	2.820	0.351	0.568	0.568	0.593	1.162

Figure 3.20 **Aerial view of Bviii9**

Table 3-32 **Bviii9: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 02/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff : Bviii

Annual Flows (Mill. cu. m or index values):
MAR               =   48.636
S.Dev.            =   10.707
CV                =    0.220
Q75               =    0.750
Q75/MMF           =    0.185
BFI Index         =    0.379
CV(JJA+JFM) Index =    1.049

Ecological Category = C

Total IFR         =   11.738 (24.13 %MAR)
Maint. Lowflow    =    8.066 (16.58 %MAR)
Drought Lowflow   =    4.273 ( 8.79 %MAR)
Maint. Highflow   =    3.672 ( 7.55 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   5.137   1.145   0.223    1.077   0.573     0.380     1.457
 Nov   2.950   0.631   0.214    0.959   0.511     0.086     1.045
 Dec   1.377   0.422   0.307    0.599   0.324     0.000     0.599
 Jan   0.623   0.300   0.481    0.301   0.168     0.000     0.301
 Feb   0.410   0.241   0.587    0.204   0.115     0.000     0.204
 Mar   0.448   0.435   0.971    0.186   0.082     0.000     0.186
 Apr   1.389   1.604   1.155    0.257   0.107     0.000     0.257
 May   3.890   2.414   0.621    0.459   0.251     0.420     0.879
 Jun   7.139   3.637   0.509    0.755   0.405     0.787     1.543
 Jul   8.758   3.022   0.345    0.984   0.524     1.211     2.195
 Aug   9.116   2.319   0.254    1.141   0.606     0.263     1.403
 Sep   7.399   1.765   0.239    1.145   0.608     0.525     1.670
```

Figure 3.21 **Upstream view of Bvii22**

Table 3-33 **Bvii22: Hydrology RQOs**

Source: DWS (2018)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 02/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area :
Total Runoff :           Bvii2

Annual Flows (Mill. cu. m or index values):
MAR               =   34.807
S.Dev.            =   11.201
CV                =    0.322
Q75               =    0.390
Q75/MMF           =    0.134
BFI Index         =    0.359
CV(JJA+JFM) Index =    1.650

Ecological Category = B/C

Total IFR         =    4.696 (13.49 %MAR)
Maint. Lowflow    =    3.852 (11.07 %MAR)
Drought Lowflow   =    2.598 ( 7.46 %MAR)
Maint. Highflow   =    0.844 ( 2.42 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   3.351   1.083   0.323    0.427   0.279     0.000     0.427
 Nov   1.899   0.738   0.389    0.323   0.219     0.000     0.323
 Dec   0.841   0.434   0.516    0.235   0.161     0.000     0.235
 Jan   0.382   0.354   0.925    0.180   0.125     0.000     0.180
 Feb   0.254   0.273   1.077    0.149   0.104     0.000     0.149
 Mar   0.265   0.335   1.265    0.144   0.095     0.000     0.144
 Apr   0.798   1.196   1.498    0.173   0.120     0.000     0.173
 May   2.642   2.694   1.020    0.247   0.169     0.077     0.324
 Jun   5.384   3.689   0.685    0.384   0.259     0.077     0.461
 Jul   6.681   3.638   0.545    0.506   0.340     0.307     0.813
 Aug   7.056   3.200   0.454    0.582   0.390     0.307     0.889
 Sep   5.254   1.828   0.348    0.502   0.337     0.077     0.579
```

3.1.14 Additional ecological and strategic consideration for River RQOs – NFEPA, ESA, CBA and SWSA

During the consultation with Stakeholders, it was requested that additional information be provided in terms of the link between the identified river nodes and river resource units for which RQOs were being developed and areas of significant ecological importance and also related to the strategic water source areas (SWSA). The reason being that in addition to the RQOs developed for a specific location or prioritised RU, it was also important to identify the physical areas within each sub-catchment that should be protected in terms of ecological importance.

The link between the individual river nodes and associated river resource units with the Ecological infrastructure has been accounted for in the tables below (Table 3-34 and Table 3-35) and the figures that follow. Data in the tables are presented for all quaternary catchments in the study area. The Recommended Ecological Category from the various EWR studies are presented next to the baseline conditions (PES 2014, DWS 2014) and the Target Ecological Category and the percentage of the natural Mean Annual Runoff (DWS 2018 Scenarios Report). Quaternary catchments are annotated where the TEC is greater than a C category, (EC>C) the rivers are in good condition, where there are Freshwater Ecosystem Protected Areas (FEPA), where indigenous fish populations occur (FishCons), and where there are Critical Biodiversity Areas (CBA) and Ecological Support Areas.

It is proposed that should plans to develop water resource infrastructure or other developments in these sensitive areas then all requirements of CARA, NEMA and the NWA, as required, must be fulfilled. This may include but not be limited to a GA, a WULA, a Rapid III Reserve study, an EIA, an MMP and so on. It is also suggested that where the NWA restrictions do not apply, then DEADP or DAFF should engage with DWS or other relevant authorities to fund the studies required and that this is critical before any water use licence can be given. This suggestion is put forward to motivate the responsible department to verify the data in the table and maps below.

Table 3-34 Identified critical biodiversity areas, FEPAs and strategic water source areas (SWSA) for River RUs (G1)

IUA	Node	River	EWR REC	EC	% nMAR	TEC	TEC > C	FEPA	FishCons	CBA	ESA	SWSA
D8 Upper Berg	Bvii13	Berg		A	98.2	A	x	FEPA	x			x
	Bviii1	Berg	C	C	27.4	B/C	x	FEPA	x			x
	Biv5	Franschhoek		D	82.5	D		Fish FSA	x			
	Biii2	Wemmershoek		D	28.4	D		Fish FSA	x			x
	Bvii14	Dwars		C	72.7	C		Rehab	x			x
	Biii3	Berg		E	53.9	E						x
D9 Middle Berg	Bviii11	Pombers	C	D	366.0	D						
	Bvii3	Kromme	D	D/E	89.9	D/E		Rehab	x			x
	Bvii10	Berg		D	53.2	D						x
	Bvii15	Doring		D	66.8	D						x
	Bvii4	Kompanjies		D	74.0	D						x
	Bvii5	Berg	D	D	49.7	C						x
C5 Berg Tributaries	Biii4	Klein Berg		C	82.0	C						x
	Bi1	Vier-en-Twintig		C	23.6	B/C	x	FEPA	x			
	Bvii16	Leeu		C	12.7	C		Rehab	x			
B4 Lower Berg	Bvii11	Berg		D	50.5	C						
	Biv1	Berg		D	58.3	D						
	Biv3	Klein-Berg		D	53.7	D						
	Biv4	Vier-en-twintig		D	29.3	D						
	Bvii17	Sandspruit		C	88.5	C						
	Bvii6	Berg	D	D	52.3	D						
	Biii5	Matjies		D	81.5	D						
	Bvii8	Berg		D	53.2	D						
	Bvii18	Moreesburgspruit		D	100.0	D						
	Bvii12	Berg	D	D	51.1	D						
	Bii1	Sout		D	99.4	D						
	Biv2	Berg		D	48.8	D						

Table 3-35 Identified critical biodiversity areas, FEPAs and strategic water source areas (SWSA) for River RUs (G2)

IUA	Node	River	EWR REC	PES	% nMAR	TEC	TEC > C	FEPA	Fish Cons	CBA	ESA	SWSA
A3 West Coast	Bviii3	Yzerfontein		D	0.0	D		FEPA				
	Bviii10	KleinSout		E	57.5	E				x		
D10 Diep	Bv1	Diep	D	E	66.8	E		Rehab				
	Bviii4	Swart		D	69.5	D		Upstream				
	Biv7	Mosselbank		D	26.7	D		Upstream				
	Biv6	Diep		D	68.0	D		Fish FSA				
E12 Cape Flats	Bviii8	Elsieskraal		F	85.3	F						
	Bvii7	Keysers		D	93.4	D				x		
E11 Peninsula	Bviii6	Hout Bay		D	97.6	D		Fish FSA	x			x
	Bvii20	Silvermine		C	98.2	C		FEPA	x			
D6 Eerste	Biv8	Klippies		D	90.0	D						
	Biii6	Eerste (Jonkershoek)	C	C	77.6	C		FEPA		x		
	Biv9	Kuils		E	289.9	E						
D7 Sir Lowry's	Bvii21	Lourens	D	D	84.6	D		Fish FSA	x			x
	Bviii9	Sir Lowry's Pass*		C	81.5	C		Fish FSA	x			x
	Bvii22	Steenbras	B/C	B/C	47.5	B/C	x	FEPA				x

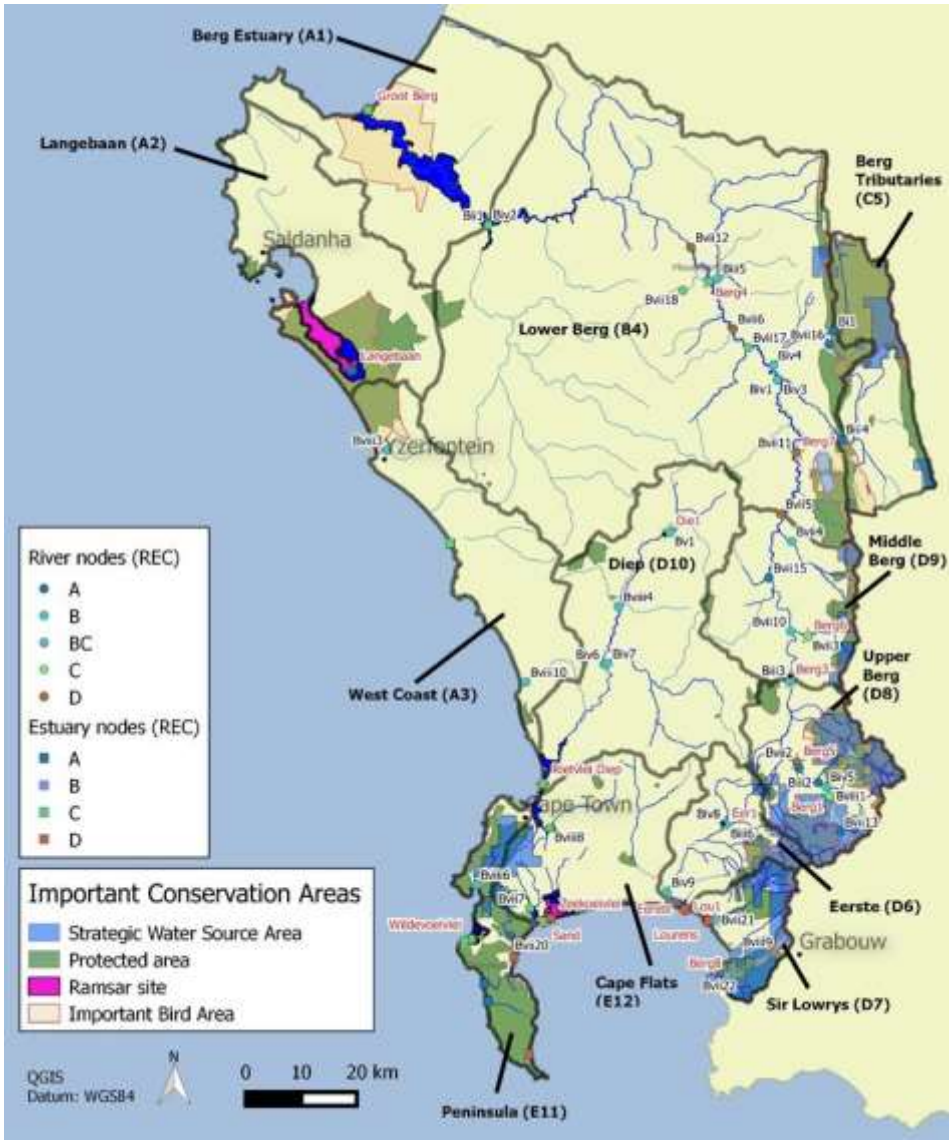
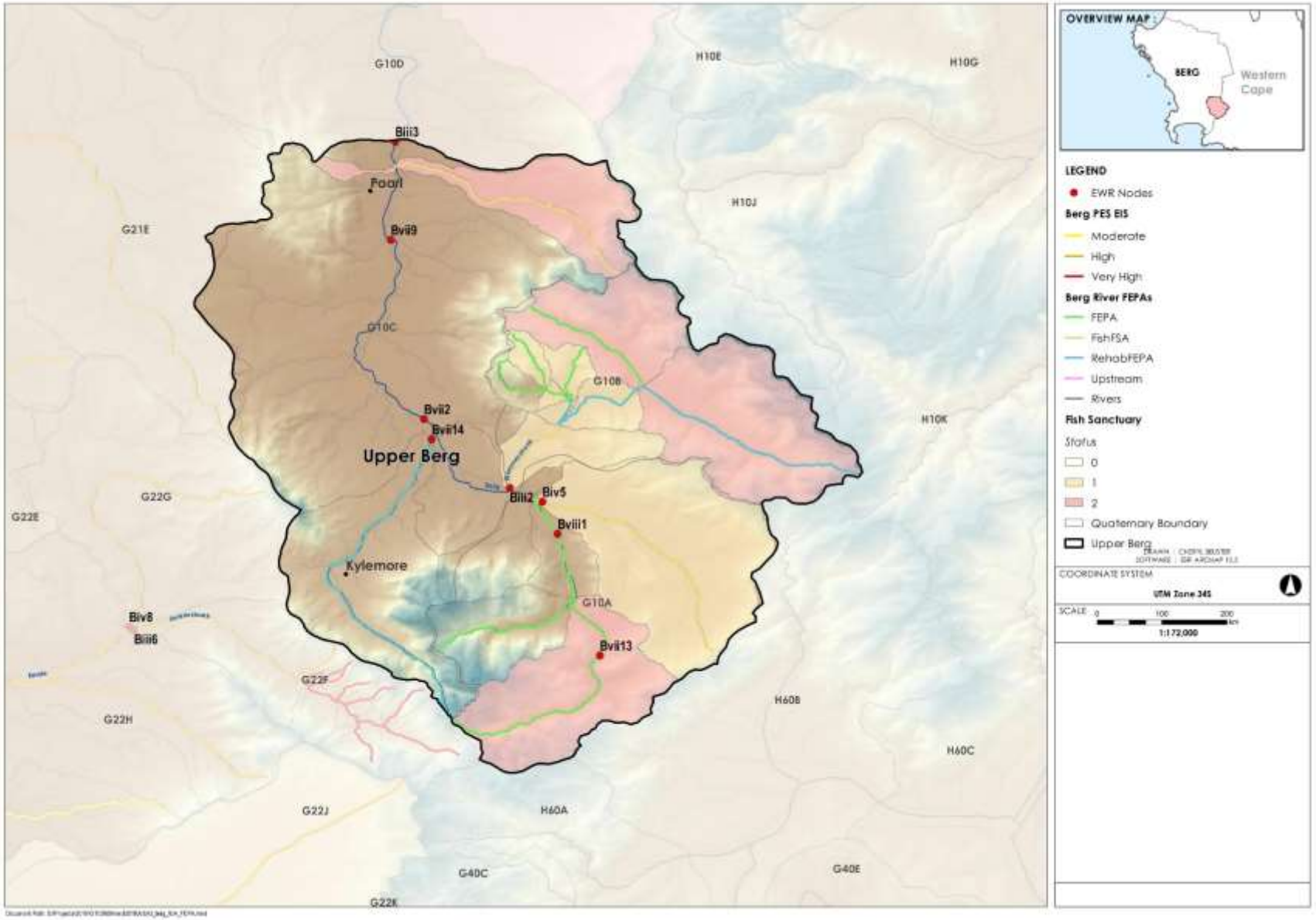
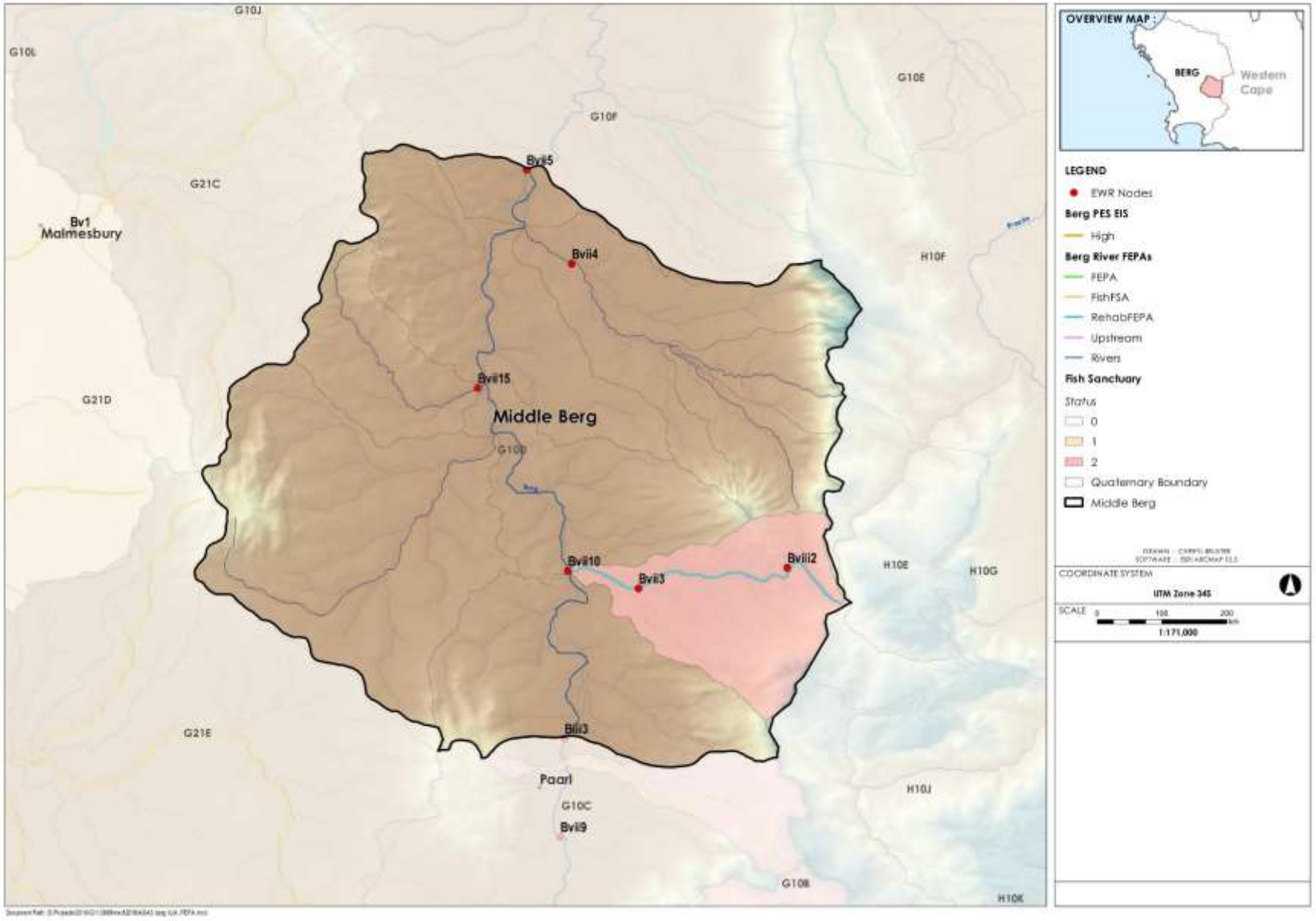


Figure 3-22 Map of the Study Area showing the strategic water source areas and protected areas used to define individual resource units within each IUA for the final recommended water resource class.



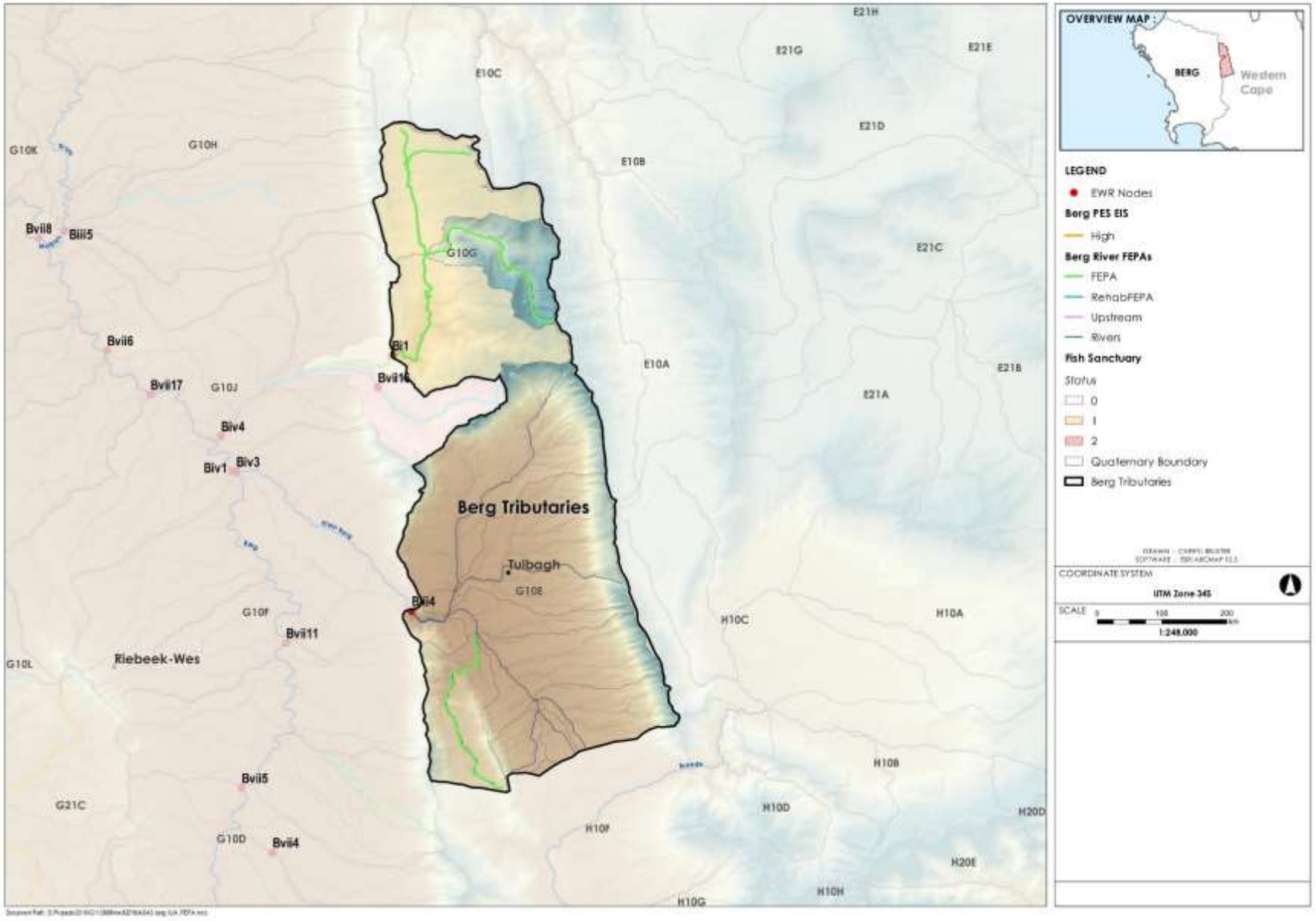
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-23 D8 Upper Berg – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



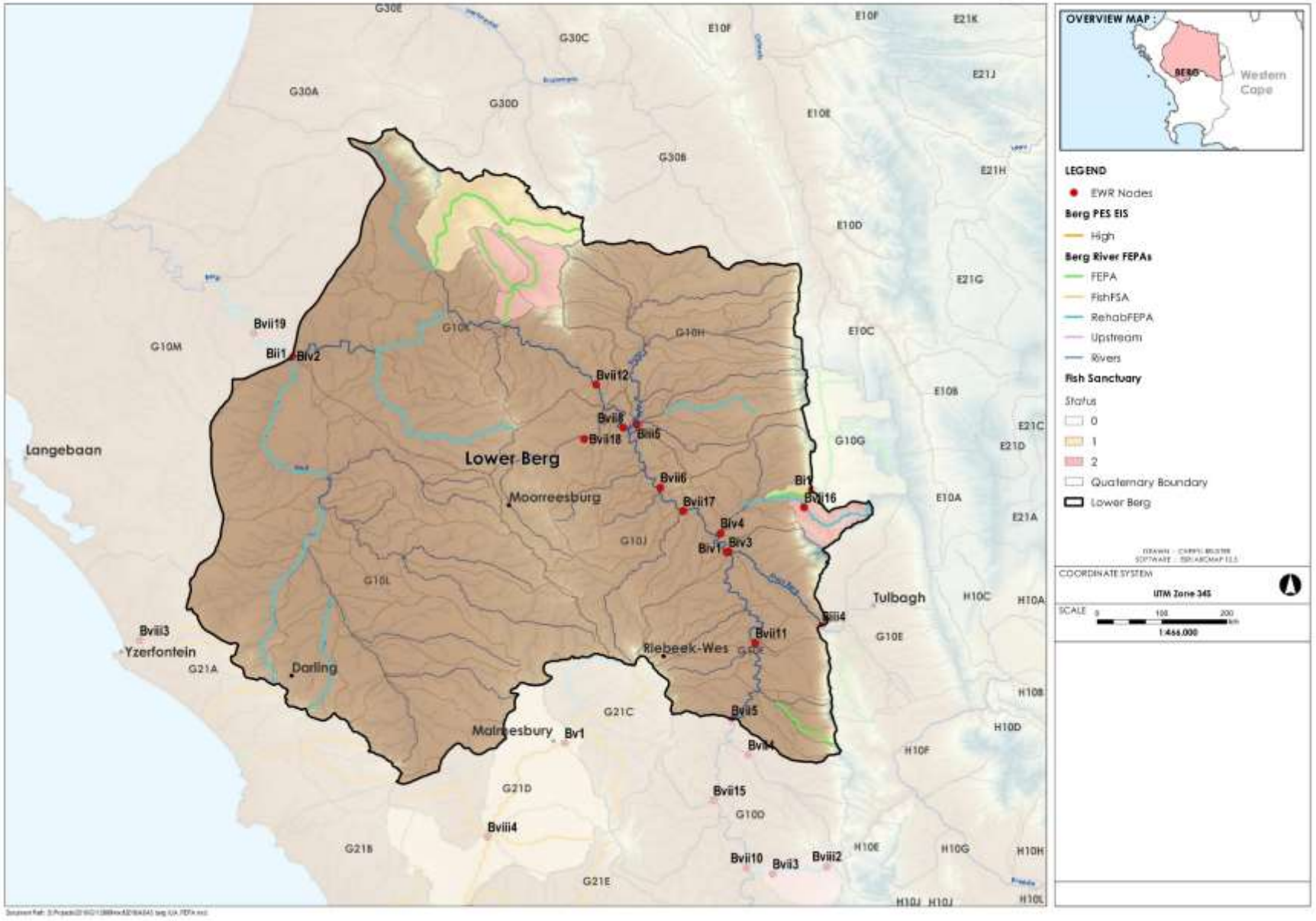
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-24 D9 Middle Berg – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-25 C5 Berg Tributaries – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)

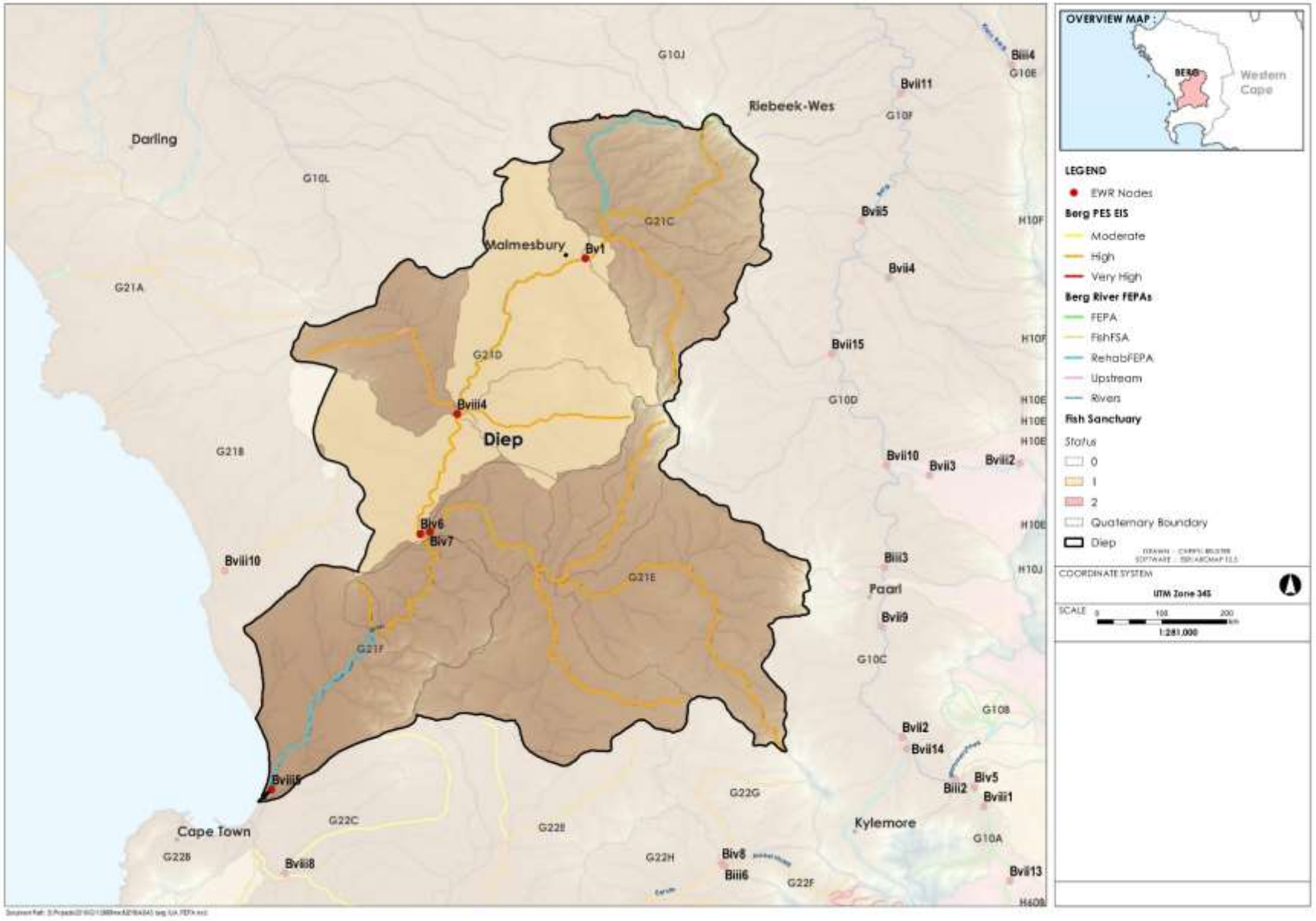


Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-26 B4 Lower Berg – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)

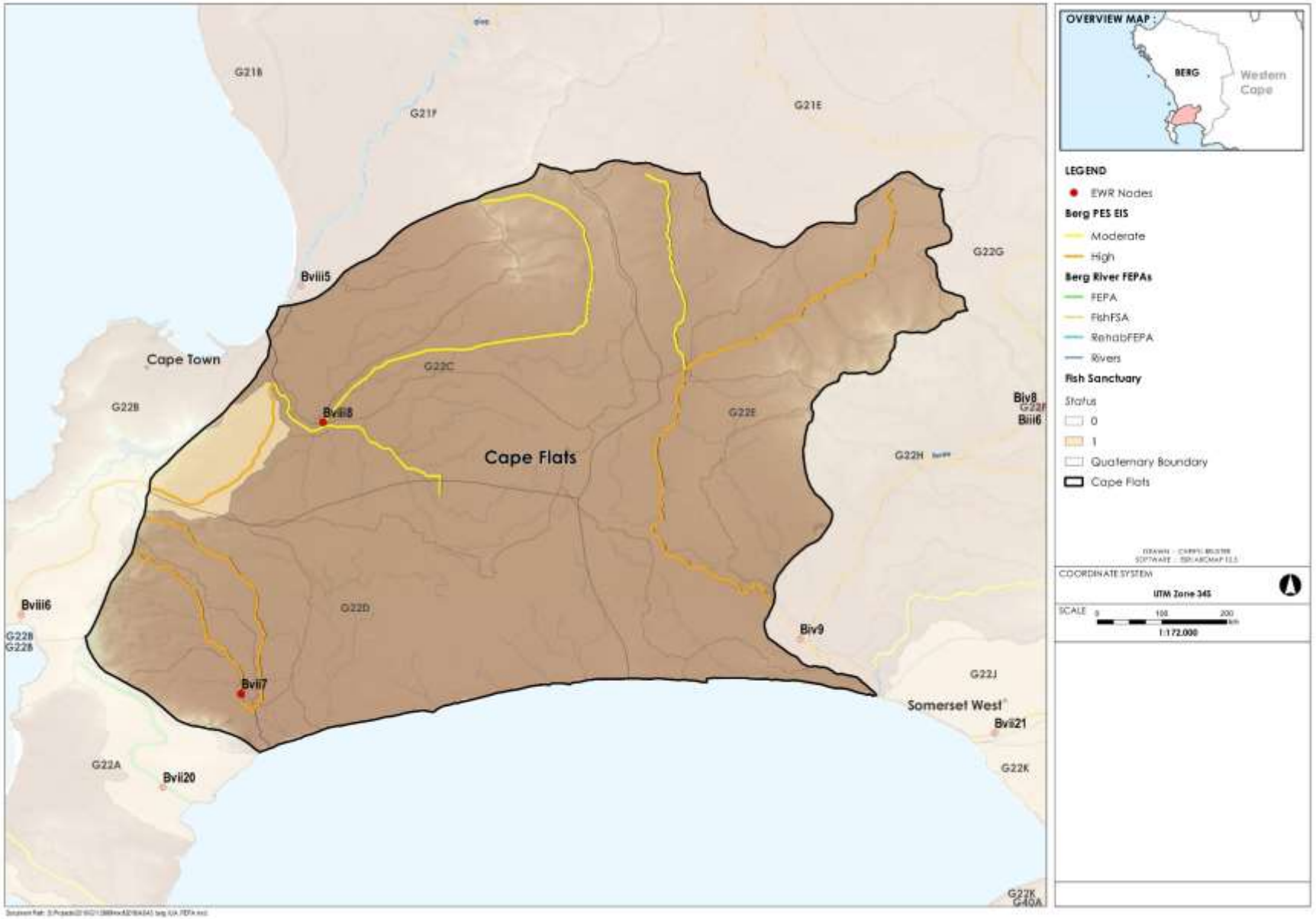
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-27 A3 West Coast – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



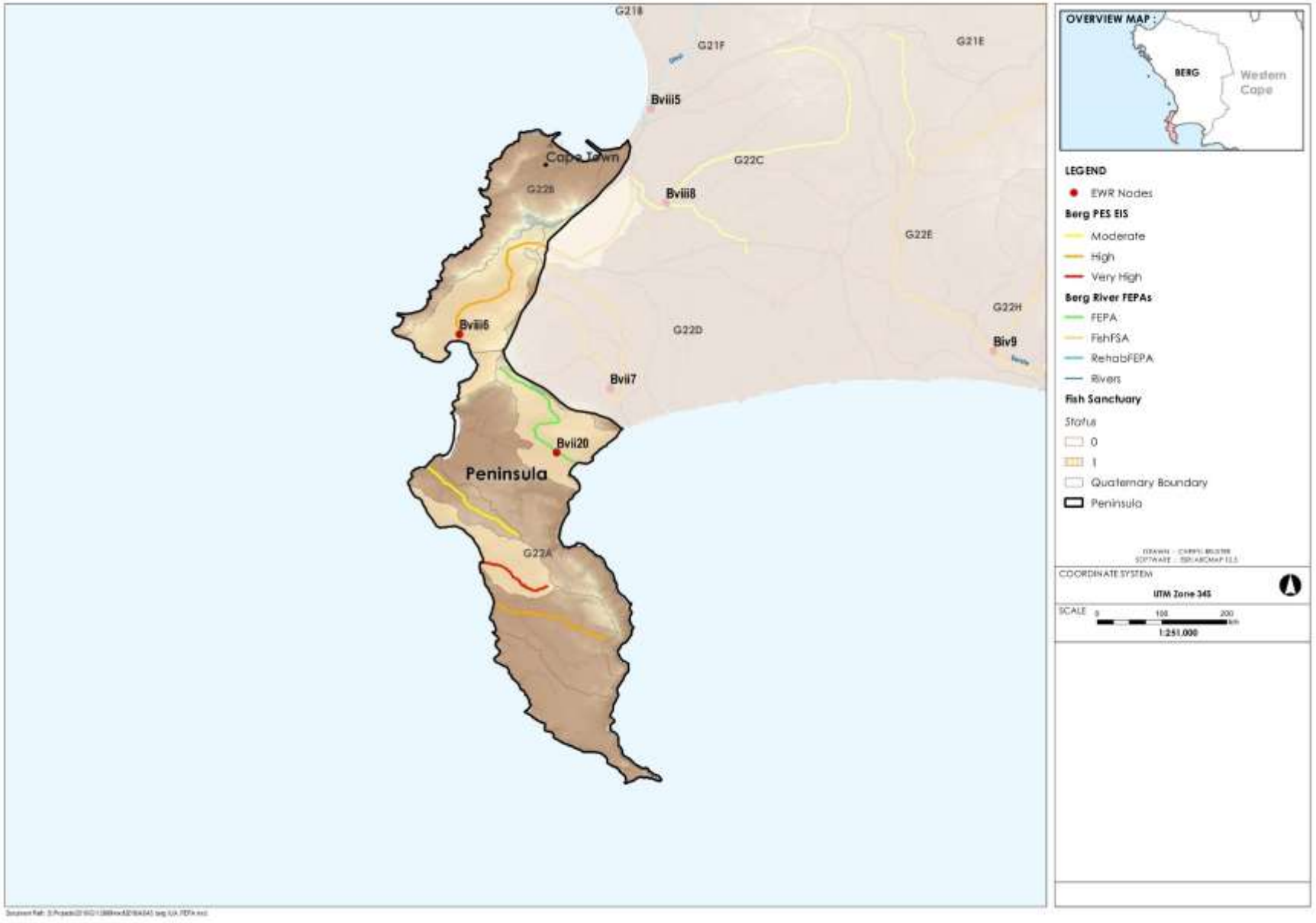
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-28 D10 Diep – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



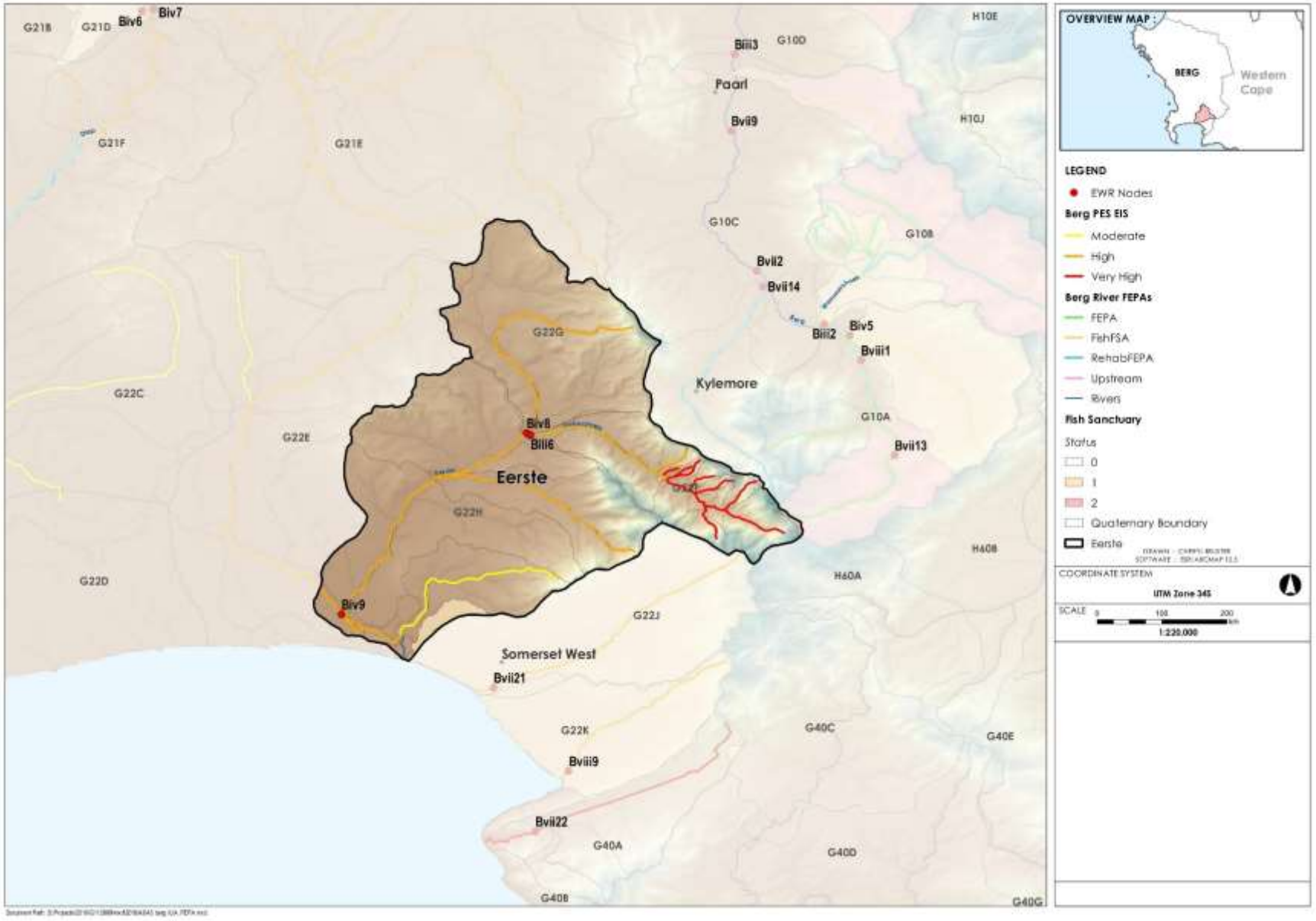
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-29 E12 Cape Flats – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



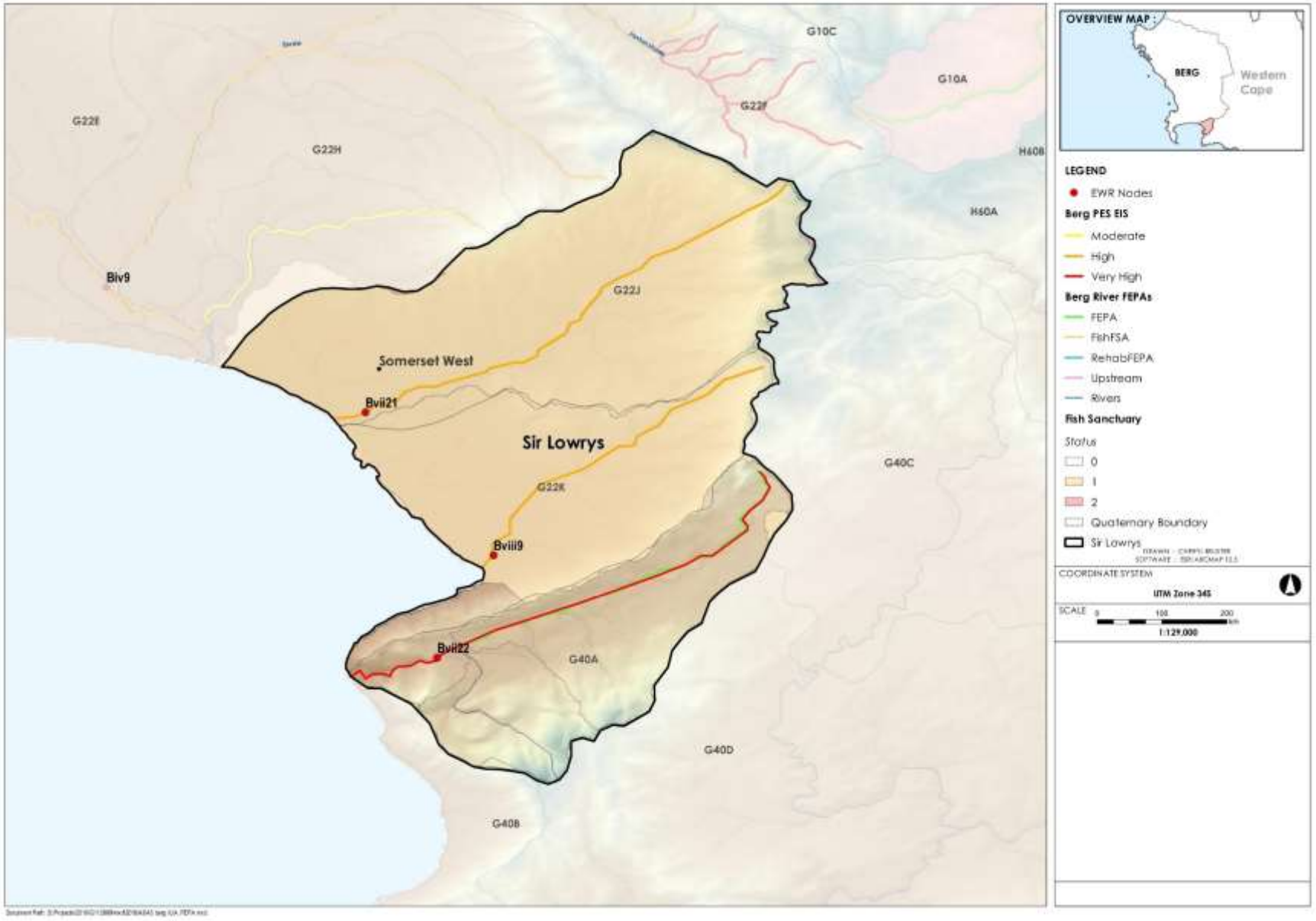
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-30 E11 Peninsula – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-31 D6 Eerste – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-32 D7 Sir Lowry's – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)

3.2 Estuary RQOs and numerical limits

The target ecological condition (TEC) for all the estuaries identified in the Berg catchment are given in Table 3-36. This table gives the minimum flow requirements to meet the TEC under both current and improved water quality. The final recommended flow requirement for each estuary, given in the detailed RQOs might be slightly different from these as the take into consideration other factors including the contribution from upstream river nodes.

The eight priority estuaries for which detailed RQOs have been developed are highlighted in Table 3-36. The locations of the priority estuaries are given in Figure 3-33 with the recommend RQOs in the tables that follow.

Table 3-36 Proposed Target Ecological Condition (TEC) and EWRs for the estuary nodes

Node	IUA	Quat	Name	PES	TEC	EIS	Minimum %MAR to achieve TEC Current WQ	Minimum %MAR to achieve TEC Improved WQ
Bxi1	**A1**	**G10M**	**Berg River Estuary**	**C**	**C**	**H**	**46**	**33**
Bxi3	**A2**	**G10M**	**Langebaan Estuary**	**B**	**B**	**VH**	**94**	**94**
Bxi12	A3	G21A	Modder Estuary	C	C	M	n/a	33
Bxi7	**D10**	**G21F**	**Rietvlei/Diep Estuary**	**D**	**C**	**H**	**n/a**	**33**
Bxi9	**E12**	**G22K**	**Zandvlei Estuary**	**D**	**C**	**H**	**n/a**	**56**
Bxi20	**E12**	**G22D**	**Zeekoe Estuary**	**E**	**D**	**U**	**110**	**60**
Bxi10	E11	G22B	Hout Bay Estuary	E	D	U	35	26
Bxi11	E11	G22A	Silvermine Estuary	D	D	U	35	26
Bxi19	E11	G22A	Elsies Estuary	E	D	U	35	26
Bxi18	E11	G22A	Buffels Wes Estuary	F	D	U	66	67
Bxi17	E11	G22A	Krom Estuary	A	A	U	95	95
Bxi16	E11	G22A	Schuster Estuary	A	A	U	95	95
Bxi15	E11	G22A	Bokramspruit Estuary	C	C	U	65	42
Bxi14	**E11**	**G22A**	**Wildvoëlvlei Estuary**	**D**	**C**	**M**	**79**	**62**
Bxi3	**D6**	**G22H**	**Eerste Estuary**	**E**	**D**	**M**	**61**	**26**
Bxi4	**D7**	**G22J**	**Lourens Estuary**	**D**	**D**	**U**	**69**	**56**
Bxi6	D7	G22K	Sir Lowry's Pass Estuary	E	D	U	35	26
Bxi6	D7	G40A	Steenbras estuary	B	B	U	97	35

With IUA = Integrated Unit of Analysis; Quat = Quaternary catchment; PES = Present Ecological Category; TEC = Target Ecological Category; VH = Very High; H = High; M = Moderate; U = Undefined. BAS = Best attainable state. n/a indicates that it is not possible to improve the Ecological State of the estuary by increasing flows only (WQ also needs to be improved).

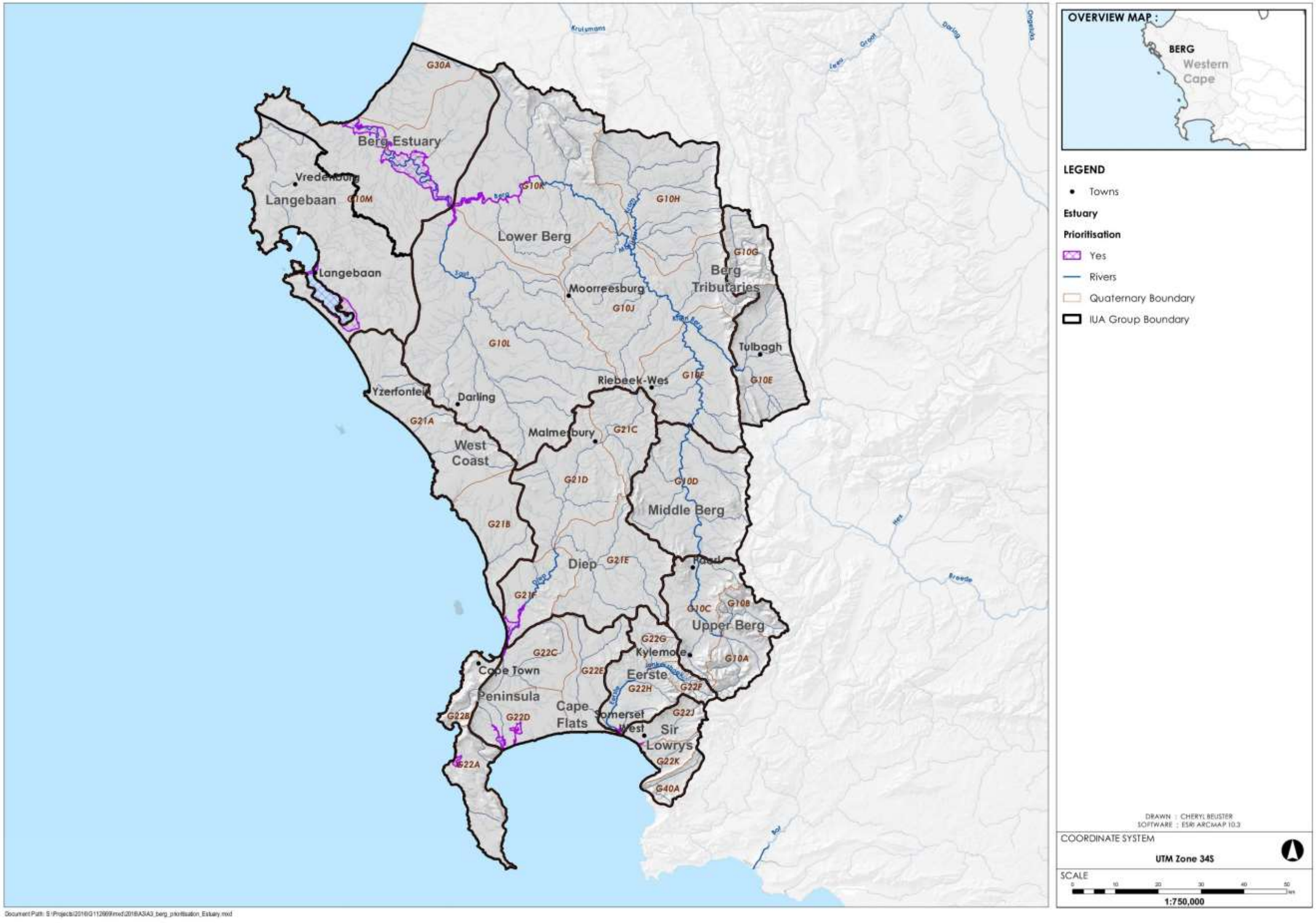


Figure 3-33 Priority Estuary RUs selected for evaluation of RQOs in the Berg Catchment

Table 3-37 RQOs and Numerical Limits for priority estuaries in the Berg Estuary IUA

IUA	Estuary	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
A1 Berg Estuary	Great Berg	Bxi1	Quantity	Low flows	C	Low flow magnitude	Freshwater inflow adequate to maintain water quality and habitat suitable for flora and fauna	River inflow should never drop below 0.6 $m^3.s^{-1}$ and should not below 1 $m^3.s^{-1}$ for longer than 4 months	River inflow <0.6 m^3s^{-1} or < 1 $m^3.s^{-1}$ for longer than 4 months
				High flows		Flood frequency		Should not increase/decrease by more than 10% from 2004 baseline conditions	Flood frequency increases/decreases by >5%
			Quality	Nutrients		Dissolved Inorganic Nitrogen (DIN) Dissolved Reactive Phosphate (DRP)	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	River inflow (< 1 m^3.s-1, summer): DIN <80 µg/l; DRP <20 µg/l	River inflow (< 1 m^3.s-1, summer): DIN >70 µg/l; DRP >15 µg/l
								River inflow (>5 $m^3.s^{-1}$, winter): DIN <800 µg/l; DRP <60 µg/l	River inflow (>5 $m3.s^{-1}$, winter): DIN >700 µg/l; DRP >50 µg/l
								Estuary (low flows < 1 $m3.s^{-1}$, summer): DIN <300 µg/l; DRP <100 µg/l in Zones A and B, DIN <80 µg/l ; DRP <30 µg/l in Zones C and D	Estuary (low flows < 1 $m3.s^{-1}$, summer): DIN >250 µg/l; DRP >80 µg/l in Zones A and B, DIN >60 µg/l ; DRP >20 µg/l in Zones C and D
								Estuary (high flows > 5 $m3.s^{-1}$, winter): DIN <800 µg/l; DRP <60 µg/l in Zones A-D	Estuary (high flows > 5 $m3.s^{-1}$, winter): DIN >700 µg/l; DRP >50 µg/l in Zones A-D
				Salinity		Longitudinal salinity gradient		Salinity <20 for longer than 3 months at 20 km upstream from the mouth	Salinity >20 for longer than 3 months at 20 km upstream from the mouth
								Salinity <1 ppt above 40 km upstream of the mouth Salinity of Salinity everywhere in estuary <35	Salinity >1 above 40 km upstream of the mouth Salinity of Salinity everywhere in estuary <35
								Groundwater salinity on floodplain <45	Groundwater salinity on floodplain >45
								TDS of river inflow <3500 mg/l	TDS of river inflow >3500 mg/l
				Dissolved oxygen		Dissolved oxygen		River inflow: DO >4 mg/l Estuary DO >4 mg/l	River inflow: DO <4 mg/l Estuary DO <4 mg/l
				pH		pH		River inflow: 7 < pH < 8.5 Estuary: 7 < pH < 8.5	River inflow: Ph <7 or >8.5 Estuary: pH <7 or >8.5
				Turbidity		Suspended sediment concentration		Secchi disc depth in Zones A and B <1.0 m during low flow (< $1m^3.s^{-1}$)	Suspended sediment concentration increases by >5%
				Toxins		Trace metals, pesticides/herbicides		Refer to SA Water Quality Guidelines for coastal marine waters	Concentrations in estuary exceed target values as per SA Water Quality Guidelines for coastal marine waters
				Pathogens		*Enterococci*		≤185 Enterococci/100 ml) (90th percentile, hazen system)	*Enterococci*/100 ml) (90^{th} percentile) >185
						E. coli		≤500 *E. coli*/100 ml (90^{th} percentile, hazen system)	*E. coli*/100 ml (90^{th} percentile) >500

IUA	Estuary	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
			Habitat	Hydrodynamics & mouth state		Tidal amplitude	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Changes in tidal amplitude at 2 km, 11 km, ~40 km and 51 km should not change more than 10% from present state (2004)	Tidal amplitude increases/decreases by >5%
				Sedimentary processes		Median bed sediment diameter		Should not increase/decrease by more than 10% from 2004 baseline conditions	Median bed sediment diameter increases/decreases by >5%
						Channel bathymetry (location of channel banks - ML contours and deepest bottom line)		Should not increase/decrease by >10% from 2004 baseline conditions	Increases/decreases by >5%
						Suspended sediment concentration		Should not increase by >10% from 2004 baseline conditions	Increase by >5%
			Biota	Microalgae		Phytoplankton biomass/ composition	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Phytoplankton biomass <15 µg/l chlorophyll a in summer and <10 ug/l chlorophyll a in winter	Phytoplankton biomass >15 µg/l chlorophyll a in summer and >10 ug/l chlorophyll a in winter
								Blue-green algae <10% of phytoplankton cell counts	Blue-green algae >10% of phytoplankton cell counts
								Benthic microphytobenthic < 40 mg/m2 chlorophyll a	Benthic microphytobenthic biomass exceed 40 mg/m^2 chlorophyll a
								The frequency of dinoflagellates < 5% of the total phytoplankton counts	Dinoflagellates >5% of the total phytoplankton counts, Flagellates cease to be the dominant group and diatoms become less diverse (<10 taxa per site)
				Macrophytes		Macrophyte community composition and abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain the present distribution (2003-2005) and abundance of the different plant community types and estuarine habitats (intertidal mudflats with *Zostera capensis* 206 ha, intertidal salt marsh 499 ha, open pan 1159 ha, halophytic floodplain 1521 ha, xeric floodplain 919.1 ha, reeds and sedges 586.6 ha and sedge pan 292.5 ha).	Greater than 10% change in the area covered by different plant community types
								Prevent an increase in mats of macroalgae in the lower intertidal reaches	Percentage cover should not exceed 100% in more than 50% of the quadrats.
								Reduce the area covered by water hyacinth (*Eicchornia crassipes*) in the upper reaches by 50% compared to the present state (2003-2005).	Upper reaches of the estuary with greater than 50% of estuary water channel covered by water hyacinth.
								Prevent an increase in size of the open pan dry areas (1159 ha in 2003-2005)	Greater than 10 % increase in area.

IUA	Estuary	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
								Prevent a decrease in size of the sedge pan areas (293 ha in 2003-2005). *Juncus maritimus*, and waterblommetjies *Aponogeton distachyos* are present.	Greater than 10 % decrease in area. *Juncus maritimus*, and waterblommetjies *Aponogeton distachyos* are absent.
								Prevent the spread of invasive aliens in the riparian zone (e.g. *Acacia mearnsii* and *Eucalyptus camaldulensis*)	Greater than 10 % increase in area covered by invasive plants.
								Maintain intact reed and sedge stands along the banks of the estuary by ensuring that salinity is not greater than 20 ppt for 3 months at 20 km from the month during summer.	Dieback of reeds and sedges at 20 km and further upstream from the mouth.
								Prevent an increase in bare ground in the halophytic and xeric floodplain habitats by maintaining the present-day flooding patterns	Greater than 20% increase in bare ground in halophytic and xeric floodplain habitats
				Invertebrates		Invertebrate community composition and abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Retain present species richness, distribution of species and mix (low species abundance, high dominance) in Zones A to the middle reaches of Zone C. One or two species will always be present at high densities compared to others (e.g. *Pseudodiaptomus hessei, Grandidierella* sp.) in these Zones (A to C).	Species richness increases or decreases by more than 25% in any of the invertebrate categories (zooplankton, subtidal zoobenthos or intertidal benthos) in Zones A to C compared to present.
								Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	*Capitella capitata* exceeds 50% abundance of benthic species at any site
								Callianassa kraussi and *Upogebia africana* distribution patterns remain similar to present state.	Areas of distribution extend upstream or downstream by more than 4-5 km.
				Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Retain the full complement of estuarine resident (7 species) and estuary associated marine (5 species) present in the estuary with population sizes sufficient to ensure their persistence in perpetuity.	Comprehensive survey of fish in the estuary (40 + sites sampled across full estuary with fine mesh seine net) during summer fails to confirm presence of viable populations of 15 common species. Bi-annual sampling.
								Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	Abundance of exotic freshwater species increases by more than 50% above present levels
								Maintain recruitment of adult and juvenile fish at present levels. This requires maintaining sufficient flow for freshwater plume (temperature, salinity and olfactory gradient) entering the sea. This implies that there should be a significant number of 0 -1-year-old fish and no missing year classes.	There are a missing year class within a species

IUA	Estuary	Node	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 15% across five or more annual surveys
									The overall numbers of any of the defined groups decreases relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.
									The numbers of any species decrease relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.

Table 3-38 Supplementary information for Estuary RQOs in the Berg Estuary IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
A1 Berg Estuary	II	Great Berg	Bxi1	G10M	B	PES: C %nMAR: 50.0	EC: C %nMAR: 52.0	Additional non-flow related interventions required in addition to the RQOs specified above to secure the REC of a C for the Berg estuary include the following: • eradicate invasive alien vegetation (especially dense tree stands) from floodplains; • remove derelict, redundant and old quays, jetties, wharfs and revetments; and rehabilitate banks to natural sediments; • prohibit dredge spoil dumping (from lower main channel as well as marina) in inappropriate areas; • install additional culverts into road and rail bridge embankments; • manage agricultural practises in the estuary to avoid trampling of estuarine vegetation by livestock; • manage agricultural practises in the catchment to minimise nutrient and sediment loads entering the estuary; • control fish factory effluent discharged to the estuary to reduce nutrient loading to the system; • upgrade the sewage treatment works in the catchment to reduce nutrient inputs to the estuary; • environmentally acceptable, soft engineering, bank stabilization techniques that could be used to tackle erosion issues at many of the key sites at the estuary	DWAF (2010) Intermediate Determination of Resource Directed Measures for the Great Berg Estuary

Table 3-39 RQOs and Numerical Limits for priority estuaries in the Langebaan IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
A2 Langebaan	Langebaan	Bxi3	G10M	Quantity	Flow	A	Groundwater level and rate of inflow	Groundwater inflow maintains water quality and habitat suitable for flora and fauna	Groundwater inflow not <10% of present day (2017) rate	Groundwater inflow <10% of present day (2017) rate
									Ground water level not <10% below present day (2017) level	Ground water level drops by >10% from present day (2017) level
				Quality	Nutrients		NO_3	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	NO_3 <1.3 mg.l^{-1}	NO_3 >1.2 mg.l^{-1}
					Salinity		Salinity		Salinity at the head of the lagoon <40	Salinity at the head of the lagoon >40
									Rest of the lagoon 34 < Salinity < 36	Salinity in rest of lagoon <34 or >36
					System variables		Dissolved oxygen		>4 mg.l^{-1}	Dissolved oxygen <4 mg.l^{-1}
							Turbidity		Sechii depth >1 m	Sechii depth <1 m
					Toxins		Trace metals		Refer to SA Water Quality Guidelines for coastal marine waters	Concentrations in estuary exceed target values as per SA Water Quality Guidelines for coastal marine waters
					Pathogens		Faecal indicator bacteria		≤185 *Enterococci*/100 ml) (90th percentile, hazen system)	*Enterococci*/100 ml) (90th percentile) >185
									≤500 *E. coli*/100 ml (90th percentile, hazen system)	*E. coli*/100 ml (90th percentile) >500
				Habitat	Sedimentary processes		Median bed sediment diameter	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Should not increase/decrease by more than 10% from 2017 baseline conditions	Median bed sediment diameter increases/decreases by >5%
							Channel bathymetry (location of channel banks - ML contours and deepest bottom line)		Should not increase/decrease by >10% from 2017 baseline conditions	Increases/decreases by >5%
							Median bed sediment diameter		Should not increase/decrease by more than 10% from 2017 baseline conditions	Median bed sediment diameter increases/decreases by >5%
					Hydrodynamics & mouth state		Tidal amplitude		Tidal amplitude should not change more than 10% from present state (2017)	Tidal amplitude increases/decreases by >5%
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Maintain low phytoplankton biomass (chlorophyll- a < 20 µg/ℓ) and a diversity of phytoplankton groups.	Consistent high phytoplankton biomass (chlorophyll- a >20 µg/ℓ) due to nutrient input and change in dominance of phytoplankton groups.

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain the distribution and area cover of macrophyte habitats particularly the salt marsh and seagrass. Maintain the large groundwater fed rush habitat.	Greater than 10% change in the area covered by different macrophyte habitats due to disturbance, increase in nutrients and turbidity. However, seagrass *Zostera capensis* can be naturally variable. Die-back of groundwater dependent rushes and reeds.
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	In terms of Invertebrates Langebaan lagoon is currently in an A category. The invertebrate communities are in good health with species richness, abundances and composition scoring highly.	Loss of any of the three identified estuarine species (*Afrochiltonia capensis*, *Exosphaeroma hylecoetes*, *Tomichia ventricosa*; Day 1959) dependant on fresh or brackish water. Species richness or abundance changes by more than 10%.
					Fish		Fish community composition & abundance	Abundance and community composition of fish community suitable for birds	The fish community should include healthy populations of exploited fish species, specifically the harders, white stumpnose, blacktail, elf and smooth hound shark juveniles should all be present in beach seine net sampling surveys (at least 10 hauls in 3 different sites) of the nearshore areas. Adults of these species should remain the main components in the catches of line and net fisheries in the lagoon, and catch rates should remain stable or increase.	Exploited fish species become rare (mullet average of <100/haul, white stumpnose <20 per haul, other species present in some hauls) or disappear from seine net survey catches.
					Birds		Avifauna community composition & abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 15% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.
										The numbers of any species decrease relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.

Table 3-40 Supplementary information for Estuary RQOs in the Langebaan IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
A2 Langebaan	II	Langebaan	Bxi3	G10M	A	B	A	• Development in the Estuary Functional Zone (EFZ) and associated disruption of sediment transport and loss/degradation of habitat, macrophytes and fauna • Shoreline erosion linked to dredging and development of the Port of Saldanha • Changes in water and sediment quality in the lagoon linked with port development and port operations, aquaculture, and effluent discharged to the bay • Disturbance of sensitive species due to high intensity recreational activities	

Table 3-41 RQOs and Numerical Limits for priority estuaries in the Eerste IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
E6 Eerste	Eerste	Bxi3	G22H	Quantity	Flow	D	MAR	Freshwater inflow adequate to maintain water quality and habitat suitable for flora and fauna	Total freshwater inflow should be reduced to within 20% of Natural through diversion/recycle of effluent from WWTW in the catchment	Total freshwater inflow >20% above Natural
				Quality	Salinity		Longitudinal salinity gradient	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Average salinity in lower >10, maximum = 35	Average salinity <10, maximum salinity >35
					Nutrients		DIN		River inflow: <1000 µg.l^{-1} Lower estuary: <1000 µg.l^{-1}	RQO limits exceeded
							DIP		River inflow: <500 µg.l^{-1} Lower estuary: <500 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤500 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Mouth state		Tidal amplitude	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Tidal amplitude should not change more than 10% from present state	Tidal amplitude changes by >10%
							Mouth state		Mouth should remain permanently open	Estuary mouth closes
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Maintain low phytoplankton biomass (chlorophyll- a < 20 µg/ℓ) and a diversity of phytoplankton groups.	Phytoplankton biomass >20 µg/ℓ

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Restore and maintain the distribution and area cover of macrophyte habitats particularly salt marsh	Greater than 10% loss in the area covered by different plant community types
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Restore and maintain species richness, distribution of species and mix (low species abundance, high dominance)	Any reduction in invertebrate species composition (zooplankton, subtidal zoobenthos or intertidal benthos)
									Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	
									Callianassa kraussi and *Upogebia africana* distribution patterns similar to reference state.	
					Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Restore and maintain the full complement of estuarine resident and estuary associated marine present in the estuary with population sizes sufficient to ensure their persistence in perpetuity.	Any reduction in estuarine/marine fish species
									Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	
									Maintain recruitment of adult and juvenile fish at present levels.	
					Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 15% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.
										The numbers of any species decrease relative to the baseline average by more than 15% over a five-year period, after correcting for regional/global population changes.

Table 3-42 Supplementary information for Estuary RQOs in the Eerste IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related interventions	References
E6 Eerste	II	Eerste	Bxi3	G22H	D	PES: E %nMAR: 154	EC: C %nMAR: 114	Additional non-flow related interventions are required in addition to the RQOs specified above to secure the REC of a C for the Eerste estuary include the following: • Divert or recycle at least 75% of the effluent from WWTW in the Eerste catchment • Treat any residual effluent to DWS special standards	DWS (2018): Rapid assessment of the Ecological Water Requirements for the Eerste Estuary

Table 3-43 RQOs and Numerical Limits for priority estuaries in the Diep IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D10 Diep	Diep	Bviii5	G21F	Quantity	Flow	D	Low flows	Freshwater inflow adequate to maintain water quality and habitat suitable for flora and fauna	Total freshwater inflow should not drop below 0.3 m^3/s or 0.8 Mm/month	Total freshwater inflow <0.3 m^3/s or 0.8 Mm/month
				Quality	Salinity		Longitudinal salinity gradient	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Average salinity in lower estuary (Milnerton lagoon) = 20, maximum = 35	Average salinity <15, maximum salinity >35
					Nutrients		DIN		River inflow: <800 µg.l^{-1} Lower estuary (Milnerton lagoon): <1000 µg.l^{-1}	RQO limits exceeded
							DIP		River inflow: <60 µg.l^{-1} Lower estuary (Milnerton lagoon): <500 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤500 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Sedimentary processes		Median bed sediment diameter	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Should not increase/decrease by more than 10% from baseline conditions	Median bed sediment diameter changes by >10%
					Mouth state		Tidal amplitude		Tidal amplitude should not change more than 10% from present state	Tidal amplitude changes by >10%
							Mouth state		Mouth should remain open >95% of the time	Estuary mouth closes

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Maintain low phytoplankton biomass (chlorophyll- a < 50 µg/ℓ) and a diversity of phytoplankton groups.	Phytoplankton biomass >50 µg/ℓ
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain the distribution and area cover of macrophyte habitats particularly the salt marsh	Greater than 10% change in the area covered by different plant community types
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Retain present species richness, distribution of species and mix (low species abundance, high dominance)	Species richness increases or decreases by more than 25% in any of the invertebrate categories (zooplankton, subtidal zoobenthos or intertidal benthos) in
									Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	
									Callianassa kraussi and *Upogebia africana* distribution patterns remain similar to present state.	
					Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Retain the full complement of estuarine resident and estuary associated marine present in the estuary with population sizes sufficient to ensure their persistence in perpetuity.	Community composition (representation by estuarine resident, marine migrant or freshwater species) changes by >25%
									Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	
									Maintain recruitment of adult and juvenile fish at present levels.	
					Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 20% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
										The numbers of any species decrease relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.

Table 3-44 Supplementary information for Estuary RQOs in the Diep IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
D10 Diep	III	Diep	Bviii5	G21F	D	PES: D %nMAR: 95	EC: D %nMAR: 78	Additional non-flow related interventions are required in addition to the RQOs specified above to secure the REC of a C for the Diep estuary include the following: • Maintaining return flows from the wastewater treatment plants is important in terms of maintaining the flow in the estuary, but these must comply with required discharge standards. • establishment of riparian buffers in the catchment; • improving the quality of stormwater entering the system especially from informal settlements, • dredging Milnerton lagoon to improve tidal exchange but only once water quality issues have been addressed to prevent problems with anoxia; • reduce in illegal fishing (by recreational fishers and poachers using gill nets), • remove alien plants from the catchment and estuary functional zone (EFZ), • remove any remaining portions of the weir that was constructed near the mouth of Milnerton lagoon in 1928 • consider introducing hippos to control vegetation in the EFZ,	Rapid RDM Assessment for the Diep Estuary

Table 3-45 RQOs and Numerical Limits for priority estuaries in the Peninsula IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
E11 Peninsula	Wildevoelvlei	Bxi14	G22A	Quantity	Flow	D	MAR	Freshwater inflow does not exceed requirements for maintaining water quality and habitat suitable for flora and fauna	Should be reduced and maintained within 20% of Natural MAR. Effluent from the WWTW should be diverted away from the estuary.	MAR more than 20% above or below Natural MAR
				Quality	Salinity		Longitudinal salinity gradient	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish,	Average salinity in lower estuary (backshore lagoon) >10, maximum = 35, average salinity in Wildevoelvlei > 2	Average salinity in backshore lagoon <10, maximum salinity >35, average salinity in Wildevoelvlei <2
					Nutrients		DIN		River inflow: <1000 µg.l^{-1} Wildevoelvlei: <1000 µg.l^{-1} Lower Estuary (backshore lagoon):	RQO limits exceeded

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
								birds and recreational use	<200 µg.l^{-1}	
							DIP		Wastewater inflow: <500 µg.l^{-1} Wildevoelvlei: <500 µg.l^{-1} Lower estuary (backshore lagoon): <50 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤500 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Sedimentary processes		Tidal amplitude	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Tidal amplitude should not change more than 10% from present state	Tidal amplitude changes by >10%
					Mouth state		Mouth state		Mouth should remain open >70% of the time	Estuary mouth closed for longer than 3 months at a time
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Improvement from current hypereutrophic state where toxic cyanobacteria are common and flow to the sea.	Phytoplankton biomass / water column chlorophyll-a greater than 100 µg/ℓ for 50% of the year in the vleis. Microcystin concentration greater than 1 µg/ℓ for 50% of the year in the vleis.
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Retain present species richness, distribution of species and mix (low species abundance, high dominance)	Loss of salt tolerant macrophyte species in the lower reaches (e.g. succulents, grasses such as Sarcocornia and Sporobolus).
									Maintain the fringing vegetation around the vleis as this is important for bank stabilisation and nutrient uptake.	Greater than 10 % change in the area covered by riparian vegetation in the lower and upper vlei.
									Improve connectivity between the sea, channel and lower vlei.	Overgrown vegetated channel, no visible water in the channel between the lower estuary reaches and lower vlei.
									Control the spread of invasive floating aquatic macrophyte species present in the vleis e.g. water fern.	Invasive aquatic plants cover greater than 10% of the total water surface area

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Move from a D category to a C category. The estuary should have a viable population of *Callichirus kraussi* in the backwater lagoon (10/m^2). In addition, the invertebrate community should include 2 other estuarine species in the canal. At least three marine invertebrate species present near the mouth.	Loss of *Callichirus kraussi* populations from the mouth region (currently populations are of low density). Number of estuarine species drop to less than 2 in the canal (estimated current situation). Less than three marine dependant species present in the backwater lagoon.
					Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Maintain fish assemblage that includes at least two species of mullet, Liza richardsonii and either/both Mugil cephalus and Pseudomyxus capensis. Substantial seasonal fluctuations in abundance of these mullet species are expected to occur, but mullet should remain more abundant than the alien freshwater species currently inhabiting the vleis.	Mullet species absent from vleis. Fish community dominated by alien freshwater species, or no fish present in the system.
					Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 20% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.
										The numbers of any species decrease relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.

Table 3-46 Supplementary information for Estuary RQOs in the Peninsula IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
E11 Peninsula	II	Wildevoelvlei		G22A	D	PES: C %nMAR: 147	EC: D %nMAR: 107	Further improvements could also be achieved by opening up the channel between the lagoon and WIldevöelvlei, clearing some of the reeds in the vlei and channel, and dredging some of the accumulated sludge from the bottom of the system. Urban runoff is a significant concern and will need to be addressed to improve condition.	DWS (2018): Rapid assessment of the Ecological Water Requirements for the Wildevoelvlei Estuary

Table 3-47 RQOs and Numerical Limits for priority estuaries in the Cape Flats IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
E12 Cape Flats	Zandvlei	Bxi9	G22K	Quantity	Flow	D	MAR	Freshwater inflow adequate to maintain water quality and habitat suitable for flora and fauna	Total freshwater inflow should not change by >10% from present	Total freshwater inflow changes by >10%
				Quality	Salinity		Salinity	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	15 < Average salinity <35	Average salinity <15, maximum salinity >35
					Nutrients		DIN		River inflow: <1000 µg.l^{-1} Estuary: <150 µg.l^{-1}	RQO numerical limits exceeded
							DIP		River inflow: <300 µg.l^{-1} Estuary: <100 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤500 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Sedimentary processes		Median bed sediment diameter	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Should not increase/decrease by more than 10% from baseline conditions	Median bed sediment diameter changes by >10%
					Mouth state		Tidal amplitude		Tidal amplitude should not drop >10% from present state	Tidal amplitude changes by >10%
							Mouth state		Mouth should remain open >20% of the time	Estuary mouth closed >20% of the time
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Maintain low phytoplankton biomass (chlorophyll- a < 20 µg/ℓ) and a diversity of phytoplankton groups.	Phytoplankton biomass >20 µg/ℓ

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain and/or restore distribution and area cover of macrophyte habitats particularly salt marsh	Greater than 10% loss in the area covered by different plant community types
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Retain present species richness, distribution of species and mix (low species abundance, high dominance)	Species richness increases or decreases by more than 25% in any of the invertebrate categories (zooplankton, subtidal zoobenthos or intertidal benthos) in
									Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	
									Callianassa kraussi and *Upogebia africana* distribution patterns remain similar to present state.	
					Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Retain the full complement of estuarine resident and estuary associated marine present in the estuary with population sizes sufficient to ensure their persistence in perpetuity.	Community composition (representation by estuarine resident, marine migrant or freshwater species) changes by >25%
									Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	
									Maintain recruitment of adult and juvenile fish at present levels.	
					Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community.	The number of non-passerine waterbird species recorded in counts decreases by more than 20% across five or more annual surveys
E12 Cape Flats	Zeekoei	Bxi20	G22D	Quantity	Flow	D	MAR	Freshwater inflow does not exceed requirements for maintaining water quality and habitat suitable for flora and fauna	Total freshwater inflow should not differ by >20% from Natural. Effluent from the Cape Flats WWTW must be diverted away from the estuary.	Total freshwater inflow differs by >20% from Natural
				Quality	Salinity		Salinity	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	10 < average salinity in lower estuary (channel below Zeekoevlei) <35	Average salinity <10, maximum salinity >35
					Nutrients		DIN		River inflow: <1000 µg.l^{-1} Estuary (Zeekoevlei and channel to sea): <1000 µg.l^{-1}	RQO numerical limits exceeded

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
							DIP		River inflow: <500 µg.l^{-1} Estuary (Zeekoevlei and channel to sea): <500 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤1000 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Mouth state		Mouth state	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Mouth should remain open >30% of the time	Estuary mouth closed >70% of the time
				Biota	Microalgae		Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Phytoplankton biomass (measured as chlorophyll-a) <100 µg/ℓ) and a diversity of phytoplankton groups.	Phytoplankton biomass >100 µg/ℓ
					Macrophytes		Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain and/or restore distribution and area cover of macrophyte habitats particularly salt marsh	Any loss in the area covered by estuarine plant community
					Invertebrates		Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Maintain and/or restore species richness, distribution of species and mix	Any reduction in invertebrate species composition (zooplankton, subtidal zoobenthos or intertidal benthos)
									Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	
					Fish		Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Maintain and/or restore species richness, distribution of species and mix. Facilitate reintroduction of estuarine and marine species to Zeekoevlei and channel to mouth	Any reduction in estuarine/marine fish species
									Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	
									Maintain recruitment of adult and juvenile fish	

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Birds		Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 20% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.
										The numbers of any species decrease relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.

Table 3-48 Supplementary information for Estuary RQOs in the Cape Flats IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
E12 Cape Flats	III	Zandvlei	Bxi9	G22K	D	PES: D	EC: D	Key interventions to be implemented to improve the health of the Zandvlei estuary included the following: • It is recommended that the rubble weir and other obstructions (pipelines) at mouth of the estuary be completely removed to allow improved tidal flushing. • Remove bank stabilisation (concrete banks in lower reaches of the estuary and reshape banks as far as possible) to create more shallow water marginal habitat. • Improve management of the Westlake Wetlands and any interventions that would improve the quality of influent stormwater. • Consider dredging of parts of the upper vlei to -1 m or -1.5 MSL and also of a channel linking this are to the mouth region. This may assist in entraining more salt water into the estuary and hence improving the salinity structure and further diluting nutrient inputs from the catchment and improving the nursery function of the system. The impacts of this intervention on the hydrodynamic functioning and water quality would need to be investigated in detail using a hydrodynamic model before such a measure can be implemented	DWS (2018): Rapid assessment of the Ecological Water Requirements for the Zandvlei Estuary

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related issues and interventions	References
E12 Cape Flats	II	Zeekoevlei	Bxi9	G22K	D	PES: E %nMAR: 93	EC: D %nMAR: 93	Key interventions to be implemented to improve the health of Zeekoevlei included the following: • Divert/recycle at least 75% of effluent from the Cape Flats WWTW • Facilitate access by marine and estuarine fish into Zeekoevlei and Rondevlei through (1) construction of fish ladders at the Zeekoevlei and Rondevlei weirs and at the causeway beneath the main effluent line running to the Cape Flats WWTW, (2) maintaining the channel between the estuary mouth and the weirs free of water hyacinth, and (3) diversion of water from the cut-off drain back into the WWTW. (Note that effluent quality of water in this canal is extremely poor with ammonia levels above that which can be tolerated by most fish species.)	DWS (2018): Rapid assessment of the Ecological Water Requirements for the Zeekoe Estuary

Table 3-49 RQOs and Numerical Limits for priority estuaries in the Sir Lowry's IUA

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
D7 Sir Lowry's	Lourens	Bxi4	G22J	Quantity	Flow	B	MAR	Freshwater inflow adequate to maintain water quality and habitat suitable for flora and fauna	MAR should not drop by more than 10% from Present Flow <0.15 m3.s^{-1} for >3 months at a stretch	MAR reduction >10% Flow <0.15 for more than 3 months in any year
				Quality	Salinity	D	Longitudinal salinity gradient	Water quality within appropriate limits for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Average salinity in lower estuary >15, maximum = 35	Average salinity <10, maximum salinity >35
					Nutrients		DIN		River inflow: <350 µg.l^{-1} Lower estuary: <300 µg.l^{-1}	RQO limits exceeded
							DIP		River inflow: <80 µg.l^{-1} Lower estuary: <80 µg.l^{-1}	
					Oxygen		Dissolved oxygen		>4 mg.l^{-1}	
					Pathogens		Faecal indicator bacteria		≤185 Enterococci/100 ml) (90th percentile, hazen system) ≤500 E. coli/100 ml (90th percentile, hazen system)	
					Toxic substances		Toxic substances		Toxic substances: Comply with water/sediment quality guidelines (DWAF, 1995; CSIR/UNEP, 2009 or future updates)	
				Habitat	Mouth state	B	Tidal amplitude	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Tidal amplitude during open phase should not change more than 10% from present state	Tidal amplitude during open phase changes by >10%
							Mouth state		Mouth should remain permanently open	Estuary mouth closes
				Biota	Microalgae	D	Phytoplankton biomass and diversity	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Maintain low phytoplankton biomass (chlorophyll- a < 20 µg/ℓ) and a diversity of phytoplankton groups.	Phytoplankton biomass >20 µg/ℓ

IUA	Estuary	Node	Quat	Component	Sub-component	TEC	Indicator/ measure	RQO narrative	RQO numeric	TPC
					Macrophytes	D	Macrophyte community composition & abundance	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Restore and maintain the distribution and area cover of macrophyte habitats particularly salt marsh	Greater than 10% loss in the area covered by different plant community types
					Invertebrates	D	Invertebrate community composition & abundance	Abundance and community composition of Invertebrates suitable for fish, birds	Restore and maintain species richness, distribution of species and mix (low species abundance, high dominance)	Any reduction in invertebrate species composition (zooplankton, subtidal zoobenthos or intertidal benthos)
									Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	
									Callianassa kraussi and *Upogebia africana* distribution patterns similar to reference state.	
					Fish	D	Fish community composition and abundance	Abundance and community composition of fish community suitable for birds	Restore and maintain the full complement of estuarine resident and estuary associated marine present in the estuary with population sizes sufficient to ensure their persistence in perpetuity.	Any reduction in estuarine/marine fish species
									Ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions	
									Maintain recruitment of adult and juvenile fish at present levels.	
					Birds	C	Avifauna community composition and abundance	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average.	The number of non-passerine waterbird species recorded in counts decreases by more than 20% across five or more annual surveys
										The overall numbers of any of the defined groups decreases relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.
										The numbers of any species decrease relative to the baseline average by more than 20% over a five-year period, after correcting for regional/global population changes.

Table 3-50 Supplementary information for Estuary RQOs in the Sir Lowry's IUA

IUA	Class	Estuary	Node	Quat	REC	Current	Target	Non-flow related interventions	References
D7 Sir Lowry's	II	Lourens	Bxi4	G22J	D	PES: %nMAR: 85	EC: %nMAR: 85	There has been significant loss of habitat in the functional zone of the Louren estuary. Concrete retaining walls and boulders used to prevent erosion have transformed habitats in the middle and upper reaches of the estuary. This has contributed to significant loss of intertidal area. Coast vegetation surrounding the estuary has been lost due to development including an extensive golf course. Presently 80% of the estuary habitat is developed or disturbed resulting in loss of almost all natural macrophyte habitats from the Lourens estuary. Concerted effort is required to restore estuarine habitat around this system.	DWS (2018): Rapid assessment of the Ecological Water Requirements for the Lourens Estuary

3.3 Dam RQOs and numerical limits

The prioritised dams for which RQOs have been developed are shown in Table 3-51 and in Figure 3-34.

Table 3-51 Priority Dams Resource Units for the Berg Catchment

No of dam	Name of dam	Quaternary Drainage Area	River or Watercourse	Wall type	Capacity (1000 m^3)	Purpose / use	Owner
G100/03	Voëlvlei Dam	G10F	Vogelvlei	Earthfill	168 000	Domestic and Industrial supply	Dept. of Water and Sanitation
G100/02	Berg River Dam	G10A	Berg	Rockfill	130 000	Domestic supply and irrigation	Trans-Caledon Tunnel Authority (TCTA)
G100/13	Wemmershoek Dam	G10B	Wemmershoek	Rockfill	58 644	Domestic and Industrial supply	Cape Town Metropolitan Municipality
G400/30	Steenbras Reservoir (Lower Steenbras Dam)	G40A	Steenbras	Gravity	36 133	Domestic and Industrial supply	Cape Town Metropolitan Municipality
G400/51	Upper Steenbras Dam	G40A	Steenbras	Earthfill	31 767	Domestic and Industrial supply	Cape Town Metropolitan Municipality
G100/06	Misverstand Weir	G10K	Berg	Arch & gravity	7 737	Domestic and Industrial supply	Dept. of Water and Sanitation

The proposed RQOs and numerical limits (NL) determination for dams are described in the tables that follow.

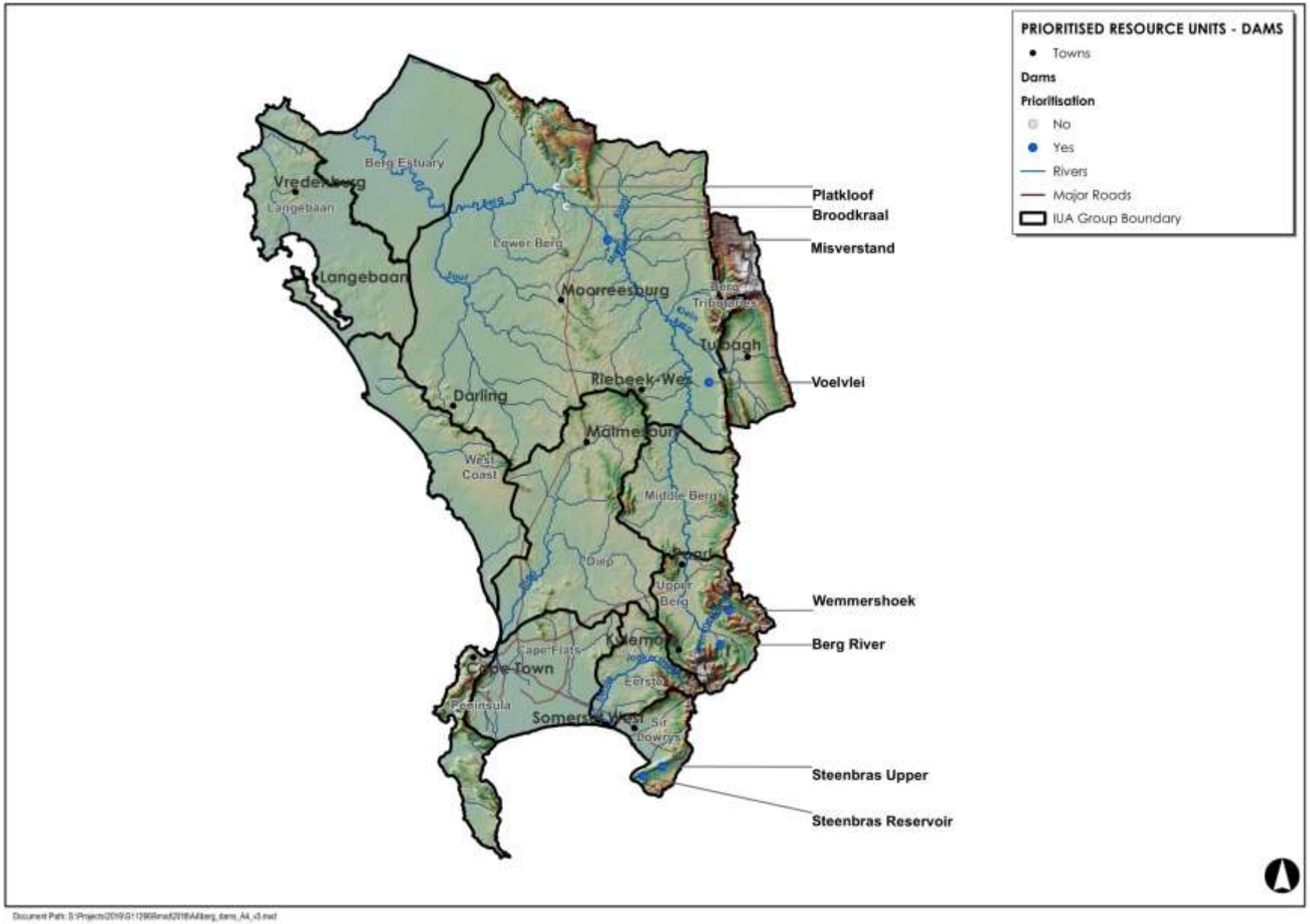


Figure 3-34 Priority dams considered in the Berg Catchment

Table 3-52 RQOs for Berg River Dam in the Upper Berg IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D8 Upper Berg	Berg River Dam	Quantity	Low flows	Dam level Flow releases: Berg EWR1 in G10A (located immediately downstream of Berg River Dam and upstream of the Franschhoek River junction) nMAR = 141.68 million m3/a pMAR: 126.00 million m3/a REC = C category	During the dry season dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream. Water intake temperature to be managed.	**Refer to** Table 3-54: EWR for the Berg River Dam
			High flows		During the wet season high flow ecological releases are made according to the decision-support system.	
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in a mesotrophic (moderately enriched) state or better to protect against nuisance algal blooms and excessive water treatment costs.	Median ≤ 0.015 mg/ ℓ P
				Total inorganic nitrogen (TIN)[1]		Median ≤ 0.07 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, are maintained in an Ideal category for domestic and irrigation water supply.	95th percentile ≤ 30 mS/m
			System variables	pH	The water in the dam is naturally acidic and it should be maintained within the historical range.	5.5 ≥ pH ≤ 7.5
			Pathogens	E coli	The dam must be maintained in a state that is in an Ideal category for full contact recreation to protect its domestic water supply purpose.	95th percentile ≤ 130 cfu/100ml
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of Berg River Dam must be maintained in a suitable condition to contribute to, or not impact negatively on regional biodiversity.	Habitat suitability and fish wellbeing in a state which is equivalent to a B or better ecological category (low impairment).
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 10 µg/ℓ Chl *a*

[1] – Total inorganic nitrogen (TIN) (mg/l) = NO2+NO3-N (mg/l) + NH4-N (mg/l)

Table 3-53 Supplementary information for Berg River Dam on ecosystem scale

IUA	Dam	Component	Sub-component	Context of the RQO	TPC	Reference
D8 Upper Berg	Berg River Dam	Quantity	Low flows	The Berg River Dam on the upper Berg River is a key water supply dam in the Western Cape Water Supply System, providing urban water supply to the City of Cape Town. Transferred water for irrigation is released downstream, along with compensation releases for irrigation. The dam is operated as in integral part of the WCWSS and the downstream Supplement Scheme, with transfers made to and from Theewaterskloof Dam. The upper reaches of the IUA are located in a strategic water source area.	Not applicable	DWS, 2017.
			High flows			
		Quality	Nutrients	No in-lake water quality monitoring and data collected just downstream of the dam were used. Nutrients are in an oligotrophic (unenriched) state. Land use in the catchment is largely natural with very low export of nutrients. There is a slight risk of nutrient enrichment via transfers from Theewaterskloof Dam, and more so from the Berg Supplement Scheme. As a key domestic and irrigation water supply reservoir in the Western Cape system the current state should be maintained.	Ortho-phosphate (PO_4-P) 0.012 mg/ ℓ P	DWAF, 2002
					Total inorganic nitrogen (TIN) 0.056 mg/ℓ N	
			Salts	The salt concentrations are low in an Ideal category for domestic and irrigation water supply. There is a slight risk of elevated salts being transferred from Theewaterskloof Dam, and from the Berg Supplement Scheme. The low salinity status should be maintained to protect water quality of consumers, and in the middle Berg River.	Electrical conductivity 24 mS/m	DWA, 2006
			System variables	pH in Berg River Dam is slightly acidic to neutral. This is naturally so and should be maintained. Berg River Dam is stratified during the summer months and water should be released from a depth where the in-lake water temperature is similar to the inflowing water temperature.	pH 6 ≥ pH ≤ 7	
		Biota	Fish	Berg River Dam has no conservation status because the fish community is dominated by invasive alien fish species such as bass, catfish and carp (Impson, pers comm., Turner, 2017). The numbers of fish are, however, low due to the low productivity and low nutrient concentrations in the dam. Cape Nature has tried to introduce indigenous whitefish but predation has probably lead to limited numbers surviving. No recreational angling is yet allowed on the dam. The healthy indigenous fish communities in the tributary streams upstream of the dam should be protected.	Habitat suitability and fish wellbeing (FRAI) in a state not worse than a B ecological category	Impson, pers. com. Turner, 2017
			Phytoplankton	Berg River Dam is probably in an oligotrophic state with low phytoplankton growth due to low nutrient concentrations, and reduced light penetration resulting from the tea coloured water in the dam (no in-lake chlorophyll a monitoring). This should be maintained to prevent an increase in domestic water treatment costs.	Chlorophyll a ≤ 12 µg/ℓ	DWAF, 2002

Table 3-54 EWR for the Berg River Dam (EWR 1 C (DWAF 1996)) (refer to Table 3-47)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	VOL ($X10^6$ m^3)	MAR %
	TRN	***TRN***	***DRY***	***DRY***	***DRY***	***DRY***	***TRN***	***TRN***	***WET***	***WET***	***WET***	***TRN***		
MAINTENANCE														
CAPPING FLOWS	**3.1**	**3.1**	**3.1**	**3.1**	**3.1**	**3.1**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**		
LOW FLOWS m^3s^{-1}	**0.8**	**0.5**	**0.4**	**0.3**	**0.3**	**0.3**	**0.8**	**1.2**	**1.6**	**2.1**	**2.1**	**1.5**	**31.3**	23.9
Depth (average in m)	0.25	0.20	0.18	0.15	0.15	0.15	0.25	0.32	0.35	0.40	0.40	0.33		
Flow percentile	80	70	60	50	40	35	40	60	75	70	83	75		
FLOOD m^3s^{-1}		1) 4.5 2) 1.6	1) 4.5 2) 1.6				10.0		30.0	85.0		2.0		
Flood volumes		0.5	0.5				1.6		4.5	12.8		0.2	20.1	15.3
Depth (average in m)		1) 0.68 2) 0.45	1) 0.68 2) 0.45				0.87		1.2	1.65		0.48		
DURATION in days		**1) 0.5 2) 1.0**	**1) 0.5 2) 1.0**				**5.0 peak = 1**		**7.0 peak = 2**	**7.0 peak = 2**		**1.0**		
Return period (years)		1)1:1 2)1:1	1)1:1 2)1:1				1:1		1:1	1:1		1:1		
TOTAL	2.1	1.8	1.6	0.8	0.7	0.8	3.7	3.2	8.6	18.4	5.6	4.1	51.4	39.4
DROUGHT														
LOW FLOWS m^3s^{-1}	0.5	0.30	0.16	0.16	0.16	0.16	0.30	0.50	0.80	0.80	1.0	1.0		
Depth (average in m)	0.20	0.15	0.10	0.10	0.10	0.10	0.20	0.20	0.25	0.25	0.29	0.29		
FLOOD m^3s^{-1}	0.8			0.3					15					
DURATION in days	**1**			**1**					**7.0 peak = 1**					

Table 3-55 RQOs for Wemmershoek Dam in the Upper Berg IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D8 Upper Berg	Wemmershoek Dam	Quantity	Low flows	Dam levels	Dam levels must be sufficient for urban and industrial use water supply, and to supply some irrigators.	% of dam volume No EWR site
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The reservoir is currently in a Natural state and should be kept in an oligotrophic state. for supply to the City of Cape Town and Paarl. As a key domestic water supply reservoir this status should be maintained and protected.	Median ≤ 0.005 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic water use.	95th percentile ≤ 30 mS/m
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category (Moderately impaired state or better).
				Fish health evaluation		Fish health must not deviate significantly from the baseline state.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in an oligotrophic state.	Median ≤ 10 µg/ℓ Chl *a*

Table 3-56 Supplementary information for Wemmershoek Dam on ecosystem scale

IUA	Dam	Component	Sub-component	Context of the RQO	TPC	Reference
D8 Upper Berg	Wemmershoek Dam	Quantity	Low flows	Wemmershoek Dam is a key water supply dam of the City of Cape Town and Drakenstein Municipality. The dam is situated in a near-natural catchment. Domestic and industrial water is supplied from the dam to the Western Cape Water Supply System (City of Cape Town and Paarl) via the Wemmershoek WTW. Releases are made to the Berg River strictly in accordance with a court order, including to some downstream irrigators that irrigate from compensation flows. Fresh water releases are required from the dam to help maintain downstream conditions. There is no EWR site in the downstream Wemmershoek river or located nearby in the Berg River below the Wemmershoek River confluence. The upper reaches of the IUA are located in a strategic water source area.	Not applicable	DWS, 2017.
		Quality	Nutrients	Nutrients are in an oligotrophic (largely natural) state because the catchment is largely natural. As a key domestic water supply reservoir this status should be maintained and protected.	Ortho-phosphate (PO_4) 0.005 mg/ ℓ P Total inorganic nitrogen (TIN) 0.56 mg/ℓ N	DWAF 2002
			Salts	The salt concentrations are low in an Ideal category for domestic water supply. This should be maintained to protect domestic water supply and downstream ecosystems.	Electrical conductivity 24 mS/m	DWA 2006
		Biota	Fish	Wemmershoek Dam has no conservation status because the fish community is dominated by invasive alien fish species such as catfish and carp (Impson, pers. comm., Turner, 2017).	Habitat suitability and fish wellbeing in a state worse than a D ecological category.	Impson, pers comm. Impson (2006) Turner (2017)

Table 3-57 RQOs for Voëlvlei Dam in the Lower Berg IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
B4 Lower Berg	Voëlvlei Dam	Quantity	Low flows	Dam levels	Dam levels must be sufficient for urban and industrial use water supply via the two WTWs, and releases to Berg River for human and irrigation use.	% of dam volume No EWR site
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The reservoir is currently in an Eutrophic state and should be improved to a mesotrophic state or better to protect the water supply to the City of Cape Town and Swartland towns against harmful algal blooms and taste & odour problems in treated domestic water.	Median ≤ 0.025 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic water use and for irrigation water use.	95th percentile ≤ 30 mS/m
			Pathogens	E coli, Faecal coliforms	The system must be maintained in a state that is in an Acceptable category for intermediate contact recreation	95th percentile ≤ 2000 cfu/100ml
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of Voëlvlei Dam must be maintained in a suitable condition to support the local recreational angling industry. Consumption of fish must not pose a health risk to consumers.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category (Moderately impaired state or better).
				Fish health evaluation		Fish health must not deviate significantly from the baseline state. Toxicants in fish tissue must not exceed guideline thresholds.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 20 µg/ℓ Chl *a*

Table 3-58 Supplementary information for Voëlvlei Dam on ecosystem scale

IUA	Dam	Component	Sub-component	Context of the RQO	TPC	Reference
B4 Lower Berg	Voëlvlei Dam	Quantity	Low flows	Voëlvlei Dam is a key water supply reservoir to the City of Cape Town and Swartland towns. This is an off-channel dam (old pan) with limited natural inflow located along a small mountain catchment. Domestic and industrial water is supplied from the dam to the Western Cape Water Supply System (City of Cape Town via the Voëlvlei WTW, and towns in the Swartland via the Swartland WTW). Releases are made to the Berg River via a canal, for abstraction (for use by West Coast and Swartland towns) from the Misverstand Weir and for irrigators along the Berg River. No EWR releases are made. Should the Voëlvlei Augmentation Scheme be constructed, releases will need to be made to maintain the baseflow into the estuary.	Not applicable	DWS, 2017.
		Quality	Nutrients	Algal blooms occur from time to time due to high nutrient concentrations, causing taste & odour problems in drinking water. NEMP data indicate phosphate concentrations in the eutrophic range. These originate from the Klein Berg catchment.	Ortho-phosphate (PO_4) 0.020 mg/ ℓ P Total inorganic nitrogen (TIN) 0.56 mg/ℓ N	DWAF 2002
			Salts	The salt concentrations are low in an Ideal category for domestic and irrigation water supply.	Electrical conductivity 24 mS/m	DWA 2006
			Pathogens	Concerns about pathogens from WWTWs in Tulbach & Wolseley area and NMMP monitoring up to 2013 indicated moderate to high E coli counts in the Klein Berg River. With implementation of Voëlvlei Augmentation Scheme there is potential for contamination from the Berg River. Targets were set to protect intermediate contact recreation and domestic water treatment systems.	E. coli or Faecal coliforms 2000 cfu/100ml	
		Biota	Fish	Voëlvlei Dam has no conservation status because the fish community is dominated by invasive alien fish species such as catfish and carp (Impson, pers comm., Turner, 2017). There is also rainbow trout, tench and some Cape witvis. The dam used to be a clearwater system dominated by bass making it a desired bass fishing venue in the Western Cape. However, after the drought of 2004/5 the turbidity increased and catfish and carp became the dominant species (Impson, 2006). Voëlvlei Dam should be maintained as a recreational fishing venue for non-indigenous species.	Habitat suitability and fish wellbeing in a state worse than a D ecological category.	Impson, pers comm. Impson (2006) Turner (2017)
			Phytoplankton	NEMP data indicated that the frequency of high algal concentrations has increased and satellite imagery indicate that Voëlvlei Dam is now mostly in an eutrophic to hypertrophic state. This has major treatment cost implications for the two WTWs treating water to domestic standards. Targets were set to restore the dam to a mesotrophic (moderately enriched) state.	Chlorophyll a 12 µg/ℓ	DWAF, 2002

Table 3-59 RQOs for Misverstand Weir in the Lower Berg IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
B4 Lower Berg	Misverstand Weir	Quantity	Low flows	Dam levels	Water levels in the weir must be sufficient for supply for human use via the Withoogte WTW.	% of dam volume
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The reservoir is currently in an Eutrophic state and should be in the short term be maintained in its current state or better. The long term objective should be to improve the nutrient status to a mesotrophic state or better to protect the water supply to the West Coast towns.	Median ≤ 0.025 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use, and for irrigation water use.	95th percentile ≤ 70 mS/m
			Pathogens	E. coli	The reservoir must be maintained in a state that is safe for domestic water use (with treatment) and for intermediate contact recreation as the dam is a popular recreation venue.	≤ 1000 counts/100 ml
				Faecal coliforms		≤ 1000 counts/100 ml
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The Berg River Baseline Monitoring report found no indigenous fish species in the mainstem Berg River. The fish health therefore refers to the current non-indigenous species, e.g. carp, catfish, bass, bluegill sunfish, mosquito fish, etc. The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category (Moderately impaired state or better).
				Fish health evaluation		Fish health must not deviate significantly from the baseline state. Toxicants in fish tissue must not exceed guideline thresholds for consumption.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 20 µg/ℓ Chl *a*

Table 3-60 Supplementary information for Misverstand Weir on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	TPC	Reference
B4 Lower Berg	Misverstand Weir	Quantity	Low flows	Misverstand Weir is an important infrastructure component for domestic and industrial water supply source to the West Coast District. Water is abstracted and treated at the Withoogte WTW for supply to West Coast towns. Water spills over the weir to irrigators downstream.	Not applicable	DWS, 2017
		Quality	Nutrients	Nutrients are in an eutrophic range due to domestic and agricultural sources in the middle Berg and Klein Berg catchments.	Ortho-phosphate (PO_4) 0.020 mg/ ℓ P Nitrate (NO_3) Nitrite (NO_2) 0.560 mg/ℓ N	DWAF, 2002
			Salts	Salts are in an acceptable range for irrigation water supply and Ideal range for domestic water supply. It was recommended that it be maintained in the present state to protect industrial users in the Langebaan area, and irrigation users downstream of Misverstand Weir.	Electrical conductivity 56 mS/m	DWA, 2006
		Biota	Fish	The weir has no conservation status because the fish community is dominated by invasive alien fish species such as bass, catfish and carp (Turner, 2017). The weir should be maintained as a recreational fishing venue for non-indigenous species.	Habitat suitability and fish wellbeing in a state worse than a D ecological category.	Turner (2017)
			Phytoplankton	NEMP data indicate that chlorophyll concentrations varied between oligotrophic to mesotrophic conditions with occasional concentrations in the eutrophic range. Elevated turbidity and short water residence times probably kept algal concentrations low. Monitoring stopped in 2010. Targets were set to keep phytoplankton concentrations in a mesotrophic state or better.	Chlorophyll a 16 µg/l	

Table 3-61 RQOs for Upper Steenbras Dam in the Sir Lowry's IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D7 Sir Lowry's	Upper Steenbras Dam	Quantity	Low flows	Dam levels	Dam levels must be sufficient for releases to the Lower Steenbras Dam for urban and industrial use and protection of ecosystem functioning downstream of the Lower Steenbras Dam, hydropower energy generation via the Steenbras Pumped Storage Scheme as well as for water supply to the Western Cape Water Supply System (City of Cape Town) via the Faure WTW.	% of dam volume
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in a mesotrophic state or better.	Median ≤ 0.015 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.07 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use, and for hydropower generation.	95th percentile ≤ 30 mS/m
			Pathogens	E. coli	The system must be maintained in a state that is safe for municipal use (with treatment).	≤ 130 counts/100 ml
				Faecal coliforms		≤ 130 counts/100 ml
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Habitat suitability and fish wellbeing in a state which is equivalent to a B or better ecological category (low impairment index).
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 10 µg/ℓ Chl *a*

Table 3-62 Supplementary information for Upper Steenbras Dam on ecosystem scale

IUA	Dam	Component	Sub-component	Context of the RQO	TPC	Reference
D7 Sir Lowry's	Upper Steenbras Dam	Quantity	Low flows	The dam is situated in the Steenbras River and supplies domestic and industrial water to the City of Cape Town via the Faure WTW. Releases are made as needed to the Lower Steenbras Dam, situated just downstream. The dam is also used for hydropower energy generation via the Steenbras Pumped Storage Scheme.	Not applicable	DWS, 2017
		Quality	Nutrients	Nutrients probably similar to lower dam, i.e. oligo- to mesotrophic (unenriched to moderately) state. As a key domestic water supply and hydropower reservoir this status should be maintained and protected.	Ortho-phosphate (PO_4) 0.010 mg/ ℓ P Total Inorganic Nitrogen (TIN) 0.056 mg/ℓ N	DWS NCMP data
			Salts	The salt concentrations are probably similar to lower dam; low and in an Ideal category for domestic water supply. This should be maintained to protect domestic water supply and hydropower production.	Electrical conductivity 24 mS/m	
			Pathogens	There is a low risk of microbial pollution in the lower dam due because there are no sources of concern in the Steenbras catchment.	E. coli 104 counts/100 ml Faecal coliforms 104 counts/100 ml	DWA, 2006
		Biota	Fish	Both Upper and Lower Steenbras Dam have no conservation status because the fish communities are dominated by invasive alien fish species such as bass, catfish and carp (Impson, pers comm.). The numbers of fish are probably low due to the low productivity and nutrient content of the dam. No recreational angling is allowed on the dam.	Habitat suitability and fish wellbeing in a state worse than a B ecological category.	Impson, pers. comm.
			Phytoplankton	No in-lake or satellite chlorophyll monitoring data available. Protective targets were set to protect the lower dam and the supply of water to the Faure WTW.	Chlorophyll a 8 µg/l	

Table 3-63 RQOs for Lower Steenbras Dam in the Sir Lowry's IUA

IUA	Dam	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D7 Sir Lowry's	Lower Steenbras Dam	Quantity	Low flows	Dam level Spills from dam. Flow releases: Berg EWR8 in G40A *below Lower Steenbras Dam* nMAR = 54.88 million m^3/a pMAR: 0 million m^3/a REC = B/C category	Dam levels must remain sufficient to provide for supply to the Western Cape Water Supply System (City of Cape Town) via the Steenbras WTW, and low flows to the lower Steenbras River and estuary for the protection of ecosystem functioning downstream.	Refer to Table 3-65: EWR for the Steenbras Dam
			High flows		High flow ecological releases should be made during the wet season to meet flood requirements, but within the constraints of the existing outlet structure, and utilising spills where possible.	
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The reservoir must be maintained in a mesotrophic state or better.	Median ≤ 0.015 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.07 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use.	95th percentile ≤ 30 mS/m
			Pathogens	E. coli	The reservoir must be maintained in a state that is safe for contact recreation.	95th percentile ≤ 130 counts/100 ml
				Faecal coliforms		95th percentile ≤ 130 counts/100 ml
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Habitat suitability and fish wellbeing in a state which is equivalent to a B or better ecological category (low impairment index).
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 10 µg/ℓ Chl *a*

Table 3-64 Supplementary information for Lower Steenbras Dam on ecosystem scale

IUA	Dam	Component	Sub-component	Context of the RQO	TPC	Reference
D7 Sir Lowry's	Lower Steenbras Dam	Quantity	Low flows	The dam supplies domestic and industrial water to the City of Cape Town via the Steenbras WTW, and ecological flows to the lower Steenbras River and estuary for the protection of ecosystem functioning downstream.	Not applicable	DWS, 2017
			High flows			
		Quality	Nutrients	Nutrients are in an oligo- to mesotrophic (unenriched to moderately) state because the Steenbras catchment is largely natural and the upstream dam acts as a nutrient trap.	Ortho-phosphate (PO_4) 0.010 mg/ ℓ P	
					Total Inorganic Nitrogen (TIN) 0.056 mg/ℓ N	
			Salts	The salt concentrations are low in an Ideal category for domestic water supply. This should be maintained to protect domestic water supply and downstream ecosystems.	Electrical conductivity 24 mS/m	
			Pathogens	There is a low risk of microbial pollution in the lower dam due to the protection afforded to the upper dam (very limited recreation allowed) and no microbial pollution sources of concern in the Steenbras catchment. A target was set to protect the integrity of the dam as a safe source of drinking water.	E. coli 104 counts/100 ml	DWA, 2006
					Faecal coliforms 104 counts/100 ml	
		Biota	Fish	Both Upper and Lower Steenbras Dam have no conservation status because the fish communities are dominated by invasive alien fish species such as bass, catfish and carp (Impson, pers comm.). The numbers of fish are probably low due to the low productivity and nutrient content of the dam. No recreational angling is allowed on the dam.	Habitat suitability and fish wellbeing in a state worse than a B ecological category.	Impson, pers. comm.
			Phytoplankton	No in-lake chlorophyll monitoring. Satellite imagery provided by Cyanolakes indicate that chlorophyll concentrations were in a mesotrophic state or better but during the 2017/18 drought concentrations in the eutrophic range were observed. Protective targets were set to maintain the reservoir in a mesotrophic state or better.	Chlorophyll *a* 8 µg/l	

Table 3-65: EWR for the Lower Steenbras Dam

Desktop Version 2, Generated on 2009/07/09
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff : R002.NATG4R00

Annual Flows (Mill. cu. m or index values):

MAR	=	54.876
S.Dev.	=	18.443
CV	=	0.336
Q75	=	0.930
Q75/MMF	=	0.203
BFI Index	=	0.397
CV(JJA+JFM) Index	=	1.527

Ecological Category = B/C

Total IFR	=	7.404	(13.49 %MAR)
Maint. Lowflow	=	6.073	(11.07 %MAR)
Drought Lowflow	=	4.095	(7.46 %MAR)
Maint. Highflow	=	1.331	(2.42 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	4.030	3.196	0.793	0.673	0.440	0.000	0.673
Nov	2.136	1.330	0.623	0.509	0.345	0.000	0.509
Dec	1.488	1.203	0.809	0.370	0.253	0.000	0.370
Jan	1.018	1.032	1.013	0.284	0.196	0.000	0.284
Feb	0.773	0.448	0.579	0.235	0.164	0.000	0.235
Mar	0.864	0.813	0.941	0.227	0.150	0.000	0.227
Apr	1.972	2.103	1.066	0.273	0.189	0.000	0.273
May	4.352	4.180	0.960	0.390	0.266	0.121	0.511
Jun	8.480	7.360	0.868	0.605	0.408	0.121	0.726
Jul	11.189	6.818	0.609	0.798	0.535	0.484	1.281
Aug	11.715	6.676	0.570	0.918	0.615	0.484	1.402
Sep	6.861	4.713	0.687	0.792	0.532	0.121	0.913

Month	Peak daily Q (m^3s^{-1})	Duration (Days)	Volume (MCM)	%MAR
October	0.000	0	0.000	0.000
November	0.000	0	0.000	0.000
December	0.000	0	0.000	0.000
January	0.000	0	0.000	0.000
February	0.000	0	0.000	0.000
March	0.000	0	0.000	0.000
April	0.000	0	0.000	0.000
May	1.000	2	0.121	0.220
June	1.000	2	0.121	0.220
July	4.000	2	0.484	0.880
August	4.000	2	0.484	0.880
September	1.000	2	0.121	0.220

3.4 Wetland RQOs and numerical limits

The conceptual understanding of priority wetland resource units was used to define indicators for each Wetland Resource Unit. A summary of the reason for selection of each sub-component is given in Table 3-66.

Table 3-66 Sub-component and indicator selection for prioritized rivers in the study area

Component	Sub-component	Reason for selection	Example of indicator
Quantity	High flows	Floodplain wetlands require high flow events in order to overtop banks. River flow RQOs are given as monthly average volumes (MCM) that include maintenance low and high flows combined.	High flow (i.e. The frequency and size of flood events that overtop the banks and inundated the floodplain)
	Hydroperiod	In order to maintain wetland functioning water needs to be retained and distributed, often with seasonal fluctuations. Wetlands have a dynamic hydrology varying daily, seasonally and annually. Due to this dynamic nature it is difficult to define the frequency and duration of water retention and distribution. An approach to define prolonged saturation up to the temporary zone relies on defining the wetland plants and wetland soils. The hydrological regime (Hydroperiod) describes the behaviour of water within the system and, for wetlands, in the underlying soil. For wetlands and inland water bodies the hydrological regime may be classified according to the period of inundation and saturation, as well as inundation depth class for permanently inundated waterbodies.	Ground water level for seasonal wetlands and extent of open water inundation for seasonally or permanently inundated water bodies
Water quality	Nutrients	Nutrient concentration defines the trophic status (i.e. level of enrichment) of a system	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)
	Pathogens	Pathogens cause waterborne diseases in humans such as diarrhoea, cholera, dysentery, etc. Although human pathogens in general don't affect aquatic biota they are often associated with high organic loads (untreated or partially treated sewage) which affects the dissolved oxygen concentration of the water.	E coli
Habitat	Geomorphology	The relationship of water and sediment creates a stable equilibrium for a wetland. Any change to this equilibrium will push a wetland into a vulnerable state of either aggradation (sediment deposition) or degradation (sediment removal).	Sediment accumulation and erosion features
	Vegetation	Wetland vegetation is an important indicator of a wetland boundary. Alien invasive vegetation encroachment into a wetland may result in reduction of water distribution and push the wetland into a vulnerable state geomorphically.	Wetland vegetation community structure and extent of alien invasion
Biota	Frogs	Frogs require wetland habitats as important stepping stones. A decline in frog populations may be an indicator of a decline in wetland water quality.	Frog diversity
	Phytoplankton	Refer to nutrients as algae is an indicator of enrichment. Free floating algae is referred to as Phytoplankton for open water wetland systems. Benthic algae are the most dominant and conspicuous of freshwater algae, and this is the most important group of primary producers in autotrophic aquatic ecosystems, particularly for seasonal wetlands. Algal species are very responsive to changes in nutrient levels or the level of inundation or saturation. Changes in nutrient and water levels can lead to changes in the species composition and biomass of the algal assemblages in a wetland. Although the nature of these changes is not yet well understood in South Africa, monitoring of algal assemblages is considered to be a useful means of tracking natural or anthropogenic shifts in surface aquatic ecosystems.	Chl-a
	Benthic algae		Benthic algae community structure

As described in the *Evaluation Report* (DWS, 2018), the most important driver of a wetland ecological condition is the quantity of water, followed by quality and the responses of habitat and biota. For most of the HIGH priority wetlands an understanding of the hydrological functioning is important, but for other systems the responders (i.e. vegetation/birds/fish) are considered the most important component for consideration.

Priority wetlands were assessed in the Berg Catchment (G1: Figure 3-35), West Coast (G10M and G21A, G21B: Figure 3-36) and the more urban catchments of City of Cape Town and surrounds (G2 and G40A: Figure 3-37).

The outcomes of the RQO and NL determination for wetlands is shown as follows:

- RQOs for the wetland water per IUA are presented below.
- Supplementary information for Wetland RQOs on ecosystem scale are presented below.

Table 3-67 Key sub-components for prioritised wetlands in the Berg Catchment (G1)

Catchment	RU	Wetland Name	HGM	Sub-component				
				Flow	Hydroperiod	Vegetation	Geomorphology	Other
Berg (G1)	D8-W1	Strategic Water Source wetlands	Seep		x	x		Benthic algae
	D9-W2	West Coast Shale Renosterveld FLOODPLAIN (Berg)	Floodplain	x		x	x	Frogs
	C5-W3	Strategic Water Source wetlands	Seep		x	x		Benthic algae
	B4-W4	West Coast Shale Renosterveld FLOODPLAIN (Berg)	Floodplain	x		x	x	Frogs
	B4-W5	Northwest Sandstone Fynbos SEEP (Boesmans River)	Seep		x	x		Benthic algae
		West Coast Shale Renosterveld FLOODPLAIN (Boesmans River)	Floodplain	x		x		Frogs
	B4-W6	West Coast Shale Renosterveld DEPRESSION (Kiekoesvlei)	Depression		x	x		Nutrients, Benthic algae
	B4-W7	West Coast Shale Renosterveld DEPRESSION (Koekiespan)	Depression		x	x		Nutrients, Benthic algae
	A1-W8	Southwestern Shale Fynbos UNCHANNELED VALLEY BOTTOM (Berg)	Unchanneled valley bottom		x	x	x	

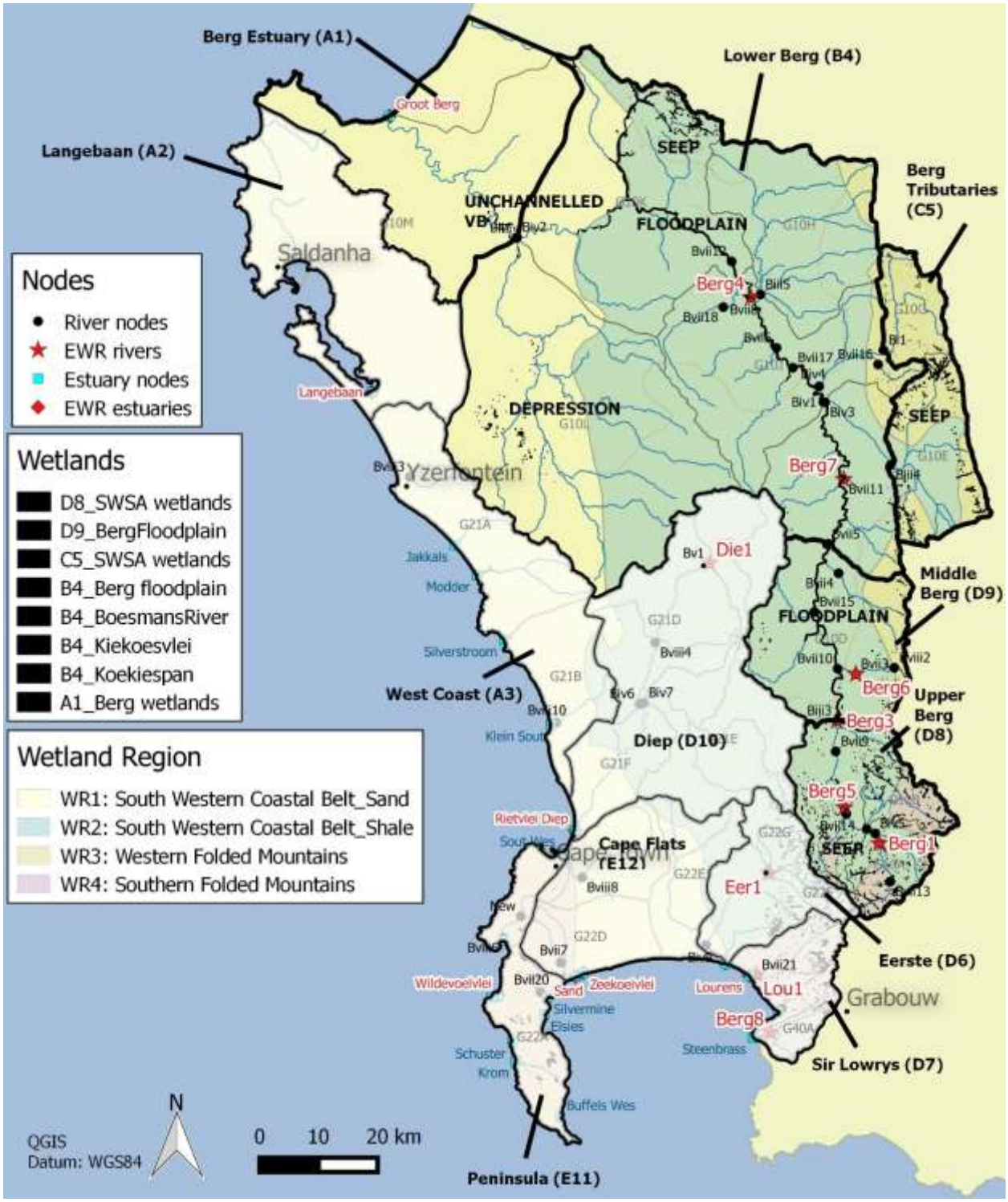


Figure 3-35 Wetlands and wetland regions associated with each IUA in the Berg Catchment (G1)

Table 3-68 RQOs for Wetlands within the Upper Berg IUA (D8)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D8	Southern Folded Mountains (WR4)	D8-W1	SWSA* Southwest Sandstone Fynbos_ Seep	A	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of seeps in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Seeps to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Tale 3-69 Supplementary information for Wetland within the Upper Berg IUA (D8)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D8	Southern Folded Mountains (WR4)	D8-W1	SWSA* Southwest Sandstone Fynbos_Seep	Quantity	Hydroperiod	Groundwater level	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Habitat	Vegetation	Wetland vegetation community structure	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	

Table 3-70 RQOs for Wetlands within the Middle Berg IUA (D9)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D9	Southern Folded Mountains (WR4)	D9-W2	West Coast Shale Renosterveld FLOODPLAIN (Berg)	C	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at river node Biii3 to be maintained.
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation versus invasive vegetation (both alien invasive plants and invasive plants) to be maintained.	Define wetland vegetation community structure and monitor annually.
					Habitat	Geomorphology	Alien invasive plants on floodplain banks	Alien invasive vegetation on floodbanks need to be maintained in order to limit erosion features.	Assess geomorphology and monitor annually. Alien invasive plants on river banks to be managed.

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
					Biota	Frogs	Frog diversity	NFEPA frog (wetland within 500 m of threatened frog species as listed by IUCN red data listing) population to be maintained.	Auditory survey during breeding season (end of wet season). Develop an amphibian acoustic library for surveying every second year.

Table 3-71 Supplementary information for Wetland within the Middle Berg IUA (D9)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D9	Southern Folded Mountains (WR4)	D9-W2	West Coast Shale Renosterveld FLOODPLAIN (Berg)	Quantity	Flow	High flow	Floodplain requires overbank flooding in order to inundate floodplain vegetation.	N/A	N/A
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered Swartland Shale Renosterveld.	N/A	SANBI, 2017 and Nel et al., 2011
				Habitat	Geomorphology	Alien invasive plants on floodplain banks	Alien invasive vegetation causes erosion of river banks.	N/A	Berg River Improvement Implementation Plan, 2009
				Biota	Frogs	Frog diversity	NFEPA frog populations to be maintained.	N/A	Nel et al., 2011

Table 3-72 RQOs for Wetlands within the Berg Tributaries IUA (C5)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
C5	Western Folded Mountains (WR3)	C5-W3	SWSA* Southwest Alluvium Fynbos Seep and Channelled Valley-bottom	A	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of seeps and channelled valley bottom wetlands in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Seeps and channelled valley bottom wetlands to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Seeps and channelled valley bottom wetlands to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Tale 3-73 Supplementary information for Wetland within the Berg Tributaries IUA (C5)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
C5	Western Folded Mountains (WR3)	C5-W3	SWSA* Southwest Alluvium Fynbos Seep and Channelled Valley-bottom	Quantity	Hydroperiod	Groundwater level	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Habitat	Vegetation	Wetland vegetation community structure	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	

Table 3-74 RQOs for Wetlands within the Lower Berg IUA (B4)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
B4	South Western Coastal Belt_Sand (WR1) and South Western Coastal Belt_Shale (WR2)	B4-W4	West Coast Shale Renosterveld (Berg FLOODPLAIN)	C	Quantity	Flow	High flow	High flow events (frequency and size) need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow frequency and size at Bvii5 to be maintained.
					Habitat	Geomorphology	Alien invasive plants on floodplain banks	Alien invasive vegetation on floodbanks need to be maintained in order to limit erosion features.	Assess geomorphology and monitor every 5 years. Alien invasive plants on river banks to be managed.
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation versus invasive vegetation (both alien invasive plants and invasive plants) to be maintained.	Define wetland vegetation community structure and monitor annually.
					Biota	Frogs	Frog diversity	NFEPA frog (wetland within 500 m of threatened frog species as listed by IUCN red data listing) population to be maintained.	Auditory survey during breeding season (end of wet season). Develop an amphibian acoustic library for surveying every second year.
	South Western Coastal Belt_Shale (WR2)	B4-W5	Northwest Sandstone Fynbos SEEP (Boesmans River)	AB	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of seeps and channelled valley bottom wetlands in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
					Biota	Benthic algae	Benthic algae community structure	Seeps to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.
			West Coast Shale Renosterveld FLOODPLAIN (Boesmans River)	C	Quantity	Flow	High flow	High flow events (frequency and size) need to be maintained in order to overtop banks and inundate floodplain vegetation.	No upstream node, but monitor upstream seeps which provide water to floodplain.
					Habitat	Vegetation	Wetland vegetation community structure	Vulnerable vegetation versus invasive vegetation (both alien invasive plants and invasive plants) to be maintained.	Define wetland vegetation community structure and monitor annually.
					Biota	Frogs	Frog diversity	NFEPA frog (wetland within 500 m of threatened frog species as listed by IUCN red data listing) population to be maintained.	Auditory survey during breeding season (end of wet season). Develop an amphibian acoustic library for surveying every second year.
	South Western Coastal Belt_Shale (WR2)	B4-W6	West Coast Shale Renosterveld DEPRESSION (Kiekoesvlei)	C	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of depression to be maintained in order to provide for wetland habitat.	Define groundwater level and monitor annually
					Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Maintain or improve nutrient level.	Define nutrient level and monitor during dry season annually.
					Habitat	Vegetation	Wetland vegetation community structure	Freshwater depression to be maintained as important habitat through maintenance of vegetation community structure.	Define wetland vegetation community structure and monitor annually
					Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually
	South Western Coastal Belt_Shale (WR2)	B4-W7	West Coast Shale Renosterveld Depression (Koekiespan)	C	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of saline depression to be maintained in order to provide for wetland habitat.	Define groundwater level and monitor annually
					Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Maintain or improve nutrient level.	Define nutrient level and monitor during dry season annually.
					Habitat	Vegetation	Wetland vegetation community structure	Saline depression to be maintained as important habitat through maintenance of vegetation community structure.	Define wetland vegetation community structure and monitor annually
					Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually

Table 3-75 Supplementary information for Wetland within the Lower Berg IUA (B4)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
B4	South Western Coastal	B4	West Coast	Quantity	Flow	High flow	Floodplain requires overbank flooding in order to inundate floodplain vegetation.	N/A	N/A

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
				Habitat	Geomorphology	Alien invasive plants on floodplain banks	Alien invasive vegetation causes erosion of river banks.	N/A	Berg River Improvement Implementation Plan, 2009
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered Swartland Shale Renosterveld.	N/A	SANBI, 2017 and Nel et al., 2011
				Biota	Frog	Frog diversity	NFEPA frog populations to be maintained.	N/A	Nel et al., 2011
	South Western Coastal Belt_Shale (WR2)	B4-W5	Northwest Fynbos Sandstone (Boesmans SEEP River)	Quantity	Hydroperiod	Groundwater level	Important hillslope seeps contribute to water supply of downstream rivers. Seeps are also priority NFEPA clusters.	N/A	CSIR, 2017; Nel et al., 2011
				Habitat	Vegetation	Wetland vegetation community structure	Important hillslope seeps contribute to water supply of downstream rivers. Seeps are also priority NFEPA clusters.	N/A	CSIR, 2017; Nel et al., 2011
				Biota	Benthic algae	Benthic algae presence	Benthic algae indicative of water quality and quantity changes.	N/A	
	South Western Coastal Belt_Shale (WR2)	B4-W6	West Coast Shale Renosterveld DEPRESSION (Kiekoesvlei)	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of depression to be maintained in order to provide for wetland habitat.	N/A	N/A
				Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Depression wetlands vulnerable to pollution.	N/A	Malan et al., 2015
				Habitat	Vegetation	Wetland vegetation community structure	Freshwater depression to be maintained as important habitat through maintenance of natural vegetation versus alien invasive vegetation. Vegetation type (Swartland Shale Renosterveld) is critically threatened.	N/A	SANBI, 2017
				Biota	Benthic algae	Benthic algae presence	Benthic algae indicative of water quality and quantity changes.	N/A	
	South Western Coastal Belt_Shale (WR2)	B4-W7	West Coast Shale Renosterveld DEPRESSION (Kiekoesvlei)	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of saline depression to be maintained in order to provide for wetland habitat.	N/A	N/A
				Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Depression wetlands vulnerable to pollution.	N/A	Malan et al., 2015
				Habitat	Vegetation	Wetland vegetation community structure	Saline depression to be maintained as important habitat through maintenance of natural vegetation versus alien invasive vegetation. Vegetation type (Swartland Shale Renosterveld) is critically threatened.	N/A	SANBI, 2017
				Biota	Benthic algae	Benthic algae presence	Benthic algae indicative of water quality and quantity changes.	N/A	

Table 3-76 RQOs for Wetlands within the Berg Estuary IUA (A1)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
A1	South Western Coastal Belt_Sand (WR1)	A1-W8	Southwestern Shale Fynbos UNCHANNELED VALLEY BOTTOM	C	Quantity	Hydroperiod	Groundwater level	Water distribution and retention is important in unchanneled valley-bottom wetlands.	Define groundwater level and monitor annually
					Habitat	Geomorphology	Erosion features	Limited erosion features.	Assess geomorphology to establish baseline and monitor every 5 years.
					Habitat	Vegetation	Wetland vegetation community structure	Endangered vegetation to be maintained and alien invasive plants managed. Maintain connectivity of vegetation habitat between NFEPA wetland clusters.	Define wetland vegetation community structure and monitor annually

Table 3-77 Supplementary information for Wetland within the Berg Estuary IUA (A1)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
A1	South Western Coastal Belt_Sand (WR1)	A1-W8	Southwestern Shale Fynbos Unchanneled Valley Bottom (Berg)	Quantity	Hydroperiod	Groundwater level	Unchanneled valley-bottom wetlands require retention of water with limited flow concentration.	N/A	N/A
				Habitat	Geomorphology	Erosion features	Headcuts within unchanneled valley-bottom wetlands will encourage the concentration of flow through the wetland, thus limiting the water distribution and retention.	N/A	N/A
				Habitat	Vegetation	Wetland vegetation community structure	Southwest Sand Fynbos vegetation is endangered and hardly protected. NFEPA cluster provides important connectivity for biota.	N/A	SANBI, 2017, Nel et al., 2011

Table 3-78 Key sub-components for prioritised wetlands along the West Coast IUA (G10M and G21A, G21B)

Catchment	RU	Wetland Name	HGM	Sub-component				
				Flow	Hydroperiod	Vegetation	Geomorphology	Other
West Coast (G10M and G21A, G21B)	A2-W9	Salt marsh SEEP (Geelbek)	Seep		x	x		Benthic algae
	A3-W10	Southwest Sand Fynbos DEPRESSION (Yzerfontein)	Depression		x	x	x	Benthic algae

Figure 3-36 Wetlands and wetland regions associated with each IUA along the West Coast (G10M and G21A, G21B)

Table 3-79 RQOs for Wetlands within the Langebaan IUA (A2)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
A2	South Western Coastal Belt_Sand (WR1)	A2-W9	Salt marsh SEEP (Geelbek)		Quantity	Hydroperiod	Groundwater level	Groundwater levels to be maintained.	Define groundwater level and monitor annually
					Habitat	Vegetation	Wetland vegetation community structure	Wetland vegetation to be maintained in order to provide important habitat for Ramsar wetland.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually

Table 3-80 Supplementary information for Wetland within the Langebaan IUA (A2)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
A2	South Western Coastal Belt_Sand (WR1)	A2– W9	Salt marsh SEEP (Geelbek)	QUANTITY	Hydroperiod	Water level	Seep maintained by precipitation and groundwater.	N/A	CSIR, 2004
				HABITAT	Vegetation	Wetland vegetation community structure	Cape Estuarine Salt Marsh vegetation is not vulnerable but Langebaan Lagoon is a Ramsar wetland therefore maintenance of the vegetation habitat is important.	N/A	SANBI, 2017, Langebaan Ramsar conditions
				BIOTA	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	

Table 3-81 RQOs for Wetlands within the West Coast IUA (A3)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
A3	South Western Coastal Belt_Sand (WR1)	A3-W10	Southwest Sand Fynbos DEPRESSION (Yzerfontein)	B	QUANTITY	Hydroperiod	Groundwater level	Hydrological functioning of saline depression to be maintained in order to provide for wetland habitat.	Define groundwater level and monitor annually
					HABITAT	Geomorphology	Depth of depression	Depth of depression to be maintained at levels that maintain hydroperiod.	Assess geomorphology to establish baseline and monitor every 5 years.
					HABITAT	Vegetation	Wetland vegetation community structure	Saline depression to be maintained as important habitat through maintenance of natural vegetation versus alien invasive vegetation.	Define wetland vegetation community structure and monitor annually
					BIOTA	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually

Table 3-82 Supplementary information for Wetland within A3 IUA

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
A3	South Western Coastal Belt_Sand (WR1)	A3-W10	Southwest Sand Fynbos DEPRESSION (Yzerfontein)	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of saline depression to be maintained in order to provide for wetland habitat.	N/A	Malan et al., 2015
				Habitat	Geomorphology	Depth of depression	Depression at risk due to gypsum mining. Mining removes sediment which changes the geomorphology of wetland.	N/A	Malan et al., 2015
				Habitat	Vegetation	Wetland vegetation community structure	The vulnerable Cape Inland Salt Pans vegetation needs to be maintained in order to maintain integrity of wetland.	N/A	SANBI, 2017
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	

Table 3-83 Key sub-components for prioritised wetlands in the G2 catchments (and G40A)

Catchment	RU	Wetland Name	HGM	Sub-component				
				Flow	Hydroperiod	Vegetation	Geomorphology	Other
Urban catchments (G2 and G40A)	D10-W11	Southwest Sand Fynbos FLOODPLAIN (Rietvlei)	Floodplain	x		x		
		Dune Strandveld FLOODPLAIN (Rietvlei)	Floodplain		x	x		
	D10-W12	Depression and Seeps (Riverlands)	Depression and seeps		x	x		Benthic algae
	E11-W13	Sand Fynbos DEPRESSION (Wildvoelvlei: open water)	Depression		x			Nutrients, Pathogens, Phytoplankton
	E11-W14	Sand Fynbos DEPRESSION (Seasonal)	Depression		x	x		Benthic algae
	E11-W15	Sand Fynbos Depression (Pick n Pay Reedbeds: open water)	Depression		x			Nutrients, Frogs
	E11-W16	Strategic Water Source wetlands	Flat		x	x		Benthic algae
	E12-W17	DEPRESSION (Zeekoeivlei main waterbody)	Depression		x	x		Nutrients, Pathogens, Phytoplankton
		DEPRESSION (Zeekoeivlei seasonal)	Depression		x	x		
	E12-W18	DEPRESSION (Rondevlei main water body)	Depression		x	x		Nutrients, Pathogens, Phytoplankton
		DEPRESSION (Rondevlei seasonal)	Depression		x	x		
	E12-W19	DEPRESSION (Blouvlei)	Depression		x	x		
	E12-W20	FLOODPLAIN (Nooiesfontein)	Floodplain	x		x		
	E12-W21	DEPRESSION (Princessvlei)	Depression		x			Nutrients, Pathogens
	E12-W22	DUNE SLACK (Denel wetlands)	Dune Slack		x	x		Benthic algae
	D7-W23	Strategic Water Source wetlands	Seep		x	x		Benthic algae
	D6-W24	Strategic Water Source wetlands	Seep		x	x		Benthic algae

Figure 3-37 Wetlands and wetland regions associated with each IUA within G2 catchments (and G40A)

Table 3-84 RQOs for Wetlands within the Diep IUA (D10)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D10	South Western Coastal Belt_Sand (WR1)	D10-W11	Southwest Sand Fynbos FLOODPLAIN (Rietvlei)	C	Quantity	Flow	High flow	High flow events (frequency and size) need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow event frequency and size at upstream river nodes to be maintained.
					Habitat	Vegetation	Wetland vegetation community structure	Vegetation community structure to be maintained and invasive plants managed.	Define wetland vegetation community structure and monitor annually
			Dune Strandveld FLOODPLAIN (Rietvlei)	A	Quantity	Hydroperiod	Groundwater level	Seasonality to be maintained in order to retain and distribute water for wetland vegetation.	Define groundwater level and monitor annually
					Habitat	Vegetation	Wetland vegetation community structure	Vegetation to be maintained and invasive plants managed.	Define wetland vegetation community structure and monitor annually
	South Western Coastal Belt_Sand (WR1)	D10-W12	Depression and Seeps (Riverlands)		Quantity	Hydroperiod	Groundwater level	Seasonality to be maintained in order to retain and distribute water for wetland vegetation.	Define groundwater level and monitor annually
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation to be maintained and alien invasive plants managed.	Define wetland vegetation community structure and monitor annually
					Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually

Table 3-85 Supplementary information for Wetland within the Diep IUA (D10)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D10	South Western Coastal Belt_Sand (WR1)	D10-W11	Southwest Sand Fynbos FLOODPLAIN (Rietvlei)	Quantity	Flow	High flow	Floodplain requires overbank flooding in order to inundate floodplain vegetation.	N/A	N/A
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered Cape Sand Fynbos vegetation needs to be maintained.	N/A	SANBI, 2017
D10			Dune Strandveld FLOODPLAIN (Rietvlei)	Quantity	Hydroperiod	Water level	Seasonality to be maintained.	N/A	City of Cape Town Wetland Inventory.
				Habitat	Vegetation	Wetland vegetation community structure	Natural vegetation (Cape Inland Salt Pans and Cape Lowland Freshwater Wetlands) versus invasive vegetation extent to be maintained.	N/A	SANBI, 2017

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D10	South Western Coastal Belt_Shale (WR2)	D10-W12	DEPRESSION and SEEPS (Riverlands)	Quantity	Hydroperiod	Water level	Surface water inputs from precipitation, overland low and seasonal stream. The wetted perimeter indicates the level of water distribution and retention.	N/A	Unpublished wetland assessment
				Habitat	Vegetation	Wetland vegetation community structure	Atlantis Sand Fynbos vegetation with rare plant: *Erica capensis*.	N/A	SANBI, 2017 Unpublished wetland assessment
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	TMGA-EMA, 2010

Table 3-86 RQOs for Wetlands within the Peninsula IUA (E11)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
E11	Southern Folded Mountains_Peninsula (WR5)	E11-W13	Sand Fynbos DEPRESSION (Wildvoelvlei: open water)		Quantity	Hydroperiod	Wetland water inundation extent	Water levels and water retention to be maintained.	Define wetland inundation level and monitor annually.
					Quality	Nutrients and pathogens	PO_4-P and TIN-N	Nutrient levels for present state rating value at a tolerable (D) level.	PO_4-P (mg/L) Tolerable: 0.025-0.125
									TIN-N (mg/L) Tolerable: 1.0-4.0
							E. Coli	Pathogen levels for recreational use (intermediate contact) need to be maintained at a tolerable level with the intention to improve to an acceptable level.	E. coli to be Tolerable: 4000 or better with the intention to improve to Acceptable: 2500 or better.
					Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at a tolerable (D) level.	Phytoplankton Chl-a (µg/L) Tolerable: 20-30
	Southern Folded Mountains_Peninsula (WR5)	E11-W14	Sand Fynbos DEPRESSION (Seasonal)	B	Quantity	Hydroperiod	Groundwater level	Seasonality to be maintained.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Endangered vegetation to be maintained and alien invasive plants managed.	Define wetland vegetation community structure and monitor annually.
	Southern Folded Mountains_Peninsula (WR5)	E11-W15	Sand Fynbos Depression (Pick n Pay Reedbeds)	C	Quantity	Hydroperiod	Groundwater level	Water levels and water retention to be maintained.	Define groundwater level and monitor annually.
					Quality	Nutrients	PO_4-P and TIN-N	Nutrient levels for present state rating value at acceptable (C) level.	PO_4-P (mg/L) Acceptable: 0.015-0.025
									TIN-N (mg/L) Acceptable: 0.7-1.0
					Habitat	Vegetation	Wetland vegetation community structure	Wetland vegetation to be maintained and invasive plants (such as reeds) managed.	Define wetland vegetation community structure and monitor annually.
					Biota	Frogs	Frog diversity	NFEPA frog (wetland within 500 m of threatened frog species as listed by IUCN red data listing) population to be maintained.	Auditory survey during breeding season (end of wet season). Develop an amphibian acoustic library for surveying every second year.

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
	Southern Folded Mountains_Peninsula (WR5)	E11-W16	SWSA* Southwest Sandstone Fynbos Unchanneled valley-bottom, flat	A	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of Wetland in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Wetland to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Wetland to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Table 3-87 Supplementary information for Wetland within the Peninsula IUA (E11)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
E11	Southern Folded Mountains_Peninsula (WR5)	E11-W13	Sand Fynbos DEPRESSION (Wildvoelvlei open water)	Quantity	Hydroperiod	Wetland water inundation extent	Water levels and water retention to be maintained.	N/A	N/A
				Quality	Water quality	PO_4-P and TIN-N	Nutrient levels for present state rating value at a tolerable (D) level due to the recreational use of the wetland and the current condition of the wetland.	PO_4-P (mg/L) not above 0.125	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
								TIN-N (mg/L) not above 4.0	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
						Pathogens	Pathogen levels for recreational use (intermediate contact) need to be maintained at a tolerable level with the intention to improve to acceptable.	E. coli not less than 4000	Resource Directed Management of Water Quality (DWAF, 2006)
				Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at a tolerable (D) level due to the recreational use of the wetland and the current condition of the wetland.	Phytoplankton Chl-a (µg/L) not above 30	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
E11	Southern Folded Mountains_	E11-W14	Sand Fynbos DEPRESSION	Quantity	Hydroperiod	Groundwater level	Seasonality to be maintained.	N/A	N/A

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
				Habitat	Vegetation	Wetland vegetation community structure	Hangklip Sand Fynbos is endangered.	N/A	SANBI, 2017
E11	Southern Folded Mountains_Peninsula (WR5)	E11-W15	Sand Fynbos DEPRESSION (Pick n Pay Reedbeds)	Quantity	Hydroperiod	Groundwater level	Water levels and water retention to be maintained.	N/A	N/A
				Quality	Nutrients	PO_4-P and TIN-N	Nutrient levels for present state rating value at an acceptable (C) level due to nutrients enriching the wetland and stimulating overgrowth of reeds.	PO_4-P (mg/L) not above 0.125 TIN-N (mg/L) not above 4.0	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
				Habitat	Vegetation	Wetland vegetation community structure	Natural reedbed may become overgrown with elevated nutrient levels.	N/A	N/A
				Biota	Frogs	Frog diversity	NFEPA frog population to be maintained.	N/A	Nel et al., 2008
E11	Southern Folded Mountains_Peninsula (WR5)	E11-W16	SWSA* Southwest Sandstone Fynbos Unchanneled valley-bottom, flat	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of wetland in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	N/A	CSIR, 2017
				Habitat	Vegetation	Wetland vegetation community structure	Wetland to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	N/A	CSIR, 2017, Nel et al., 2008
				Biota	Benthic algae	Benthic algae community structure	Seeps to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	N/A	TMGA-EMA, 2010

Table 3-88 RQOs for Wetlands within the Cape Flats IUA (E12)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
E12	South Western Coastal Belt_Sand (WR1)	E12-W17	DEPRESSION (Zeekoeivlei main waterbody)	D	Quantity	Hydroperiod	Wetland water inundation extent	Water levels and water retention to be maintained.	Define wetland inundation level and monitor annually.
					Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Nutrient levels for present state rating value at a tolerable (D) level.	PO_4-P (mg/L) Tolerable: 0.025-0.125 TIN-N (mg/L) Tolerable: 1.0-4.0
							E. coli	Pathogen levels for recreational use (intermediate contact) need to be maintained at an ideal level.	E. coli Ideal: 1000
					Habitat	Vegetation	Water weed	Limited water weed infestation.	Seasonal infestation of water weed monitored every year.

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
					Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at a tolerable (D) level.	Phytoplankton Chl-a (µg/L) Tolerable: 20-30
E12			DEPRESSION (Zeekoeivlei seasonal)	B	Quantity	Hydroperiod	Groundwater level	Seasonality of wetland water inputs to be maintained.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Endangered vegetation to be maintained and invasive plants managed.	Define wetland vegetation community structure and monitor annually.
E12	South Western Coastal Belt_Sand (WR1)	E12-W18	DEPRESSION (Rondevlei main water body)	B	Quantity	Hydroperiod	Wetland water inundation extent	Water levels and water retention to be maintained.	Define wetland inundation level and monitor annually.
					Quality	Nutrients	Nutrients	Nutrient levels for present state rating value at an acceptable (C) level.	PO_4-P (mg/L) Acceptable: 0.015-0.025
									TIN-N (mg/L) Acceptable: 0.70-1.0
					Habitat	Vegetation	Water weed	Limited water weed infestation.	Seasonal infestation of water weed monitored every year.
					Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at an acceptable (C) level.	Phytoplankton Chl-a (µg/L) Acceptable: 15-20
E12			DEPRESSION (Rondevlei seasonal)	A	Quantity	Hydroperiod	Groundwater level	Seasonality of wetland water inputs to be maintained.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Endangered vegetation to be maintained and invasive plants managed.	Define wetland vegetation community structure and monitor annually.
E12	South Western Coastal Belt_Sand (WR1)	E12-W20	FLOODPLAIN (Nooiensfontein)	D	Quantity	Flow	High flow	High flow events (frequency and size) need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow frequency and size to be maintained.
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation to be maintained and alien invasive plants managed.	Define wetland vegetation community structure and monitor annually.
E12	South Western Coastal Belt_Sand (WR1)	E12-W19	DEPRESSION (Blouvlei)	B	Quantity	Hydroperiod	Groundwater level	Seasonal water levels and water retention to be maintained.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation to be maintained and alien invasive plants managed.	Define wetland vegetation community structure and monitor annually.
E12	Southern Folde	E1	DEPRES	C	Quantity	Hydroperiod	Wetland water inundation extent	Water levels and water retention to be maintained.	Define wetland inundation level and monitor annually.

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
					Quality	Water quality	Nutrients	Nutrient levels for present state rating value at an acceptable (C) level.	PO_4-P (mg/L) Acceptable: 0.015-0.025
									TIN-N (mg/L) Acceptable: 0.70-1.0
							Pathogens	Pathogen levels for recreational use (intermediate contact) need to be maintained at an acceptable level.	E. coli Acceptable: 2500
					Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at an acceptable (C) level.	Phytoplankton Chl-a (µg/L) Acceptable: 15-20
E12	South Western Coastal Belt_Sand (WR1)	E12-W22	DUNE SLACK (Denel)	A	Quantity	Hydroperiod	Groundwater level	Seasonal water levels and water retention to be maintained.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation to be maintained and alien invasive plants managed.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Wetland to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Table 3-89 Supplementary information for Wetland within the Cape Flats IUA (E12)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
E12	South Western Coastal Belt_Sand (WR1)	E12-W17	DEPRESSION (Zeekoeivlei main waterbody)	Quantity	Hydroperiod	Wetland water inundation extent	Surface water inputs to the wetland are from surrounding stormwater and Big and Little Lotus Rivers. These inputs need to be maintained.	N/A	City of Cape Town Wetland Inventory.
				Quality	Nutrients and pathogens	PO_4-P and TIN-N	Nutrient levels for present state rating value at a tolerable (D) level due to the recreational use of the wetland and the current condition of the wetland.	PO_4-P (mg/L) not above 0.125	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
								TIN-N (mg/L) not above 4.0	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
						E.coli	Pathogen levels for recreational use (intermediate contact) need to be maintained at an Ideal level.	E. coli not above 1000	Resource Directed Management of Water Quality (DWAF, 2006)
				Habitat	Vegetation	Water weed	Aquatic water weed needs to be managed.	N/A	City of Cape Town Wetland Inventory.
				Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at a tolerable (D) level due to the recreational use of the wetland and the current condition of the wetland.	Phytoplankton Chl-a (µg/L) not above 30	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
			DEPRESSION (Zeekoeivlei seasonal)	Quantity	Hydroperiod	Groundwater level	Seasonal wetlands on the perimeter of the open water body to have natural seasonality maintained.	N/A	City of Cape Town Wetland Inventory.
				Habitat	Vegetation	Wetland vegetation community structure	Endangered Cape Flats Dune Strandveld vegetation to be maintained.	N/A	SANBI, 2017
	South Western Coastal Belt_Sand (WR1)	E12-W18	DEPRESSION (Rondevlei)	Quantity	Hydroperiod	Wetland water inundation extent	Depression wetland receives water inputs from surrounding stormwater and Big/Little Lotus Rivers/Princcessvlei. The wetted perimeter indicates the level of water distribution and retention.	N/A	City of Cape Town Wetland Inventory.
				Quality	Nutrients	PO_4-P and TIN-N	Wetland hosts important animals (i.e. Hippos) therefore water quality needs to be maintained in order to allow for this service. Nutrient levels for present state rating value at an acceptable (C) level.	PO_4-P (mg/L) not above 0.125	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
								TIN-N (mg/L) not above 4.0	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
				Habitat	Vegetation	Water weed	Aquatic water weed needs to be managed.	N/A	City of Cape Town Wetland Inventory.
				Biota	Phytoplankton	Chl-a	Wetland hosts important animals (i.e. Hippos) therefore water quality needs to be maintained in order to allow for this service. Nutrient levels for present state rating value at an acceptable (C) level.	Phytoplankton Chl-a (µg/L) not above 30	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
			DEPRESSION (Rondevlei seasonal)	Quantity	Hydroperiod	Groundwater level	Seasonal wetlands on the perimeter of the open water body to have natural seasonality maintained.	N/A	City of Cape Town Wetland Inventory.
				Habitat	Vegetation	Wetland vegetation community structure	Endangered Cape Flats Dune Strandveld vegetation to be maintained.	N/A	SANBI, 2017
	South Western Coastal Belt_Sand (WR1)	E12-W20	FLOODPLAIN (Nooiensfontein)	Quantity	Flow	High flow	Floodplain requires overbank flooding in order to inundate floodplain vegetation.	N/A	City of Cape Town Wetland Inventory.
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered Cape Flats Sand Fynbos vegetation needs to be maintained.	N/A	SANBI, 2017
	South Western Coastal Belt_Sand (WR1)	E12-W19	Blouvlei DEPRESSION	Quantity	Hydroperiod	Groundwater level	Depression wetland receives surface water from groundwater and precipitation. Stormwater inputs are managed.	N/A	Intaka Island Environmental Management Plan
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered Cape Flats Sand Fynbos vegetation needs to be maintained.	N/A	SANBI, 2017

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
	Southern Folded Mountains_Peninsula (WR5)	E12-W21	DEPRESSION (Princessvlei)	Quantity	Hydroperiod	Wetland water inundation extent	Surface water inputs from precipitation, overland low and seasonal stream. The wetted perimeter indicates the level of water distribution and retention.	N/A	City of Cape Town Wetland Inventory.
				Quality	Nutrients and pathogens	PO_4-P and TIN-N	Nutrient levels for present state rating value at an acceptable (C) level due to recreational fishing and use of the wetland.	PO_4-P (mg/L) not above 0.125	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
								TIN-N (mg/L) not above 4.0	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
						E.coli	Pathogen levels for recreational use (intermediate contact) need to be maintained at an acceptable level.	E. coli not above 1000	Resource Directed Management of Water Quality (DWAF, 2006)
				Biota	Phytoplankton	Chl-a	Nutrient levels for present state rating value at an acceptable (C) level due to recreational fishing and use of the wetland.	Phytoplankton Chl-a (µg/L) not above 30	Methods for determining the water quality component of the ecological Reserve for rivers (DWAF, 2008)
	South Western Coastal Belt_Sand (WR1)	E12-W22	DUNE SLACK (Denel)	Quantity	Hydroperiod	Groundwater level	Seasonal water levels and water retention to be maintained.	N/A	City of Cape Town Wetland Inventory.
				Habitat	Vegetation	Wetland vegetation community structure	Critically endangered vegetation to be maintained and alien invasive plants managed.	N/A	SANBI, 2017
				Biota	Benthic algae	Benthic algae community structure	Wetland to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	N/A	TMGA-EMA, 2010

Table 3-90 RQOs for Wetlands within the Eerste IUA (D6)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D6	Southern Folded Mountains (WR4)	D6-W24	SWSA* Southwest Sandstone Fynbos_Seep	A	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of seeps in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Seeps to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Tale 3-91 Supplementary information for Wetland within the Eerste IUA (D6)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D6	Southern Folded Mountains (WR4)	D6-W24	SWSA* Southwest Sandstone Fynbos_SEEP	Quantity	Hydroperiod	Groundwater level	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Habitat	Vegetation	Wetland vegetation community structure	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	TMGA-EMA, 2010

Table 3-92 RQOs for Wetlands within the Sir Lowry's IUA (D7)

IUA	Wetland Region	RU	Wetland Name	TEC	Component	Sub-component	Indicator/ measure	RQO narrative	RQO numeric
D7	Southern Folded Mountains (WR4)	D7-W23	SWSA* Southwest Sandstone Fynbos_Seep	A	Quantity	Hydroperiod	Groundwater level	Hydrological functioning of seeps in Strategic Water Source Areas to be maintained. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define groundwater level and monitor annually.
					Habitat	Vegetation	Wetland vegetation community structure	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define wetland vegetation community structure and monitor annually.
					Biota	Benthic algae	Benthic algae community structure	Seeps to be maintained as Strategic Water Source Areas. Benthic algae indicative of water quality and quantity changes.	Define division of growth form during wet and dry season and monitor wet and dry season annually.

Tale 3-93 Supplementary information for Wetland within the Sir Lowry's IUA (D7)

IUA	Wetland Region	RU	Wetland Name	Component	Sub-component	Indicator/ measure	Context of the RQO	TPC	References
D7	Southern Folded Mountains (WR4)	D7-W23	SWSA* Southwest Sandstone Fynbos_SEEP	Quantity	Hydroperiod	Groundwater level	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Habitat	Vegetation	Wetland vegetation community structure	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
				Biota	Benthic algae	Benthic algae community structure	Benthic algae indicative of water quality and quantity changes.	N/A	TMGA-EMA, 2010

3.5 Groundwater RQOs and numerical limits

Whilst groundwater resource units (GRUs) have been defined for the Berg Catchment, the preferred scale for application of RQOs is at quaternary catchment scale. Therefore, prioritisation of GRUs was completed at quaternary catchment level, with the aim of at least one quaternary catchment being prioritise per GRU.

The groundwater resource units, for which RQOs are developed, are shown in Table 3-94 and in Figure 3-38.

The selected components, sub-components and indicators are listed in Table 3-95. In addition, Table 3-95 provides the narrative RQOs applied, and shows the numerical limits applied for each RQO (where applicable, and where standardised). The supporting information column provides a motivation for the selection of this indicator, and its value. The items listed in Table 3-95 were considered for applicability in each prioritised area. Water quantity and yield related RQOs are aimed at ensuring sufficient yield for all users, and to maintain groundwater discharge to support low flow river requirements. The setting of water quality related RQOs is aimed at maintaining the groundwater quality in relation to its background/present level.

In all cases the setting of RQO's has considered the aquifer-specific conditions such as interaction with surface water, and differing water quality. An RQO that is applicable to all aquifers will be listed as "all", alternatively a specific aquifer grouping will be listed. The setting of RQOs is therefore based on an understanding of the behaviour of the various aquifers within each GRU. This is outlined in the *Status Quo Report* and that information should be referred to in order to support the understanding of the RQOs established (specifically the detailed status quo assessment in Appendix B in the *Status Quo Report*, along with the geological maps).

The recommended RQOs for prioritised RUs in each IUA are shown in Table 3-96 to

Table 3-104.

Table 3-94 Groundwater resource units prioritised for development of RQOs

GRU	Quaternary	Reason for prioritisation / high score (or reason for lack of prioritisation)
1-Peninsula	(None)	GRU is not considered a priority; few criteria are met. G22B may experience an increase in future private groundwater use (in and around city centre), however RQOs considered unnecessary.
2-Cape Flats	G22C	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities (agriculture). Potentially significant future GW use for domestic supply (CCT), and private groundwater use currently under significant increase. The catchment is currently moderately used, projected to increase to heavily used in future. With the current land uses in the catchment, and the predominantly high groundwater vulnerability status (related to the sandy aquifer), there is a high risk of impact on groundwater quality. Groundwater could play a moderate role in supporting EWRs.
	G22D	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities (agriculture). Potentially significant future GW use for domestic supply (CCT), and private groundwater use currently under significant increase. The catchment is currently moderately used, projected to increase to heavily used in future. With the current land uses in the catchment, and the predominantly high groundwater vulnerability status (related to the sandy aquifer), there is a high risk of impact on groundwater quality. Groundwater could play a moderate role in supporting EWRs, and the groundwater-fed wetlands in the quaternary are considered a priority.
	G22E	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities (agriculture). Potentially significant future GW use for domestic supply (CCT), and private groundwater use currently under significant increase. The catchment is currently minimally used, projected to increase to heavily used in future. With the current land uses in the catchment, and the predominantly high groundwater vulnerability status (related to the sandy aquifer), there is a high risk of impact on groundwater quality. Groundwater could play a significant role in supporting EWRs.

GRU	Quaternary	Reason for prioritisation / high score (or reason for lack of prioritisation)
3-Helderberg	(None)	GRU is not considered a priority; few criteria are met. G22F and G22G may experience an increase in future municipal groundwater use (managed via the WULA process), however RQOs considered unnecessary.
4-Paarl-Upper Berg	G10A	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities (agriculture). The catchment is currently minimally used, projected to increase to heavily used in future. With the current land uses in the catchment, there is a moderate risk of impact on groundwater quality. Groundwater could play a moderate role in supporting EWRs.
	G10B	Quaternary catchment lies within a SWSA-gw. The catchment is currently minimally used, projected to increase to moderately used in future. Groundwater could play a significant role in supporting EWRs, and the groundwater-fed wetlands in the quaternary are considered a priority.
5-Tulbagh Valley	G10E	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities (agriculture). The catchment is currently moderately used, projected to increase to heavily used in future. The groundwater-fed wetlands in the quaternary are considered a priority.
6-24 Rivers	G10J	Catchment has moderate groundwater use to support economic activities (agriculture). Groundwater could play a significant role in supporting EWRs, and the groundwater-fed wetlands in the quaternary are considered a priority.
7-Piketberg	(None)	GRU is not considered a priority; few criteria are met. G30A very low score. G30D included in Olifants-doorn and has RQOs developed
8-West Coast	G10L	Quaternary catchment lies within a SWSA-gw, and groundwater supports domestic use in Hopefield. Available data shows a potential decline in water levels and a worsening trend in groundwater quality, hence there is a risk to users. Groundwater could play a moderate role in supporting EWRs and the groundwater-fed wetlands in the quaternary are considered a priority.
	G10M	Quaternary catchment lies within a SWSA-gw, related to the use of groundwater for (part of the) domestic supply to a key economic centre (Saldanha). Groundwater supports domestic supply in several towns (Saldanha, Langebaan, Langebaanweg, Aurora). The catchment is currently minimally used, projected to increase to moderately used in future. Available data shows a potential decline in water levels, hence there is a risk to users. With the current land uses in the catchment, and the predominantly high groundwater vulnerability status (related to the sandy aquifer), there is a high risk of impact on groundwater quality. Groundwater could play a moderate role in supporting EWRs and the groundwater-fed wetlands in the quaternary are considered a priority.
9-Atlantis	G21B	Quaternary catchment lies within a SWSA-gw, related to high groundwater use to support economic activities and the use of groundwater for (part of the) domestic supply to a key economic centre (Atlantis). With the current land uses in the catchment, and the predominantly high groundwater vulnerability status (related to the sandy aquifer), there is a high risk of impact on groundwater quality. The catchment is currently heavily used, and private groundwater use in the area is currently increasing. Groundwater could play a moderate role in supporting EWRs and the groundwater-fed wetlands in the quaternary are considered a priority.
10-Malmesbury	G21D	Groundwater supports domestic supply in Malmesbury and Abbotsdale. The catchment is currently moderately used, projected to increase to heavily used in future. Groundwater could play a significant role in supporting EWRs.

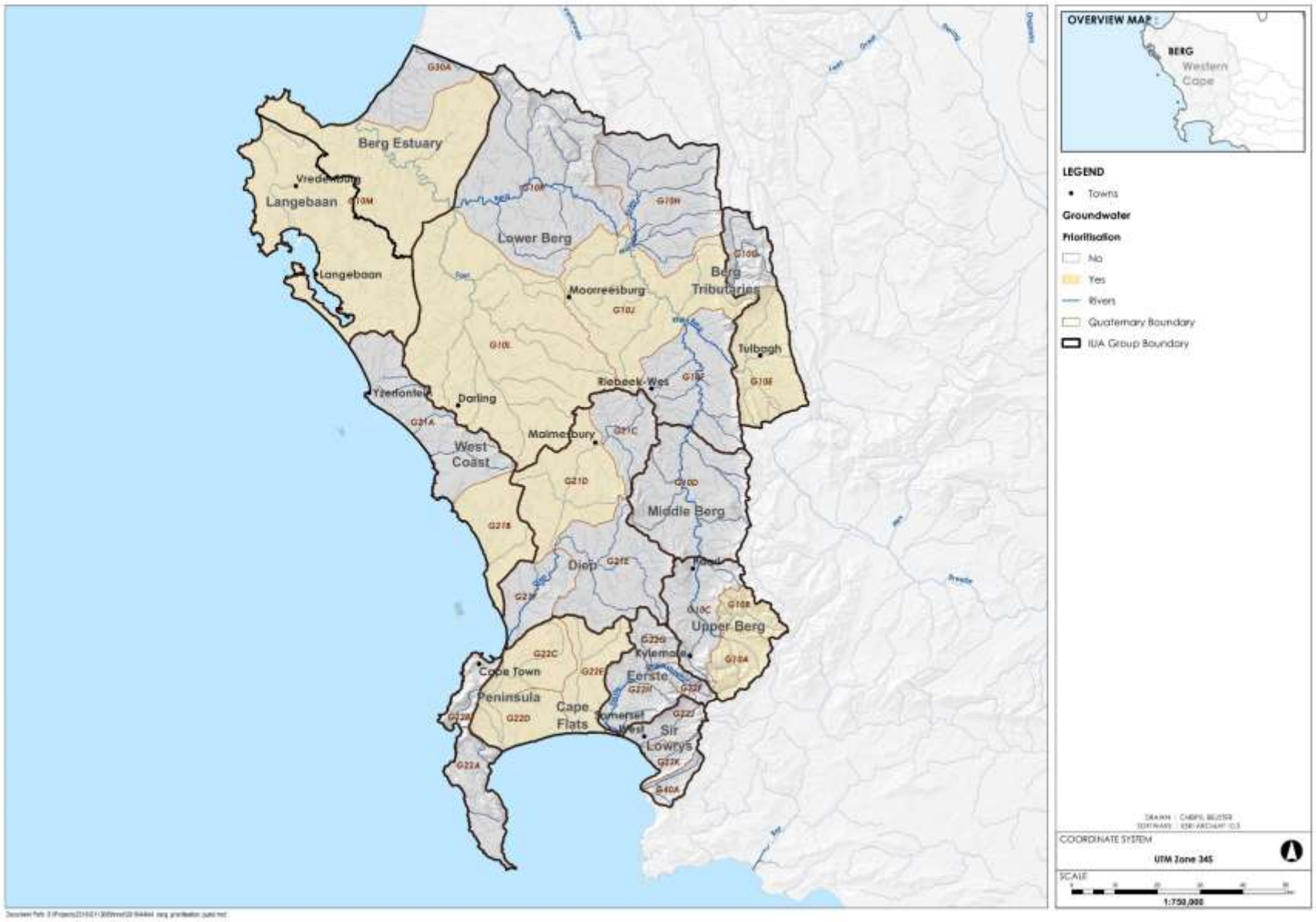


Figure 3-38 Groundwater RUs selected for evaluation in the Berg WMA

Table 3-95 Outcome of Resource Evaluation stage for groundwater showing sub-components, indicators, and RQOs considered for each prioritised GRU

Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric	Supporting information
Quantity	Abstraction	Water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles.	Groundwater use should be sustainable for all users and the environment	n/a	Whilst exploiting groundwater storage is acceptable for managing drought, and could be acceptable for short periods to bridge the transition to other bulk water supplies (i.e. 5-10 years desalination/ re-use), over the long-term, groundwater use should be sustainable for all users and the environment. The RQO essentially implies that groundwater mining is considered unacceptable in the long-term. Implementation of this RQO requires the authority to isolate the cause of groundwater level decline, and identify over-abstraction (unacceptable) from transition to new dynamic equilibrium (unavoidable), drought and climate change (unavoidable).
	Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	0.5 or 1 mamsl	Saline intrusion is a risk in coastal aquifers, and maintaining groundwater levels above sea level prevents saline intrusion via upcoming and direct intrusion.
	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a	Groundwater use should be sustainable for all users and the environment. In areas where groundwater and surface water are hydraulically connected, it is assumed that the reversal of the natural gradient with surface water would have unacceptable impacts. Where groundwater discharges to surface water, groundwater abstraction close to surface water (distance dependent on aquifer diffusivity), or groundwater abstraction rates that reduce aquifer water levels beneath that of the river, would reverse the gradient towards the river, and surface water would be 'lost' to groundwater (indirect recharge). The setting of this RQO assumes that this would be unacceptable (for surface water resources / ecology).
	Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m	Whilst all abstraction reduces natural discharge to some extent and at some point, in time, the timing of surface water depletion (the response time) is related to the distance to surface water, and the hydraulic diffusivity. It is therefore aquifer- and abstraction location- specific. Abstraction far from surface water, and in an aquifer with lower diffusivity, may for all practical purposes not impact on surface water (for millennia). Given the variability in hydraulic diffusivity even at different locations within the same aquifer, the data is not available in order to determine area-specific numerical values. The numerical value listed is in alignment with best-practice guidelines.
	Low flow in river	Compliance with the low flow requirements in the river (as per riverine RQO)	Maintain (groundwater component of) the low flow requirements in the river	(Case specific)	It is assumed that the maintenance low flow is derived from groundwater. Whilst all abstraction reduces natural discharge to some extent and at some point, in time, it would be unacceptable for abstraction to cause groundwater discharge to reduce below the maintenance low flow value required in the catchment to meet the surface water RQOs.
Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall	(Case specific)	Groundwater management measures must ensure groundwater quality is protected. The parameters selected will support identification of a variety of pollution sources (captured in increase in salts and pH), agricultural
	Salts	EC		(Case specific)	
		PO_4		(Case specific)	

Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric	Supporting information
	System variables	pH	not deteriorate from natural background	(Case specific)	pollution (fertilisers), and saline intrusion. The numerical values represent either the 90 or the 95 percentiles for the listed aquifer within the GRU. This is taken as a limit of acceptable deviation from natural background. Where insufficient data exists to establish robust statistics for an aquifer within an area, numerical values are either taken from the same aquifer in neighbouring areas or from data for the same aquifer across the region. In certain cases where local data is not available, and where regional data is considered inapplicable for this area, drinking water quality standards are used.
	Pathogens	E-coli		0 counts / 100 ml	Groundwater management measures must ensure groundwater quality is protected. The parameters selected will support identification of pollution from waste water (pathogens) and other bacteriological sources. The numerical value is based on drinking water quality standards. Although pollution of groundwater is possible, there are no known areas (supported with data) where the source of e-coli in groundwater is thought to be surface water (i.e. poorly functioning WWTW discharging to SW, and SW recharging groundwater). E-coli is however found in groundwater in some areas (i.e. Cape Flats for example, and this is likely (although not proven) linked to leaking sewers. It may also come from contaminated storm water / seepage from informal settlement areas (non-point source pollution). This form of pollution is unacceptable and should be prevented from entering groundwater. A count of 0 is feasible with non-leaking reticulation, and appropriate sanitation systems in urban areas.
	Pathogens	Total Coliform		10 counts / 100ml	

Table 3-96 RQOs and Numerical Limits for groundwater's priority RUs in Cape Flats GRU

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
2-Cape Flats	G22C, G22D, G22E	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>1 mamsl
		Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a

		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All		Low flow in river	Compliance with the lowflow requirements in the river	Maintain (groundwater component of) the low flow requirements in the river, as per surface water RQO requirement.	Maintenance low flow: 0.348 Mm3/a (7.74 %MAR) at Bvii7 (no gauge)
		Coastal cenozoic sediments	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 9.2 mg/l
				Salts	EC		< 180 mS/m
				System variables	pH		6.6 – 8.4
		Basement		Nutrients	NO_3 (as N)		< 11.0 mg/l
				Salts	EC		< 953 mS/m
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

[2]The groundwater quality numerical values assigned for basement aquifers in G22C, G22D, G22E are considered preliminary, and as such will not be gazetted. There is no water quality data for the area, and given the high natural variability in water quality across the region, it is not possible to use a neighbouring catchment. The monitoring / implementation report will provide necessary steps to establish a local baseline.

Table 3-97 RQOs and Numerical Limits for groundwater's priority RUs in Paarl-Upper Berg GRU (G10A)

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
2-Paarl-Upper Berg	G10A	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Low flow in river	Compliance with the lowflow requirements in the river	Maintain (groundwater component of) the low flow requirements in the river, as per surface water RQO requirement.	Maintenance low flow requirements: 29.177 Mm3/a (34.39 %MAR) at G1H076 (Bvii13); 27.421 Mm3/a (19.35 %MAR) at G1H077 (Bviii1)
		All	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic	< 3.3 mg/l

				Salts	EC	use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 70 mS/m
		All		System variable	pH		5.2 – 8.4
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-98 RQOs and Numerical Limits for groundwater's priority RUs in Paarl-Upper Berg GRU (G10B)

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
3-Paarl-Upper Berg	G10B	All	Quantity	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 3.3 mg/l
				Salts	EC		< 70 mS/m
		All		System variable	pH		5.2 – 8.4
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-99 RQOs and Numerical Limits for groundwater's priority RUs in Tulbagh Valley GRU

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
4-Tulbagh Valley	G10E	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic	<11.0 mg/l

				Salts	EC	use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<953 mS/m
		All		System variable	pH		(none)
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

[2]The groundwater quality numerical values assigned for G10E are considered preliminary, and as such will not be gazetted. There is no water quality data for the area, and given the high natural variability in water quality across the region, it is not possible to use a neighbouring catchment. The monitoring / implementation report will provide necessary steps to establish a local baseline.

Table 3-100 RQOs and Numerical Limits for groundwater's priority RUs in 24 Rivers GRU

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
5-24 Rivers	G10J	Superficial aquifers	Quantity	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All		Low flow in river	Compliance with the lowflow requirements in the river	Maintain (groundwater component of) the low flow requirements in the river, as per surface water RQO requirement.	Maintenance low flow requirements: 114.338 Mm3/a (13.28 %MAR) at G1H013 (Bvii6)
		Cenozoic coastal sand	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 6.9 mg/l
				Salts	EC		< 942 mS/m
		Basement		Nutrients	NO_3 (as N)		<11.0 mg/l
				Salts	EC		< 875 mS/m
		All		System variable	pH		5.2 – 8.1
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-101 RQOs and Numerical Limits for groundwater's priority RUs in West Coast GRU (G10L)

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
6-West Coast	G10L	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a

		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		Coastal cenozoic sand	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 8.2 mg/l
				Salts	EC		< 520 mS/m
		Basement		Nutrients	NO_3 (as N)		< 11.0 mg/l
				Salts	EC		< 899 mS/m
		All		Salts	PO_4		< 0.3 mg/l
		All		System variable	pH		6.7 - 8.3
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-102 RQOs and Numerical Limits for groundwater's priority RUs in West Coast GRU (G10M)

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
7-West Coast	G10M	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>1 mamsl
		All		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All		Discharge	Compliance with the groundwater flow requirements to the Geelbek (Langebaan) estuary	Compliance to the groundwater flow requirements to the estuary, as per estuary RQO requirement	Groundwater inflow not <10% of present day (2017) rate
							Ground water level not <10% below present day

							(2017) level
		Coastal cenozoic sand	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 11.0 mg/l
				Salts	EC		< 520 mS/m
				System Variable	pH		7.1 - 8.4
		Basement		Nutrients	NO_3 (as N)		< 11.0 mg/l
				Salts	EC		< 1571 mS/m
		All		Salts	PO_4		< 0.3 mg/l
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-103 RQOs and Numerical Limits for groundwater's priority RUs in Atlantis GRU

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
8-Atlantis	G21B	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		All		Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>1 mamsl
		All		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 2.3 mg/l
				Salts	EC		< 287 mS/m
		Basement		Nutrients	NO_3 (as N)		< 10.4 mg/l
				Salts	EC		< 1052 mS/m
		All		System variable	pH		6.7 – 8.3
		All		Pathogens	E-coli		0 counts / 100 ml

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
		All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-104 RQOs and Numerical Limits for groundwater's priority RUs in Malmesbury GRU

GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator/ measure	RQO narrative	RQO numeric
9-Malmesbury	G21D	All	Available Yield	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
		Superficial aquifers	Quantity	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
		All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
		All		Low flow in river	Compliance with the lowflow requirements in the river	Compliance to the low flow requirements in the river, as per surface water RQO requirement	Maintenance low flow requirements: 0.578 (6.22 %MAR) at node Biv6 (no gauge)
		Coastal cenozoic sediments	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	< 7.1 mg/l
				Salts	EC		< 358 mS/m
		Basement		Nutrients	NO_3 (as N)		< 6.4 mg/l
				Salts	EC		< 617 mS/m
		All		System variable	pH		6.3 – 8.6
		All		Pathogens	E-coli		0 counts / 100 ml
		All		Pathogens	Total Coliform		<10 counts / 100ml

4 Addressing Uncertainties in RQOs

Some of the key limitation and uncertainties which may influence the confidence of the outcomes of the RQOs and numerical limits process which should be considered when implementing the RQOs are described below.

4.1.1 Rivers

There are placeholders in the RQO tables that can be filled once the monitoring programme commences. The monitoring report will describe how to collect the data required to calculate the missing RQOs. RQOs for rivers were written from data collected in the various Reserve studies, the Berg River Monitoring Programme, the River Ecostatus Monitoring Programme and by the project team in this project. These data are a baseline against which future monitoring data may be compared and adjusted as needed, once a long-term data set is established.

4.1.2 Estuaries

Data availability limits confidence in RQOs for many of the estuaries in the Berg WMA. Confidence cannot be improved without collection of a great deal of additional baseline data.

4.1.3 Dams

There is some uncertainty regarding data availability, which slightly limits the confidence of certain indicators and NLs. The limitation with respect to the outlet structures of almost all dams, may imply that it will remain unlikely that larger floods can be released from almost all dams, unless there is a commitment for significant investment into upgrading the outlet infrastructure. The conflict between high release flows from dams for agriculture vs. low flow EWR requirements in downstream river reaches makes it uncertain whether the seasonality of EWR low flows regimes can be attained, unless irrigation release patterns can be changed, which seems unlikely.

4.1.4 Wetlands

Detailed information available about wetlands is either through the Reserve Determination studies, or through specific rehabilitation projects such as the Working for Wetlands project. In other systems which have not been prioritised as part of larger studies this level of data is not available. The level of detail required for RQO determination for wetlands is not comparable to the level of detail that has gone into the longer term and detailed river or estuarine systems. The spatial scale of wetland systems also needs to be considered as implementation of the RQOs may require monitoring over large spatial scales.

4.1.5 Groundwater

Given the nature of groundwater it is not possible or meaningful to assign numerical limits for several indicators. Some relate to long term trends, or to maintaining relative rather than absolute values. This has become accepted in RQO development for groundwater (for example DWA, 2013), however then requires the regulator to undertake the necessary analysis to determine compliance. RQOs must be implementable, and the non-numeric RQOs and the analysis required to enforce them will specifically be discussed with stakeholders.

The availability of water quality data varies considerably across the area with some quaternary catchments having >100 datasets on which to base a numerical value, and others having less than 5. Where water quality data is sparse, a balance must be struck between setting a limit which may be too stringent for the natural background of that area, and a limit that is too high and provides ineffective aquifer protection. The setting of aquifer-specific values, and the use of the regional aquifer-specific values where local information was not available, have minimised the uncertainties. Nevertheless, where a decision was required, the limits set were generally conservative. A conservative limit is implementable by the Department: the onus would be on a groundwater user to demonstrate that the groundwater quality at their borehole is naturally beyond the limit.

4.2 Way forward

The next step of the RQO determination process, Sub-step 5.8, involves the confidence assessment in both the RQOs and in the process followed in determining the narrative statements. The confidence in the RQOs is dependent on the accuracy of information used in the process. The assessment of confidence was undertaken for the processes applied and associated outputs at both the catchment and Resource Unit scale.

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