water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

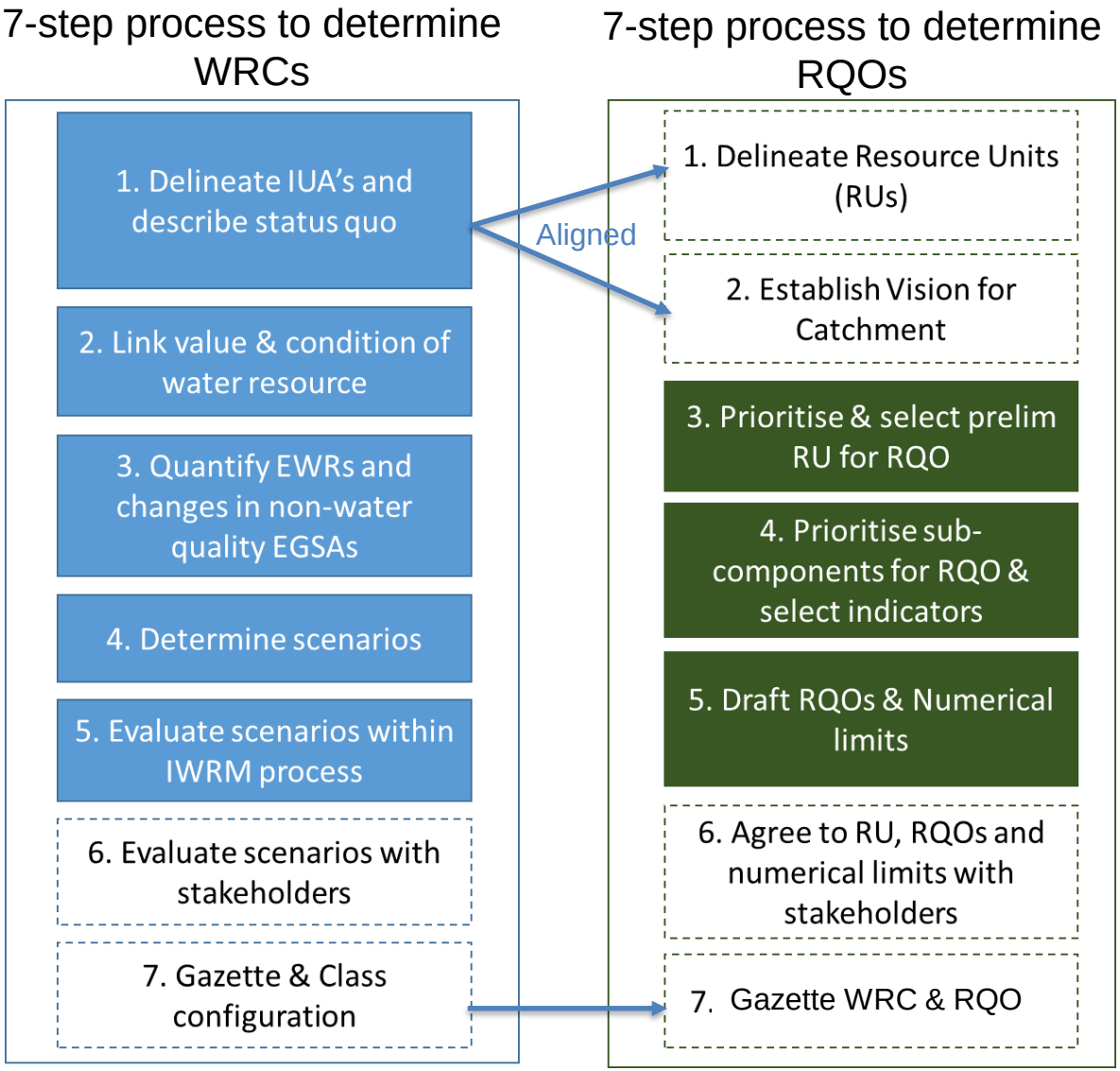
2030 NDP

The Determination of Water Resources Classes and Resource Quality Objectives for the water resources in in the Breede-Gouritz WMA

Project Steering Committee Meeting

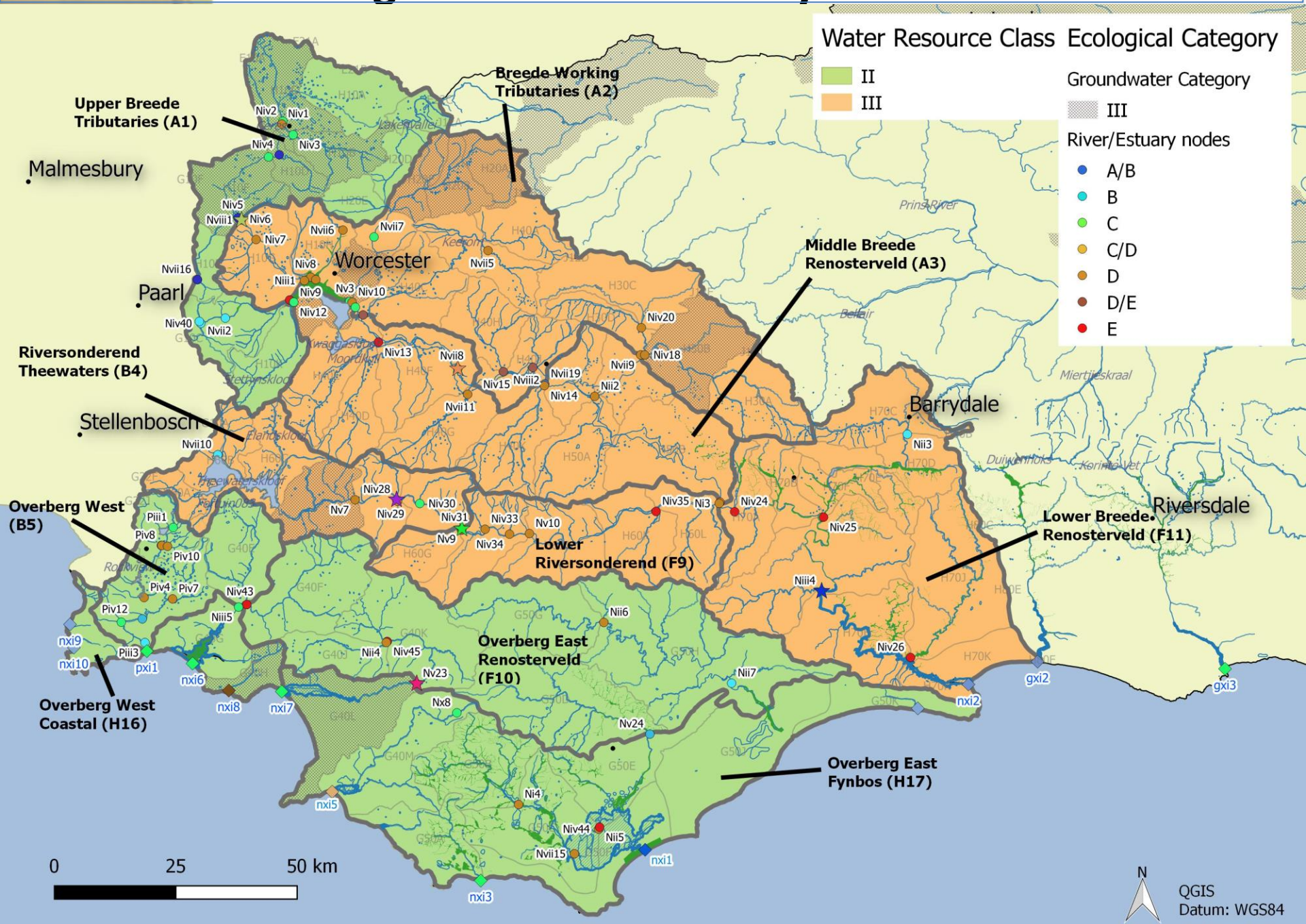
2018

Classification and RQOs Steps



Proposed Scenario

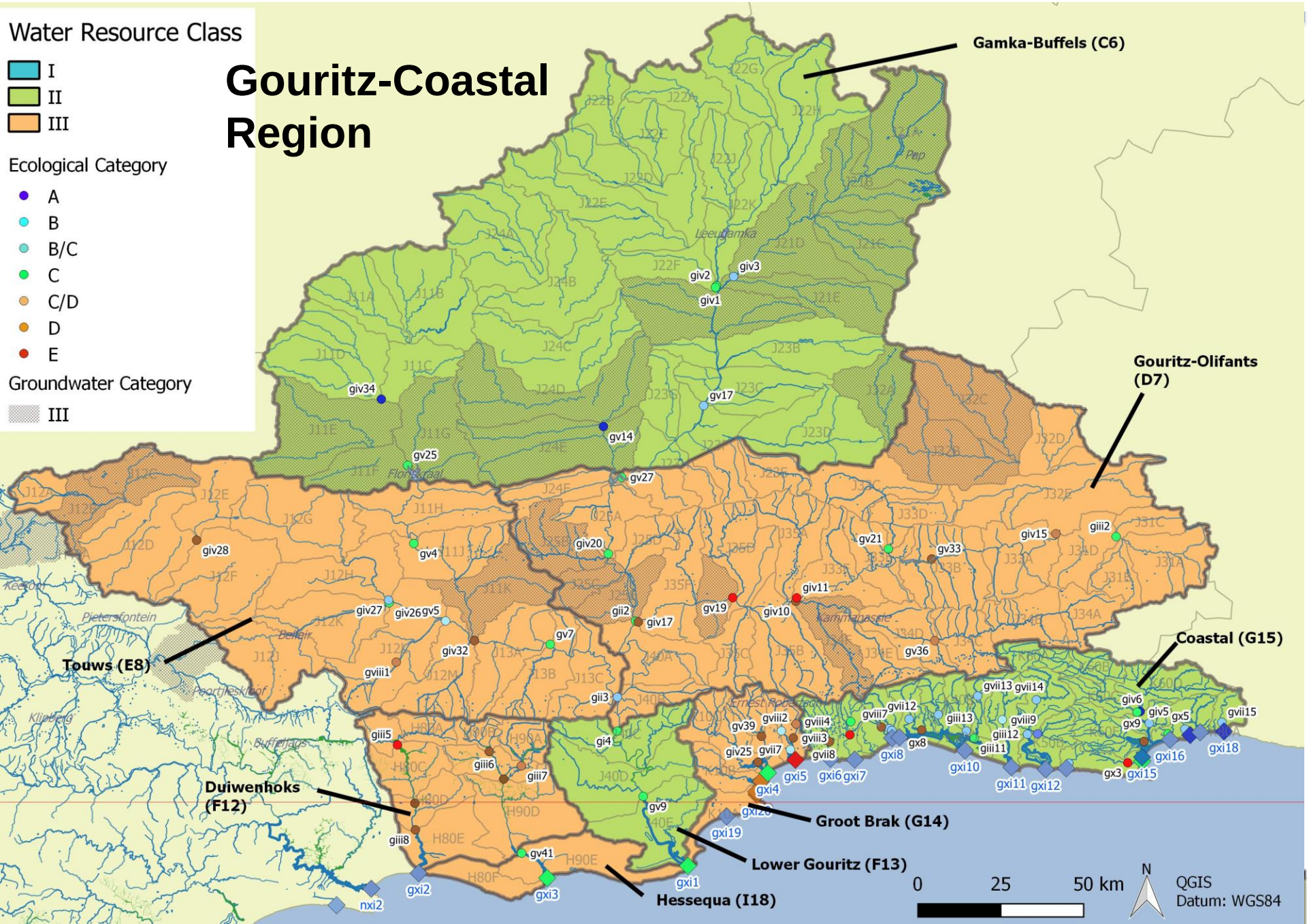
Integrated Units of Analysis and Nodes



Breede-Overberg Region

Integrated Unit of Analysis (IUA)	Recommended Classes
A1 Upper Breede Tributaries	II
A2 Middle Breede Renosterveld	III
A3 Breede Working Tributaries	III
B4 Riversonderend Theewaters	III
F9 Lower Riversonderend	III
B5 Overberg West	II
H16 Overberg West Coastal	II
F10 Overberg East Renosterveld	II
H17 Overberg East Fynbos	III
F11 Lower Breede Renosterveld	II

Integrated Units of Analysis and Nodes



Gouritz-Coastal Region

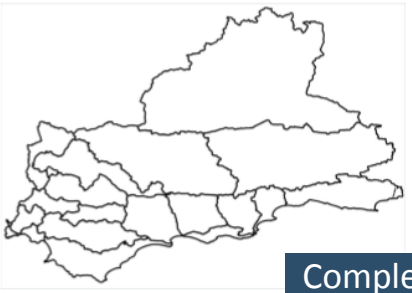
Integrated Unit of Analysis (IUA)		Recommended Classes
Gamka Buffels	C6	II
Touws	E8	III
Gouritz-Olifants	D7	III
Lower Gouritz	F13	II
Duiwenhoks	F12	III
Hessequa	I18	III
Groot Brak	G14	III
Coastal	G15	II

Methodology for Determination of RQOs

Study Status: RQOs

STEP 1: DELINEATE CATCHMENT

Outcome: Integrated Units of Analysis and Resource units as defined in the WRCS approach.

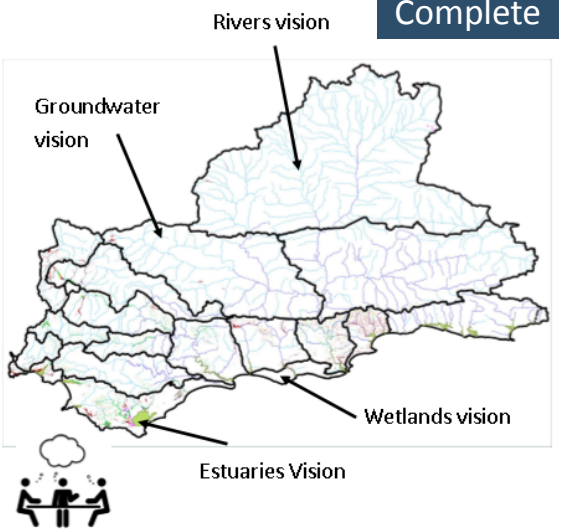


Complete

STEP 2: ESTABLISH VISION FOR CATCHMENT

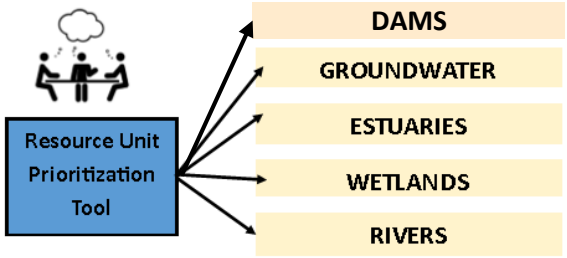
Outcome: Align the diverse and competing interests in the resource into a collective desired future state. This involves multiple stakeholders in the strategic planning process.

Complete



STEP 3: PRIORITISE & SELECT PRELIMINARY RESOURCE UNITS FOR RQO

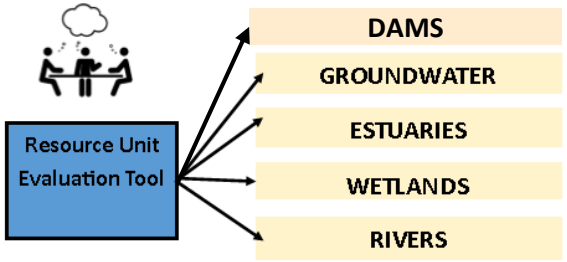
Outcome: Use the resource unit prioritization tool to sect priority resource units.



Final

STEP 4: PRIORITISE SUB-COMPONENTS FOR RQO & SELECT INDICATIORS FOR MONITORING

Outcome: Identify & prioritize sub-components that may be important to users or environment. Select sub-components and associated indicators for RQOs and Numerical Limits.



Draft

STEP 5: DEVELOP DRAFT RQOs & NUMERICAL LIMITS

Outcome: RQOs are essentially narrative but sometimes broadly quantitative descriptions of the resource. These are gazette, whilst Numerical Limits are not. These should be set for discussion with stakeholders.

Draft

STEP 6: AGREE RESOURCE UNITS, RQOs AND NUMERICAL LIMITS WITH STAKEHOLDERS

Outcome: .Stakeholders who were involved in the setting of the vision are involved in reviewing how their input has been considered and taken forward. Decide on Resource Units, RQOs and Numerical Limits.

STEP 7: GAZETTE RESOURCE QUALITY OBJECTIVES

Outcome: A Water Resource Class configuration and associated RQOs for the entire catchment is published by the Minister in the Government Gazette as required in the National Water Act of 1998.

Overview

Classification:

- Proposed Scenario
  (RUs with Targeted ECs (TECs) for water resources, per IUA class)

RQOs:

- Resource Unit prioritisation (using RUPT Tool, where applicable)
- Resource Unit evaluation (using RUET Tool, where applicable)
- Define RQO and Numerical Limits
- Define Monitoring Program

Overview

- **Prioritised Resource Unit per IUA**
  - i.e. grouped areas e.g. river basins, deemed similar in terms of various characteristics
- **Target Ecological Category (TEC)**
  - Ecological Category taken forward from the proposed scenario
- **Component/Sub-component**
  - E.g. Quantity/Flow
- **Indicator**
  - Representation of trend tracking the measurable change in a system over time. Focuses on a small manageable set of information to get a sense of the "bigger picture"
- **Resource Quality Objective (RQO)**
  - Descriptive broad statements describing overall objectives for the Resource Unit
- **Numerical limit**
  - Quantitative descriptors of different components of the Resource Unit

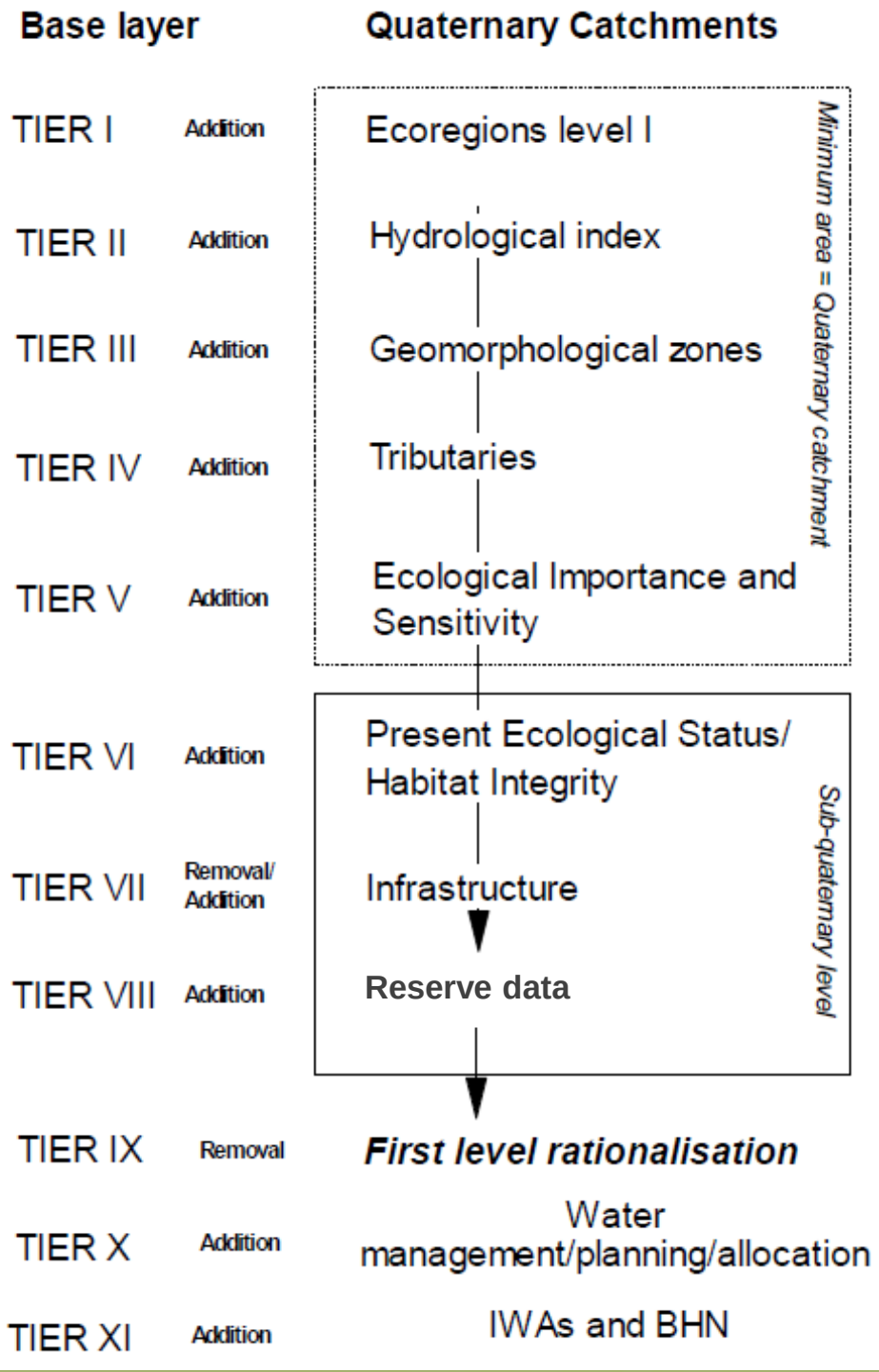
Example of indicators: River Example

Component		Sub-Component	Indicator example
	QUANTITY	Flow	Water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles
	QUALITY	Nutrients	NO_3/NO_2
	HABITAT	Geomorphology	Sediment particle size (D_{50})
	BIOTA	Macroinvertebrates	SASS and ASPT scores

Rivers

- Background to Resource Unit
- RU prioritisation
- RU evaluation
- Define RQO and Numerical Limits
- Worked example

Selecting rivers



Methodology (DWAF, 2007):

- Eleven "tiers" of rules used to establish river nodes.

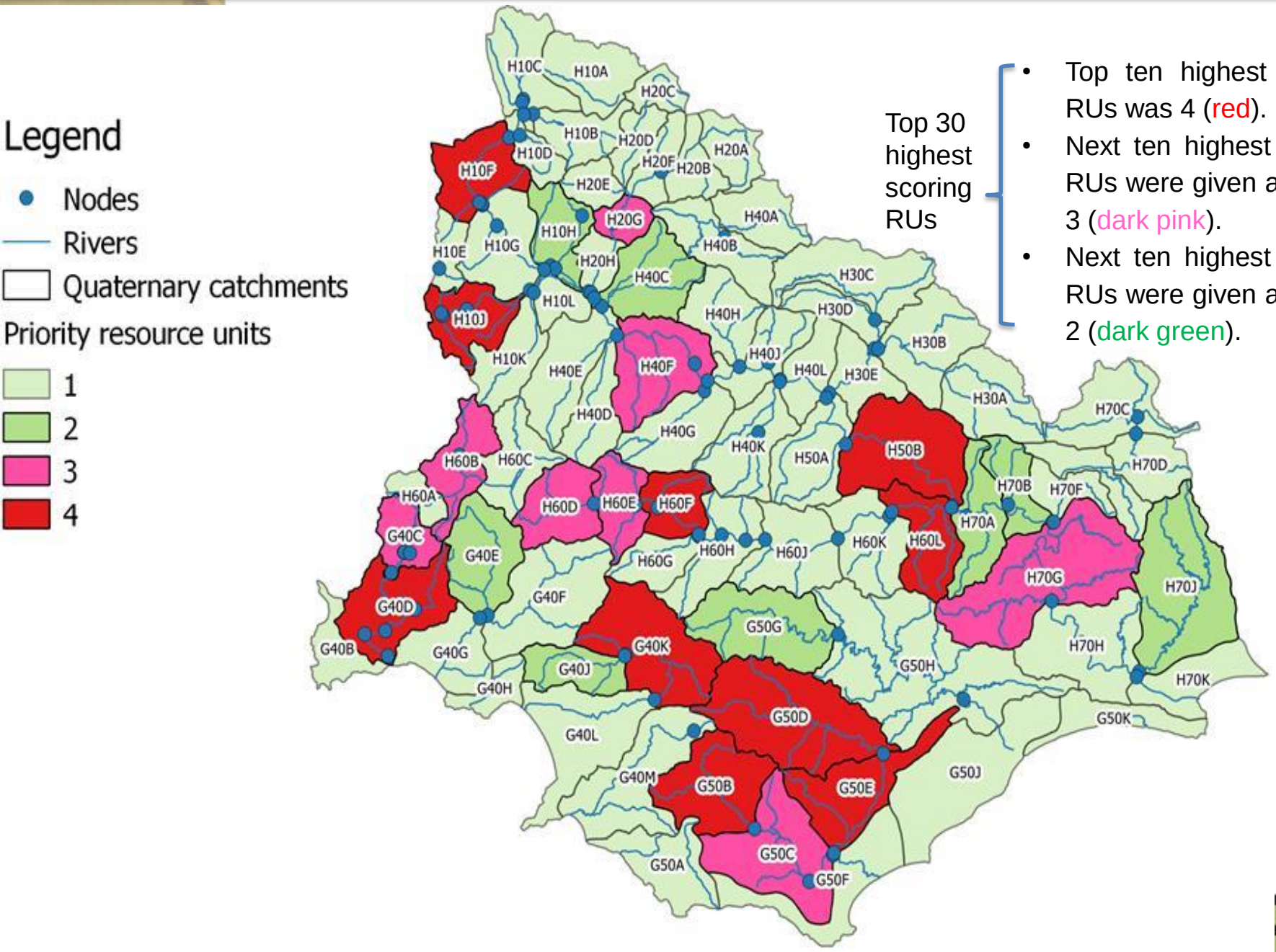
Nodes:

- 66 river nodes - Gouritz WMA
- 76 river nodes - Breede WMA

RU Prioritisation

- DWS RU prioritisation tool used
- Breede+Overberg ranked separately to Gouritz+Outeniqua
- All quaternary catchments were prioritised
  - Common unit of measure for all disciplines
  - Nodes used if present or river selected if absent
- Prioritisation based on
  - Position in IUA, NB to users (social, international, power, regulating services), NB to economy, WQ, environment (NFEPA, CBA, EC)
  - Threat posed to the above, management actions, practical considerations

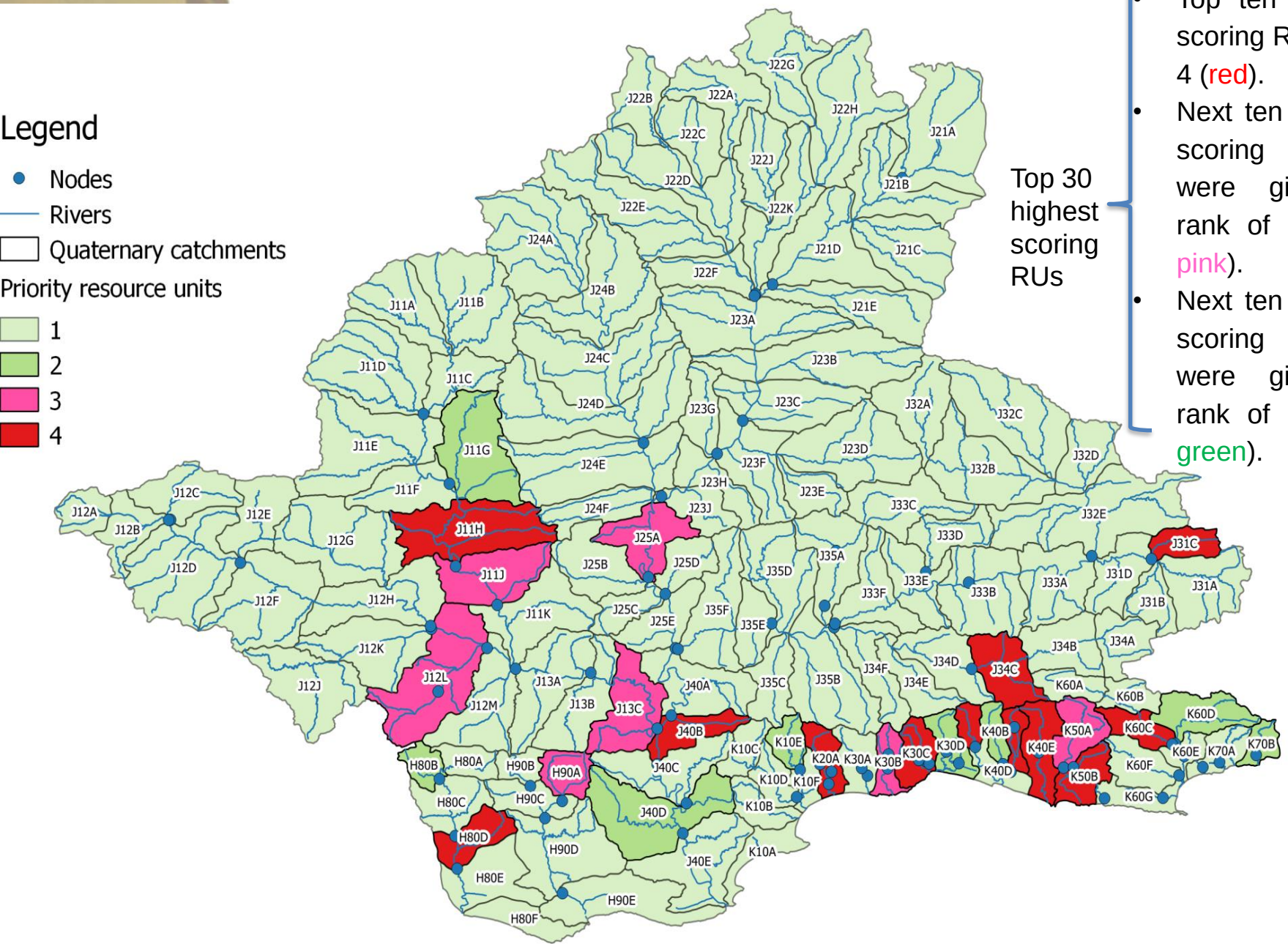
RU Prioritisation



Top 30 highest scoring RUs

- Top ten highest scoring RUs was 4 (red).
- Next ten highest scoring RUs were given a rank of 3 (dark pink).
- Next ten highest scoring RUs were given a rank of 2 (dark green).

RU Prioritisation



Top 30 highest scoring RUs

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- Next ten highest scoring RUs were given a rank of 2 (dark green).

RU Evaluation

- The DWS RU evaluation tool was used to select indicators for RQOs based on:
  - Activities that impact on the water resource
    - Dams, Inter-Basin Transfers, afforestation, agriculture, etc.
    - User requirements
    - Conservation and ecosystem characteristics (including PES, trajectory of change)
    - Industry, agriculture, ecotourism, real estate (including fitness for use and trajectory of change)

RU Evaluation

Component	Sub-component	Reason for selection	Example of indicator
QUANTITY	Low flows	Component selected as part of original Reserve baseline information and standard for measuring all other ecosystem responses	Flow RQOs given are a monthly average volumes (MCM) that include maintenance low and high flows combined i.e. they include the inter-annual floods with a return period greater than 1:2 years
	High flows		
QUALITY	Nutrients	WQ influences habitat quality for organisms and also fitness for use for users	Water quality fitness-for-use categories, ranging from Ideal, Acceptable, and Tolerable. If in Unacceptable category the quality should be improved to a Tolerable category. Limits are specified for the different categories, for different uses.
	Salts	High salt concentrations affect crops yields, unpalatable drinking water, and interferes with the osmoregulation of aquatic organisms.	
	System variables (temperature, salinity, oxygen, pH, turbidity)	System variables such as pH, water temperature, suspended sediment, affect aquatic biota and uses.	
	Toxic substances	Agrochemicals (pesticide & herbicides residues) can have chronic or acute impacts on aquatic biota.	Conservative approach followed, no agrochemicals present in water.
	Pathogens	Water-borne diseases negatively affect domestic water supplies.	Fitness for use categories for domestic water supply and contact recreation.
HABITAT	Index of Habitat Integrity	Provides an overall score for ecological condition.	Scores are ranked as: A natural B near natural C moderately modified with natural functions still in place D moderately modified with a loss of natural functions E severely modified F critical modified with a total loss of biota and function
	PAI	Provides a score for the water quality condition.	
	GAI	Instream habitat influences aquatic biota. Riparian habitat influences river channel structure and also protects agricultural land from erosion and provides habitat to riparian organisms.	
	FRAI	Provides a score for the fish condition (see below).	
	VEGRAI	Provides a score for the vegetation condition (see below).	
	MIRAI	Provides a score for the macroinvertebrate condition (see below).	
BIOTA	Fish	Indigenous fish are of conservation importance	Catch per Unit Effort (CPUE) of fish species present. Frequency of occurrence (FROC) of key fish species.
	Aquatic and Riparian vegetation	Riparian habitat influences river channel structure and also protects agricultural land from erosion and provides habitat to riparian organisms	% cover of indigenous and riparian plant species.
	Macroinvertebrates	Invertebrates provide a useful measure of aquatic biodiversity and also are indicators of water quality.	SASS and ASPT scores from SASS. The number of macroinvertebrate families present. Presence of key families.
	Aquatic and Riparian vegetation	Riparian habitat influences river channel structure and also protects agricultural land from erosion and provides habitat to riparian organisms	% cover of indigenous and riparian plant species.

RQO outcomes

- Target Ecological Category (TEC) was the Proposed Scenario
- Prioritisation outcome:
  - High priority Resource Units (RUs):
    - 20 Gouritz and Coastal
    - 17 Breede and Overberg
    - 3 other *rivers* were estuarine in character
    - These RUs will have Descriptive RQOs, numerical limits and Thresholds of Potential Concern
  - Next highest priority RUs:
    - 40 Gouritz
    - 32 Breede
    - These RUs will have hydrological and ecological condition RQOs
  - Next highest priority RUs:
    - 66 Breede River nodes and 23 Overberg nodes
    - These RUs will have hydrological and ecological condition RQOs
  - Other:
    - A table of importance for SWSA, EC, FEPAs/CBAs/ESAs and endangered fish

RQOs – low priority

- Target Ecological Category (TEC) from the Proposed Scenario
- Monthly average volume (MCM) that include inter-annual floods (return period > 2 years)
- Annual volume (MCM) – sum of months

%nMAR – annual flow as a % of natural

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
giv30	J12C	Ysterdams		D	0.03	0.11	0.02	0.05	0.01	0.01	0.06	0.11	0.41	0.32	0.25	0.06	1.44	40.77
giv31	J12B	Donkies		D	0.09	0.27	0.10	0.16	0.06	0.02	0.16	0.38	0.88	0.82	0.72	0.17	3.83	47.30
giv28	J12D	Touws		D	0.18	0.67	0.18	0.36	0.10	0.04	0.34	0.81	2.39	1.95	1.60	0.33	8.95	44.15
giv27	J12H	Touws		B	0.38	1.07	0.45	0.69	0.53	0.24	0.66	1.22	3.06	2.42	2.02	0.52	13.25	44.95
giv26	J12K	Brak		C	0.01	0.14	0.07	0.02	0.04	0.03	0.03	0.03	0.01	0.01	0.02	0.01	0.41	13.77
gviii1	J12L	Doring (EWR7-**priority**)	C/D	C/D	0.10	0.11	0.12	0.13	0.15	0.10	0.17	0.12	0.04	0.05	0.09	0.07	1.24	43.79
gv5	J12L	Touws (EWR3-**priority**)	B/C	B/C	0.55	1.38	0.70	0.90	0.80	0.41	0.93	1.42	3.13	2.50	2.17	0.63	15.53	43.01
gv4	J11H	Buffels (EWR5-**priority**)	C	C	1.01	1.02	1.45	2.89	1.17	0.89	1.52	1.26	1.64	1.28	1.07	1.33	16.52	66.36

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

Doring River: rank 3

IUA	Water Resource Class	Quat	Node	River	TEC	Position	Users	Environ.	Manage	Score	Rank	Description
		J12A	-	Smalblaar	-	0.00	0.03	0.03	0.06	0.15	1	
		J12C	giv30	Ysterdams	D	0.00	0.00	0.01	0.10	0.11	1	
		J12B	giv31	Donkies	D	0.00	0.00	0.00	0.08	0.08	1	
		J12D	giv28	Touws	D	0.00	0.00	0.05	0.08	0.12	1	
		J12E	-	Kragga	-	0.00	0.02	0.03	0.04	0.09	1	
		J12F	-	Kruis	-	0.00	0.03	0.05	0.04	0.12	1	
		J12G	-	Elandskloof	-	0.00	0.03	0.05	0.04	0.12	1	
		J12H	giv27	Touws	B	0.00	0.00	0.05	0.08	0.13	1	
		J12J	-	Gatkraal se	-	0.00	0.03	0.01	0.06	0.11	1	
		J12K	giv26	Brak	C	0.00	0.00	0.05	0.08	0.12	1	
E8 Touws	III	J12L	gviii1	Doring	C/D	0.00	0.02	0.16	0.13	0.30	3	Management and environmental importance
		J12L	gv5	Touws	B/C	0.00	0.07	0.11	0.13	0.31	3	Users, management and environmental importance
		J12M	-	Brandwag	-	0.00	0.03	0.06	0.06	0.15	1	
		J11H	gv4	Buffels	C	0.00	0.09	0.13	0.13	0.34	4	IUA outlet
		J11J	gv6	Groot	D	0.00	0.09	0.13	0.13	0.34	3	Users, management and environmental importance
		J11K	giv32	Groot	D	0.00	0.00	0.11	0.10	0.21	1	
		J13A	gv7	Groot	C	0.00	0.01	0.13	0.10	0.24	1	
		J13B	-	Derde/Bos	-	0.00	0.02	0.08	0.06	0.16	1	
		J13C	gii3	Groot	B	0.25	0.00	0.06	0.00	0.31	3	IUA outlet

NOTE: Area of Importance example

Although some areas have a rank of 1, some are within conservation areas and will be included in a table in RQO outline report for example:

IUA	RU priority	Quat #	Node	River	FEPA	FishCons	CBA	ESA
Touws	1	J12C	giv30	Ysterdams	Rehab			
	1	J12D	giv28	Touws				x
	1	J12H	giv27	Touws		x	x	
	1	J12K	giv26	Brak				x
	1	J12L	gviii1	Doring	Upstream			
	1	J12L	gv5	Touws	Rehab			
	1	J12M	*gv5*				x	
	1	J11H	gv4	Buffels	Upstream			
	1	J11J	gv6	Groot	Rehab			
	1	J11K	giv32	Groot			x	
	1	J13A	gv7	Groot	Rehab	x		

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

Component	Sub/component	TEC
Water Quality	Nutrients	C
Habitat	Instream	C/D
Biota	Riparian Vegetation	C/D
Biota	Fish	C/D
Biota	Invertebrates	D
	EcoStatus	C/D

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

QUANTITY: Flow excludes inter-annual floods

Months	Maintenance low flows (m^3/s) (Percentile)	Drought flows (m^3/s) (Percentile)	Maintenance high flows (m3/s) (Percentile)
Oct	0.017	0	0.031
Nov	0.021	0	0.031
Dec	0.019	0	0
Jan	0.012	0	0.031
Feb	0.009	0	0
Mar	0.015	0	0
Apr	0.016	0	0.079
May	0.017	0	0
Jun	0.013	0	0
Jul	0.01	0	0
Aug	0.012	0.002	0
Sep	0.012	0	0

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

WATER QUALITY

Sub-component	TEC	RWQO	Indicator	Numerical Limits	Present state (50/95%tile) J1H018Q01
Nutrients	C	Maintain in a mesotrophic or better condition.	Phosphate (PO_4-P) Total inorganic nitrogen (TIN)	Median ≤ 0.075 mg/l PO_4-P Median ≤ 1.75 mg/l TIN	PO4 0.010 / 0.024 TIN 0.058 / 0.183
Salts		Salt concentrations should be maintained at present day levels.	Electrical conductivity (EC)	95th %tile ≤ 1500 mS/m EC	EC 873 / 1440
System variables		pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	pH Dissolved oxygen	6.5 ≥ pH ≤ 8.5 Median DO ≥ 6 mg/l	pH 8.2 / 8.5 No DO data
Toxins		Toxicity not pose a threat to aquatic ecosystems.	Toxic substances specified in DWAF 2008 (Table 4-8)	Concentration limits specified for Rating 1 in Table 4-8 DWAF 2008.	No data
Pathogens		Maintained in an Acceptable category for full contact recreation.	E coli Faecal coliforms	95%tile ≤ 165 cfu/100ml E coli / Faecal coliforms	No data

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

HABITAT: Riparian vegetation

Metric	RQOs	TPC
Marginal zone		
Exotic species	No exotic plant species.	Occurrence of exotic plant species.
Terrestrial woody species	No terrestrial woody species.	Cover > 1%
Indigenous woody species	Cover < 10%.	Cover > 10%.
Non-woody indigenous species	Cover 30-50%.	Cover < 10%
Reeds	Cover < 30%.	Cover > 40%.
Lower zone		
Exotic species	Cover < 5%.	Cover > 15%.
Terrestrial woody species	Cover < 10%.	Cover > 15%.
Indigenous woody species	Cover < 20%.	Cover > 20%.
Non-woody indigenous species	Cover 30-50%.	Cover < 10%
Reeds	Cover < 30%.	Cover > 40%.
Upper zone		
Exotic species	Cover < 10%.	Cover > 20%.
Terrestrial woody species	Cover </= 15%.	Cover > 20%.
Indigenous woody species	Cover < 70%.	Cover > 75%.
Non-woody indigenous species	Cover 30-50%.	Cover < 10%

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

BIOTA: Macroinvertebrates

Parameters	RQOs	TPCs
SASS5 and ASPT score	SASS5 score >90, ASPT ≥ 4.5.	SASS5 scores < 90, ASPT < 4.5.
Diversity of invertebrate community	>/= 15 families, at an abundance of A to C.	<15 families. Any taxon (adult) with an abundance of 1.

High priority RQOs E.g. Doring River @ GOUR_DORI_J12L

BIOTA: Fish

Metric	RQOs	TPC
Indigenous species richness	All four of the indigenous fish species should be present: *Labeo umbratus, Pseudobarbus asper , Sandelia capensis, Barbus anoplus*	< 2 indigenous species
Pseudobarbus asper	FROC = 0.5	*Pseudobarbus asper* absent for two consecutive surveys OR present at FROC of < 0.5. Also absence of juvenile fish in catches.
Barbus anoplus	FROC = 0.5	*Barbus anoplus* absent for two consecutive surveys OR present at FROC of < 0.5. Also absence of a range of life stages (juvenile to adult) in catches.
Labeo umbratus	FROC = 0.5	*Labeo umbratus* absent for two consecutive surveys OR present at FROC of < 0.5. Also absence of juvenile fish in catches.
Sandelia capensis	FROC = 0.5	*Sandelia capensis* absent for two consecutive surveys OR present at FROC of < 0.5. Also absence of juvenile fish in catches.
Exotic fish species	No increase in CPUE for: *Tilapia sparmanii* (0.6 ind/min)	Presence of any additional exotic/introduced species or increase in CPUE of any listed.

IUA	River	Node	Component	Sub-component	TEC	RQO	Indicator/ measure	Numerical limits
E8 Touws	Doring	gviii1 Doring River @ GOUR_DORI_J12L	Quantity	Hydrology		Flows shall be sufficient to maintain the Doring River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C/D).	Flow	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-42.
			Quality	Nutrients	C	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	Phosphate (PO_4-P)	Median ≤ 0.075 mg/l PO_4-P
							Total inorganic nitrogen (TIN)	Median ≤ 1.75 mg/l TIN
				Salts		Salt concentrations need to be maintained at present day levels.	Electrical conductivity (EC)	95th %tile ≤ 1500 mS/m EC
				System variables		pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	pH	6.5 ≥ pH ≤ 8.5
							Water temperature	2°C difference from ambient
							Dissolved oxygen	5%tile DO ≥ 6 mg/l
				Toxins		Toxicity levels must not pose a threat to aquatic ecosystems.	Toxic substances specified in DWAF 2008 (Table 4-8)	Concentration limits specified for Rating 1 in Table 4-8 DWAF 2008.
				Pathogens		Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	E coli Faecal coliforms	95%tile ≤ 165 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology		GAI score should equate to a C/D.		None

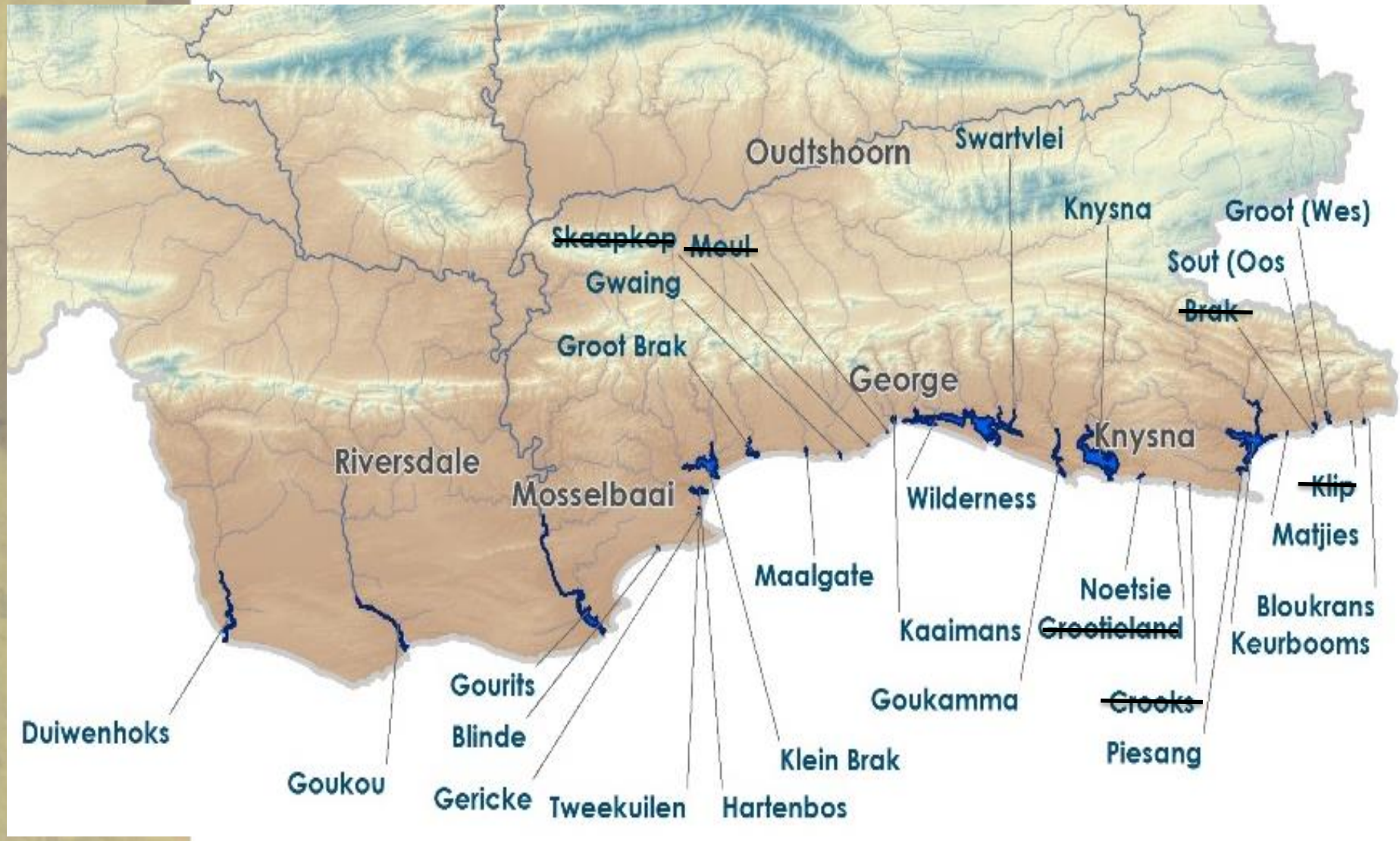
IUA	River	Node	Component	Sub-component	TEC	RQO	Indicator/ measure	Numerical limits
E8 Touws	Doring	gviii1 Doring River @ GOUR_DORI_J12L	Biota	Fish	C/D	FRAI shall yield a C/D (58.3%).	Indigenous species richness	All four of the indigenous fish species should be present: Labeo umbratus, Pseudobarbus asper, Sandelia capensis, Barbus anoplus
							Pseudobarbus asper	FROC = 0.5
							Barbus anoplus	FROC = 0.5
							Sandelia capensis	FROC = 0.5
							Exotic fish species	No increase in CPUE for: Tilapia sparmanii (0.6 ind/min)
				Aquatic and riparian vegetation	C/D	VEGRAI level 4 of at ~58% for the riparian zone.	Marginal zone	Marginal zone
							Exotic species	No exotic plant species.
							Terrestrial woody species	No terrestrial woody species.
							Indigenous riparian woody species	Cover < 10%.
							Non-woody indigenous species	Cover 30-50%.
							Reeds	Cover < 30%.
							Lower zone	Lower zone
							Exotic species	Cover < 5%.
							Terrestrial woody species	Cover < 10%.
							Indigenous riparian woody species	Cover <20%.
							Non-woody indigenous species	Cover 30-50%.
							Reeds	Cover < 30%.
							Upper zone	Upper zone
							Exotic species	Cover < 10%.
							Terrestrial woody species	Cover </= 15%.
							Indigenous riparian woody species	Cover < 70%.
							Non-woody indigenous species	Cover 30-50%.
				Macroinvertebrates	D	MIRAI score to be within D (40-59%) Category	SASS5 and ASPT score	SASS5 score >90, ASPT ≥ 4.5.

Estuaries

- Background to Resource Unit
- RU prioritisation
- RU evaluation
- Define RQO and Numerical Limits
- Worked example

Estuaries in the Breede Overberg Region

Estuaries in the Gouritz region



Estuaries in the Breede Overberg Region

"Priority Rating":

- 0.8 to 1.0 greatest importance
- 0.5 to 0.7 average importance
- lower than 0.4 or less low importance

	Rooiels	Buffels (Oos)	Palmiet	Bot/Kleinmond	Onrus	Mossel	Klein	Uilkraals	Haelkraal	Rietfontein	Ratel	Drie Vleitjies	Heuningnes	Klipdrifsfontein	Papkuils	Breede	Gouritz	Duiwenhoks	Goukou	Blinde	Tweekuilen	Gericke	Hartenbos	Klein Brak
Position in IUA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Concern for users	0.01	0.01	0.07	0.17	0.20	0.00	0.24	0.06	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.19	0.18	0.18	0.16	0.13	0.07	0.07	0.20	0.20
Concern for environment	0.03	0.03	0.03	0.11	0.13	0.00	0.11	0.01	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.16	0.23	0.19	0.19	0.11	0.06	0.06	0.17	0.19
Management and practical considerations	0.08	0.08	0.10	0.10	0.23	0.05	0.23	0.10	0.02	0.02	0.02	0.02	0.13	0.02	0.02	0.13	0.10	0.20	0.10	0.05	0.08	0.06	0.10	0.10
Total Prioritization Score	0.36	0.36	0.45	0.63	0.80	0.30	0.82	0.43	0.27	0.27	0.27	0.27	0.72	0.27	0.27	0.72	0.77	0.81	0.69	0.53	0.46	0.44	0.72	0.73
Priority Rating	0.4	0.4	0.5	0.6	0.8	0.3	0.8	0.4	0.3	0.3	0.3	0.3	0.7	0.3	0.3	0.7	0.8	0.8	0.7	0.5	0.5	0.4	0.7	0.7
Description			Management	Management, env, users	Management, env, users		Management, env, users						Management env, users			Management, env, users	High threat	Management,env, users	High threat	Users	Management		Management, users	Env, users

Estuaries in the Gouritz region

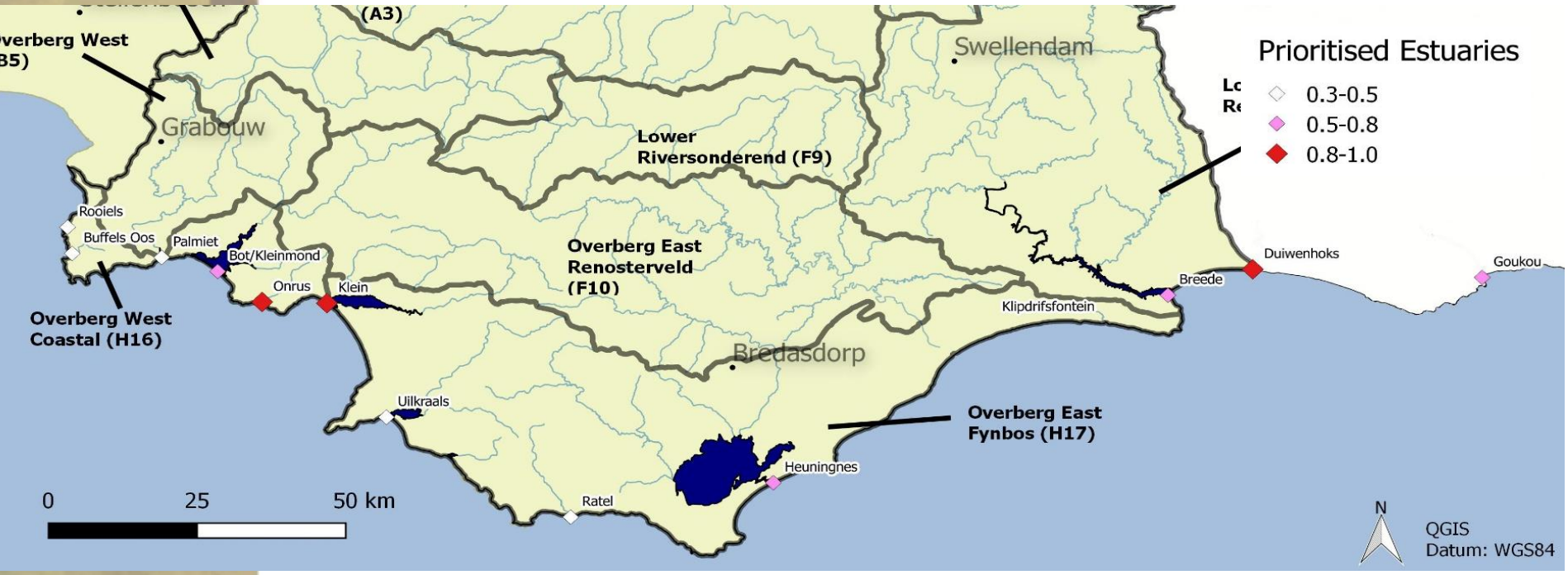
"Priority Rating":

- 0.8 to 1.0 greatest importance
- 0.5 to 0.7 average importance
- lower than 0.4 or less low importance

	Groot Brak	Rooi	**Maalgate**	**Gwaing**	Skaapkop	Meul	**Kaaimans**	**Wilderness**	**Swartvlei**	**Goukamma**	**Knysna**	**Noetsie**	Grooteiland	Kranshoek	Crooks	**Piesang**	**Keurbooms**	**Matjies**	Brak	**Sout (Oos)**	**Groot (Wes)**	Sout (Oos)	Helpmekaars	**Bloukrans**
Position in IUA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Concern for users	0.20	0.00	0.09	0.07	0.00	0.00	0.10	0.25	0.25	0.18	0.25	0.01	0.00	0.00	0.00	0.13	0.19	0.02	0.00	0.01	0.13	0.00	0.00	0.01
Concern for environment	0.19	0.00	0.08	0.08	0.00	0.00	0.08	0.25	0.25	0.19	0.25	0.00	0.00	0.00	0.00	0.19	0.25	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Management and practical considerations	0.25	0.02	0.05	0.05	0.02	0.02	0.07	0.13	0.10	0.10	0.25	0.08	0.02	0.02	0.02	0.10	0.10	0.05	0.02	0.02	0.10	0.02	0.02	0.05
Total Prioritization Score	0.88	0.27	0.46	0.44	0.27	0.27	0.50	0.88	0.85	0.72	1.00	0.34	0.27	0.27	0.27	0.66	0.79	0.32	0.27	0.28	0.53	0.27	0.27	0.31
Priority Rating	0.9	0.3	0.5	0.4	0.3	0.3	0.5	0.9	0.9	0.7	1.0	0.3	0.3	0.3	0.3	0.7	0.8	0.3	0.3	0.3	0.5	0.3	0.3	0.3
Description	High threat		Users				Users	Env, users	Env, users	Management, users	Management, env, users					Management, users	Management, env, users				Management, users			

RU Prioritisation

Breede-Overberg Region



ESTUARY (West to East)	Plant	Invert	Fish	Bird	Biodiversity	Size	Habitat	ZTR	Importance Score*	Rank
Bot/Kleinmond	90	100	100	100	98.5	100	100	70	96.6	8
Onrus	70	10	40	50	59.5	70	60	10	58.9	94
Klein	100	100	100	100	100.0	100	100	70	97.0	5
Heuningnes	100	90	60	80	90.5	90	90	20	83.1	24
Klipdrifsfontein	10	30	10	60	43.5	10	10	10	18.4	237
Breë	80	100	90	90	89.0	100	90	20	86.8	19

Breede-Overberg Region

ESTUARY (West to East)	Plant	Invert	Fish	Bird	Biodiversity	Size	Habitat	ZTR	Importance Score*	Rank
Rooiels	90	40	20	10	65.0	40	40	10	43.3	148
Buffels (Oos)	100	50	30	10	73.5	50	30	10	46.9	134
Palmiet	80	80	40	60	71.0	70	60	20	62.8	82
Bot/Kleinmond	90	100	100	100	98.5	100	100	70	96.6	8
Onrus	70	10	40	50	59.5	70	60	10	58.9	94
Klein	100	100	100	100	100.0	100	100	70	97.0	5
Uilkraals	90	80	40	90	82.0	80	90	10	76.0	47
Ratel	10	40	20	70	52.0	40	10	10	32.5	191
Heuningnes	100	90	60	80	90.5	90	90	20	83.1	24
Klipdrifsfontein	10	30	10	60	43.5	10	10	10	18.4	237
Breë	80	100	90	90	89.0	100	90	20	86.8	19

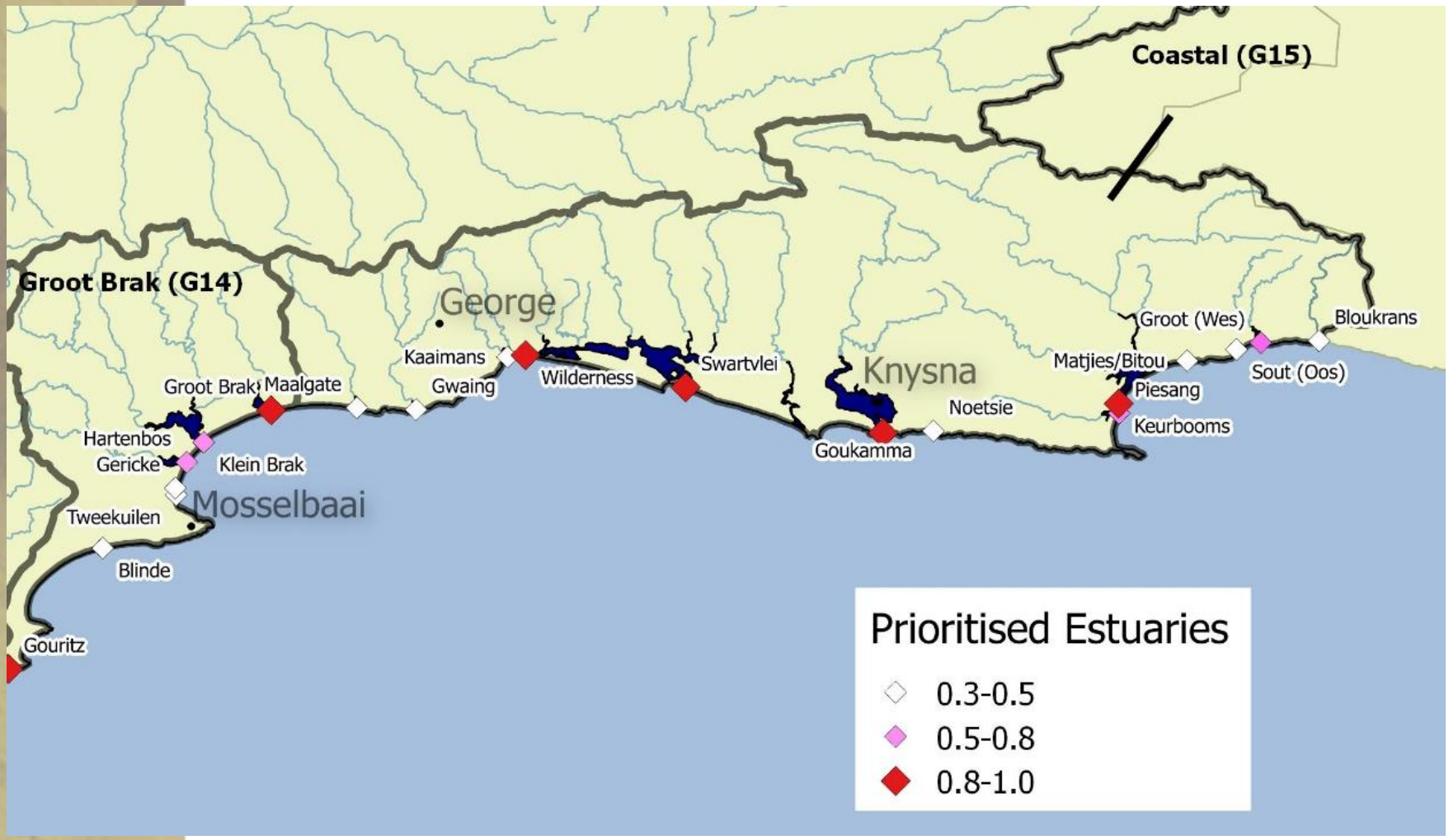
RU Prioritisation

ESTUARY (West to East)	Plant	Invert	Fish	Bird	Biodiversity	Size	Habitat	ZTR	Importance Score*	Rank
Duiwenhoks	60	100	70	80	76.5	100	90	20	83.6	23
Goukou	80	90	70	80	79.0	90	90	20	80.3	31
Gourits	90	80	80	90	88.0	90	60	20	75.0	49
Hartenbos	100	70	40	80	86.5	70	60	10	65.6	75
Klein Brak	70	80	70	60	69.0	80	10	10	52.8	115
Groot Brak	80	100	70	80	79.5	90	80	10	76.9	46
Maalgate	10	60	50	70	57.5	50	10	10	37.9	172
Gwaing	10	40	10	10	11.5	10	10	10	10.4	254
Kaaimans	50	50	40	30	45.5	30	10	20	27.9	210
Wilderness	90	40	50	100	88.0	90	70	70	82.5	27
Swartvlei	100	90	100	100	99.5	100	100	70	96.9	7
Goukamma	50	100	90	80	83.0	70	40	10	59.8	59
Knysna	100	100	100	100	100.0	100	100	100	100.0	1
Piesang	80	80	70	40	72.5	80	80	10	71.1	62
Keurbooms	100	90	80	90	95.0	100	90	20	88.3	18

RU Evaluation

Component	Sub-component	Reason for selection	Example of indicator
QUANTITY	Low flows	Component selected as part of original Reserve baseline information and standard for measuring all other ecosystem responses	Flow RQOs given are a monthly average volumes (MCM) that include maintenance low and high flows combined i.e. they include the inter-annual floods with a return period greater than 1:2 years
	High flows		
QUALITY	Nutrients	WQ influences habitat quality for organisms and also fitness for use for users	Specifications for maximum and minimum level for key properties of and contaminants in water
	System variables (temperature, salinity, oxygen, pH, turbidity)		
	Toxic substances		
	Pathogens		
HABITAT	Sedimentary processes	Provides an overall score for ecological condition.	Narrative account of the flow and/or tidal regime required to maintain sedimentary processes and habitat integrity at a specified level
	Mouth state	Provides a score for the water quality condition.	Specifications for the state of the mouth
BIOTA	Fish	Estuaries are important as nursery areas for marine fish.	Community composition and abundance of fish
	Invertebrates	Invertebrates provide a useful measure of aquatic biodiversity and also are indicators of water quality.	Community composition and abundance of benthic invertebrates and/or zooplankton
	Micro-algae	Benthic microalgae and phytoplankton provide a useful indicator of water quality and are also an important source of food for other estuarine biota	Chlorophylla
	Macrophytes	Macrophytes provide important habitat and food for other estuarine biota	% cover of indigenous aquatic macrophytes

Estuary RQO Template - Hartenbos



Estuary RQO Template - Hartenbos

IUA	Node	Quat	REC		Current		Target	
			EC	%nMAR	PES	%nMAR	EC	%nMAR
G14-Groot Brak	Gxi22	K10B	C	80.7	D	65.0	C	65.0

MOTIVATION FOR ACHIEVING REC/TEC

The Hartenbos estuary is considered to be of "average importance" from a biodiversity conservation perspective (ranked 75 out of 273 estuaries in South Africa) and has not been included on the list of existing or desired protected areas (Turpie et al. 2012). The system is nonetheless important from a socio-economic perspective – it is an important node for recreation, tourism and contributes significantly to property value. It is also important to maintain the system in a state of health that is safe for contact recreation. The REC for the estuary is thus a C, one category higher than present. However, it has been determined that water abstraction from this system cannot be reduced in future without compromising requirements for other users in this region. The MAR for the Target Ecological Condition thus remains as for present (65.0%). The most important threats to the Hartenbos estuary include freshwater deprivation (due to abstractions from the Hartbeeskuil Dam, for agricultural and domestic use), sedimentation (due to reduced flow and concomitant changes in mouth dynamics) and impaired water quality (due to agricultural return flows and poor quality of stormwater from informal settlements). Given that it is not possible to restore flows required to achieve the REC, concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) is thus required to address other threats to the estuary in accordance with the Ecological Specifications included below, thereby facilitating its restoration to the REC.

Component	SPECIFICATIONS
Flow	• %nMAR: 65.0, dry season flow >0.05 Mm^3/month
Mouth condition	• % time mouth closed should not increase/decrease by >10% from present; no period of closure >3 months
Water quality	• DIN not to exceed 200 µg/ℓ (average); DIP not to exceed 50 µg/ℓ (average)
Microalgae	• Phytoplankton not to exceed 8 µg/ℓ (median), and/or 20 µg/ℓ (once-off) and/or cell density not to exceed 10 000 cells/ml (once-off) • Benthic microalgae not to exceed 42 mg/m^2 (median)
Macrophytes (plants)	• Maintain distribution of macrophyte habitats within 20% of present (Supratidal salt marsh: 29%, Reeds & sedges: 10%, sand/mud banks: 10%)
Invertebrates	• Populations of key invertebrate species should not deviate from average baselines (as determined in first three visits) by more 30%
Fish	• Relative contribution for key groups of fish (estuarine resident, marine migrant, freshwater, etc.) should not deviate from average baselines (as determined in first three visits) by more 30%
Birds	• Number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not deviate by more than 30% from baseline median (determined by past data and/or initial surveys)

RU Prioritisation

IUA	Node	Quat	REC		Current		Target	
			EC	%nMAR	PES	%nMAR	EC	%nMAR
G14-Groot Brak	Gxi22	K10B	C	80.7	D	65.0	C	65.0
Additional (non-flow related) interventions to achieve the REC:								
• Dam construction has resulted in a reduction in base flow and floods to the system, with a shift in the onset of the high flow period and an increase in the duration of the low flow period; • Artificial breaching; • Loss of tidal flows and habitat as result of bridge construction (e.g. old N2, railway bridge); • Infilling of estuary channel and mouth area as a result of loss of floods and artificial breaching; • A significant reduction in water quality as a result of the Mossel Bay WWTW discharge and urban runoff; • Development in the EFZ; • Alien vegetation; • Limited bait collection and fishing effort; and • Human disturbance (which influences bird abundance).							
Source of information	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA							

Dams

- Resource Unit prioritisation
- Resource Unit evaluation
- Define RQO and Numerical Limits
- Worked example

Resource Unit Prioritisation

- 2 levels of ranking of dams resource units
- First level of screening:
  - 27 significant dams selected in WMA

Resource Unit Prioritisation

- Then the newly-configured **RU Prioritisation Tool** (RUPT) was applied. Steps were followed that ranks RUs against one another based on:
  - position, socio-economic and international importance
  - role in regulating services and ecological importance
  - water quality threats
  - practical considerations

Resource Unit Prioritisation

Breede-Overberg area

Dams with “Priority Rating” ≥ 0.6 are prioritised

SUMMARISED CRITERIA	Theewaterskloof	Greater Brandvlei	Eikenhof	Kogelberg Dam	Ceres Koekedouw	Rockview Dam	Stettynskloof	Elandskloof	Lakenvallei	Poortjieskloof	Keerom	Roode Elsberg	De Bos	Arieskraal	Kraaibosch	Buffeljags
Position in IUA	0.14	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Concern for users	0.21	0.21	0.14	0.18	0.16	0.11	0.09	0.09	0.09	0.07	0.07	0.05	0.05	0.05	0.05	0.07
Concern for environment	0.29	0.29	0.00	0.29	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.29	0.14	0.00
Management and practical considerations	0.14	0.14	0.14	0.14	0.14	0.09	0.09	0.14	0.14	0.14	0.14	0.14	0.12	0.12	0.12	0.14
Total Prioritization Score	0.79	0.64	0.43	0.75	0.44	0.20	0.18	0.23	0.23	0.21	0.21	0.20	0.38	0.60	0.31	0.21
Relative Priority Rating	**1.00**	**0.82**	**0.54**	**0.96**	**0.56**	0.25	0.23	0.30	0.30	0.27	0.27	0.25	0.49	**0.76**	0.40	0.27

Resource Unit Prioritisation

Gouritz-Coastal area

Dams with “Priority Rating” ≥ 0.6 are prioritised

SUMMARISED CRITERIA	Stompdrift	Floriskraal	Gamkapoort	Kammanassie	Wolwedans	Leeu-Gamka	Koos Raubenheimer	Korentepoort	Garden Route	Hartbeeskuil	Duivenhoks
Position in IUA	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concern for users	0.16	0.14	0.04	0.16	0.20	0.07	0.11	0.07	0.11	0.11	0.07
Concern for environment	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.07	0.00	0.00
Management and practical considerations	0.14	0.14	0.12	0.14	0.14	0.09	0.12	0.09	0.14	0.14	0.09
Total Prioritization Score	0.44	0.28	0.30	0.30	0.70	0.16	0.22	0.16	0.32	0.25	0.16
Relative Priority Rating	**0.56**	0.36	0.38	0.38	**0.89**	0.20	0.28	0.20	0.41	0.32	0.20

Resource Unit Prioritisation

8 Prioritised dams

Breede-Overberg area

- Theewaterskloof
- Greater Brandvlei
- Ceres-Koekedouw
- Eikenhof
- Kogelberg
- Arieskraal

Gouritz-Coastal area

- Stompdrift
- Wolwedans

Resource Unit Prioritisation

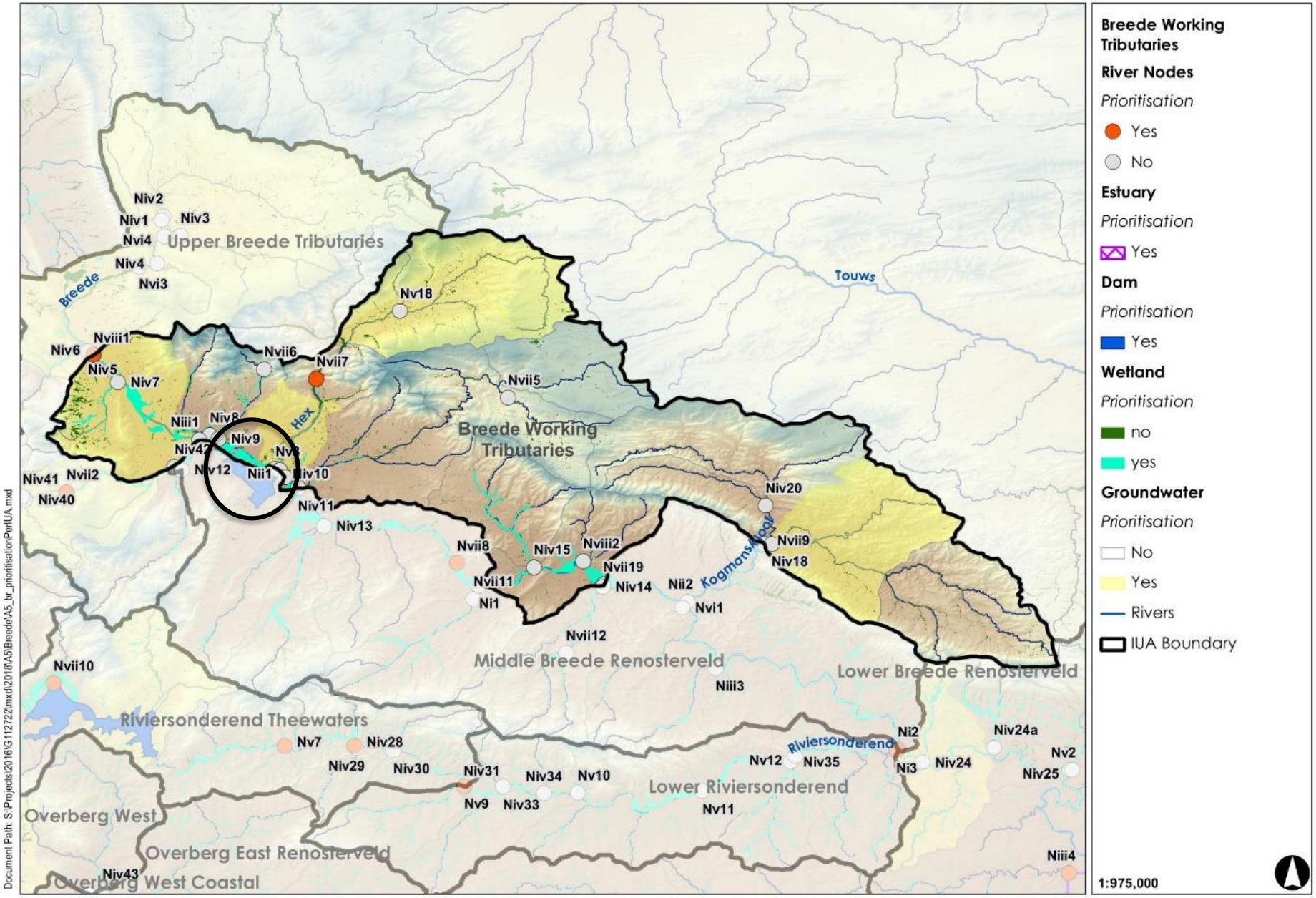
High and low priority RUs

Greater Brandvlei Dam

(IUA A2 Breede Working Tributaries)

- Largely an off-channel dam (impounds small lower Brandvlei River) with limited natural inflow, and limited farm dams located upstream. During the dry season significant irrigation releases are made.
- The important Papenkuils floodplain wetland is located just upstream of the dam, below the canal off-takes from the Smalblaar and Holsloot rivers.
- Water in the dam is mainly used for irrigation along the Breede River and for urban and rural use. Irrigation water is distributed by a system of canals receiving water directly from the dam as well as pumps and canals abstracting released water downstream.
- significant recreational activities include abseiling, sailing, kayaking and fishing, among others.

Greater Brandvlei Dam (IUA A2 Breede Working Tributaries)



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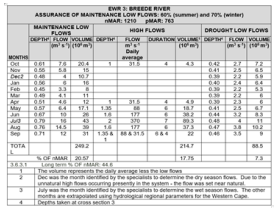
Greater Brandvlei Dam

(IUA A2 Breede Working Tributaries)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows	Dam levels must remain sufficient to make releases for irrigation, as well as releases for ecosystem function downstream.	EWR
Nutrients	The system must be maintained in an oligotrophic state.	Ortho-phosphate, nitrogen, ammonium
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem.	Electrical conductivity
Fish	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling industry. The re-infestation of alien species from the dam should be prevented. Consumption of fish must not pose a health risk.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011), fish health evaluation

Quantity & Biota RQOs for Greater Brandvlei Dam

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	During the dry season dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream. Dependent on whether increased summer base flows, lack of flow variability and turbid water can be managed. Flow releases made to manage salinity.	Flow releases: Breede EWR3 in H40F nMAR = 1210 million m^3/a pMAR: 763 million m^3/a REC = CD category	Breede EWR 3 site in Breede River – specified flows 	Not applicable
Fish	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support the local recreational angling industry. Consumption of fish must not pose a health risk.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a D ecological category.
		Populations of indigenous fish	Fish demographics and species assemblage of indigenous fish should be the same or better than the	To be established from baseline

Quality RQOs for Greater Brandvlei Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) H1R001Q01
Nutrients	The system must be maintained in an oligotrophic state	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ ℓ P	0.010 mg/ ℓ P	PO4 0.005 / 0.025
		Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N	0.60 mg/ℓ N	TIN 0.05 / 0.208
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are acceptable for rural use, and in an Ideal category for irrigation water use	Electrical conductivity	95th percentile ≤ 40 mS/m	35 mS/m	EC 8 / 12
Phytoplankton	The system must be maintained in an oligotrophic state	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	Chl a ≤ 8 µg/ℓ	6 µg/ℓ

IUA	Name of dam	Component	Sub-component	RQO	Indicator/ measure	Numerical limits
A2 Breede Working Tributaries	Greater Brandvlei	Quantity	Low flows	During the dry season dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream. *Dependent on whether increased summer base flows, lack of flow variability and turbid water can be managed.* *Ad-hoc* flow releases can be made to manage salinity if required.	Flow releases: Breede EWR3 in H40F nMAR = 1210 million m^3/a pMAR: 763 million m^3/a REC = CD category	EWR 3: BREEDE RIVER ASSURANCE OF MAINTENANCE LOW FLOWS: 60% (summer) and 70% (winter) nMAR: 1210 pMAR: 763 MAINTENANCE LOW FLOWS: DEPTH[4], FLOW ($m^3 s^{-1}$), VOLUME ($10^6 m^3$) HIGH FLOWS: DEPTH[4], FLOW $m^3 s^{-1}$ Daily average, DURATION, VOLUME[1] ($10^6 m^3$) DROUGHT LOW FLOWS: DEPTH[4], FLOW ($m^3 s^{-1}$), VOLUME ($10^6 m^3$) MONTHS: Oct 0.61 7.6 20.4 | 1 31.5 4 4.3 | 0.42 2.7 7.2; Nov 0.55 5.8 15 | 0.41 2.5 6.5; Dec2 0.48 4 10.7 | 0.39 2.2 5.9; Jan 0.56 6 16 | 0.40 2.4 6.4; Feb 0.45 3.3 8 | 0.39 2.2 5.3; Mar 0.49 4.1 11 | 0.39 2.2 6; Apr 0.51 4.6 12 | 1 31.5 4 4.9 | 0.39 2.3 6; May 0.57 6.4 17.1 | 1.35 88 6 18.7 | 0.41 2.5 6.7; Jun 0.67 10 26 | 1.6 177 6 38.2 | 0.44 3.2 8.3; Jul3 0.79 16 43 | 2 370 7 89.3 | 0.48 4 11; Aug 0.76 14.5 39 | 1.6 177 6 37.3 | 0.47 3.8 10.2; Sep 0.71 12 31 | 1.35 & 1 88 & 31.5 6 & 4 22 | 0.46 3.5 9 TOTAL 249.2 | 214.7 | 88.5 % OF nMAR 20.57 | 17.75 | 7.3 3.6.3.1 Long term % OF nMAR: 44.6 1 The volume represents the daily average less the low flows 2 Dec was the month identified by the specialists to determine the dry season flows. Due to the unnatural high flows occurring presently in the system - the flow was set near natural. 3 July was the month identified by the specialists to determine the wet season flows. The other months are extrapolated using hydrological regional parameters for the Western Cape. 4 Depths taken at cross section 3
		Quality	Nutrients	The system must be maintained in an oligotrophic state or better.	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ ℓ P
					Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N
			Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are acceptable for rural use, and in an Ideal category for irrigation water use.	Electrical conductivity	95th percentile ≤ 40 mS/m
		Biota	Fish	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support the local recreational angling industry. Consumption of fish must not pose a health risk.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.
					Populations of indigenous fish	Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.

Wetlands

- Resource Unit prioritisation
- Resource Unit evaluation
- Define RQO and Numerical Limits
- Worked example

Resource Unit Prioritisation

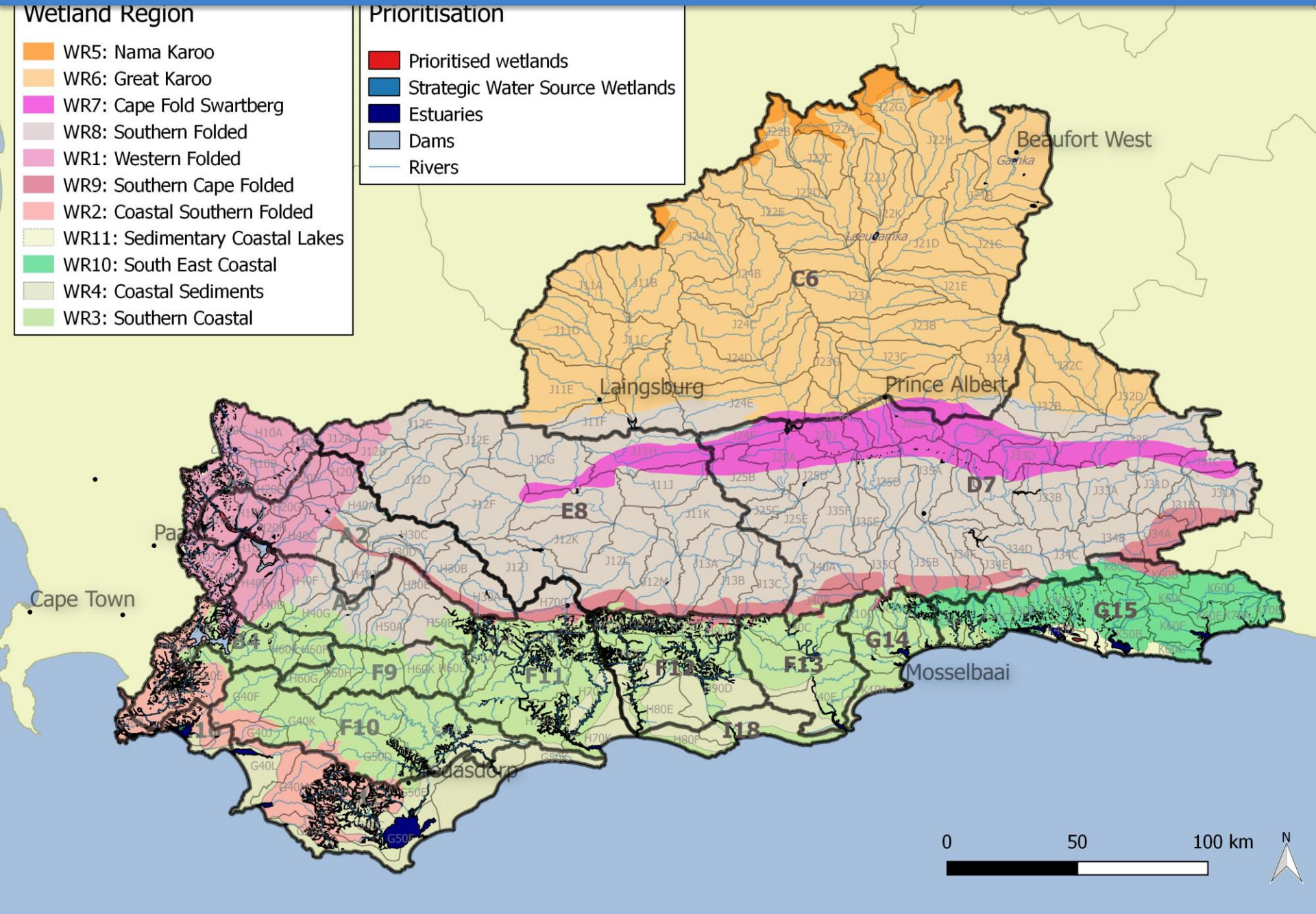
- Important wetlands include those that have ecological importance for maintenance of biodiversity ecosystem integrity, as well as those that provide ecosystem services.

WETLAND REGION

WETLAND RESOURCE UNIT

Ecological Importance		+	Ecosystem Services	
Importance	Threat		Supply	Demand
Ramsar NFEPA cluster NFEPA frog	Threat status		Climatic region Size Surrounding land use (land cover)	Dams Census and households

Resource Unit Prioritisation



Resource Unit Prioritisation – Breede-Overberg

IUA	Wetland Region	Wetland Resource Unit	Name	Ecol NB	Supply	Demand
A1 Upper Breede Tributaries	WR1 Western Folded	Wetlands within Strategic Water Source Areas	N/A		x	
		East Coast Shale Renosterveld Floodplain (Papenkuils)	Papenkuils	x	x	
A2 Breede Working Tributaries	WR1 Western Folded	East Coast Shale Renosterveld Floodplain (Papenkuils)	Papenkuils	x	x	
A3 Middle Breede Tributaries	WR1 Western Folded	East Coast Shale Renosterveld Floodplain	Breede River		x	
	WR8 Southern Folded	East Coast Shale Renosterveld Floodplain	Breede River	x	x	
F11 Lower Breede Renosterveld	WR3 Southern Coastal	East Coast Shale Renosterveld Floodplain	Breede River		x	
B4 Riviersonderend Theewaters	WR3 Southern Coastal	Wetlands within Strategic Water Source Areas	Riviersonderend River	x	x	
B5 Overberg West	WR3 Southern Coastal	Wetlands within Strategic Water Source Areas	Palmiet River		x	
F10 Overberg East Renosterveld	WR8 Southern Coastal	Southwest Ferricrete Fynbos Floodplain	Kars River	x	x	
H16 Overberg West Coastal	WR2 Coastal Southern Folded	Southwest Sand Fynbos Channelled Valley Bottom	Bot-Kleinmond Estuary	x		
		Wetlands within Strategic Water Source Areas	N/A		x	
H17 Overberg East Fynbos	WR4 Coastal Sediments	Southwest Ferricrete Fynbos Flat, Depression and Floodplain	Agulhas Wetland System	x	x	
		East Coast Shale Renosterveld Floodplain	De Hoop Vlei	x		

Note: Although HIGH priority wetlands have been identified, these may be considered a representative sample of wetlands in the Breede-Gouritz WMA. All wetlands are still to be considered under the National Water Act for triggering activities, and will need to be assessed fully. The benefit of identifying HIGH priority wetlands is to identify a representative sample of wetlands whereby further information is required, or where information is available to ensure that monitoring occurs.

Resource Unit Prioritisation – Gouritz-Coastal

IUA	Wetland Region	Wetland Resource Unit	Name	Ecol NB	Supply
C6 Great Karoo	WR6 Great Karoo	Lower Nama Karoo Depression	N/A	x	x
D7 Touws	WR7 Cape Fold Swartberg	Wetlands within Strategic Water Source Areas	N/A		x
G15 Coastal	WR10 Sedimentary Coastal Lakes	Freshwater Lake	Groenvlei	x	x
		Freshwater Lake	Wilderness Lakes	x	x
	WR11 South East Coastal	Wetlands within Strategic Water Source Areas	N/A		x
F13 Lower Gouritz	WR3 Southern Coastal	Albany Thicket Floodplain	Gouritz River	x	x
F12 Duiwenhoks	WR3 Southern Coastal	East Coast Shale Renosterveld Channelled Valley Bottom	Goukou Wetland	x	x
		East Coast Shale Renosterveld Channelled Valley Bottom	Duiwenhoks Wetland	x	x

Resource Unit Evaluation

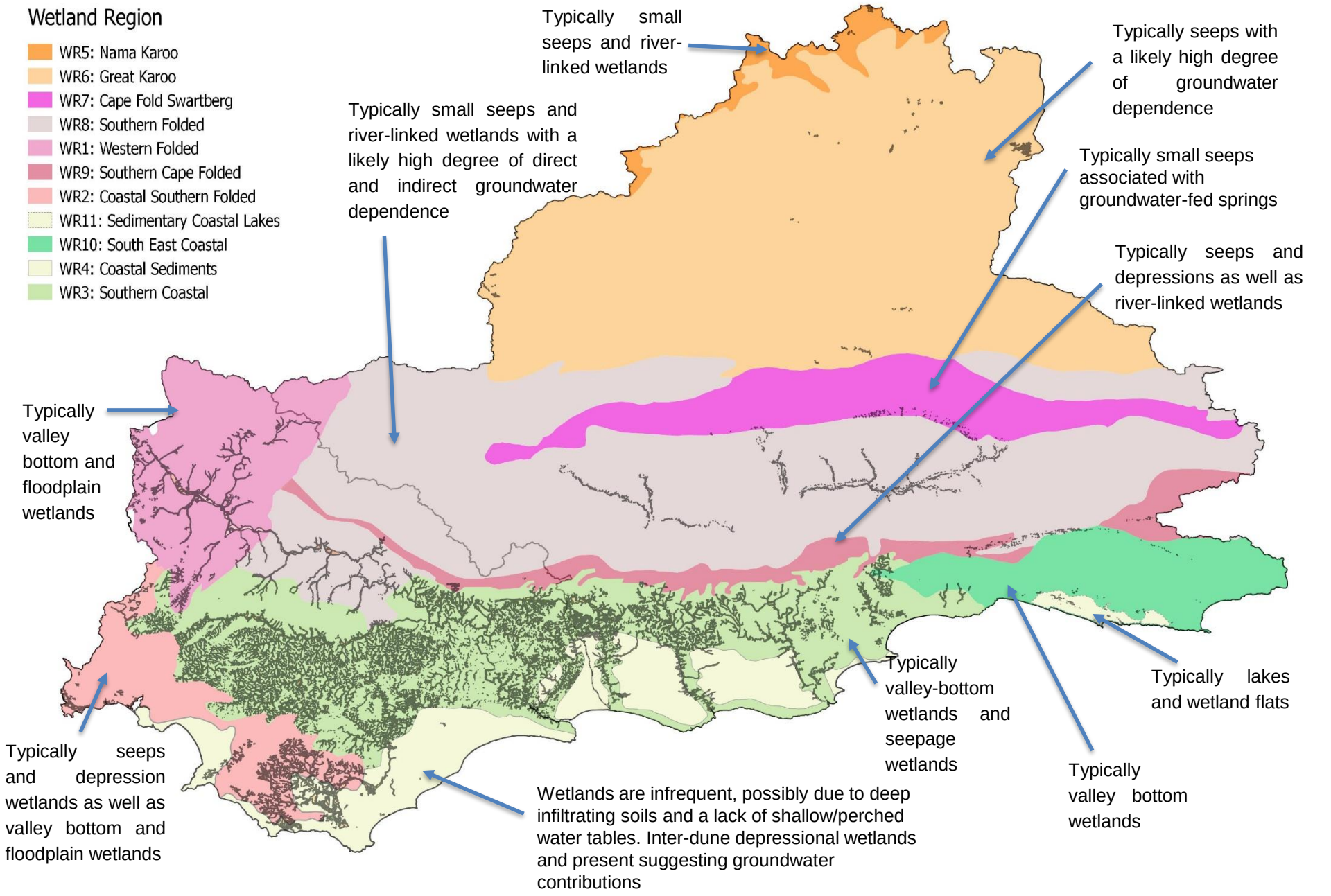
- The steps for evaluation were:
  - Develop a conceptual model of:
    - **Wetland hydrological functioning and geomorphology**
    - Wetland vegetation
    - Wetland water quality amelioration
    - Important wetland biota
  - Validation and site selection (Required as part of monitoring)
  - Monitoring should take account of the relevant RQO and if required develop a baseline of Wetland Health

BASELINE

Resource Unit Evaluation

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.
	Water retention and distribution patterns	In certain wetlands channelized flow is not as important as the retention of water. 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.
QUALITY	Nutrients	WQ influences habitat quality for organisms and also fitness for use for users	Specifications for maximum and minimum level for key properties of and contaminants in water
	System variables (temperature, salinity, oxygen, pH, turbidity)		
	Pathogens		
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
	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 integrity versus alien invasive vegetation
BIOTA	Frogs	NFEPA frog species live in wetlands and require the “stepping stone” habitats that wetlands provide.	Community composition and abundance of frogs
	Birds	Important bird species live in or near wetlands and depend on the wetland habitat.	Community composition and abundance of birds

Resource Unit Prioritisation – Wetland Regions



Characteristics of different Wetland Types

Quantity

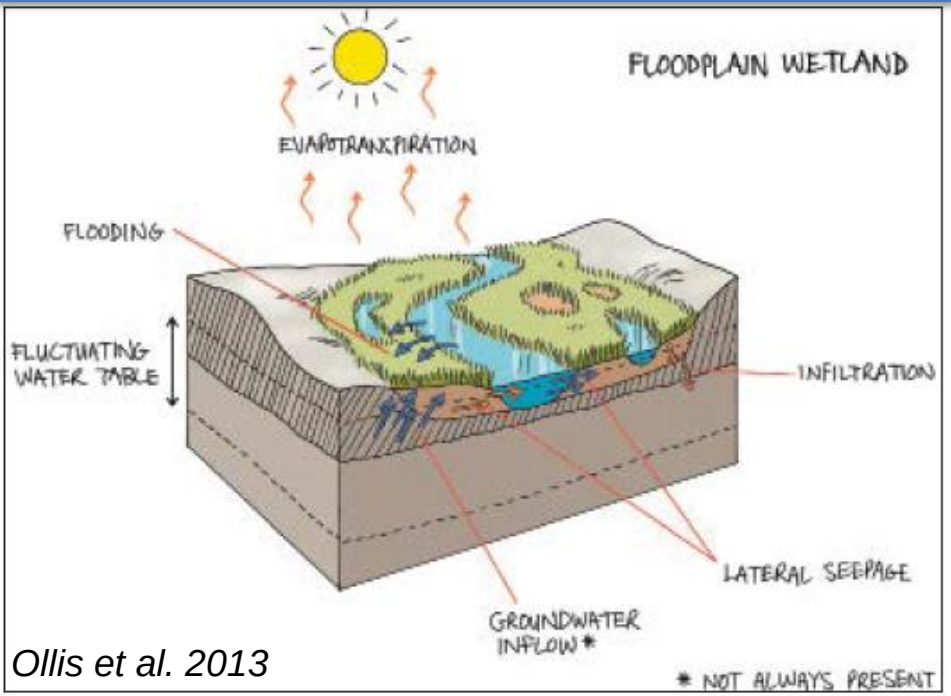
- Flow
- Water retention & distribution

Type	High flows	Baseflow	Surrounding runoff
Floodplain	x	x	x
Channelled Valley-Bottom		x	x
Unchannelled Valley-Bottom		x	x
Seep		x	x
Depression		x	x
Flat		x	x

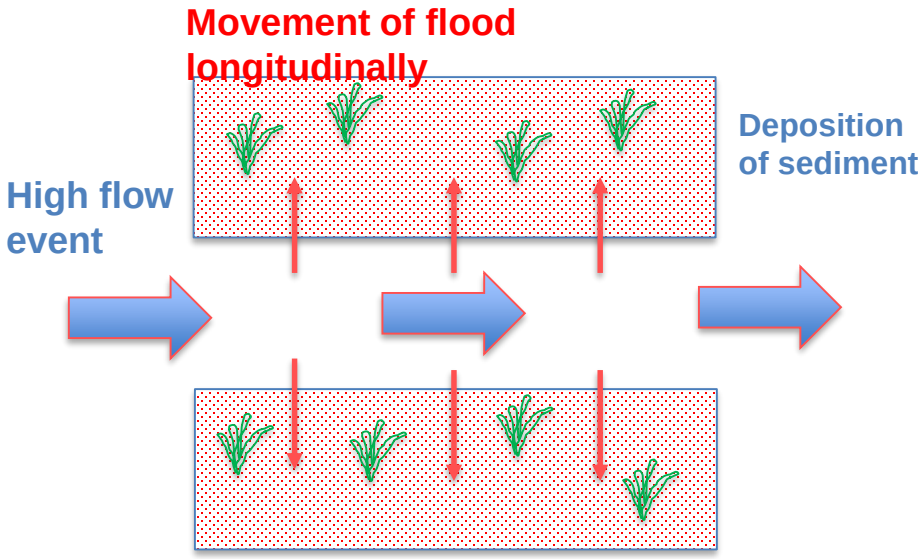
Maintain high flow events

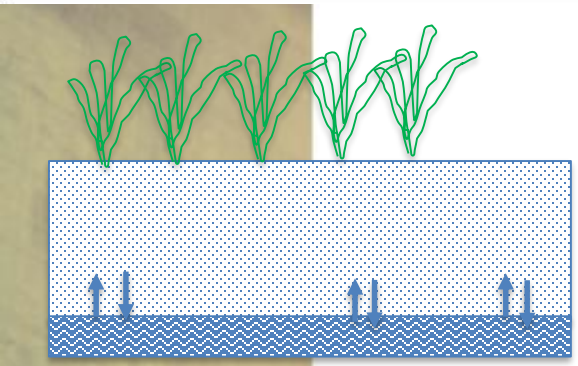
Maintain water levels

High flow events: FLOODPLAINS



Ollis et al. 2013



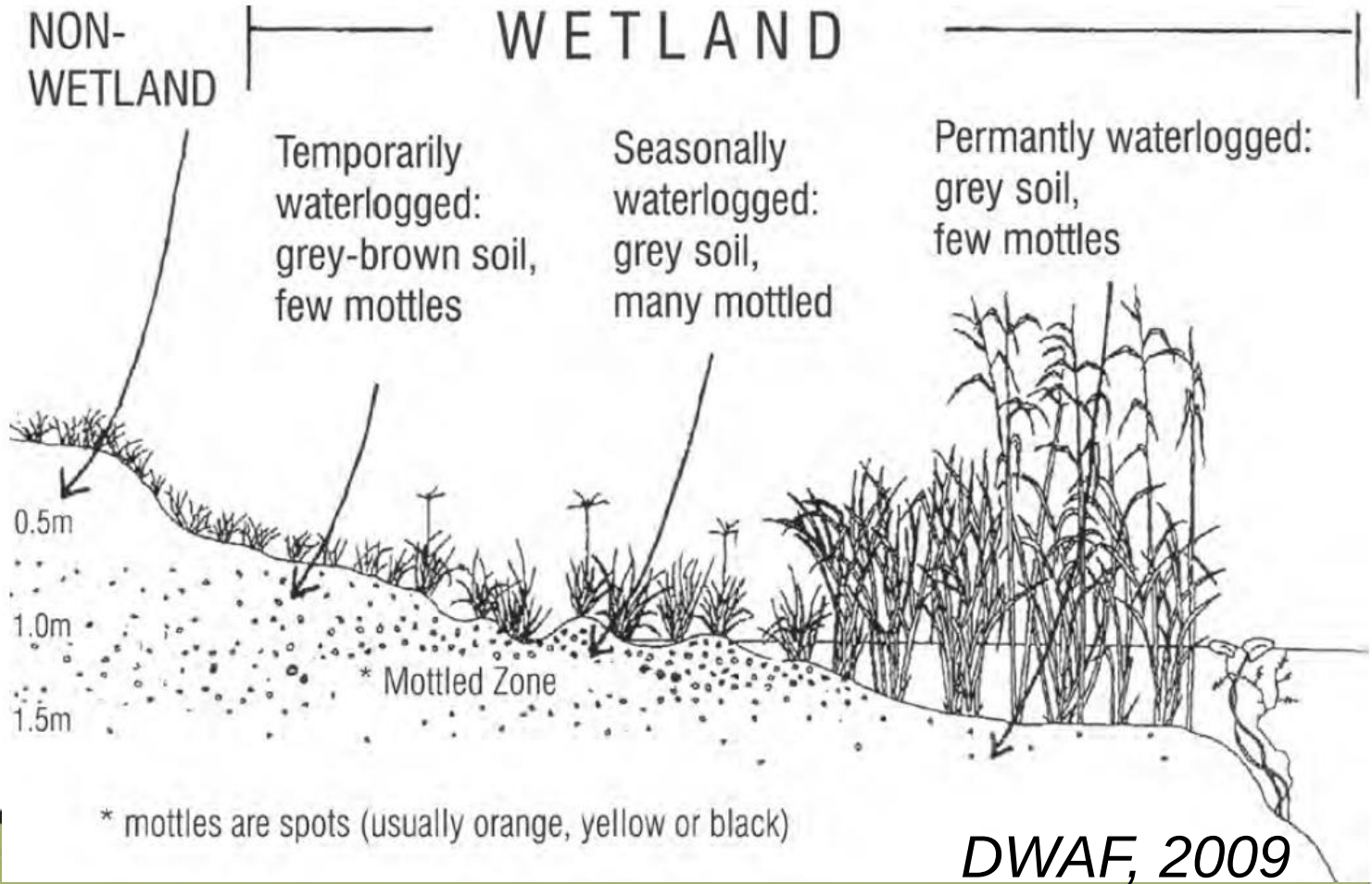


Limited infiltration/groundwater inflow (Baseflow)

- **Generally receive most water during high flow events when waters overtop the streambank.**
- **NB flood attenuation because of the nature of vegetation and topographic setting. Flood attenuation is likely to be high early in the season until the floodplain soils are saturated, whilst in the late season flood attenuation is reduced.**
- **As flood waters overtop streambanks the waters drop sediments, and nutrient bound sediments, which are left behind to accumulate.**
- **The nature of clayey soils in floodplains means that soils retain water, thus limiting contribution to streamflow and groundwater recharge.**

Water retention & distribution: ALL

Quantity: Flow/Water retention & distribution



DWAF, 2009

Evaluation: Duiwenhoks Wetland

East Coast Shale Renosterveld Unchannelled and Channelled Valley Bottom (Duiwenhoks)

Component	Sub-component	Indicator	Conceptual functioning		Baseline monitoring
QUANTITY	Flow	Monitor active erosion sites and density of alien invasive plants (especially Acacia mearnsii).	Unchannelled and Channelled-valley bottom wetland. Retention of water is important, particularly for unchannelled valley bottom wetlands. This is under threat by the concentrated flows through the erosion donga.	Upper Duiwenhoks is within the Southern Fold Wetland Region (WR), but where river flows into flatter coastal belt. Deposition of alluvium derived from steep mountainous streams, and associated vegetation growth on alluvium, resulted in extensive Valley-Bottom wetlands. The Duiwenhoks historically would have been characterised by unchannelled and weakly channelled Valley-Bottom wetlands dominated by Palmiet and Phragmites vegetation. Although the upper-western part of the wetland remain relatively intact, there is still evidence of invasive alien plants and most importantly an actively eroding donga. This erosion has resulted in reduced flows on the wetland and altering flows through berms/drains/roads have caused increased flow.	Working for Wetlands have been working in the area since 2006 (2008, 2009, 2015). Alien invasive plants have been removed, and follow up removal is conducted annually. Work has been done to stabilise the erosion donga.

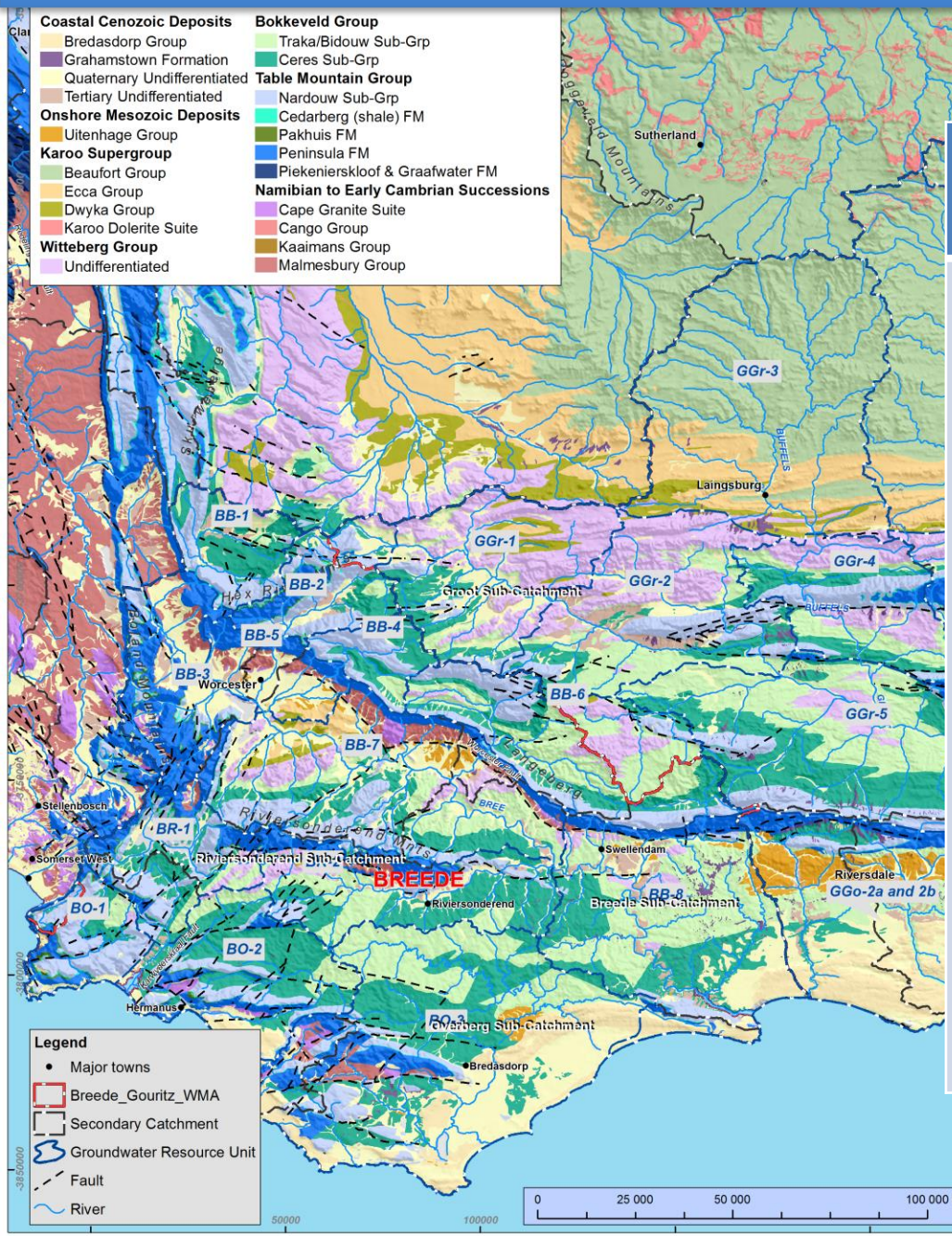
Evaluation: Duiwenhoks Wetland

IUA	RU	Component	Sub-component	Indicator/ measure	RQO	Numerical limits
F12 Duiwenhoks	East Coast Shale Renosterveld Channelled Valley Bottom (Duiwenhoks)	QUANTITY	Water distribution and retention patterns	Flow concentration	Active erosion concentrates flows and increases the rate of flow movement through the wetland. This concentration of flows needs to be managed in order to ensure that water distribution still occurs across the wetland.	Every three years: Map erosion features in the wetland and monitor whether the wetland is drying out near the erosion feature.
		HABITAT	Geomorphology	Erosion	Active erosion removes sediment and vegetation from the wetland. The erosion of banks and headcuts need to managed in order to reduce habitat removal.	Every three years: Map erosion features, particularly noting bank erosion and headcuts, and monitor impacts of erosion on natural vegetation.
			Wetland vegetation	Alien invasive plants	Alien invasive plants, particularly Acacia mearnsii, affect the water distribution and cause bank erosion. The density of alien invasive plants need to be managed, especially in the vicinity of active erosion areas.	Every three years: Monitor the density of Acacia mearnsii, especially near erosion features.

Groundwater

- Background to Resource Unit
- RU prioritisation
- RU evaluation
- Define RQO and Numerical Limits
- Worked example

Background to Resource Unit: Key aquifers

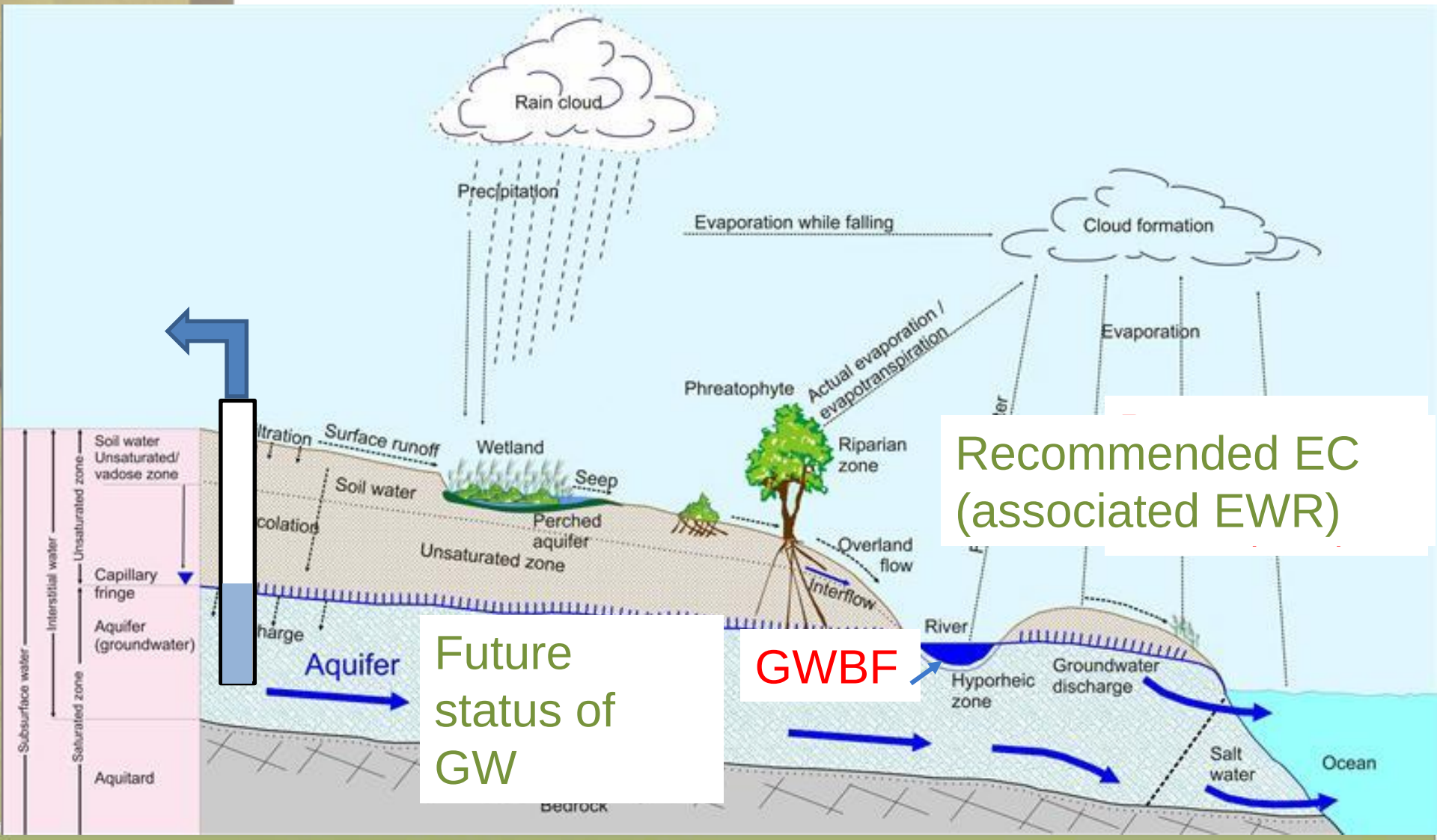


	Geology	Aquifer?
Youngest	Coastal Cenozoic Deposits	Aquifer
	Karoo Supergroup	Contains aquifers, aquitards and aquicludes
	Cape Supergroup	Contains aquifers, aquitards and aquicludes
Oldest	"Basement" Malmesbury Shale intruded by granite	Locally an aquifer Regionally an aquitard

Background to Resource Unit: Groundwater status

- Status quo and EWR report included analysis of current groundwater situation:
  - Groundwater quality, groundwater levels, analysis of trends in both of these
  - Development of groundwater balance model quantifying recharge, groundwater contribution to baseflow, current groundwater use, remaining groundwater availability
  - Identification of areas critical for groundwater use for domestic supply, agricultural supply, and for GW-SW interactions
  - Present status related to use based on stress index (use / recharge)

Relationship between groundwater status and EWRs



Relationship between groundwater status and EWRs

- The above relationships may well be widely accepted, and are theoretically acceptable, but implementation challenges remain
  - simplifying assumptions required to implement the theory,
  - scale complexities,
  - data availability,
  - varying hydrogeological terrains across SA,
  - integration between disciplines (data, models, scales)
  - modelling methods & challenges.

RU Prioritisation

- A set of criteria and sub-criteria were selected based on:
  - The framework for RU prioritisation (DWA, 2011)
  - Previous studies (specifically the Olifants-Doorn and Olifants)
  - Applied to quaternary catchment scale, grouped together and handled per GRU in RQOs

Criterion	Weights (%)
Importance for users	25
Level of surface water – groundwater interaction	30
Threat posed to users	30
Practical Considerations	15

RU Prioritisation

- Only one rating can be applied per resource unit, whereas the sub-criteria can have a spatial variability. The sub-criteria category which covers the largest part of the resource unit, or a worst case, was applied.
- Score: 0 – 100
- Score divided into three categories based on the distribution of the final scores
  - 1 (not priority) - <18 [number of quats: 50]
  - 2 (low priority) - 18 – 35.25 [number of quats: 118]
  - 3 (high priority) - >35.25 [number of quats: 42, or 20%]

RU Prioritisation

- Diverted from this scoring where:
  - in GRUs with no quaternary catchments scoring a “3”, the quaternary catchment with the highest score within that GRU was manually assigned a “3”. (Red)

RU Prioritisation

IUA	GRU	Quat	RU PRIORITY (1 to 3)	SCORE
Gamka-Buffels	GGa-2a, 2b and 2c	J21A	3	66.3
Upper Breede Tributaries	BB-1	H10C	3	58.8
Overberg East Fynbos	BO-3	G50E	3	53.8
Breede Working Tributaries	BB-3	H10G	3	51.3
Overberg West	BO-1	G40C	3	48.3
Overberg East Fynbos	BO-3	G50B	3	47.5
Breede Working Tributaries	BB-3	H10L	3	47.5
Breede Working Tributaries	BB-3	H10H	3	46.8
…….				
Touws	GGr-1	J12C	**3**	**35.0**

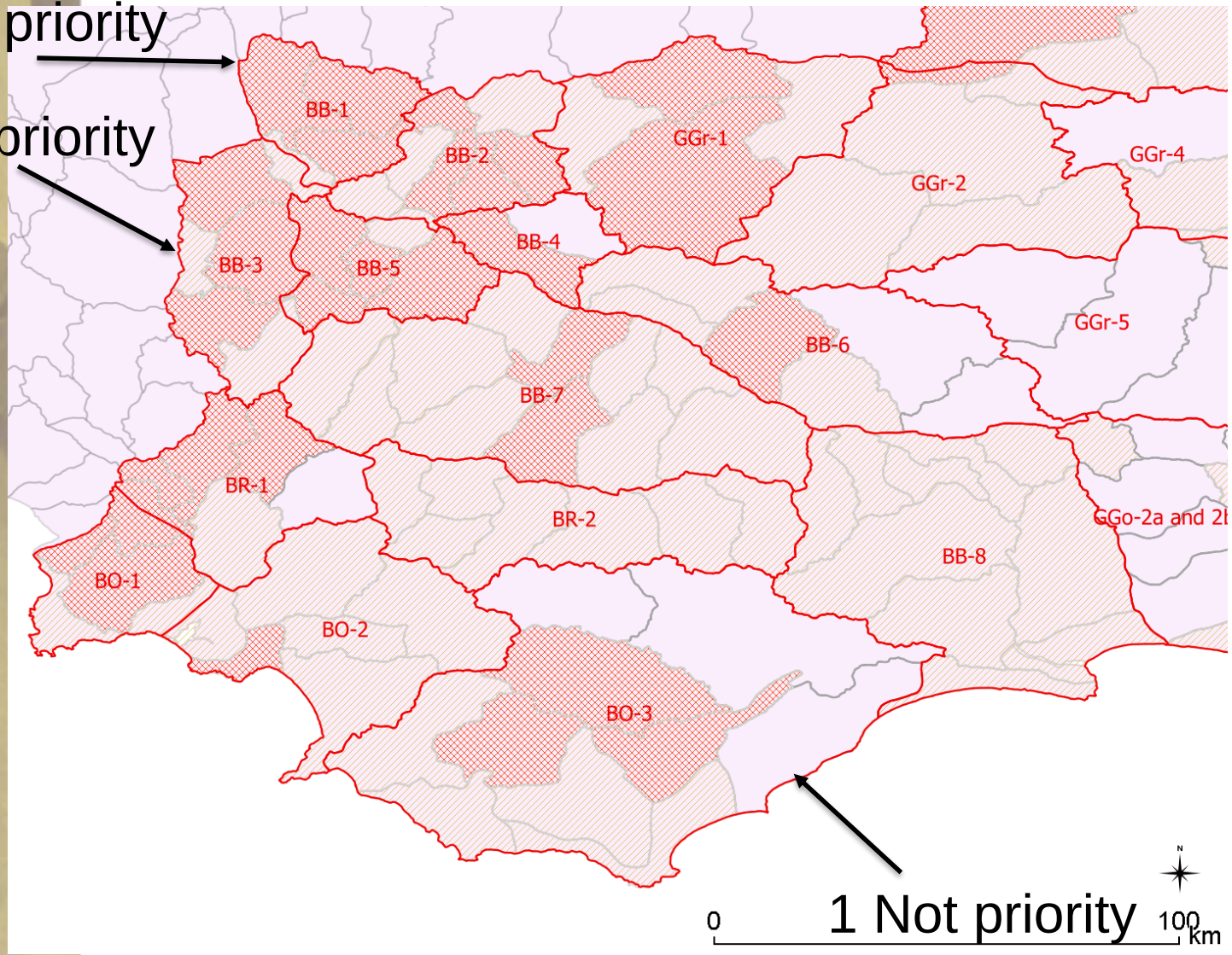
Prioritisation results

Total:
42 quats
21 GRUs
15 IUAs

RU Prioritisation

3 High priority

2 Low priority



RU Prioritisation

Areas with low scores:

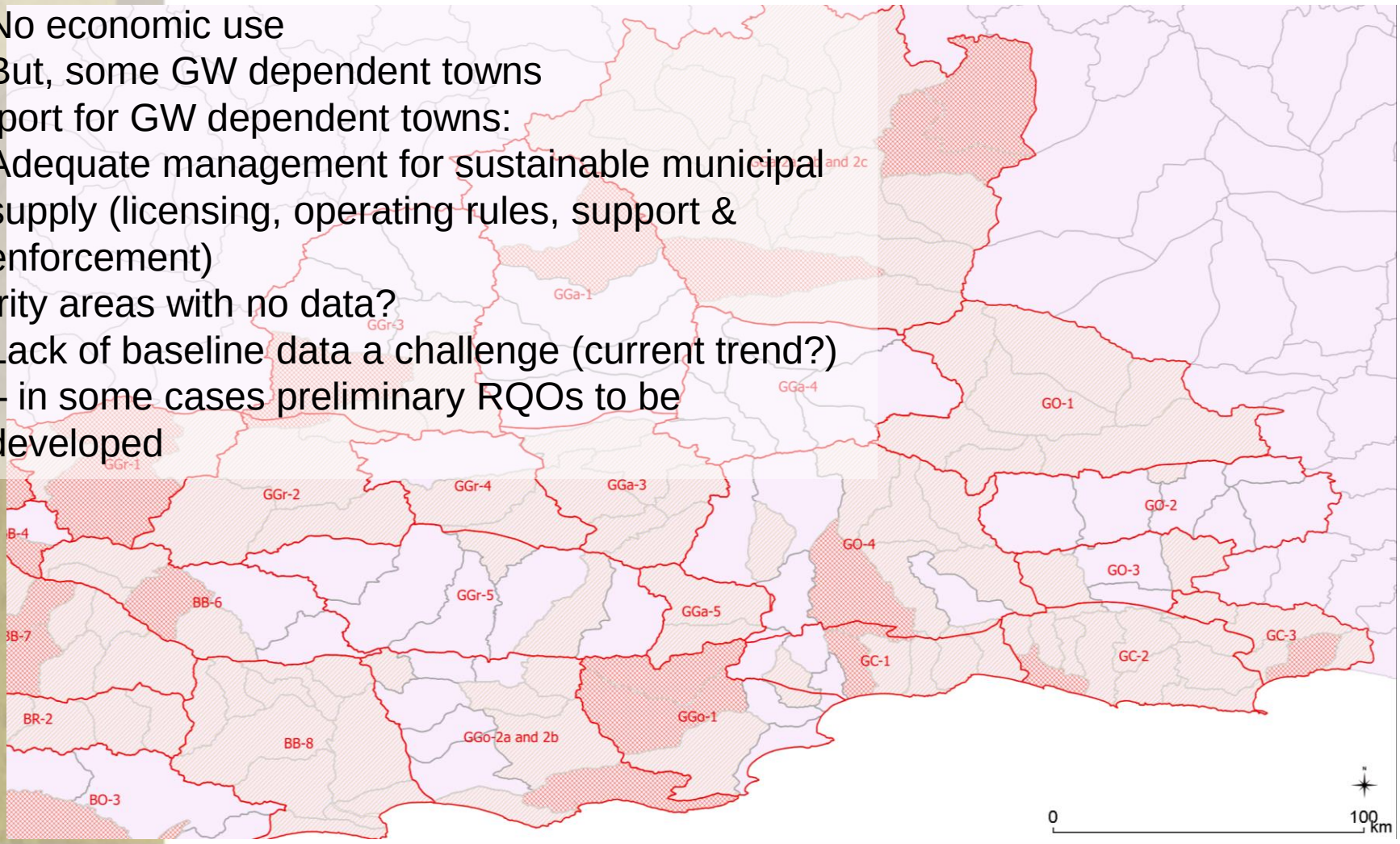
- No SW-GW interaction
- No economic use
- But, some GW dependent towns

Support for GW dependent towns:

- Adequate management for sustainable municipal supply (licensing, operating rules, support & enforcement)

Priority areas with no data?

- Lack of baseline data a challenge (current trend?) – in some cases preliminary RQOs to be developed



RU Evaluation

- Identify sub-components that may be important to users and the environment (per RU) and select indicators for which RQOs and Numerical Limits should be developed.
- Resource Unit Evaluation Tool used as a guideline - the components routinely considered for rivers (quality, quantity) are equally applicable to groundwater.
- Recent examples from other catchments, specifically the Olifants-Doorn (DWS, 2014), and the Inkomati-Usuthu (DWS, 2015).

RU Evaluation

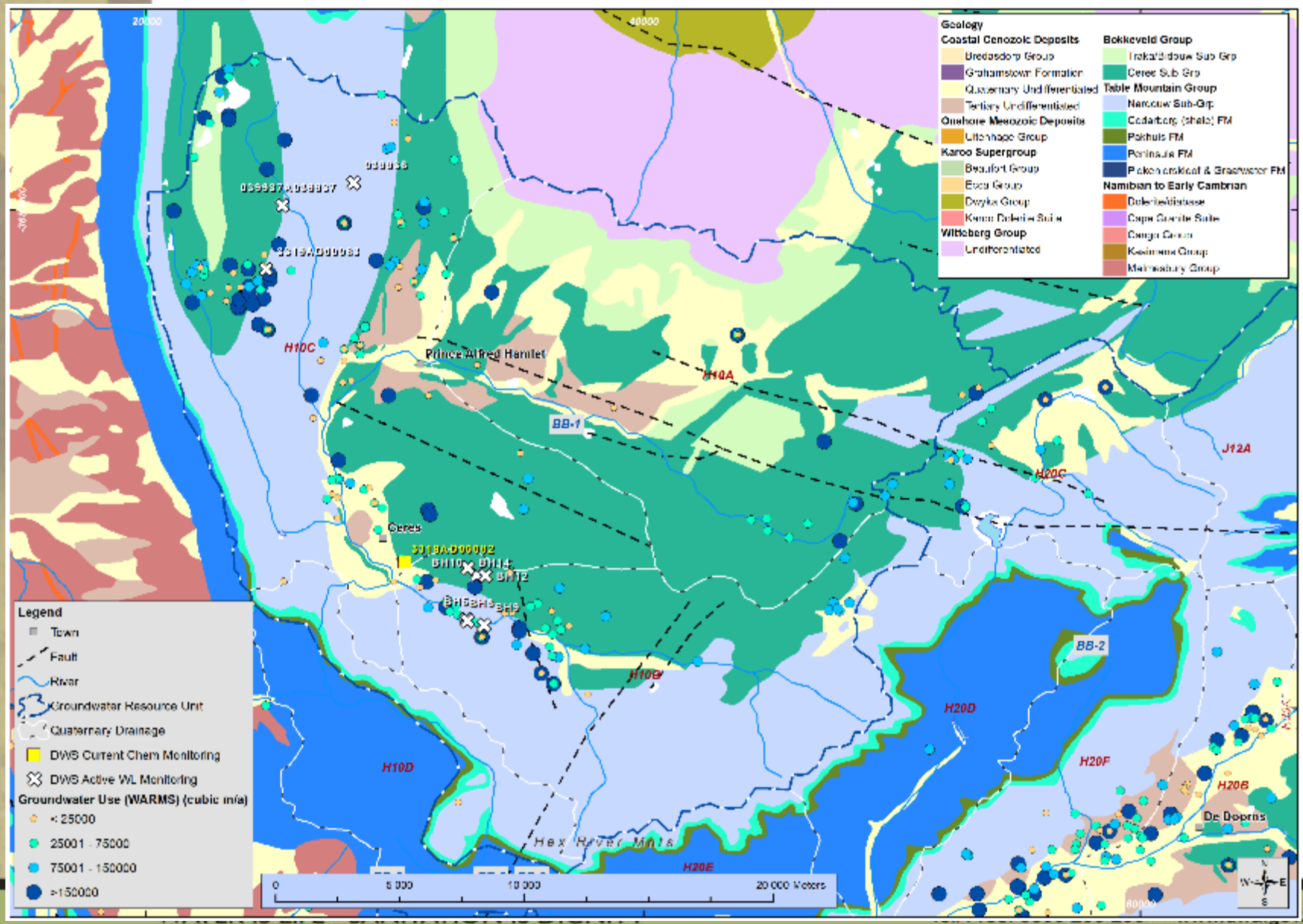
Component	Sub-Component	Indicator
Quantity	Abstraction (available yield)	Water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles
	Groundwater level (available yield)	Water level
	Discharge	Relative water levels between groundwater and surface water
	Low flow in river	Compliance with the lowflow requirements in the river
Quality	Nutrients	NO_3/NO_2
	Salts	EC
	Pathogens	E-coli
	Pathogens	Total Coliform

2. Develop an RQO (objective-descriptive), and numerical limit per indicator (if possible)

1. Consider the relevant components / sub-components / Indicators in each prioritised RU

3. Per major aquifer, per prioritised quaternary (grouped per GRU)

RQOs EXAMPLE: Groundwater Resource Unit BB-1

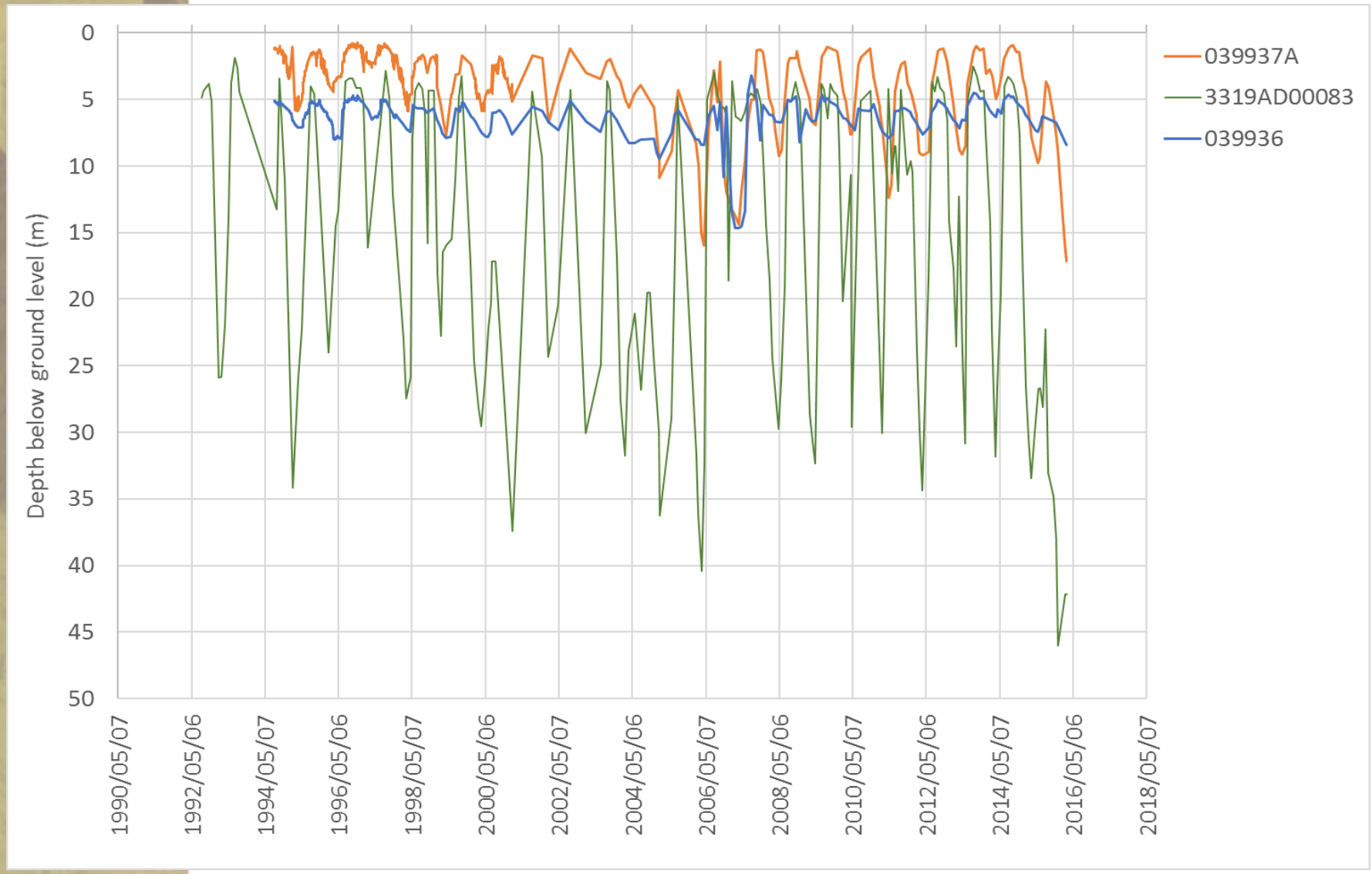


RQOs EXAMPLE: Groundwater Resource Unit BB-1

BB-1 Excludes the buried Peninsula (so not "all' and not "TMG“) given the deep Peninsula may not mimic surface topography, will not be in connection with rivers, and may be drilled into.

GRU	Quat(s)	Aquifer	Component				
BB-1	H10A, H10B, H10C	Bokkeveld Group, Nardouw Group, Cenozoic coastal deposits	Quantity	Abstraction	Groundwater use should be sustainable for all users and the environment	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.	n/a
				Discharge	The natural gradient between groundwater and surface water should be maintained	Relative water levels between groundwater and suface water (in mamsl)	n/a
				Discharge	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	Buffer zones	250m
				Low flow in river	Compliance to the low flow requirements in the river, as per surface water RQO requirement	Compliance with the lowflow requirements in the river	See section 3.1

RQOs EXAMPLE: Groundwater Resource Unit BB-1



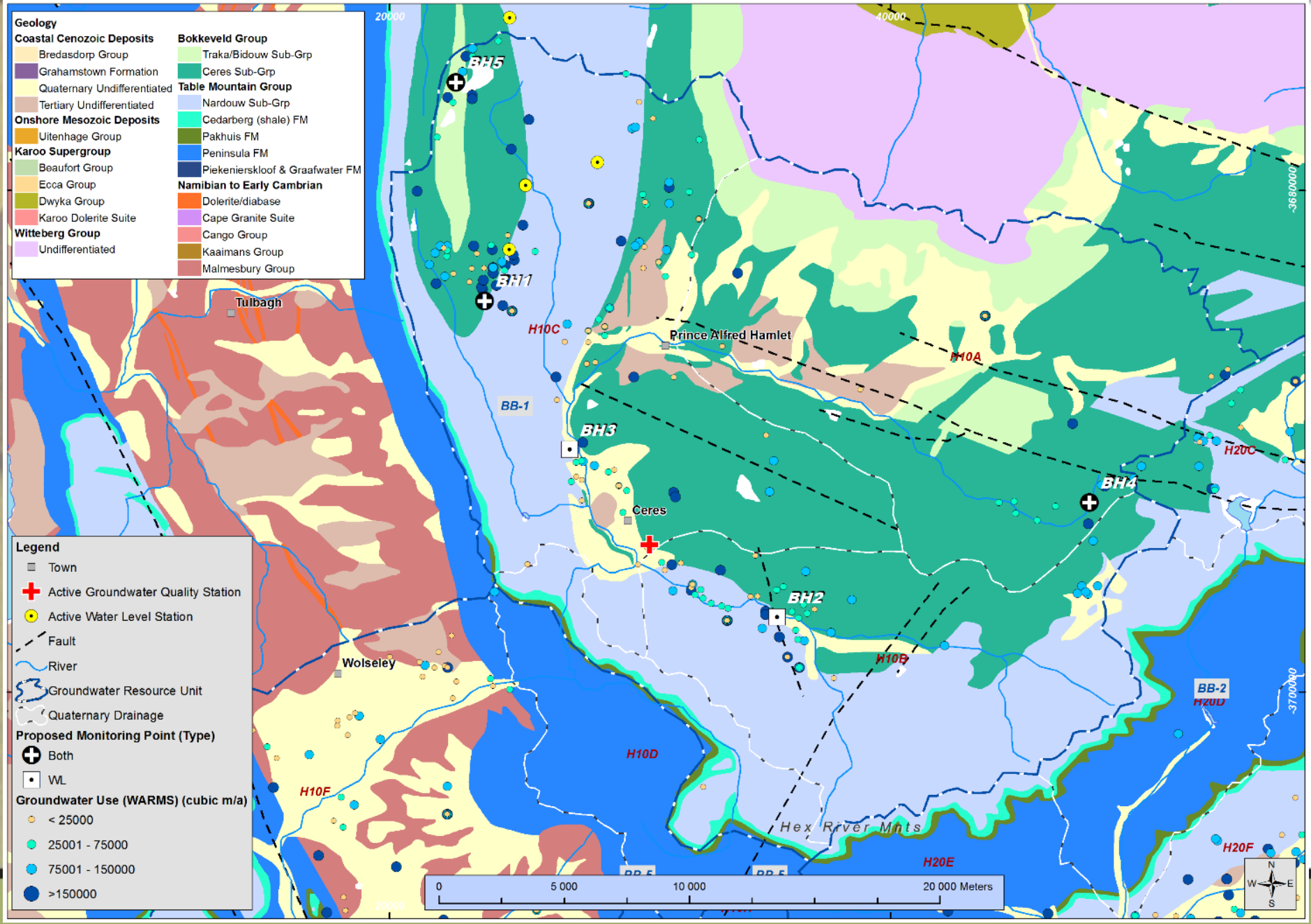
RQOs EXAMPLE: Groundwater Resource Unit BB-1

BB-1

95% from this geology in this region
90% from this geology in this region
95% from this geology across the region

GRU	Quat(s)	Aquifer	Component	Sub-Component	RQO Description (narrative)	Indicator	Numerical Value
BB-1	H10A, H10B, H10C	Cenozoic coastal deposits - alluvium	Quality	Nutrients	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	NO_3 (as N)	6.8 mg/l
				Salts		EC	311 mS/m
		Bokkeveld Group		Nutrients		NO_3 (as N)	2.4 mg/l
				Salts		EC	236 mS/m
		Nardouw Group		Nutrients		NO_3 (as N)	4.4 mg/l
				Salts		EC	119 mS/m
		Bokkeveld Group, Nardouw Group, Cenozoic coastal deposits		Pathogens		E-coli	0 counts / 100 ml
				Pathogens		Total Coliform	10 counts / 100ml

MONITORING EXAMPLE: Groundwater Resource Unit BB-1



Thank you, Any discussion?

Way Forward

- Comments from this workshop that influence reports incorporated
- Draft Gazette prepared
- Period allowed for comment on the draft gazette

Additional slides

Prioritisation sub-criteria

Criterion	Weights (%)	Sub-criteria	Weights (%)	Rating guidelines
Importance for users	25	RUs most important in supporting 'sole-supply' settlements	60 (15 points)	0 – RUs which do not support sole-supply settlements
				0.5 – RUs supporting some sole-supply settlements (1-2)
				1 – RUs supporting several sole-supply settlements (>2)
		RUs within strategic water source areas for groundwater (high groundwater availability & strategic use)	20 (5 points)	0 - RUs outside of SWSA-gw
				1 – RUs within SWSA-gw
		RUs most important in supporting activities contributing to economy (GDP, job creation) (e.g. commercial agriculture, industrial abstraction, bulk abstraction by water authorities)	20 (5 points)	0 – RUs which do not directly support any activities which contribute to economy [as indicated by <0.05l/s/km2]
				0.5 – RUs which moderately support activities which provide a contribution to economy [as indicated by 0.05-0.1l/s/km2]
				1 – RUs which significantly support activities which contribute to the economy [as indicated by >0.1l/s/km2]

Prioritisation sub-criteria

Criterion	Weights (%)	Sub-criteria	Weights (%)	Rating guidelines
Level of surface water – groundwater interaction	30	Relevance of groundwater contribution to maintain required low flow conditions	50 (15 points)	0 – RUs without relevant groundwater contribution (low GWBF/EWR) (GWBF/EWR < 11%)
				0.5 – RUs where groundwater contribution supports low flow condition (GWBF/EWR moderate, 12-75%)
				1 – RUs where groundwater contribution is crucial to maintain low flow condition (GWBF/EWR high >75%)
		Relevance of groundwater contribution to maintain priority groundwater-dependent ecology	50 (15 points)	0 – RUs without priority groundwater-dependent systems (estuaries / wetlands)
				0.5 – RUs with some priority groundwater-dependent systems (estuaries / wetlands) (<200ha)
				1 – RUs with significant area of groundwater-dependent systems (estuaries / wetlands) (>200ha)

Prioritisation sub-criteria

Criterion	Weights (%)	Sub-criteria	Weights (%)	Rating guidelines
Threat posed to users	30	Medium to Long-term declining trend in water or piezometric levels	35 (10.5 points)	0 – RUs where no trend is visible
				0.5 – RUs where short-term trend is potentially visible, or minor
				1 – RUs where long-term trend is visible, or where no data is available to assess trend
		Medium to Long-term declining trend in natural water quality	35 (10.5 points)	0 – RUs where no trend is visible
				0.5 – RUs where short-term trend is potentially visible, or minor
				1 – RUs where long-term trend is visible, or where no data is available to assess trend
		Presence of high stress category (currently)	15 (4.5 points)	0 – RUs where stress is low (category I)
				0.5 – RUs where stress is moderate (category II)
				1 – RUs where stress is high (category III)
		Presence of high stress category (future)	15 (4.5 points)	0 – RUs where stress is low (category I)
				0.5 – RUs where stress is moderate (category II)
				1 – RUs where stress is high (category III)

Prioritisation sub-criteria

Criterion	Weights (%)	Sub-criteria	Weights (%)	Rating guidelines
Practical Considerations	15	Availability of water quality monitoring data (WMS monitoring boreholes) located within RU?	50	0 – RUs where no resource quality information exists
				0.5 – RUs for which a moderate level of resource quality information exists (1-4 points)
				1 – RUs for which there is a good availability of resource quality information (>4 points)
		Availability of water level monitoring data (DWA monitoring boreholes) located within RU?	50	0 – RUs where no water level information exists
				0.5 – RUs for which a moderate level of water level information exists (1-4 points)
				1 – RUs for which there is a good availability of water level information (>4 points)

Evaluation of RUs - method

The **evaluation criteria** (applied in the **RU Evaluation Tool**) for each of the above indicators are:

- **Cumulative level of impact**: This is the anticipated level of impact of current and future use/activities in the upstream catchments on the inflows to the dam and the quality, habitat and biota in the dam
- **Protection of the Resource**: Rating of importance of components for the protection of the water resource, i.e. importance to releases of water for downstream EWRs
- **Water Resource Dependent Activities**: Rating of importance of components for protection of in-dam activities and releases of water for downstream use (irrigation, domestic/rural supply, etc.)

Components with importance scores of 0.5 and higher were selected

Outline of RQOs - method

- Targeted Ecological Category (TEC) = Spatially Targeted Scenario, where info is available
- For the High Priority Rus:
  - Evaluate present status and suitability of data
- For the selected sub-components and indicators of each dam:
  - Write descriptive RQOs (narratives)
  - Set numerical limits
  - Set Thresholds of Potential Concern (TPCs)

BB-1

95% from this geology in this region
90% from this geology in this region
95% from this geology across the region

GRU	Quat(s)	Aquifer	Component	Sub-Component	RQO Description (narrative)	Indicator	Numerical Limit
BB-1	H10A, H10B, H10C	Cenozoic coastal deposits - alluvium	Quality	Nutrients	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	NO_3 (as N)	**6.8 mg/l**
				Salts		EC	**311 mS/m**
		Bokkeveld Group		Nutrients		NO_3 (as N)	**2.4 mg/l**
				Salts		EC	**236 mS/m**
		Nardouw Group		Nutrients		NO_3 (as N)	**4.4 mg/l**
				Salts		EC	**119 mS/m**
		Bokkeveld Group, Nardouw Group, Cenozoic coastal deposits		Pathogens		E-coli	0 counts / 100 ml
				Pathogens		Total Coliform	10 counts / 100ml