

DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE UPPER ORANGE RIVER CATCHMENT, WP11422

Project Steering Committee meeting 2 – Bloemfontein

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Designation: PSP

Directorate: for Chief Directorate Water Ecosystems Management

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WATER IS LIFE - SANITATION IS DIGNITY



water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA



Protection of Water Resources

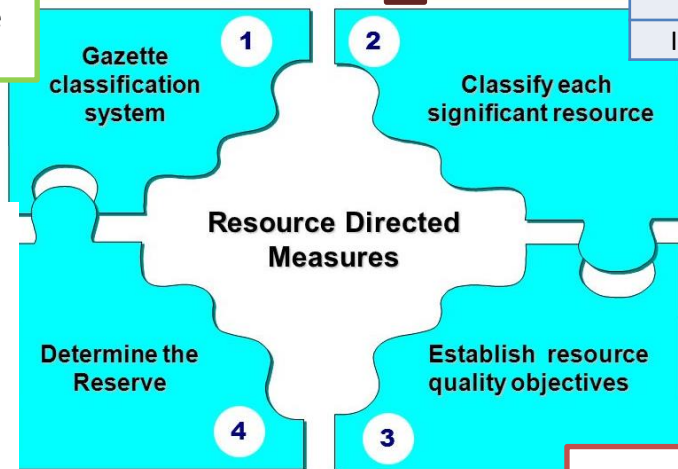
National system for classifying resources

- Gazetted on 17 September 2010, Gazette No. 33541, Regulation 810

Defines and specifies the procedures for determining the classes of water resources (7 steps), the Reserve (8 steps) and resource quality objectives (6 steps).

Rivers, groundwater and wetlands, estuaries.

Class	Description of use	Ecological Category	Description of resource
I	Minimally used	A-B	Minimally altered
II	Moderately used	C	Moderately altered
III	Heavily used	D	Heavily altered



Each class represents:

- a different **level of protection** that is required for the water resource, and the extent to which the water can be used.

Classification is used in two ways:

- To define the **present status** of the water resource
- To define the state towards which the water resource needs to be managed sustainably (**future state**).

- Only right in NWA
- The Reserve is an integral part of the RQO
- The Reserve is part of the water resource that is under the direct control of the Minister.
- It has priority over all other water use. Reserve must be met before water resources can be allocated to other water users

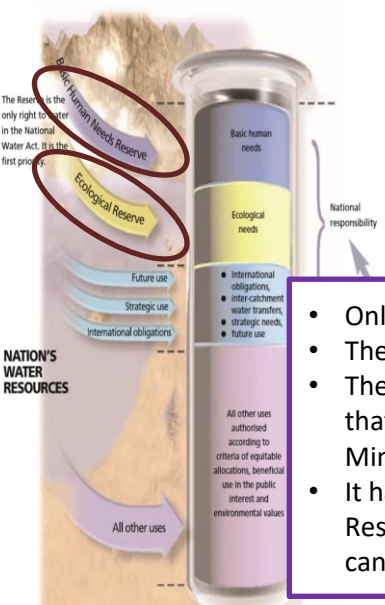
Targets or objectives/ management goals that provide statements about:

- what the **quantity** of the water should be (water level, pattern, timing)
- what the water **quality** should be (physical, chemical and biological)
- what the **condition** of the **instream and riparian** (riverbank) habitat should be
- what the **condition** of the **aquatic** (water) animal and plant life should be.

This is perfect for me

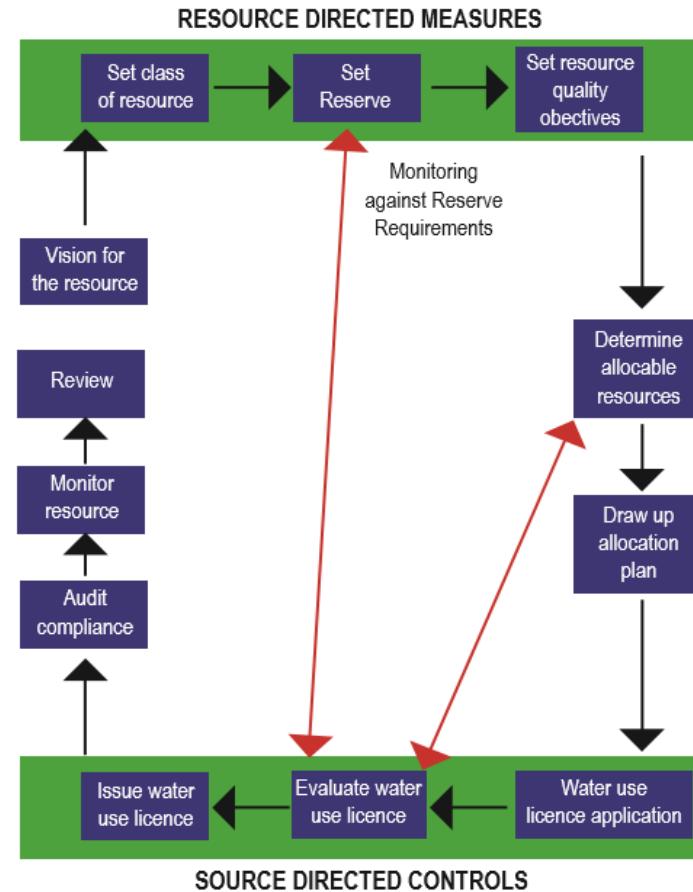
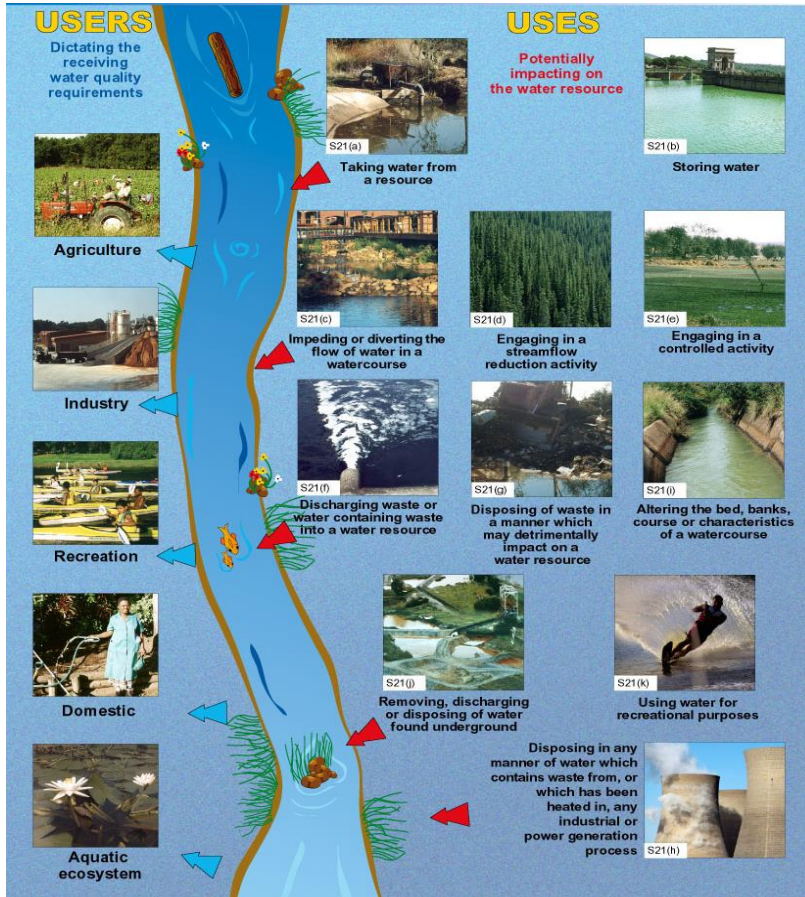


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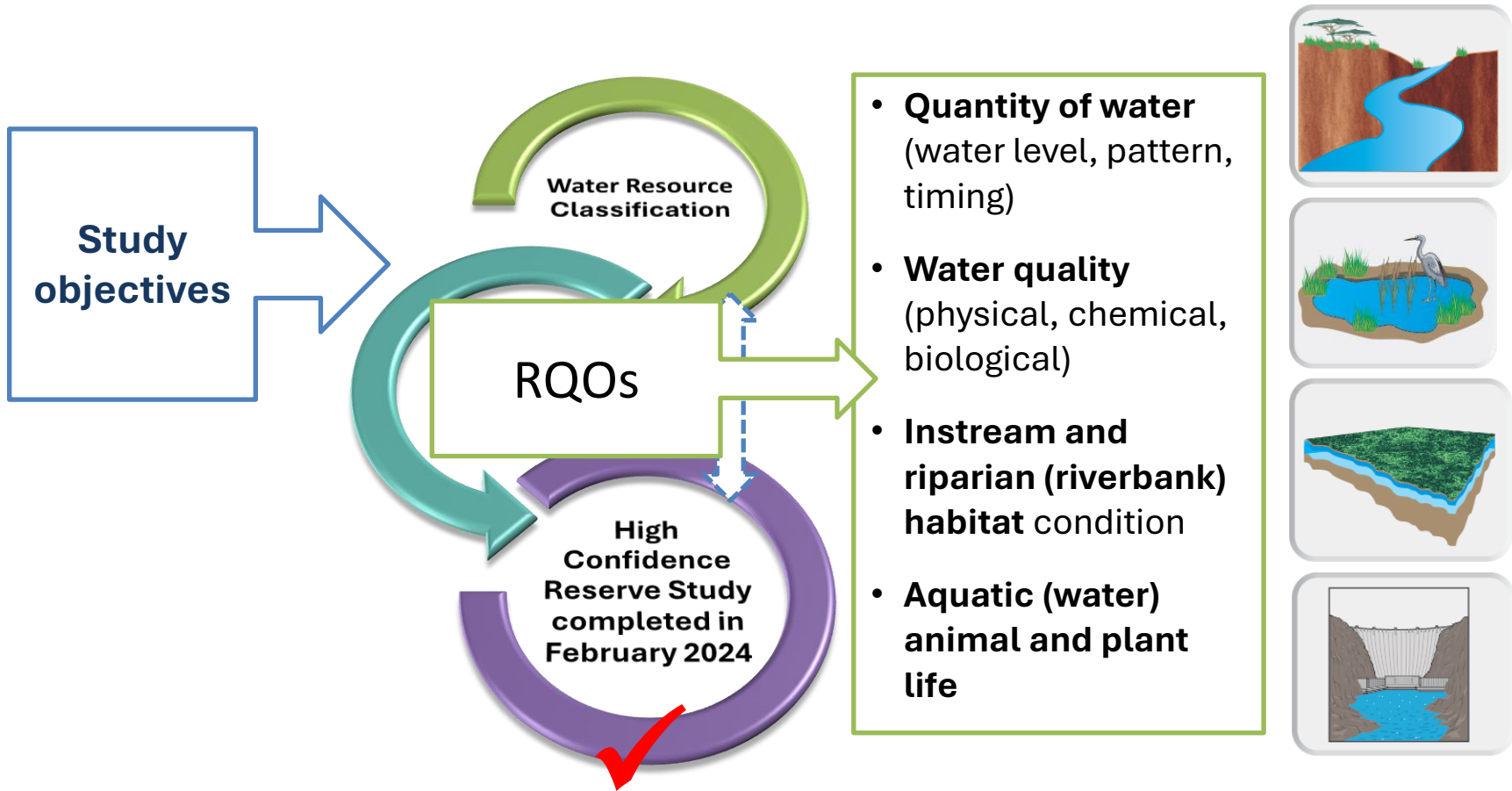


Balancing Use and Protection

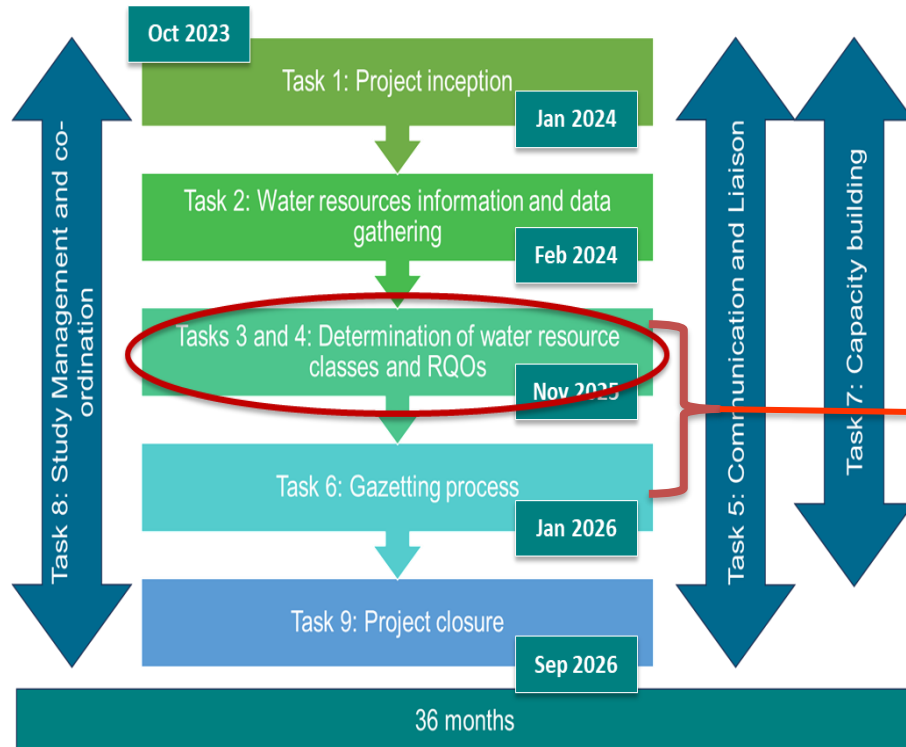
Integrated Water Resources Management (IWRM)



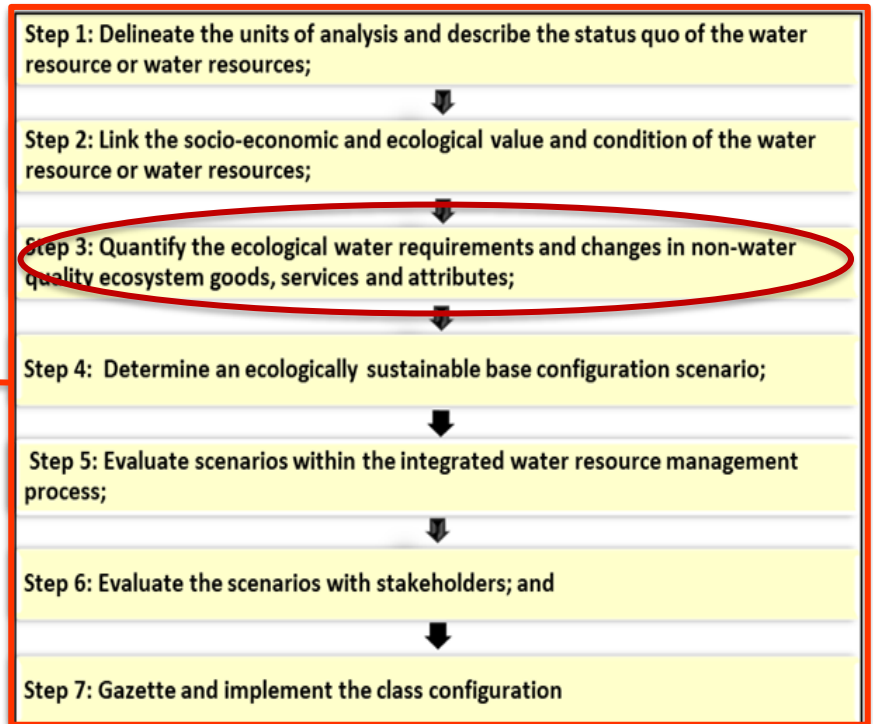
Protection Measures



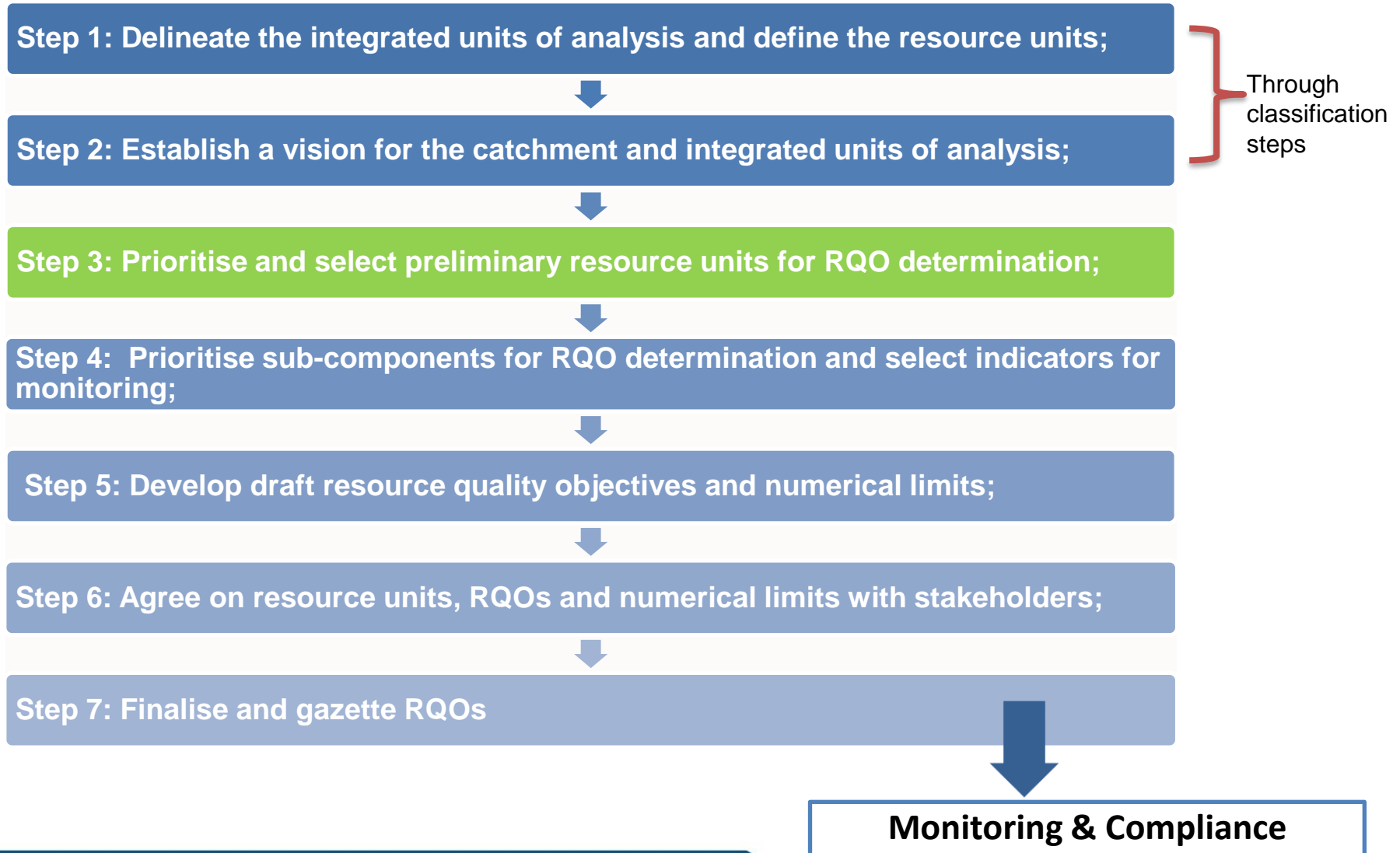
Overall study tasks



Classification



RQO Determination Process



Focus of the meeting

- Progress to date for both the classification and RQOs components
- Resource Units delineated and prioritised
- Present the outputs from the ecological water requirements quantification

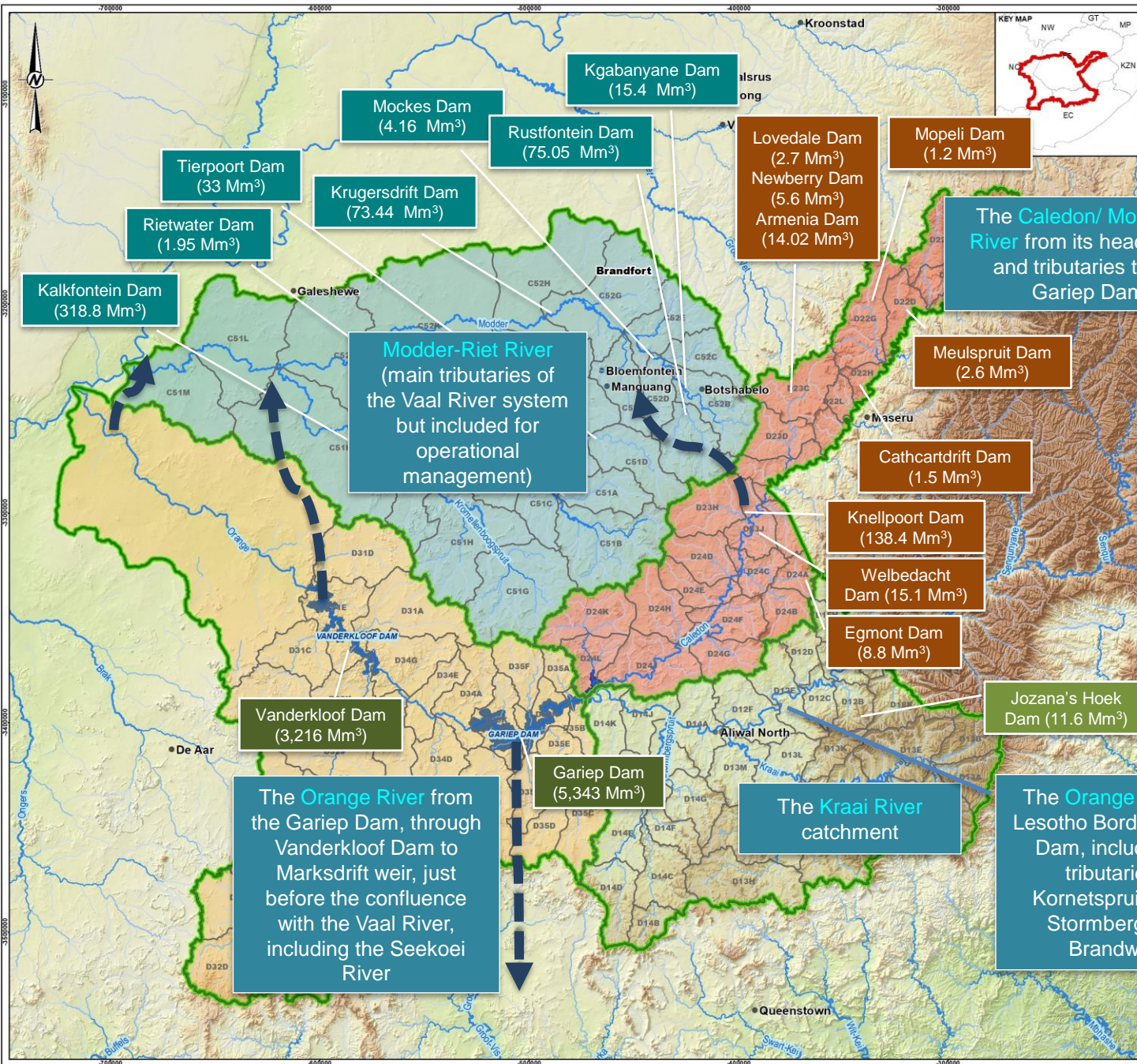


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**WATER RESOURCE CLASSES AND ASSOCIATED RQOs:
UPPER ORANGE RIVER CATCHMENT, WP11422**

Study area



LEGEND

- Towns
- Water Management Area - Upper Orange Catchment (DWAf 2012)
- Dam
- Rivers

Secondary catchment areas

- C5

The Upper Orange River catchments stretch across the Northern Cape, Free State and Eastern Cape provinces and across three ecoregions: the Eastern Escarpment Mountains, Nama Karoo and Highveld

SWSA-sw: Maloti Drakensberg area and the Eastern Cape Drakensberg; and

SWSA-gw: Central Pan belt, De Aar Region and Eastern Upper Karoo



NOTE(S)

684 L031	
AND SANITATION	
ROQS DETERMINATION	
REQUIREMENTS FOR CLASSIFICATION OBJECTIVES SETTING (WP11422)	
YYYY-MM-DD	2023/11/22
DESIGNED	TS
PREPARED	MB
REVIEWED	LB
APPROVED	LB

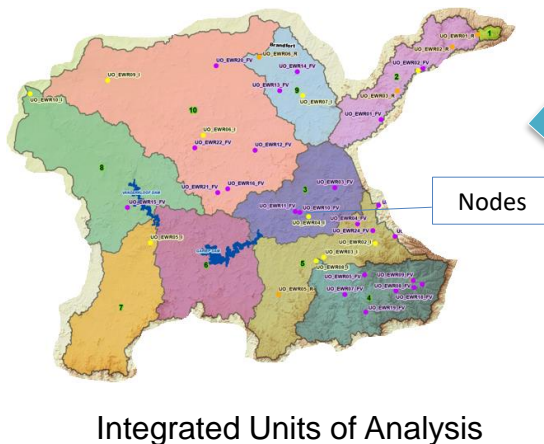
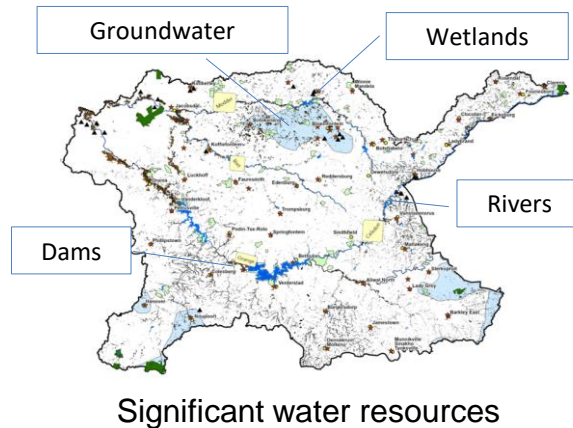
PROJECT NO. 41104900 CONTROL REV 0 9 FIGURE 0



Water Resource Classification

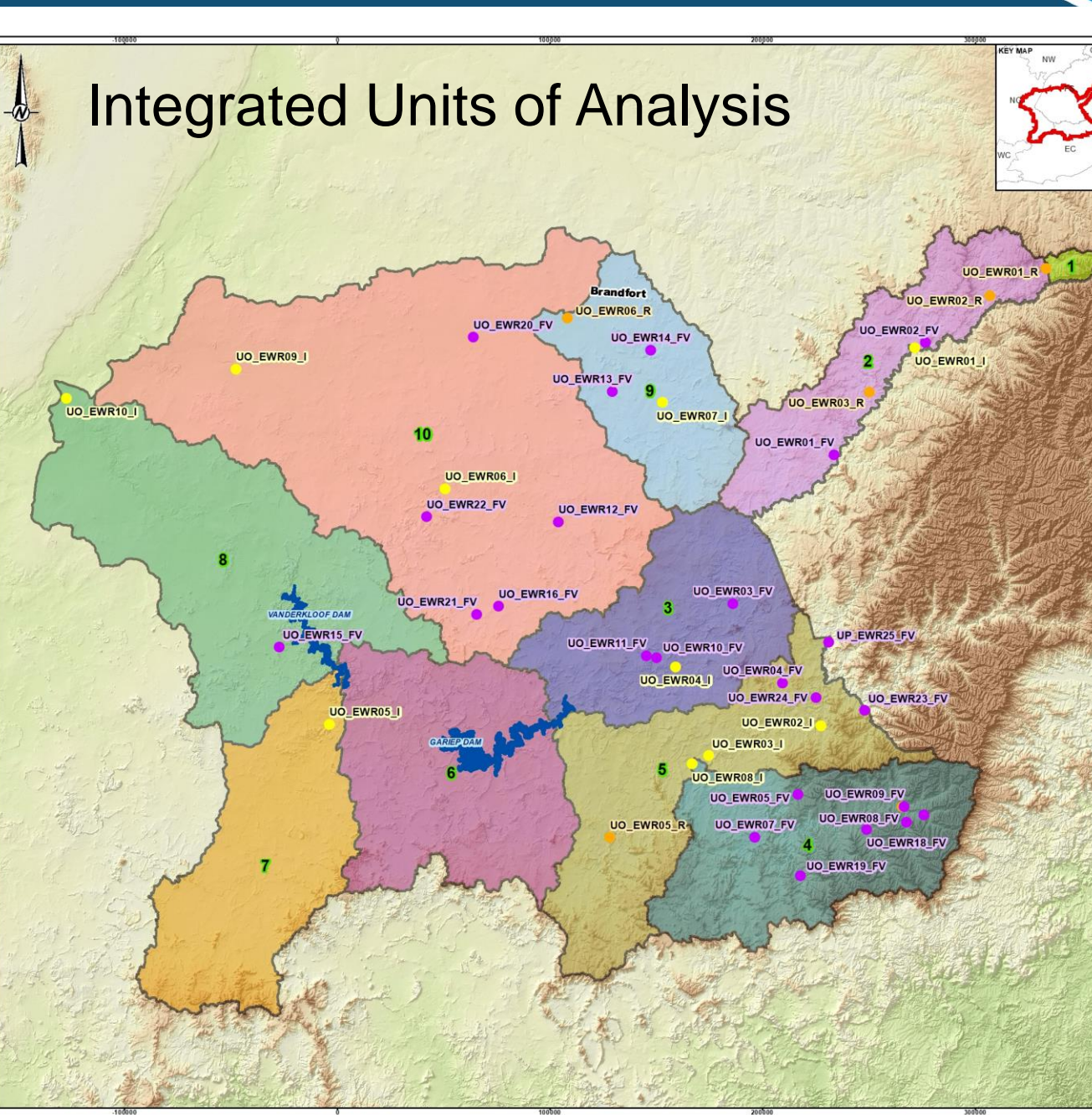
Step 1: delineate the catchment and describe the status quo

- Identify a network of significant resources, describe water resource infrastructure and identify water user allocations.
- Define a network of significant resources and establish biophysical nodes.
- Define Integrated Units of Analysis.



- Socio-economic zones (SEZs)
- Catchment area boundaries (drainage regions and water resource systems)
- The resolution of the hydrological analysis and available water resource network configurations within the water resource models.
- Location of significant water resource infrastructure.
- Land use characteristics.
- Distinctive functions of the catchments in context of the larger system.
- The Present Ecological State (PES) of each biophysical node was considered, the type of impacts and the homogeneity of the status and impacts.
- The practicalities of the existing model setup and network in terms of the scenario evaluation of each proposed IUA.
- Present status of water resources.
- Stakeholder input.

Integrated Units of Analysis



IUA	Description	Quaternary
1	Golden Gate	D21D and a portion of D21A along South Africa/ Lesotho border
2	Caledon / Leeu River	D21E, D21F, D21G; portion of D21C; D22A, D22B; portions of D21H and D22C along the SA/ Lesotho border; Portions of D22D, D22G, D22H, D22L, Portion of D23A, D23C, D23D and portion of D23E
3	Caledon River	D23F, D23G, D23H, D23J, D24A, D24B, D24C, D24D, D24E, D24F, D24G, D24H, D24J, D24K and D24L
4	Kraai River	D13A – D13M
5	Upper Orange River	D12A – D12F, D14A – D14K, Portions of D15G, D15H, D18K and D18L
6	Gariep Dam	D34A, D34B, D34C, D34D, D34E, D34F, and D34G, D35A, D35B, D35C, D35D, D35E, D35F, D35J, D35G, D35H, D35K
7	Seekoei River	D32A, D32B, D32C, D32D, D32E, D32F, D32G, D32H, D32J, D32K
8	Vanderkloof Dam	D33A – D33K (along main stem Orange River); D31A – D31E
9	Upper Modder River	C52A, C52B, C52C, C52D, C52E, C52F and C52G
10	Modder/ Riet River	C51A, C51B, C51C, C51D, C51E, C51F, C51G, C51H, C51J, C51K, C51L, C51M, C52H, C52J, C52K and C52L



**WATER RESOURCE CLASSES AND ASSOCIATED RQOs:
UPPER ORANGE RIVER CATCHMENT, WP11422**

Resource Quality Objectives

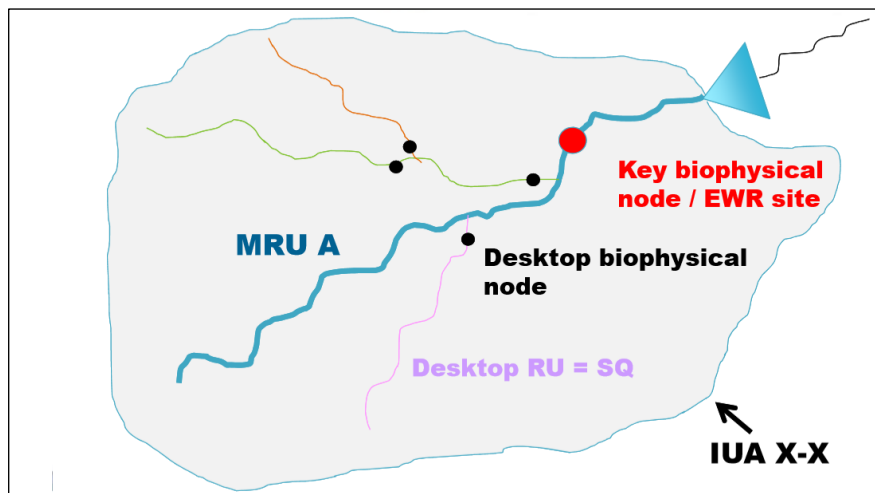
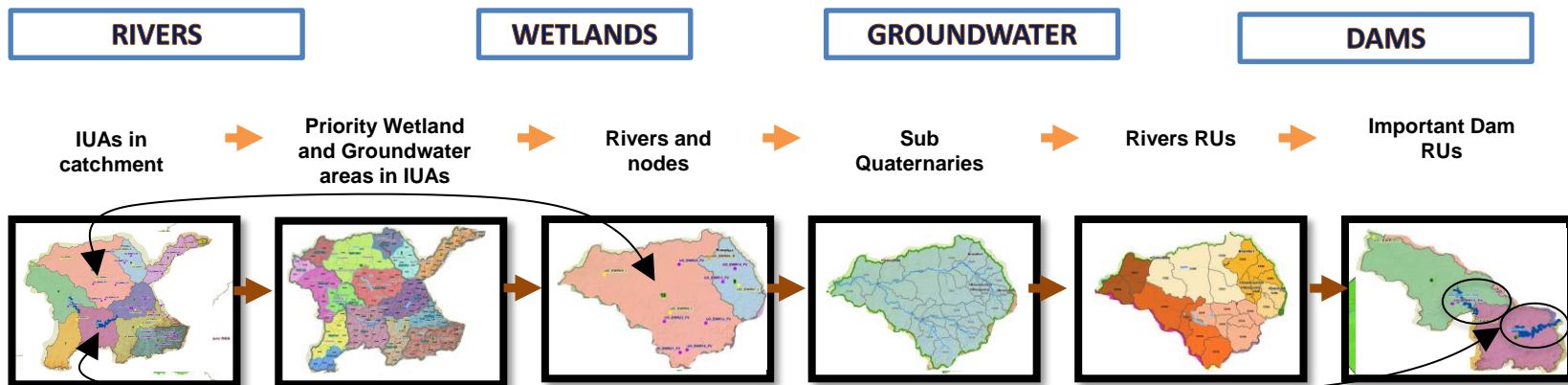
Resource Quality Objectives

- Purpose is *to establish clear goals relating to the quality of the relevant water resources*: provide limits or boundaries for the sustainable use of water resources
- In determining RQOs, *a balance must be sought between the need to protect and sustain water resources and the need to use them*
 - Must take account of user requirements and the class of the resource
 - Binding on all authorities and institutions
 - The RQOs may inform decision-making relating to the use of the water in a specific water resource.
- RQOs can be numerical and/or descriptive statements and may relate to:
 - Water Quality
 - Quantity (pattern and timing of flow)
 - Character and condition of riparian habitat, and
 - Characteristics and condition of the aquatic biota.

Delineating Resource Units

- As it would not be appropriate to set the same RQOs for the headwaters of a river as for the lowland reaches, RUs are required.
- The RUs are river reaches that are each **significantly ecologically different** to warrant their own specification of the RQOs and as such the geographic boundaries of each must be clearly delineated.
- A RU is a section of a river that frequently has **different natural flow patterns** and reacts differently to stress according to sensitivity.
- The delineation of a catchment into RUs is done primarily on a biophysical basis, and where the hydrology, geomorphic characteristics (i.e. geomorphic zone), water quality attributes and river size remains relatively similar, a RU can be defined.
- In addition, **management requirements** also play a role in RU delineation.
- A RU may be a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements.
- These management units are based on the **principle of homogeneity of impacts** in the demarcated RU.
- This may include the **modification of flows** in the system due to abstraction, regulation by impoundments and development along the RU and upstream from the RU which may influence the geomorphology and water quality conditions.

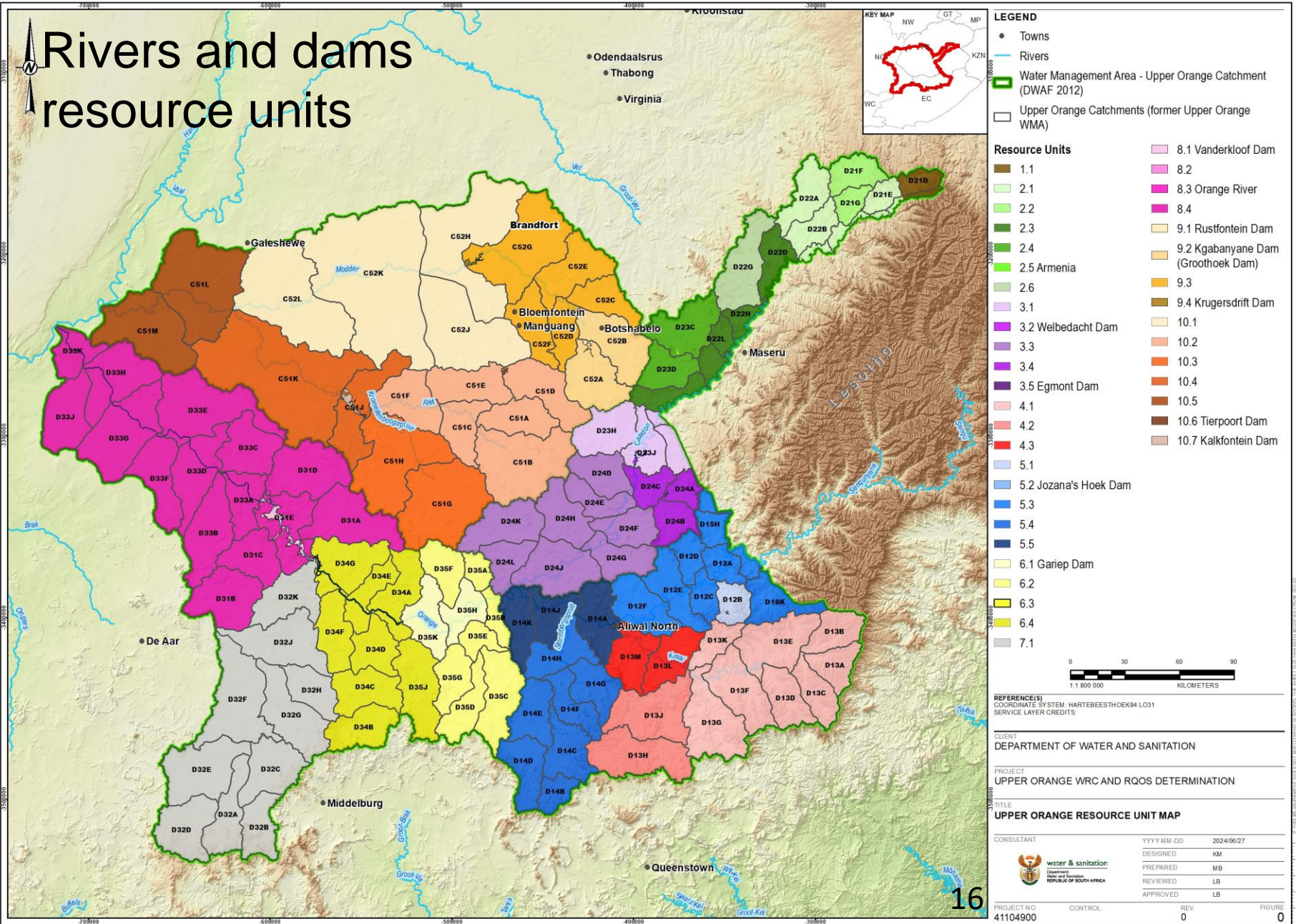
Step 1: Describe the status quo and delineate IUAs and *Resource Units*



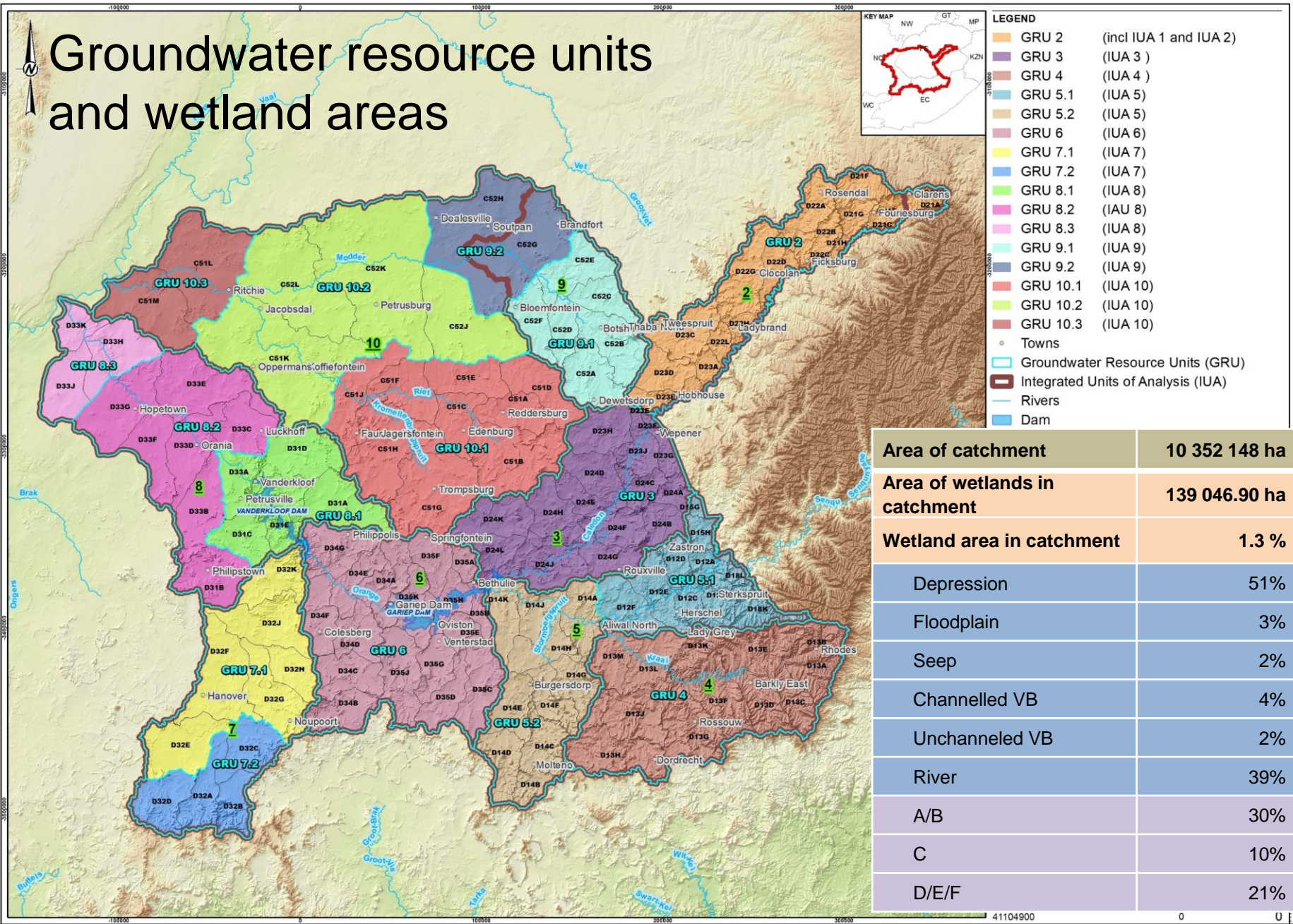
- 40 river resource units, including 6 dams
- 16 groundwater resource units
- 16 wetlands/ wetland complexes

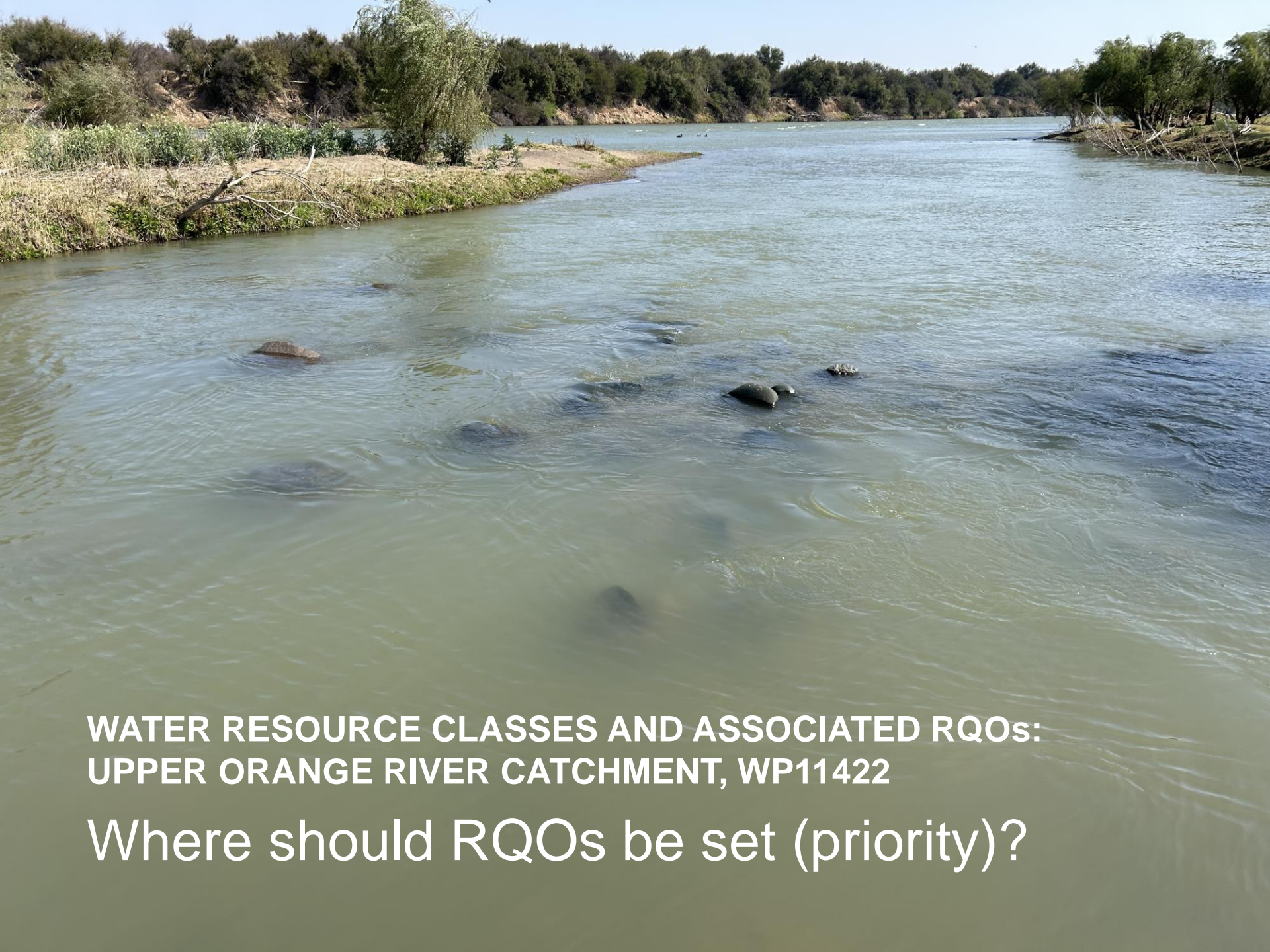
WATER RESOURCE CLASSES AND ASSOCIATED RQOs: UPPER ORANGE RIVER CATCHMENT, WP11422

Rivers and dams resource units



Groundwater resource units and wetland areas





**WATER RESOURCE CLASSES AND ASSOCIATED RQOs:
UPPER ORANGE RIVER CATCHMENT, WP11422**

Where should RQOs be set (priority)?

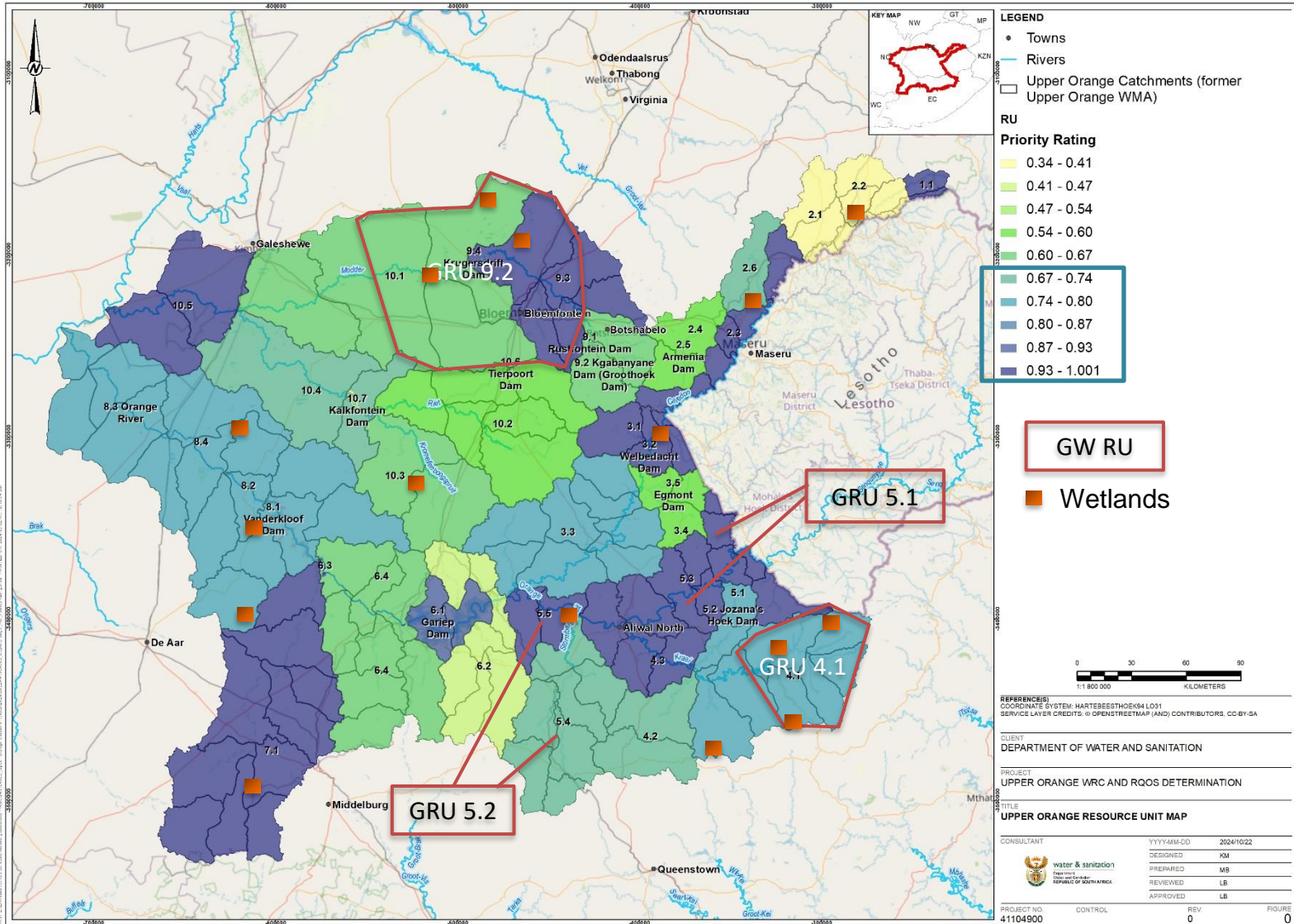
Prioritisation of Resource Units

- Setting RQOs for each resource unit is not always feasible because of the potentially large number of RUs that could be delineated for a catchment.
- A rationalisation process was developed as part of the RQO Determination Procedure (DWA, 2011)
- Resource Unit Prioritisation Tool
 - incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs
- Objective – to prioritise and select the most useful RUs for RQO determination

Prioritisation of Resource Units

	Groundwater	Wetlands
<ul style="list-style-type: none"> Position of RU within IUA (main stem) 	<ul style="list-style-type: none"> In addition to the hydrogeological characteristics, the following criteria were also used: 	<ul style="list-style-type: none"> Important Bird Areas (IBAs) and Crane sightings and nest sites
<ul style="list-style-type: none"> Assessment of the importance of each Resource Unit to users: <ul style="list-style-type: none"> Cultural services to society Supporting livelihoods of significant vulnerable communities Meeting strategic requirements and international obligations Provide supporting and regulating services Most important in supporting activities contributing to the economy 	<ul style="list-style-type: none"> Importance of the aquifer system(s) to users (degree of groundwater dependence) 	<ul style="list-style-type: none"> Hydrogeomorphic (HGM) unit type, which was used to determine the level to which each system may provide services associated with: <ul style="list-style-type: none"> Flood attenuation Stream flow regulation Erosion control Sediment trapping; and Water quality enhancements (assimilation of nutrients).
<ul style="list-style-type: none"> Level of threat posed to the water resource quality for users 	<ul style="list-style-type: none"> Threat posed to water resource quality for users (aquifer vulnerability) 	<ul style="list-style-type: none"> Wetlands with a Present Ecological State (PES) of A/B
<ul style="list-style-type: none"> Ecological importance: EIS/ PES/ NEC/ NFEPA and Priority habitats/species identified in provincial conservation plans 	<ul style="list-style-type: none"> Threat posed to water resource quality for the environment (baseflow) 	<ul style="list-style-type: none"> Wetlands that interacted with the surface and groundwater SWSAs
<ul style="list-style-type: none"> Threat posed to the water resource quality for the environment 	<ul style="list-style-type: none"> Degree of use (stress index); and 	<ul style="list-style-type: none"> Those systems classified as Critically Endangered or Endangered (Nel et al., 2012)
<ul style="list-style-type: none"> Management considerations (Resource Units with PES lower than a D category) 	<ul style="list-style-type: none"> Geo-political boundaries (according to concentrations of bulk groundwater users). 	<ul style="list-style-type: none"> Wetlands located upstream of important water supply dams; and
<ul style="list-style-type: none"> Practical considerations, e.g., Availability of EWR site data or other monitoring data (RHP, DWA gauging weirs) located within reach; Accessibility of resource units for monitoring; Safety risk associated with monitoring resource unit 		<ul style="list-style-type: none"> Identified water-stressed catchments/ basins from the river RU process of the Reserve study.

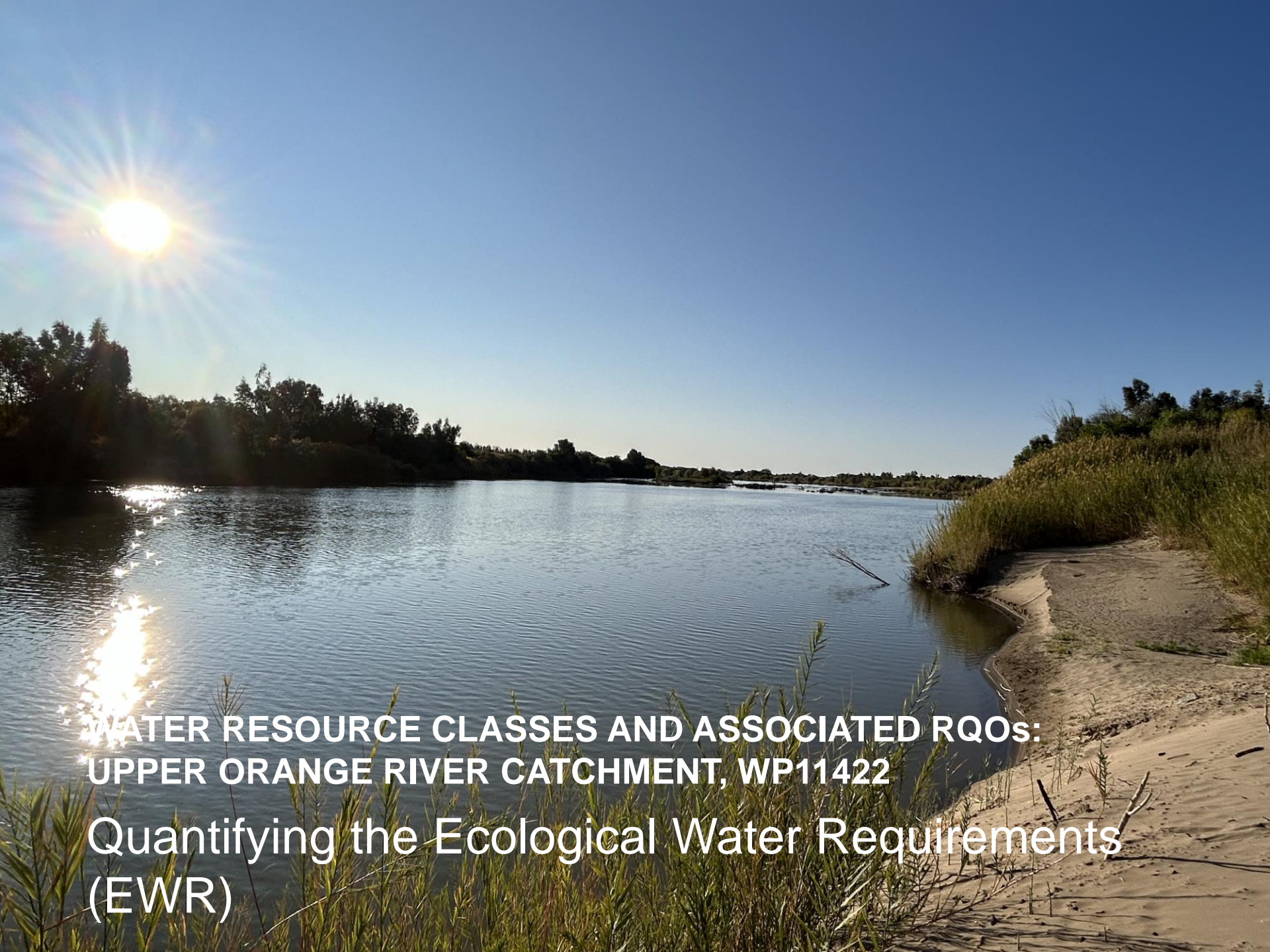
Prioritised RUs with GW and Wetlands



IUA	Surface water Resource Unit		Resource Units prioritised for RQOs		
			Surface Water	Groundwater	Wetlands
IUA 1: Golden Gate	1.1	Little Caledon River with Caledon River in the D21A portion in SA	X		
IUA 2: Caledon/ Leeu River	2.2	Swartspruit and Brandwater River, tributaries of the Caledon River	X		Brandwater floodplain
	2.3	Caledon River along the Lesotho Border to the Leeu River confluence including tributaries: Modderpoortspruit, Tenniskopspruit, Tweelingspruit, Appledorespruit and Bokpoortspruit, including Cathcartdrift Dam	X		
	2.6	Mopeli River and tributaries: Rantsho River, Morakabi River, McCabesspruit, Beytelspruit and Modderpoortspruit, and Mopeli Dam	X		Rantsho wetland complex
IUA 3: Caledon River	3.1	Caledon River and tributaries Klipspruit, Rietspruit, Nuwejaarspruit and Bloemspruit	X		Sandspruit wetlands
	3.2	Welbedacht Dam in the Caledon Nature Reserve	X		
	3.3	Caledon River and tributaries Boesmanskopspruit, Vaalspruit, Wilgeboomspruit, Vinkelspruit, Grahamstadspuit, Sandveld, Skulpspruit, Slykspruit and Hartbeesfontein	X		
	3.4	Caledon River and tributaries Klipspruit, Elandspruit, Witspruit and Blaasbalkspruit	X		
IUA 4: Kraai River	4.1	Kraai River and tributaries Malpas River, Riflespruit, Bokspruit, Koffiehoekspruit, Bamboeshoekspruit, Sterkspruit, Klein-Wildebeesspruit, Diepspruit, Three Drifts, Joggemspruit, Vlooiakraalspruit, Langkloofspruit, Rytjiesvlaktespruit, Vrouenshoekspruit, Noodshulpspruit, Vaalhoek River, Saalboomspruit, Wasbankspruit and Wolwespruit	X	GRU 4.1 (QCs D13A-F and D13K)	Tiffendell seep; Klein Wildebeespruit wetland complex; Luckoff depression wetlands; Otto du Plessis Pass wetlands; Wolwespruit headwaters wetland complex
	4.2	Holspruit and tributarie Braklaagtespruit, Leeuspruit, Skulpspruit and Telemachuspruit	X		
	4.3	Kraai River and tributaries Windvoelspruit, Bossielaagtespruit, Oslaagte, Rondefonteinspruit, Klipspruit ad Elandspruit	X		
IUA 5: Upper Orange River	5.1	Sterkspruit and tributaries Mlangeni River, Mbongo River and Kromspruit	X		
	5.2	Jozana's Hoek Dam on the Sterkspruit	X		
	5.3	Orange River and tributaries Tele River along the Lesotho border, Blikana River, KwaSijora, Pelendaba, Mantikoana River, Deklerkspruit, Worsfonteinspruit, Hendrik Smitstroom, Bamboespruit, Wilgespruit, Gyskopspruit, Winnaarspruit, Knoffelspruit, Beeskraalspruit, Nuwejaarspruit, Kop-en-pootjiespruit and Wilgerspruit	X	GRU 5.1 (QCs D12A and D15H)	Maletswai wetland complex
	5.4	Stormbergpruit and tributaries Wonderhoekspruit, Wilgespruit, Klein-Buffelsvleispruit, Witkopspruit, Barnardspruit, Mooiplaasspruit, Elandslaagte and Wikopspruit	X	GRU 5.2 (QC D14A)	
	5.5	Orange River and tributaries Gladdegrond, Melkspruit, Sanddrifspruit, Modderbuirspruit and Palmietspruit	X	GRU 5.2 (QC D14F)	
IUA 6: Gariep Dam	6.1	Gariep Dam	X		
	6.3	Main stem Orange River between Gariep and Vanderkloof dams	X		
IUA 7: Seekoei River	7.1	Seekoei River	X		Gordonville wetland complex
IUA 8: Vanderkloof Dam	8.1	Vanderkloof Dam	X		
	8.2	Orange River below Vanderkloof Dam	X		
	8.3	Orange River mainstem	X		
	8.4	Tributaries draining to the Orange River on RU8.3 Knapsak River, Hondeblaf River, Berg River, Lemoenspruit			Philipstown wetland complex; Barkley Pass wetland complex
IUA 9: Upper Modder River	9.1	Rustfontein Dam on the Modder River	X		
	9.3	Modder River and tributaries Steynspruit, Korannespruit, Koringspruit, Matjiespruit, Osspruit, Renosterspruit, Doringspruit, Rietspruit and Stinkhoutspruit	X	GRU 9.2 (QC C52G)	Aardoringsspruit wetlands
	9.4	Krugersdrif Dam on the Modder River at the outlet of quaternary catchment C52G	X		
IUA 10: Modder/ Riet Rivers	10.1	Modder River and tributaries Klein Kaalspruit and Kaalspruit	X	GRU 9.2 (QC C52H) and GRU 10.2 (C52J and C52K)	Kaalspruit wetland complex; Soutpan Depression wetland complex
	10.2	Fouriespruit and tributaries including Fouriespruit Dam, Rietspruit and tributaries, X River and tributaries up and downstream of the Tierpoort Dam; Riet River to confluence with Kromellenboogspruit	X		
	10.3	Kromellenboogspruit and tributaries Vanzylspruit and Prosespruit	X		Jagersfontein DCVB wetland
	10.4	Riet River	X		
	10.5	Main stem Riet River to Vaal River confluence	X		
	10.7	Kalkfontein Dam	X		

Summary of prioritised RUs

- 31 priority river resource units including 6 dams
- Groundwater priority RUs: areas of high stress index and aquifers of strategic importance identified in IUA 4, IUA 5, IUA 9 and IUA 10.
- 16 wetlands/ wetland complexes
- Sampling sites for surface water monitoring have been proposed - will only be finalised once the surface water RQOs have been agreed upon.



**WATER RESOURCE CLASSES AND ASSOCIATED RQOs:
UPPER ORANGE RIVER CATCHMENT, WP11422**

**Quantifying the Ecological Water Requirements
(EWR)**

RIVERS ECO-CATEGORISATION

The determination and categorisation of the PES (health and/or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition

- Done as part of Reserve determination study for Upper Orange;
- Process was followed according to the methods of Kleynhans and Louw (2007);
- Results provide information needed to derive desirable and attainable future ecological objectives for the rivers;
- Summarise all existing/available data (study surveys, REMP, etc.);

Driver components:

- Geomorphology (GAI), *In situ* water quality (diatoms inferred), Hydrology (HAI)

Response components:

- Fish (FRAI), Aquatic macroinvertebrates (MIRAI), Habitat integrity (riparian IHI) and riparian vegetation (VEGRAI)
- Overall EcoStatus / PES by integrating response components;
- Include Ecological Importance and Sensitivity;
- Identify the REC for EWR quantification.

RIVERS EWR QUANTIFICATION

What are EWRs?

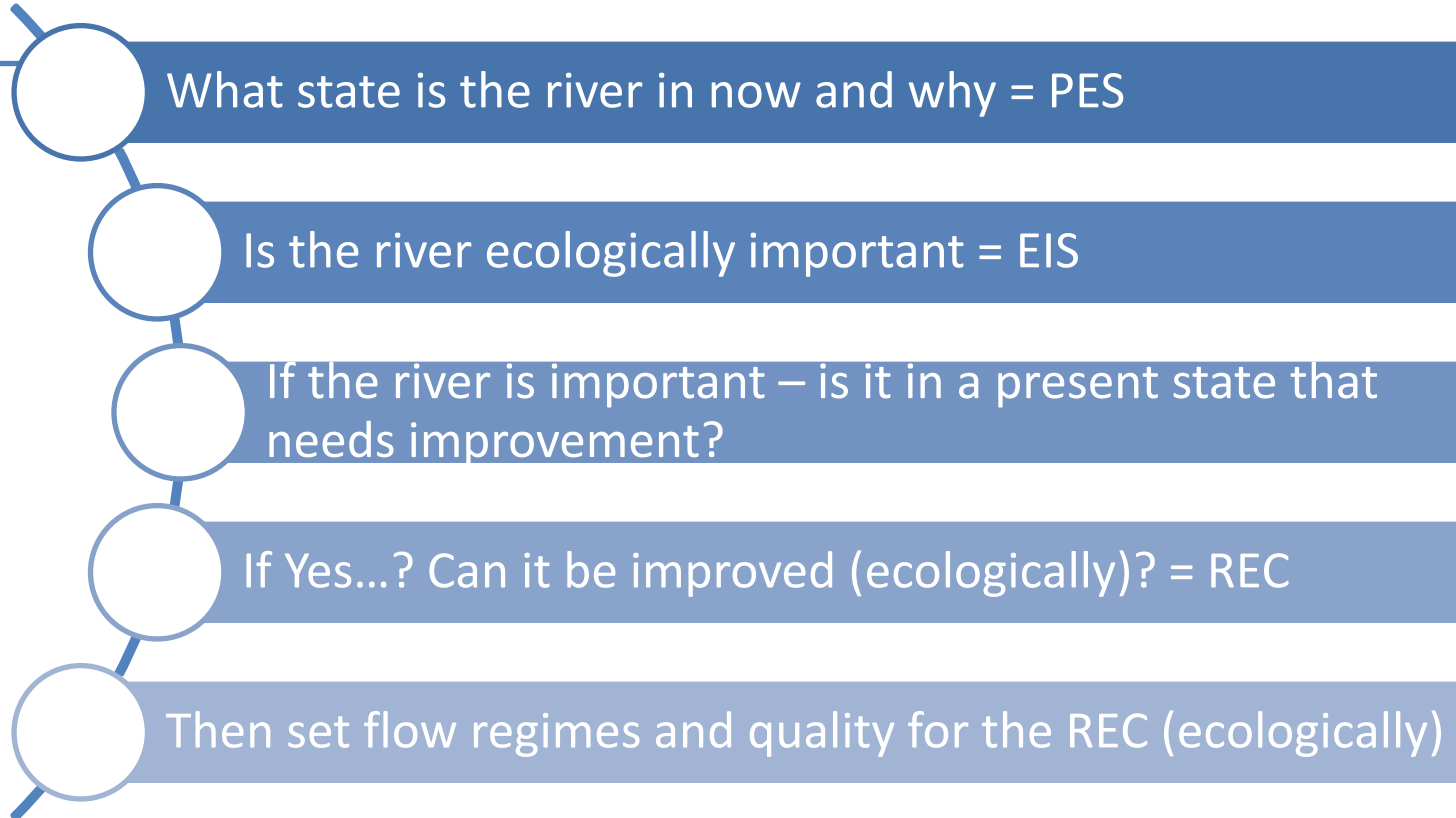
Flow and its associated characteristics (magnitude, timing and duration) and **water quality** that should be provided in the river system

biota dependent on it, as well as any **people** dependent on a functioning river (goods and services or Ecosystem Services)

RIVERS EWR QUANTIFICATION

How do we determine EWRs?

Draw on results from the eco-categorisation:

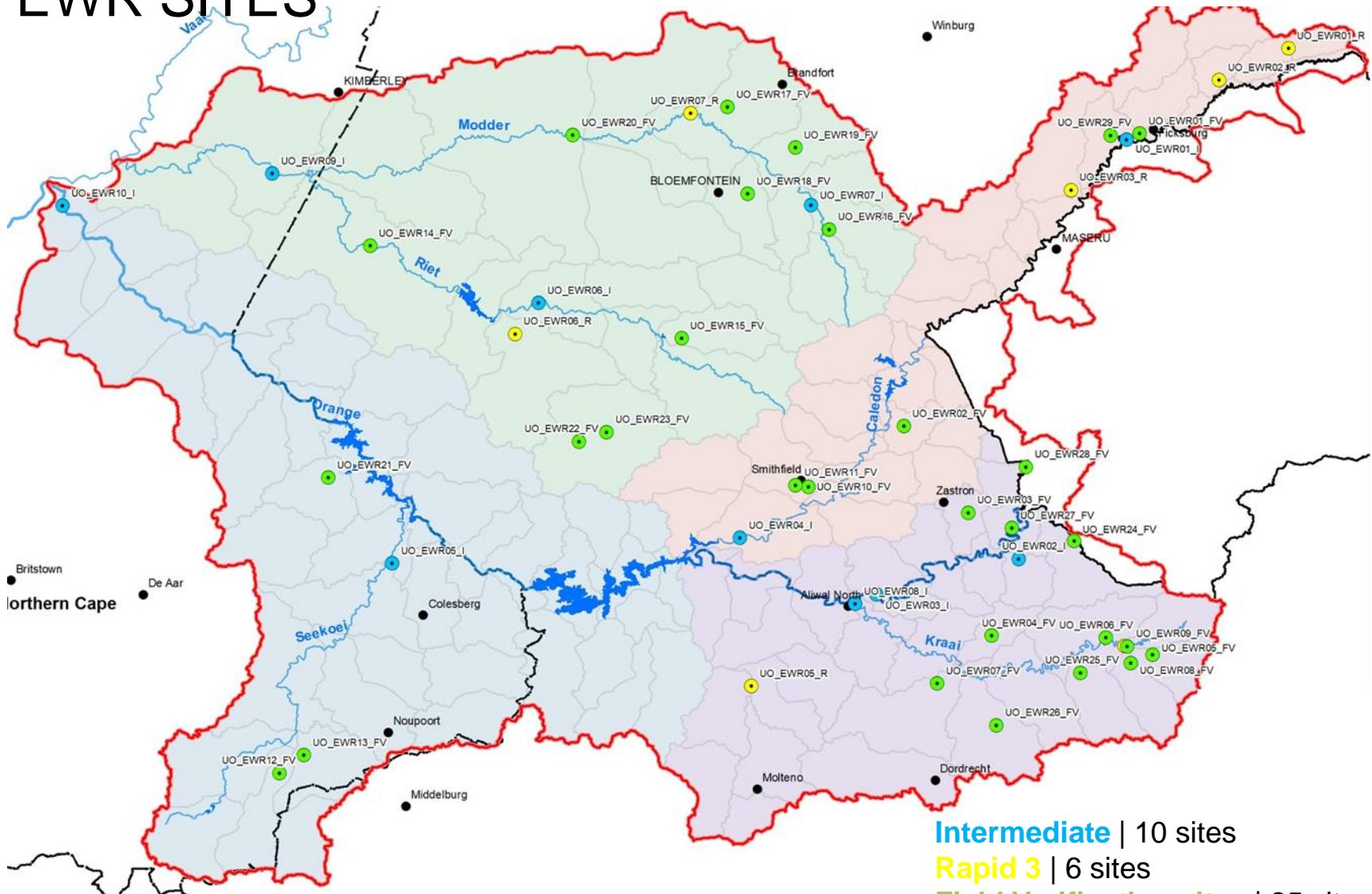


RIVERS EWR QUANTIFICATION

Primary focus is to quantify the EWRs using various approaches depending on the specific conditions/ impacts at the EWR sites using the results from the hydraulic modelling (cross-sectional profile and discharge) and output from HABFLO to determine the flow-stress relationships and to interpret the results from the flow-stress model within SPATSIM.

- Approaches:
 - Habitat Flow Stressor Response (HFSR) for the intermediate EWR sites;
 - Verification of the Desktop Reserve Model (DRM)/ Revised DRM within SPATSIM for the integration of data produced from the surveys and eco-categorisation to quantify the EWRs for the Rapid 3 sites;
 - Desktop EWRs for those EWR sites where little or no information was available from field surveys;
 - Extrapolation using the characteristics of Rapid 3/ Intermediate sites where desktop/FV sites are in the same Ecoregion level 2 and geozone;
 - Where too much flow in a system – used first principles.

EWR SITES



Intermediate | 10 sites
Rapid 3 | 6 sites
Field Verification sites | 25 sites

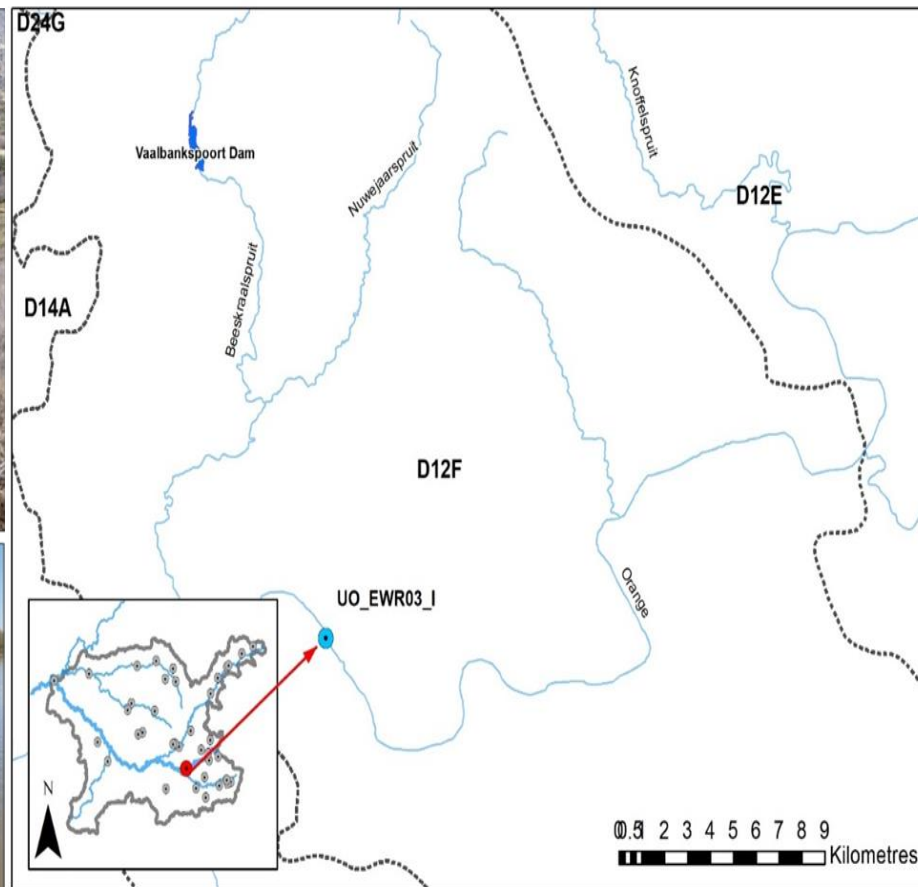
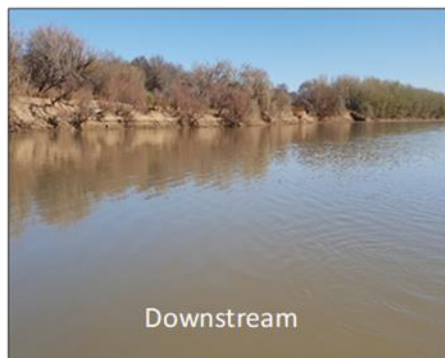
ECO-CATEGORISATION SUMMARY

IUA	EWR site code	River	Quat	PES	EI/ES	REC
1	UO_EWR01_R	Little Caledon	D21D	C	High/ High	B/C
2	UO_EWR01_I	Middle Caledon	D22D	D/E	Moderate/ Moderate	D
3	UO_EWR04_I	Lower Caledon	D24G	D	Moderate/ Moderate	C/D
4	UO_EWR08_I	Lower Kraai	D13M	C	High/ High	B/C
5	UO_EWR02_I	Sterkspruit	D12B	D	Moderate/ Moderate	C/D
	UO_EWR03_I	Upper Orange	D12F	D	Moderate/ Moderate	D
6	Field visit site in Oct 2024	Orange River between Gariep and Vanderkloof dams	D34E	Flow Management Plan PES = D = REC, EI = High = ES		
7	UO_EWR05_I	Seekoei	D32J	C	Moderate/ Moderate	C
8	UO_EWR10_I	Lower Orange	D33K	C	Moderate/ Moderate	C
9	UO_EWR07_I	Upper Modder	C52B	D	Low/ Moderate	C/D
10	UO_EWR06_I	Upper Riet	C51F	C	High/ Moderate	C
	UO_EWR09_I	Lower Riet	C51L	C	Very high/ high	B/C

EWR SUMMARY

IUA	EWR site code	River	Quat	REC	Total EWR as %nMAR	nMAR (10 ⁶ m ³)
1	UO_EWR01_R	Little Caledon	D21D	B/C	39.20	25.9
2	UO_EWR01_I	Middle Caledon	D22D	D	23.16	674.0
3	UO_EWR04_I	Lower Caledon	D24G	C/D	30.35	1 353.6
4	UO_EWR08_I	Lower Kraai	D13M	B/C	46.49	719.0
	UO_EWR02_I	Sterkspruit	D12B	C/D	38.43	30.7
	UO_EWR03_I	Upper Orange	D12F	D	25.97	4 259.5
6	Field visit site in Oct 2024	Orange River between Gariep and Vanderkloof dams	D34E	Flow Management Plan		
7	UO_EWR05_I	Seekoei	D32J	C	34.19	24.3
8	UO_EWR10_I	Lower Orange	D33K	C	21.39	6 674.2
9	UO_EWR07_I	Upper Modder	C52B	C/D	35.94	61.0
10	UO_EWR06_I	Upper Riet	C51F	C	31.05	105.2
	UO_EWR09_I	Lower Riet	C51L	B/C	28.98	373.8

Upper Orange - UO_EWR03_I



UO_EWR03_I

Diatoms: elevated nutrient concentrations prevalent at the site because of the Sterkspruit discharging untreated sewage upstream. Other contaminants and toxins were also picked up given the untreated effluent discharged upstream.

Widespread overgrazing and soil erosion in the catchment (largely Lesotho and communal land) elevating fine sediment loads)

River	Upper Orange
EWR Site Code	UO_EWR03_I
Driver component	PES
HAI	D
Diatoms	C
GAI	C
Response component	PES
FRAI	D
MIRAI	C/D
VEGRAI	D
Ecstatus	D
EI	Moderate
ES	Moderate
REC	D

Hydrological modification due to upstream impoundments in Lesotho

Poor habitat availability for both fish and aquatic macroinvertebrates

Extensive alien invasive plants

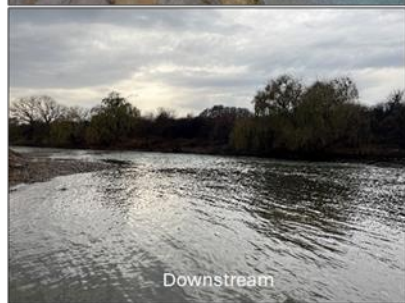
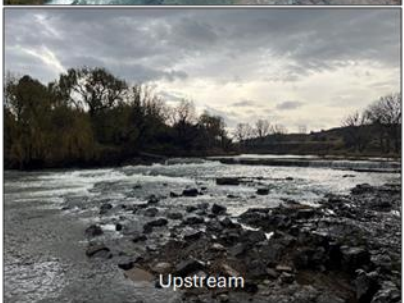
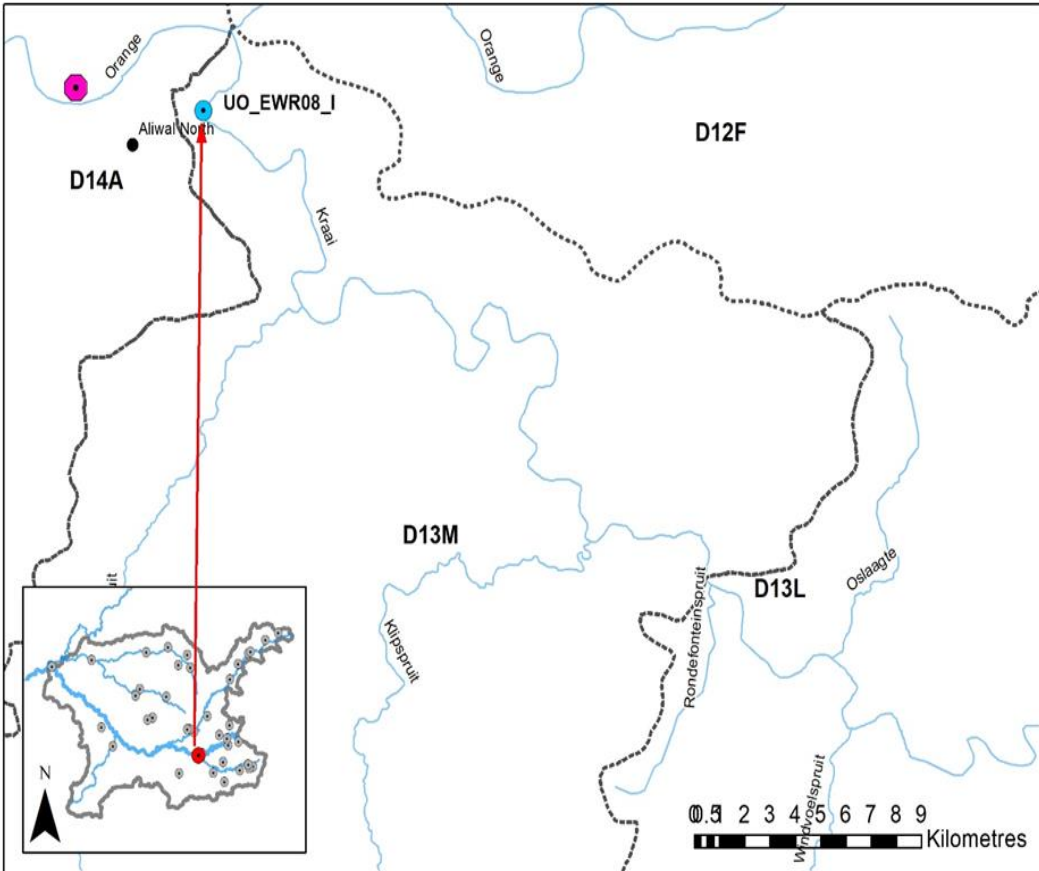
(High)-Moderate (riparian-wetland zone habitat integrity class / instream habitat integrity class)

(High)-Moderate (reduced macroinvertebrate sensitivity / riparian-wetland vegetation intolerance to water level changes)

EWR

Quaternary Catchment	D12F
nMAR at EWR site	4 259.5
Total EWR	1067.450 (25.06 %MAR)
Maintenance Low flows	554.061 (13.01 %MAR)
Drought Low flows	206.669 (4.85 %MAR)
Maintenance High flows	513.389 (12.05 %MAR)

Lower Kraai - UO_EWR08_I



Upstream

Downstream

UO_EWR08_I

Diatoms: indicated elevated electrolyte concentrations and pollutants. Algae content over the stones' biotope.

Widespread overgrazing and soil erosion in the catchment elevating fine sediment loads

REC ↑ WQ improvements through land use activities (irrigation, abstraction, return flows). Alien invasive vegetation to be managed. EWR quantification for a B/C REC.

River	Lower Kraai
EWR Site Code	UO_EWR08_I
Driver component	PES
HAI	B
Diatoms	C
GAI	C
Response component	PES
FRAI	C
MIRAI	C
VEGRAI	D/E
Ecstatus	C
EI	High
ES	High
REC	B/C

Limited hydrological modification – free flowing river

Good habitat availability for macroinvertebrates, although some algae smothering the biotopes. Presence of non-native fish species

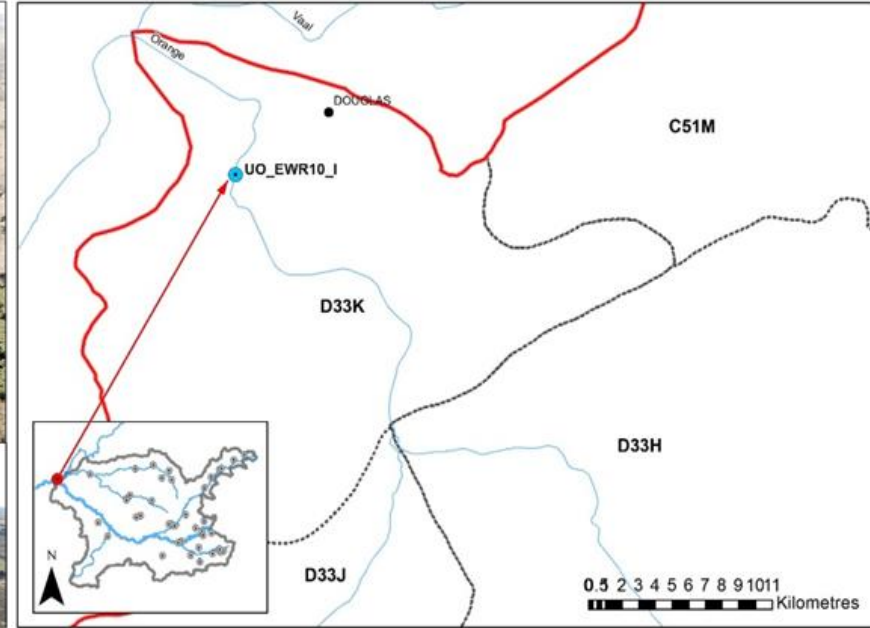
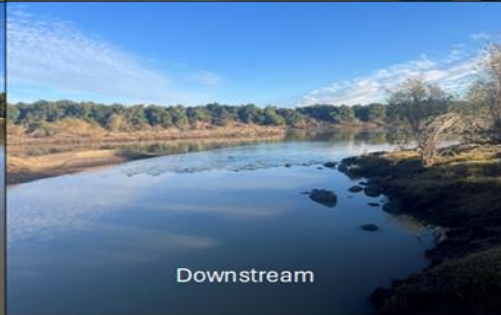
Extensive alien invasive plants

EI/ES both remain *High*

EWR

Quaternary Catchment	D13M
nMAR at EWR site	719.0
Total EWR	334.513 (46.52 %MAR)
Maintenance Low flows	200.869 (27.94 %MAR)
Drought Low flows	40.997 (5.70 %MAR)
Maintenance High flows	133.644 (18.59 %MAR)

Lower Orange - UO_EWR10_I



UO_EWR10_I

Widespread agriculture and cattle activity; soil erosion; extensive irrigation; changed flow regime; sedimentation

Diatoms: indicated elevated electrolyte concentrations species are tolerant to moderately polluted conditions.

WQ improvements through land use activities (irrigation, abstraction, return flows). Alien invasive vegetation to be managed. EWR quantification for a C REC.

Driver Component	PES
Hydrology (HAI)	C/D
Geomorphology (GAI)	C/D
Response Components	PES
Diatoms	D
Fish (FRAI)	B/C
Macroinvertebrates (MIRAI)	D
Riparian Vegetation (VEGRAI)	C
EcoStatus	C
Ecological Importance (EI)	Moderate
Ecological Sensitivity (ES)	Moderate
Recommended Ecological Category (REC)	C

Habitat modification – the marginal vegetation has completely been removed due to all the floods and hydro-peaks (scouring and sediment deposition). Presence of non-native fish species

Impaired water quality from return flows

Extensive alien invasive plants

EI/ES both remain *Moderate*

EWR

Quaternary Catchment	D13M
nMAR at EWR site	6 674.20
Total EWR	1684.770 (25.24 %MAR)
Maintenance Low flows	1341.744 (20.10 %MAR)
Drought Low flows	405.864 (6.08 %MAR)
Maintenance High flows	343.025 (5.14 %MAR)

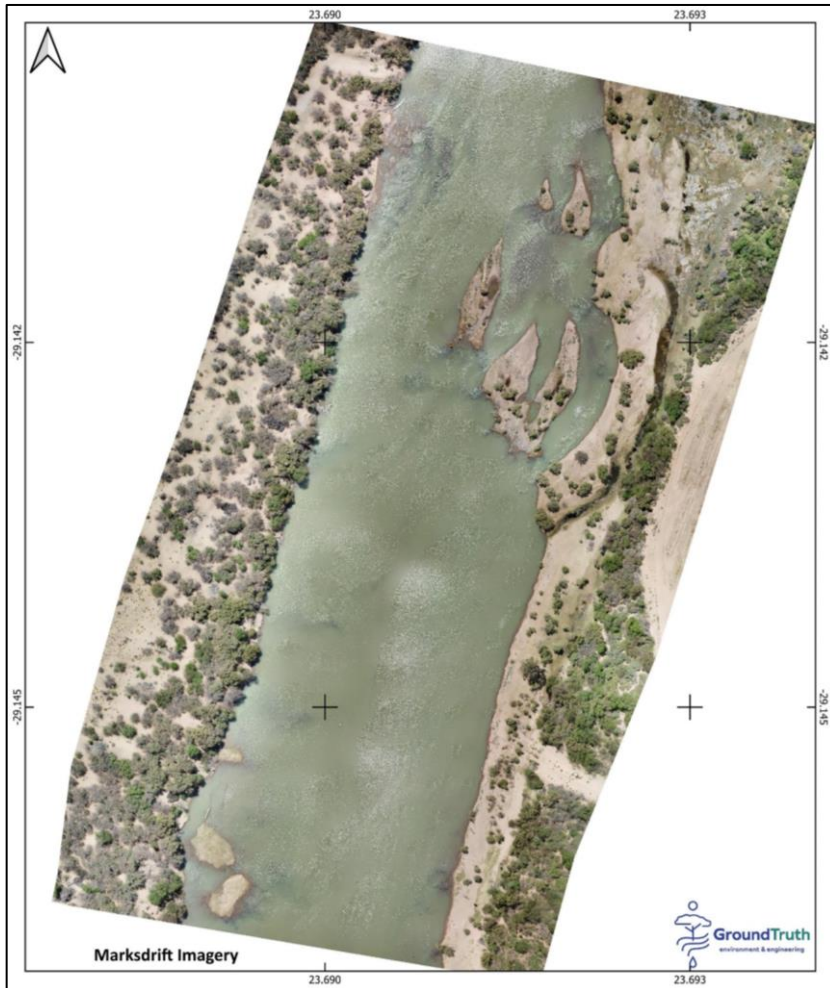
UO_EWR10_I: 2-D hydraulics model

- A 2-D hydraulic survey was undertaken at EWR site UO_EWR10_I to provide the ecologists with enhanced contextual data, enabling more informed decisions in quantifying the EWR for this site
- Novel approach
- The following activities were undertaken during the site visit in order to collect the required data to build the 2D model for the site:
 - Elevation data of the riverbanks was captured using a photogrammetry survey with an Unmanned Aerial Vehicle (UAV);
 - Elevation data of the riverbed was captured by means of carrying out a SoNAR (sound navigation and ranging/ sonic navigation and ranging) bathymetric survey;
 - Discharge data was collected from the gauging weir located upstream of the site;
 - Substrate types; and
 - EWR site photographs were taken.

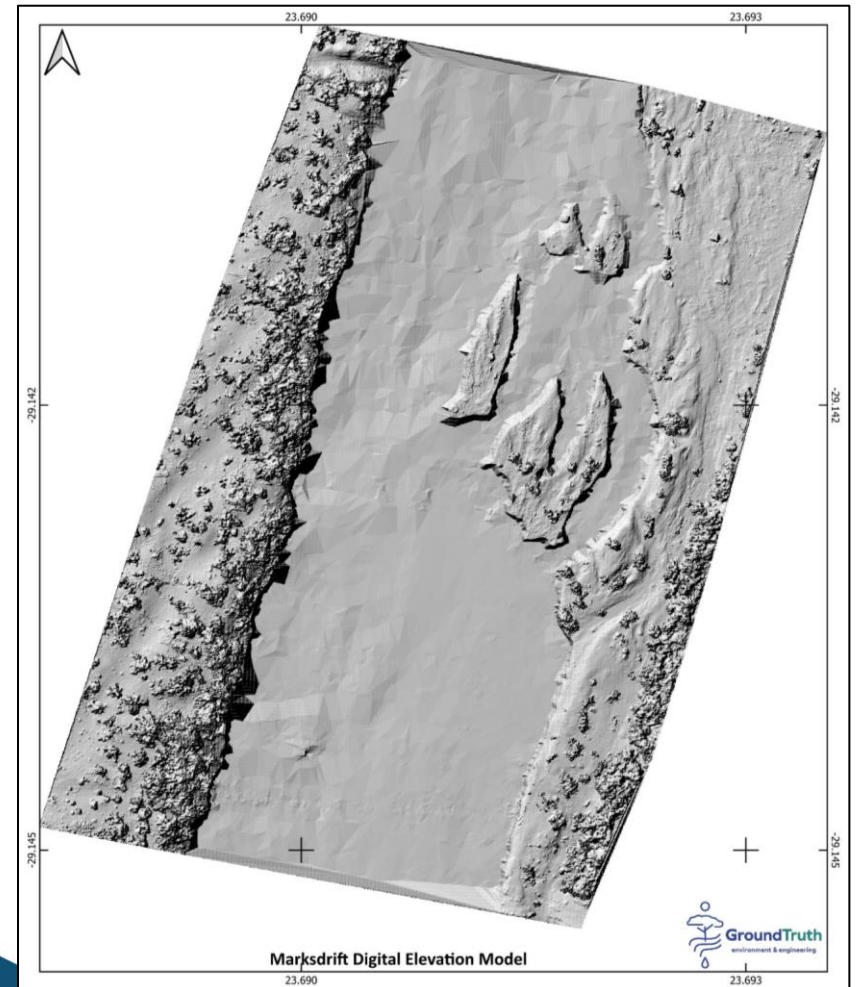


UO_EWR10_I: 2-D hydraulics model

Imagery generated from drone survey



Elevation model generated from drone and bathymetric survey

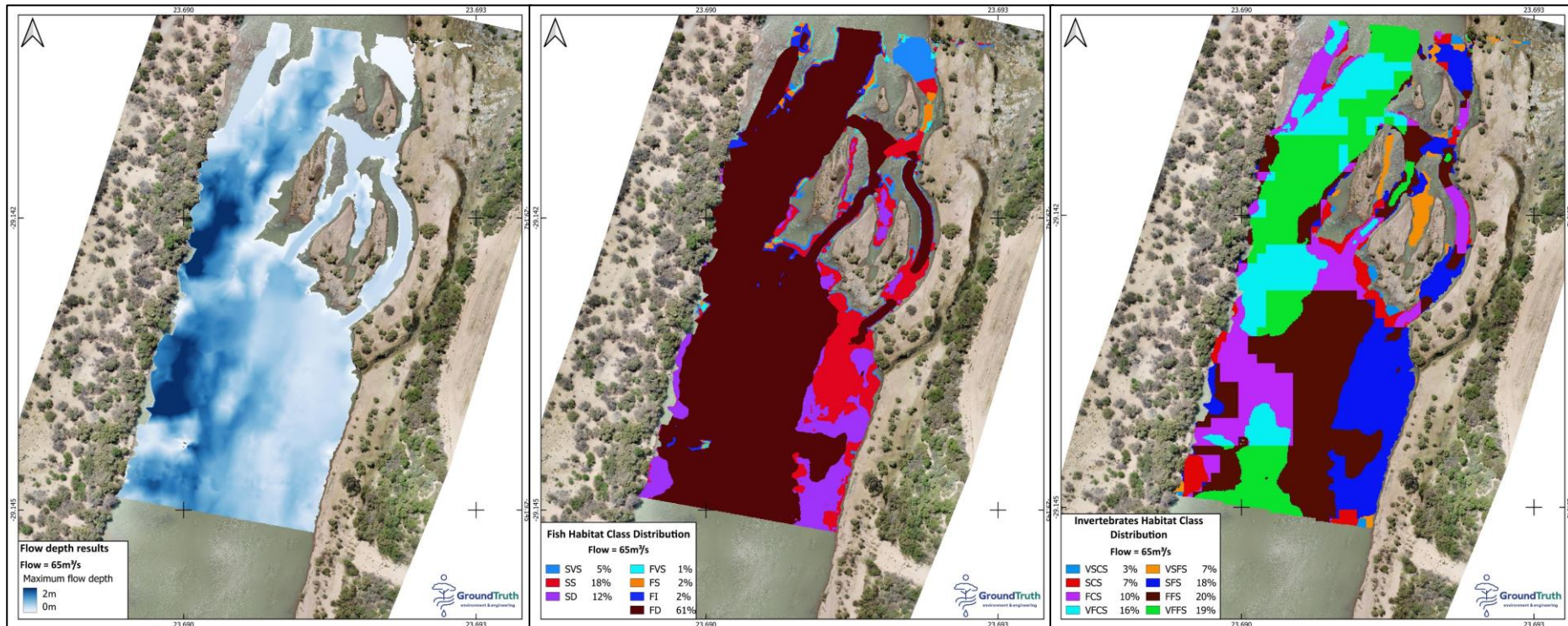


UO_EWR10_I: 2-D hydraulics model

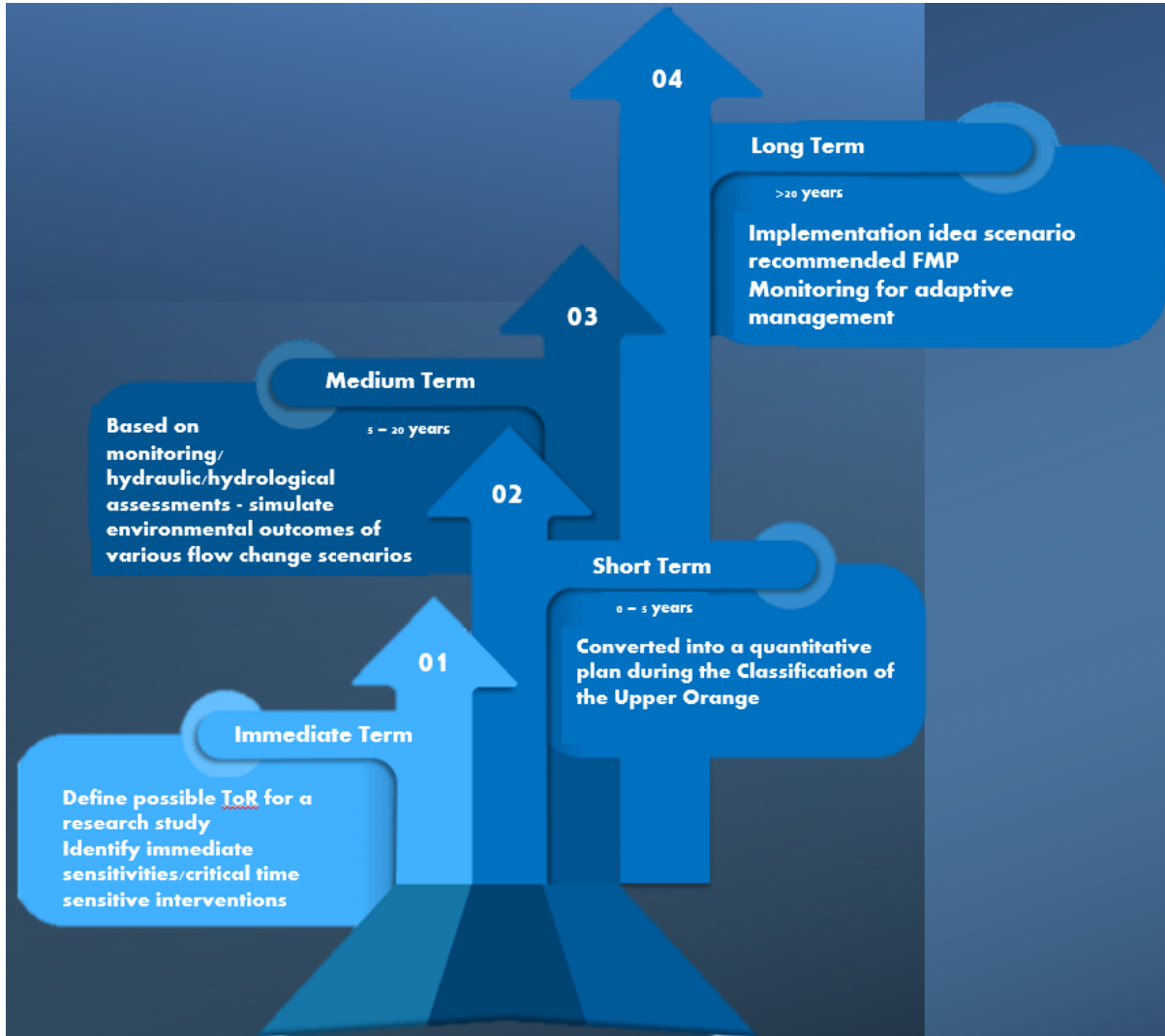
Flow depth HEC-RAS result layer for 65m³/s

Visual distribution of fish habitat classes for 65m³/s

Visual distribution of invertebrate habitat classes for 65m³/s



Conceptual Flow Management Plan



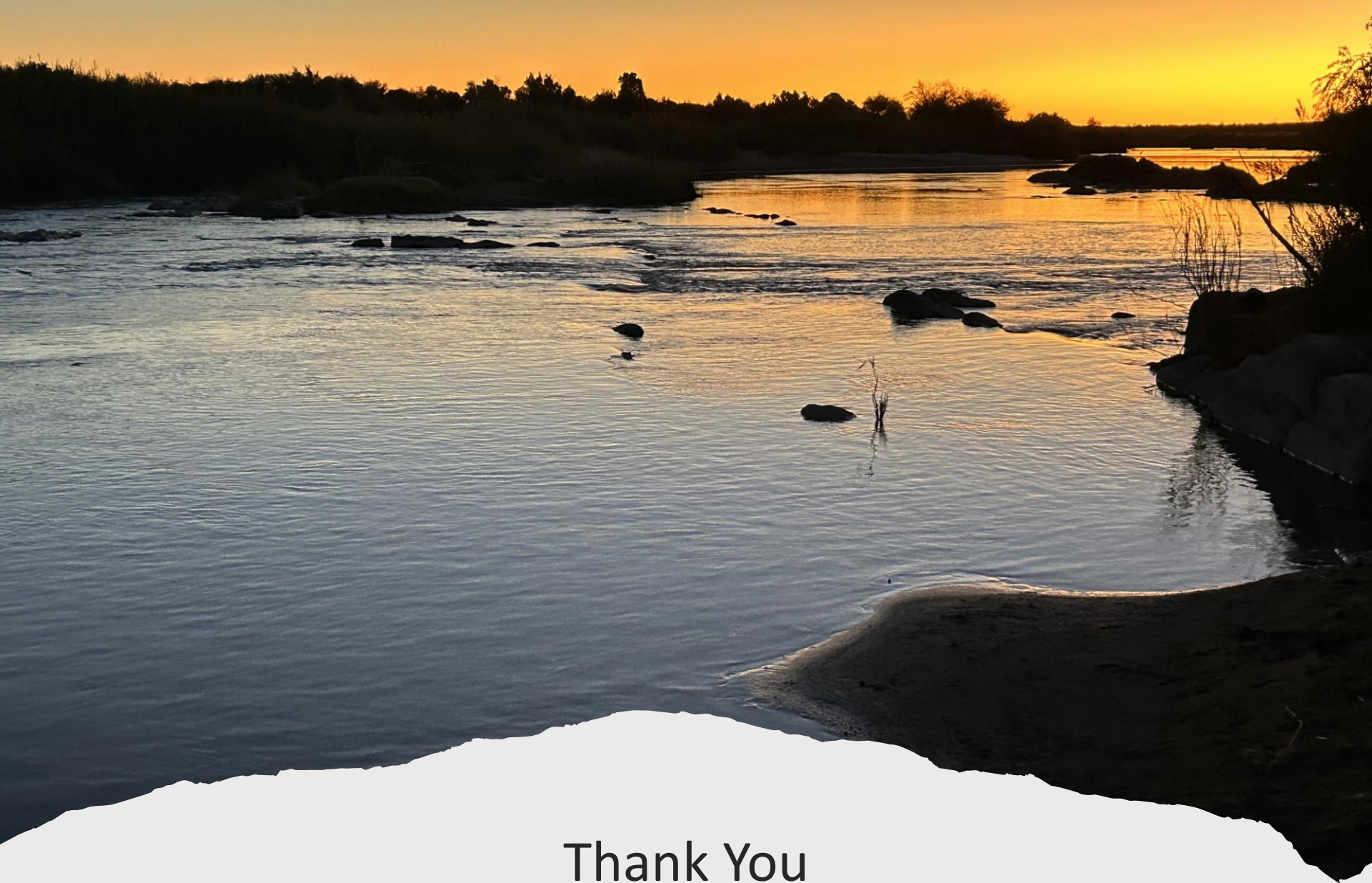
Proposed immediate-, short-, medium- and long-term action plans (adopted from DWS, 2023)

Conceptual Flow Management Plan

River	Orange River (between the 2 dams)
Response Components	PES
Diatoms	C
Fish (FRAI)	C/D
Macroinvertebrates (MIRAI)	C
Riparian Vegetation (VEGRAI)	D
EcoStatus	D
Ecological Importance (EI)	High
Ecological Sensitivity (ES)	High
Recommended Ecological Category (REC)	D

Implemented in the short term:

- Minimum flow of 40 m³/s for any given month
- Freshets:
 - November to January – 270 m³/s over 6 days
 - February – 350 m³/s over 3 days
- Releases from Gariep Dam to supplement Vanderkloof Dam in late winter to early spring should coincide with the seasonal rainfall pattern, thus a later start to the release to match the late spring natural cues for fish and cleaning of habitats



Thank You