water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Determining the Water Resource Classes and Resource Quality Objectives in the Lower Orange River Catchment

Background Information Document: Project Steering Committee Meeting 3

May 2025

PURPOSE OF THIS DOCUMENT

The purpose of this background information document (BID) is to provide Project Steering Committee (PSC) Members with information about the current study underway that will determine water resource classes and Resource Quality Objectives (RQOs) for all significant water resources in the Lower Orange River catchment, as well as the coastal F1-F6 secondary catchments between Alexander Bay and Malkopbaai, in the Northern Cape Province within the Vaal-Orange Water Management Area (WMA).

This BID contains information regarding the evaluation of scenarios configured within the integrated water resource management process so that a subset of catchment scenarios can be recommended towards proposed water resource classes.

It serves to provide feedback on the next study deliverable in preparation for the 3rd PSC meeting to be held in Upington on 06 May 2025, at which member input, guidance and review is required.

Further details or clarifications can be obtained from the DWS study team at the contact details provided below.

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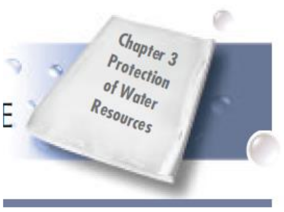
BACKGROUND

The National Water Act (NWA), Act No. 36 of 1998, is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public. It also requires that the nation's water resources be protected, used, developed, conserved, managed and controlled in an equitable, efficient and sustainable manner. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM).

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS) is responsible for the determination of the RDM. The aim of determining the RDM is to ensure that a balance is sought between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.



The DWS is underway with the process of classifying all river systems in South Africa and setting associated Resource Quality Objectives (RQOs). The DWS is currently undertaking the process to classify all significant water resources (rivers, dams, wetlands, estuaries, and groundwater) in the Lower Orange River Catchment, including the coastal F1-F6 secondary catchments, of the Vaal-Orange Water Management Area (WMA), simply referred to as the Lower Orange River catchment from here onwards. The study initiation was announced to stakeholders through various platforms encouraging participation in the study.

The classification and determination of RQOs of water resources in the Upper Orange and Lower Orange River catchments are undertaken as separate projects; however, the studies are running in parallel to ensure relevant catchment links and continuity along the river system.

This Background Information Document (BID) relates to the Lower Orange River Catchment and presents the outcomes of Steps 4 and 5 of the classification process, related to evaluation of the scenarios and the proposal of draft water resource classes. Step 6 of the process requires these scenarios are evaluated with stakeholders.

The water resource classification and RQOs process is a consultative process that allows stakeholders to provide input in the setting of the water resource classes and RQOs. The outcome of the process in the Lower Orange River catchment will be the gazetting of the water resource classes and RQOs approved by the Minister of Water and Sanitation. The gazetted classes and RQOs will be binding on all authorities or institutions when exercising any power or performing any duty under the National Water Act, 1998.

The Water Resource Class essentially describes the desired condition of the resource, along with the degree to which it can be utilised., A water resource class ranges from minimally used to heavily used (Figure 1).

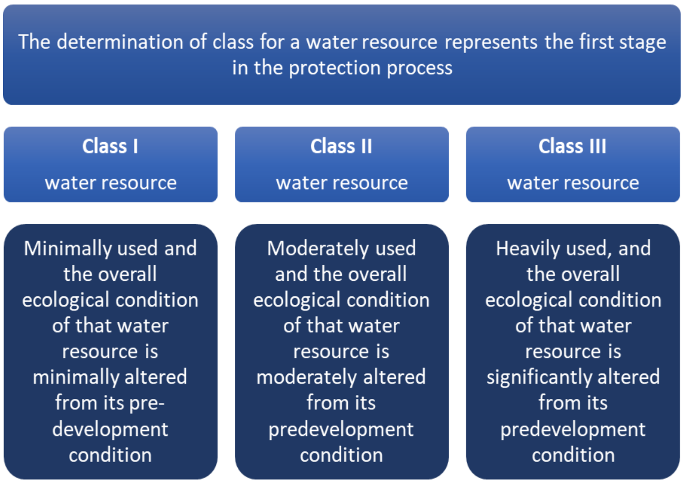


Figure 1: Water Resource Class descriptions

The class of a water resource sets the boundaries for the volume, distribution, and quality of the Reserve and RQOs and therefore informs the determination of the allocatable portion of a water resource for use.

RQOs are then determined for the water resources. RQOs are a set of narrative and/or numerical management objectives defined for any resource, and which are set to support the achievement of the water resource class. RQOs encompass four components of the resource:

- Water quantity
- Water quality
- Habitat integrity; and
- Biotic characteristics.

RQOs are important management objectives against which resource monitoring will be assessed.

LOWER ORANGE STUDY AREA

The Orange River catchment, comprising of the Upper Orange and Lower Orange catchments, is the largest in the country covering 50% of the land area and forms part of the Orange-Senqu River Basin which straddles four International Basin States (Lesotho, South Africa, Botswana, and Namibia). The Orange River WMA has recently been merged with the Vaal WMA and will be managed as one area, the Vaal-Orange WMA (WMA 4) (Figure 2).

The Lower Orange River catchment includes the main towns of Upington, Springbok, Pofadder, Kakamas, Keimoes, De Aar, Prieska, Kenhardt, Sutherland, Brandvlei and Williston. The catchment area can be subdivided by its 3 district municipalities (DM), *viz*. Pixley ka Seme DM, Z F Mgcawu DM and Namakwa DM.

The Lower Orange River portion includes the stretch of Orange River between the Orange-Vaal confluence, 20 km from Douglas, and Alexander Bay (Atlantic Ocean). The Lower Orange River, also forms the border between South Africa and Namibia, flowing over a distance of approximately 550 km.

The Lower Orange catchment is the largest, but also the driest and most sparsely populated catchment in South Africa. The area is mostly arid with rainfall varying from 400 mm in the east to 50 mm in the west coast. The topography of the area is in general flat, including large pans or endorheic areas. The average mean annual evaporation for this area is 2600 mm/a.

The Orange River is the primary river in the catchment. The major tributaries along the Lower Orange River portion from the north include:

- the Molopo, Kuruman and Nossob rivers in Namibia, Botswana and the Northern Cape Province; and
- the Fish River draining the southern part of Namibia.

Major tributaries to the Lower Orange River from the south draining the Karoo include:

- the Ongers River,
- the Sak River, and
- the Hartbees River.

The catchment area includes the coastal seasonally draining rivers and estuaries along the Atlantic Ocean from Papendorp north towards Visagiesfontein, (F primary sub-catchment), with the Buffels, Holgat and Brak as the main rivers.

The study area for this undertaking comprises only the South African portion of the Lower Orange River Catchment that includes the tertiary and quaternary catchment areas of C92B-C92C (some parts), portions of D41, D42, D51 to D58, D61, D62, D71 to D73 (excluding some portions D73), D81, D82 and primary catchment F with some exclusions (Figure 3), with a larger map of the study area included at the end of this document (see Figure 9).

Among the more valued natural resources in the river basin is a transboundary Ramsar protected wetland at the mouth of the Orange River. Important nature conservation areas include the Kgalagadi Transfrontier Park, the Ai-Ais-Richtersveld Transfrontier Park, and the Augrabies Falls National Park.

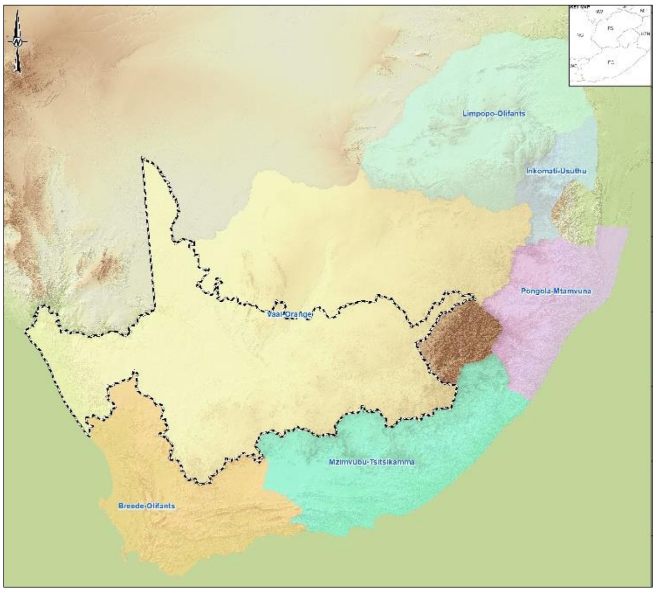


Figure 2: Orange River catchment within the Vaal-Orange WMA

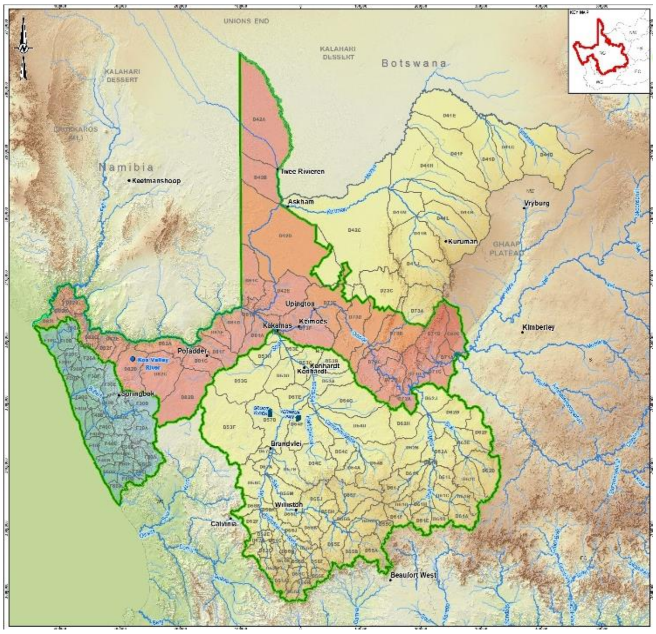


Figure 3: Lower Orange catchment – study area

Six main wetland types have been identified in the Lower Orange River catchment including depressions (pans), unchanneled valley bottom, channelled valley bottom, floodplain and flats, which are associated with major rivers Orange, Molopo, Auob and Nossob) in the catchment. There are wetlands systems also associated with the Orange River Mouth, mainly saltmarshes.

Groundwater is an extremely valuable source in the Lower Orange catchment. It is the most important source of bulk water supply to local towns and rural settlements. Several towns and villages are solely dependent on groundwater resources and in some cases potable water is piped from farms several kilometres from the town/village. Groundwater quality is variable depending on the geology of the area and the land-use activities.

The Lower Orange River serves as a significant resource to the Northern Cape Province, and is used for industrial, agricultural, recreational and domestic purposes. While most of the catchment is unsuitable for dry land cropping, the Orange River Valley, especially around Upington, Keimoes and Kakamas, has extensive grape and fruit cultivation. Water is abstracted for irrigation, urban and mining use along the main stem of the Orange River at various points, and for stock watering in the Kalahari.

There are many well-structured irrigation schemes located within the study area. However, there is also a large component of individual irrigators abstracting water directly from the river, farm dams and boreholes to supply irrigation developments. The Orange River Project is the largest water supply scheme and comprises several sub-schemes that are all supplied from the Gariep and Vanderkloof dams in the Upper Orange River catchment. Approximately 75 million m^3/a is supplied from the Lower Orange River to Namibia for irrigation purposes.

Boegoeberg, Neusberg and Vioolsdrift storage weirs are used for the regulation of flows into canal systems for irrigation purposes, and two small dams are located in the Orange River tributaries' sub-areas *viz*. Smartt Syndicate Dam on the Ongers River; and Rooiberg Dam on the Hartebeest River. Water is also transferred via pipelines to the Aggenys mines and the town of Springbok. Mining operations in the Lower Orange include underground and surface mines as well as quarries.

WHERE ARE WE IN THE STUDY PROCESS?

As part of the study, Steps 1 to 3 of the water resource classification process (Figure 4) have been completed. The outcomes of these steps were presented at PSC meetings 1 and 2 and the reports were distributed to members for comment. The outputs of Steps 1, 2 and 3 formed the basis to Steps 4 and 5 of the process, which have recently been completed. The study process is now at Step 6 where stakeholders are engaged on the outcomes of Steps 4 and 5 which will be presented at the upcoming PSC meeting 3.

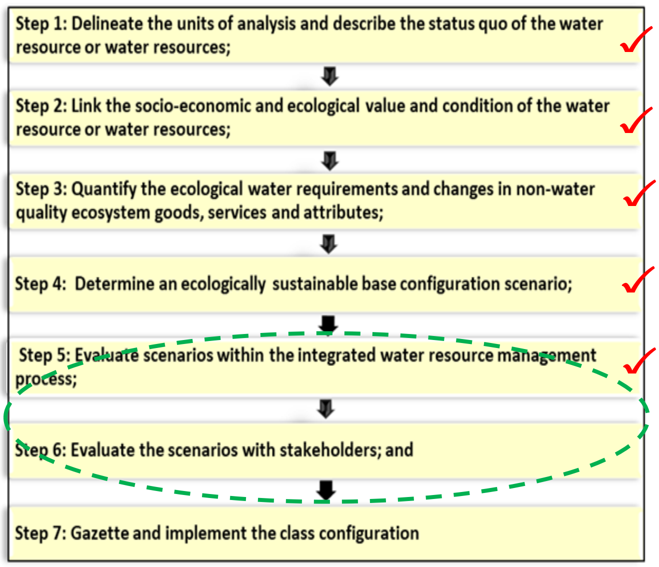


Figure 4: Steps for determining water resource classes

The RQO determination process is integrated with water resource classification process, with process steps indicated in Figure 5. RQO determination is aligned to the setting of water resource classes. To date Steps 1 to 3 have been completed, with Steps 4 and 5 to be undertaken once water resource classes have been proposed.

Step 1: Delineate the integrated units of analysis and define the resource units; ✓

Step 2: Establish a vision for the catchment and integrated units of analysis; ✓

Step 3: Prioritise and select preliminary resource units for RQO determination; ✓

Step 4: Prioritise sub-components for RQO determination and select indicators for monitoring;

Step 5: Develop draft resource quality objectives and numerical limits;

Step 6: Agree on resource units, RQOs and numerical limits with stakeholders;

Step 7: Finalise and gazette RQOs.

Figure 5: Steps to determine RQOs

EVALUATION OF SCENARIOS IN THE INTEGRATED WATER RESOURCE MANAGEMENT PROCESS

An integral component of the water resource classification process is the scenario configuration and evaluation, which is an iterative process that assesses the resulting water supply yields of alternate ecological protection categories; and current and future use to determine what is most feasible for the catchment being classified, in order to support the recommendation of water resource classes. The process requires a range of trade-offs to be evaluated, and entails assessing development scenarios to reconcile ecological protection and water use. The outcome of the process is a set of desired characteristics for water use and ecological condition for each of the water resources in a catchment.

Scenarios, in the context of water resource management and planning are plausible definitions (settings) or factors (variables) that influence the water balance and ecological condition in a catchment and the system as a whole.

Each scenario represents an alternative future condition, generally reflecting a change to the present condition. Analysis thereof gives the ability to compare the implications of one scenario against another, with the ultimate aim of selecting the preferred scenario.

Integrated Units of Analysis (IUAs) form the basis of setting water resource classes and requires finding a balance between an adequate level of protection and acceptable risk to ecosystem goods and services and socio-economic consequences, assessed through the scenario evaluation step. Ten IUAs - the spatial units (sub-catchments) that define the network of significant water resources have been delineated for the Lower Orange River Catchment. The IUAs 1 to 5 include Ecological Water Requirements (EWRs), determined as part of the Reserve, at selected sites (the mainstem Lower Orange River, being the only perennial river in the catchment). The EWR sites serve as the key modelling points (biophysical nodes) in the system presenting the ecological requirement per IUA. The key sites in the Lower Orange River are illustrated in Figure 6.

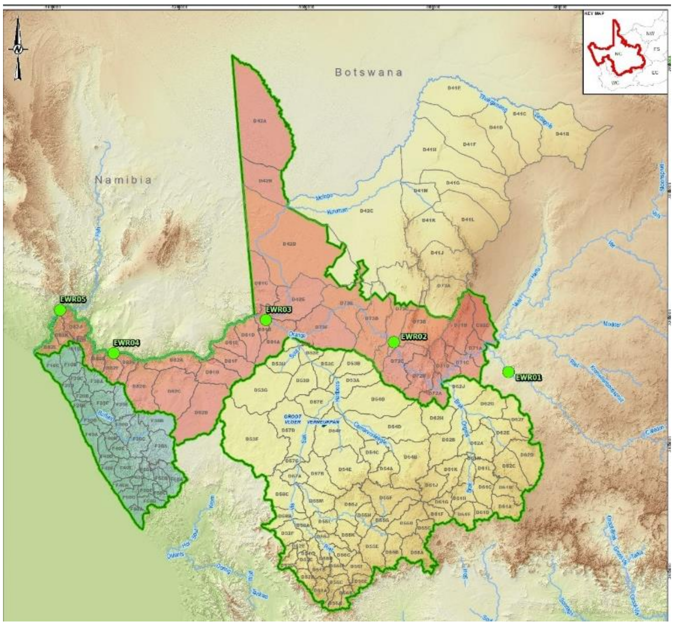


Figure 6: Key biophysical nodes (EWR sites)

In the Lower Orange River catchment five of the IUAs, IUA 6, 7, 8, 9 and 10 are groundwater driven systems (river systems are endorheic or ephemeral with almost no surface flow for most part of the year(s)). Thus, groundwater is predominantly the sole source of supply in these tributary catchments. It therefore necessitated that for these IUAs, groundwater scenarios are evaluated, and groundwater classes are set. Groundwater resource units (GRUs) have been delineated in the Lower Orange River catchment IUAs (refer to Figure 10). For IUAs, 6-10, scenarios in respect of impacts to allocable yield accounting for a domestic supply allocation and changes to rainfall and recharge have been evaluated.

WATER RESOURCE PLANNING ANALYSIS

Due to limited water availability and over-utilization that currently exists in the integrated Orange River catchment, water supply is constrained. The aim of the scenario analysis evaluation task was thus not to weigh up different development scenarios against each other, but rather to arrive at the optimal balance of the trade-off between ecological requirements and socio-economic impacts, to minimize the consequences to the users and ecosystem as much as possible. The objective was to determine the acceptable EWR scenario to ensure some level of protection of the Lower Orange River and support the flow requirements for the Orange River Estuary.

For the scenario analysis, the ecologically sustainable base case (ESBC) to be tested in respect of the ecological requirements for the Lower Orange River was determined. The ESBC scenario, which permits the maximum water use scenario, requires that the base condition for each water resource is at minimum established as either a D category or whichever higher category is required to maintain all downstream nodes in at least a D category. However, where the ecological condition requires it, a higher ecological category may be set. This was the case for the Lower Orange River, where the selected ESBC per IUA was not a D, but the Recommended Ecological Category (REC).

Additional to the establishment of the ESBC, a Target Ecological Category (TEC) was also determined and tested as an alternate scenario at the sites. The TEC is based on the ultimate target to achieve a sustainable system both ecologically and economically, considering the PES and REC. Thus, the TEC can be the same as the PES or the REC (or worse if system is targeted for development).

Table 5 indicates the PES and TEC per node (EWR site). A summary of the scenarios (ecological and development) analyzed using the Water Resources Planning Model are detailed in Tables 1 and 2.

Table 1: Summary of planning development time slices linked to different ecological catchment configurations

Time Slice	No EWR	With EWRs		
		REC	TEC	TEC+E
Present Day	X	X	X	X
Medium-Term (2040)	X	X	X	X
Long -Term (2060)	X	X	X	X

REC: the base case ecological scenario tested
TEC: management target category that considers the present ecological state and REC (acceptable and achievable)
TEC+E: riverine TEC and estuary requirements

Table 2: Scenarios summary description

Scenarios		Developments	Descriptions
1	Current day with all existing major transfers; supply and operational requirements based on current conditions and development	As per present day	Scenario 1a – no EWR
			Scenario 1b – with REC, riverine only
			Scenario 1b – TEC and estuary
2	Medium-term with projected water requirements for 2040, with all major associated infrastructure developments required to increase supply potential	LHWP2-Polihali, Vioolsdrift (size option 2 – 700 million m^3), Gariep to Bloem pipeline	Scenario 2a – no EWR
			Scenario 2b – with REC, riverine only
			Scenario 2b – with TEC and estuary
		LHWP2-Polihali, Vioolsdrift (size option 3 -2800 million m3), Gariep to Bloem pipeline	Scenario 2.1a – no EWR
			Scenario 2.1b – with REC, riverine only
			Scenario 2.1b – with TEC and estuary
3	Long term with water requirements projected for approximately the year 2060. Additional interventions will be required to meet the water requirements for the longer-term projection horizon.	LHWP2-Polihali, Vioolsdrift (size option 2), Gariep to Bloem pipeline, with Verbeeldingskraal,	Scenario 3a – no EWR
			Scenario 3b – with REC, riverine only
			Scenario 3b – with TEC and estuary
		LHWP2-Polihali, Vioolsdrift (Size option 2), Gariep to Bloem pipeline, Verbeeldingskraal and Makhaleng Dam	Scenario 3.1b – with TEC and estuary
		LHWP2-Polihali, Vioolsdrift (Size option 1), Gariep to Bloem pipeline, Boskraai Dam and Makhaleng Dam	Scenario 3.2a – no EWR
			Scenario 3b – with REC riverine only
			Scenario 3b – with TEC and estuary

LHWP-P2: Lesotho Highlands Water Project Phase 2
Polihali Dam has been designed and is proceeding into implementation. Options for other future infrastructure are still being finalised. As such, there are different sizes, or combinations of infrastructure options possible. These possible alternatives have been included in the scenarios with the goal to capture the ranging ecological and socio-economic impacts and consequences.

The results of the scenario analysis indicate that:

- The ESBC of the REC cannot be met.
- The Lower Orange catchments are projected to be in a deficit.
- Scenario analysis in the model were set up to prioritise the EWRs and thus the impacts of water shortages in the system are realised as supply shortages on other users (specifically irrigation).
- Some IUAs will be impacted, and some are even projected to have shortages without EWRs implemented in the future.
- The Orange River catchment requires a combination of review and trade-offs between the EWRs and the water supply requirements, and the urgent implementation of the water resources developments as planned.

ECOLOGICAL AND ECONOMIC CONSEQUENCES

The ecological consequences of changes in flow requirements and macro-economic consequences of the changes in water supply per scenario were assessed to determine potential impacts of the ESBC scenario. Based on the resultant magnitude of the implications of the socio-economic consequences a trade-off analysis in some IUAs between the EWRs (ESBC) and supply deficits was necessary. Various iterations of the ESBC (REC) configuration were then tested and adjusted to arrive at the TEC, that reduced the supply deficits and the target protection level. The estuary assessment is discussed in the next section.

Economic Consequences:

The following sectors, as the main water users in the study area, were considered in estimating macro-economic costs and benefits associated with different scenarios - irrigation agriculture, domestic, industry and mining. The socio-economic response to change in each scenario, which in this case is presented through key economic indicators such as Gross Domestic Product (GDP), jobs and value of ecosystem services. An Integrated Economic Model (IEM) (Figure 7) was developed for the Lower Orange River catchment that demonstrates linkages between the ecosystem services and the socio-economic baseline, with the IEM being applied in this scenarios evaluation step. The socio-economic response (cost best analysis) represents the current status quo of the catchment. The results summary of the consequence assessment is presented in Table 5.

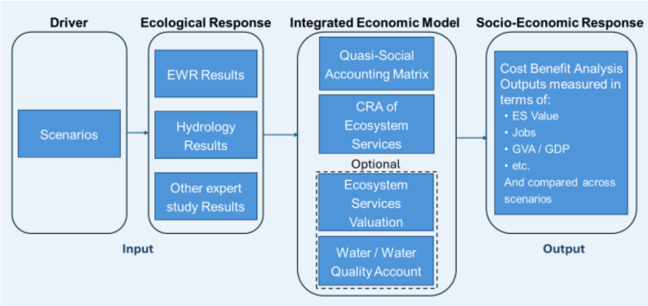


Figure 7: Approach to assessing the socio-economic consequences of the scenarios in the Lower Orange catchment

Ecological Consequences:

The process for assessing the ecological consequences included the following:

The scenarios were modelled, and a time series was provided for each scenario at each river EWR site. These scenarios encompassed present day conditions, as well as future projections for medium term (2040) and long term (2060). The scenario flows were assessed in terms of how the changes in hydrology for the various scenarios will impact on the level of stress experienced in the system and the state of the various response variables.

To aid in the interpretation of the impacts due to hydrological changes, seasonal distribution and flow duration graphs were prepared for the operational scenarios. Seasonal modelling of the biotic consequences for all scenarios, encompassing fish and macroinvertebrates, was undertaken using the Fish Invertebrate Flow Habitat Assessment Model (FIFHA). The outputs of the model provide the baseflows for each percentile, including natural flows, present-day conditions and REC (i.e., A-D), are provided according to the selected indicator species, taxa, or guild. Overall, the categories for the biotic component per scenario were assessed as to whether the EWR ESBC (REC) will be met.

If the scenario fell short of the REC by a half a category, it was colour coded orange; and if the scenario fell short of the REC by a full category or more, it was colour-coded red, signalling potential system failure from a biotic perspective, as the flows did not meet the requirements of the selected indicator species or taxa, compromising habitat suitability. The results of the ecological assessment are indicated in Table 6.

ORANGE RIVER ESTUARY ASSESSMENT

The Orange River Estuary has an area of about 2700ha. The estuary comprises an (almost) permanently open river mouth, a 2 to 3 m deep tidal basin, a braided channel system (located between sand banks covered with pioneer vegetation) and a severely degraded saltmarsh on the south bank of the river mouth. Major pressures on estuary include, flow modification (damming and regulation of flows) and non-flow modifications (structures, wastewater discharges, fishing impacts, grazing).

During the 2013 Estuary EWR study the ecological importance of the Orange Estuary was estimated to be 99 out of 100 (rated as highly important). The functional importance of the system was deemed to be very high, since the sediment supply from its catchment feeds the beaches to the north of the mouth. The sediment input from the river is also very important for flatfish in the nearshore environment in the vicinity of the mouth as it provides the habitat on which they depend.

Based on the estuary health index (EHI) assessment undertaken during this study, the PES was rated as a D category; reflecting a largely modified system. This is primarily attributed to the following factors:

- Significant freshwater flow modification – both loss of floods and increased base-flows;
- Lack of estuary mouth closure and resulting back-flooding of salt marshes with fresher water;
- Road infrastructure such as the old causeway crossing the saltmarshes and old bridge supports;
- Nutrient and salinity input from catchment;
- Gill netting of indigenous fish species and considerable fishing effort at the mouth on both sides of the estuary;
- Riparian infrastructure - levees preventing back-flooding;
- Mining activities; and
- Wastewater disposal (sewage and mining return flow).

Non-flow impacts play a significant role in the degradation of the Orange Estuary although modification of flows (both floods and base flow) remains the main cause of its degradation (See Table 7). The PES (in this case Category D) sets the minimum REC for an estuary. The degree to which the REC was elevated above the PES depended on the importance and the level of protection, or desired protection. The Orange River Estuary is rated as 'highly important', being a designated Ramsar Site, a Protected Area on the Namibian side; and a desired protected area in the South African Biodiversity Plan for the 2011 National Biodiversity Assessment. The REC for the estuary therefore should be aimed at a Category A or at least its best attainable state. In the case of the Orange Estuary the best attainable state, based on reasonable reversibility of pressures was determined as Category C (Table 8). The consequences on the estuary of the scenarios as described above were assessed. In general, the scenarios involve further reductions in freshwater inflow to the estuary, specifically loss of floods.

A key flow-related requirement to maintain the PES and/or achieve the REC is the reduction of present winter base flows to allow for mouth closure (2 to 4 years in 10 years). Of the proposed scenarios, *Scenario 2B* is associated with the least ecological consequences, but still allows for flow interventions. This scenario can be further refined by an adaptive management approach to mimic required mouth closure patterns to restore some of the back-flooding of the saltmarshes with brackish water to reduce soil salinities.

However, the REC for the Orange Estuary cannot be achieved through flow interventions only. To maintain and restore key ecosystem services such as blue carbon sequestration, in line with South Africa's climate commitments, and nursery function for depleted fish stock along this barren coast will require a range of non-flow interventions. Improving the Ramsar site health status will require long-term commitment to implementing the interventions with uncertainty regarding the available resources and effectiveness of management actions influencing the timelines for achieving the REC.

TRADE-OFF ANALYSIS

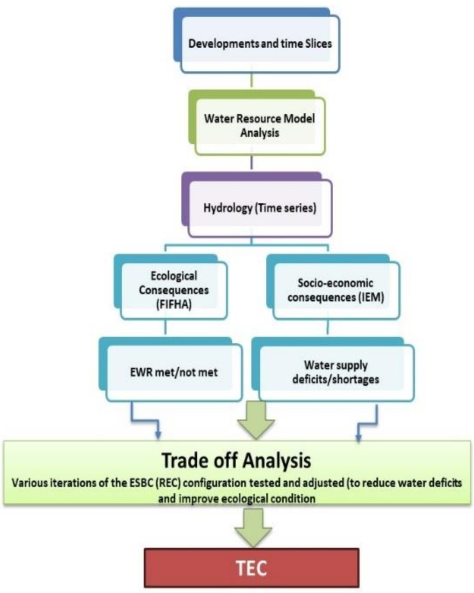


Figure 8: Depiction of the process to arrive at the TEC

During the process of testing and revising the scenarios, significant effort was made to try and minimize the impacts on both the socio-economic supply potential, and the impacts and consequences on the ecological functioning of the system (Figure 8). This required:

- Revisions of the model to include a reduction in operational losses in line with interventions planned.
- Additional storage to create more yield and ability to release stored water for time of need downstream.
- The use of both spillages and incremental flows from the Vaal River, together with the releases of water from the Upper Orange, for users in the Lower Orange River.
- Multiple iterations of the ecological requirements to both reduce the REC, as well as remove some components of the EWRs, e.g. some of the flood flows or base-flows where these were often being met by spillages or releases for downstream users; to arrive at a balanced TEC.

The Orange River System (Upper and Lower Orange Catchments) is however a large and developed system, and the further developments planned in the upstream Senqu to transfer water to the Vaal have significant further impacts of adding strain to the system and reducing the ability to reach a desirable trade-off.

The trade-offs necessary for the Lower Orange include the adjustments to the EWRs (lower categories) and deficits to irrigation to water supply in IUAs 1-5. The proposed TECs for an ecological sustainable water resource system are presented in Table 3. Table 3 also includes the ESBC (REC) that was tested and the PES. While the summary results for the Lower Orange River catchment are presented here, the outcomes are heavily linked to the Upper Orange catchment.

The implementation of the EWRs will need to be phased in over the present, medium and long term as the developments come online, in order to ensure the water availability and to limit the socio-economic consequences of deficits water supply users. An EWR implementation operational plan will need to be developed to address the timing of the implementation and optimal scenarios to keep the system in balance.

Table 3: ESBC (REC) and TEC for the Lower Orange River Catchment (IUAs 1-5)

IUAs (Lower Orange River)		EWR Site	PES	REC (ESBC)	Proposed TEC	EI - ES
1	Lower Orange from Vaal confluence to Augrabies Waterfall	LO_EWR02	C	B/C	**B/C**	High - High
2	Lower Orange - Downstream Augrabies to Pella	LO_EWR03	C	B/C	**C**	High - High
3	Lower Orange - Pella to Vioolsdrift weir	LO_EWR04	C	B/C	**C/D**	High - High
4	Downstream Vioolsdrift to Orange River Estuary	LO_EWR05	B/C	B	**C/D**	High - High
5	Orange River Estuary	Estuarine Functional Zone	D	C	**C/D**	High

EI-ES: Ecological Importance and Ecological Sensitivity

GROUNDWATER ANALYSIS

In terms of the groundwater scenario evaluation, the task assessed the impact of rainfall variation on aquifer recharge and water use increases due to population growth. Water quantity and quality were the variables considered. The objective of the groundwater analysis was to assess how these scenarios could impact the sustainability of the groundwater yields from the GRU aquifer systems.

Groundwater Resource Directed Measures (GRDM) classification system for groundwater comprise of a ranking approach by applying the stress index (SI) principle (for water quantity). The stress index provides a measure of the groundwater balance in a groundwater unit (in this case, the GRU), indicating the fraction of how much of the groundwater recharge [volume] is used*, i.e.* (i) the amount required for BHN (25 l /c /d), (ii) the volume of groundwater supporting the base flow, and (iii) the actual groundwater usage. The groundwater SI classification is an indicator of the groundwater use impact. When the SI is =1> 1.00 (100%), all the recharged groundwater is "allocated ". An SI of <60% indicates a low to moderate impact that is sustainable. The GRUs under stress are indicated Figure 11).

For the groundwater IUAs (6 to 10), of the scenarios evaluated, the following are important for the sustainability of the groundwater systems in the Lower Orange Catchment:

- The most severe consequence is the impact that is on the baseflow component as is the result of depleting water levels in the aquifer system(s) supporting the baseflow volumes from the local aquifer system
- The groundwater quality does not show sudden changes during years of lower rainfall input – it is therefore expected that the impact of lower rainfall will have a long-term effect on the water quality rather than sudden changes over one/two years.
- Given the rainfall recharge depletion, the baseflow values also reduced by several million cubic metres per groundwater resource units.
- Allocable Yield is directly linked to the groundwater recharge value, therefore, the effect of recharge reduction is directly related to this yield. In several cases, the yield dropped to below the 1.0 Mm^3/a limit and some even below the nil value.
- Groundwater abstraction for irrigation is present on a large scale;
- Groundwater abstraction for municipal bulk water supplies – which is currently becoming a significant impact due to over-abstraction due to increasing population growth that requires a water supply of much greater volume than BHN (basics services supply) (a domestic supply of 175 L/c/d was included with the other water uses);
- Groundwater quality at "sole water supply towns" are at significant risk(s) due to the poor wastewater treatment – although this untreated sewer water runs down the local stream(s), these streams are in many cases in areas where the local/underlying aquifer system supplying the town, are situated. The consequence of polluting an aquifer is much worse than having to deal with reduction in rainfall recharge.
- There are cases where "alien vegetation" starts to play an important role in the groundwater sustainability – which was found to be a significant threat in the Lower Orange Catchment.

PROPOSED WATER RESOURCE CLASSES

The approach applied to determining the proposed surface water resource class per IUA was to follow the guidelines of the WRCS. In summary the WRCS guidelines recommend that the water resource class be determined based on the ecological categories (EC) of the biophysical nodes residing in an IUA.

The groundwater classes are based on stress indices related to allocable yield, water quality and aquifer vulnerability status per resource unit in IUA. The proposed classes per IUA are set out in Table 4.

Table 4: Summarising preliminary water resource classes

IUA	Catchment area	Proposed Water Resource Class
1	Lower Orange River from Vaal confluence to Augrabies Waterfall	III
2	Lower Orange River Downstream Augrabies to Pella	III
3	Lower Orange River from Pella to Vioolsdrift weir	III
4	Lower Orange River from Vioolsdrift weir to Orange River Estuary	III
5	Orange River Estuary	III
Groundwater IUAs		
6	Brak/Ongers	II
7	Hartbees/Sak	III
8	West Coastal	III
9	Upper Kuruman/Molopo	III
10	Lower Kuruman/Molopo	II

STAKEHOLDER CONSULTATION

The classification and RQO determination study is supported by comprehensive stakeholder engagement throughout the process aligned to the technical steps of the study. Stakeholders representing relevant interests and sectors of society, and organs of state in the catchment, form part of the process and are/have been invited to participate. One of the key platforms is a PSC.

PSC meetings are being held to present information of key milestones in the study process. The 3rd meeting of the PSC at which the next study milestone will be presented and discussed is scheduled as follows.

Upington
Date: **Tuesday, 06 May 2025**
Time: **10h00 to 14h00**
Venue: **Protea Hotel**

DEFINITIONS AND ACRONYMS

BHN	Basic Humans Needs
CRA	Comparative Risk Assessment
DWS	Department of Water and Sanitation
EHI	Estuarine Health Index
EI-ES	Ecological Importance – Ecological Sensitivity
ESBC	Ecological Sustainable Base Case
EWR	Ecological Water Requirements
FIFHA	Fish Invertebrate Flow Habitat Assessment Model
GDP	Gross Domestic Product
GRU	Groundwater Resource Unit
IEM	Integrated Economic Model
IUAs	Integrated Units of Analysis
l/c/d	Litre/capita/day
LHWP-P2	Lesotho Highlands Water Project Phase 2
PES	Present Ecological State
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RU	Resource Unit
SI	Stress Index
TEC	Target Ecological Category
WMA	Water Management Area

Table 5: Summary of Economic Consequences for the Surface Water IUAs (Lower Orange River)

IUA	Socio-economic indicator	Scenarios: Scenarios With EWRs: Present day	2040 with smaller NVD, LHWP2; Gariep Bloem	2040 with larger NVD, LHWP2; Gariep Bloem	2060 LHWP2-Polihali, Vioolsdrift (size option 2), Gariep to Bloem pipeline, Verbeeldingskraal	2060 LHWP2-Polihali, Vioolsdrift (size option 2), Gariep to Bloem pipeline, Verbeeldingskraal and Makhaleng
		Sc1	Sc2	Sc2.1	Sc3	Sc3.1
IUA_01 Orange from Vaal confluence to Augrabies Waterfall	Water Supply Deficit (Irrigation)	-40.48	-22.11	-18.16	-23.73	-39.10
	GDP Economic Effect (Million R/a)	-651	-353	-290	-379	-624.8
IUA_02 Downstream Augrabies to Pella	Water Supply Deficit (Irrigation)	-18.97	-9.98	-8.14	-10.64	-17.97
	GDP Economic Effect (Million R/a)	-186	-97	-79	-103.6	-175.6
IUA_03 Pella to Vioolsdrift weir	Water Supply Deficit (Irrigation)	-3.00	-2.50	-1.79	-2.30	-3.96
	Economic Effect (Million R/a)	-29	-24	-17	-22	-38.6
IUA_04 Downstream Vioolsdrift to Orange River Estuary	Water Supply Deficit (Irrigation)	-0.52	-0.30	-0.25	-0.32	-0.52
	GDP Economic Effect (Million R/a)	-3	-2.9	-2.5	-3	-5

Table 6: Summary of the Ecological Consequences for the mainstem Lower Orange River IUAs

Scenarios	Sc1a	Sc2a	Sc2b	Sc2.1a	Sc2.1b	Sc3a	Sc3b	Sc3.1a	Sc3.1b	
	Without	Without	With EWR	Without	With EWR	Without	With EWR	Without	With EWR	
	Present day	2040 with smaller NVD, LHWP2; Gariep Bloem		2040 with larger NVD, LHWP2; Gariep Bloem		2060 LHWP2-Polihali, Vioolsdrift (size option 2), Gariep to Bloem pipeline, with Verbeeldingskraal		2060 LHWP2-Polihali, Vioolsdrift (size option 2), Gariep to Bloem pipeline, with Verbeeldingskraal and Makhaleng		
EWR ESBC (REC): B/C										
Fish Wet	B/C	B/C	B	C	A/B	C	B/C	C	B/C	
Fish Dry	B	C	B	C	A	C	B/C	C	B/C	REC is met at B/C and can be implemented
Inverts Wet	A	A	A	A	A	A	A	A	A	
InverTs Dry	B/C	C	A/B	C/D	A/B	C	C	C/D	C	
IUA2: UO_EWR03_I (Blouputs)_Wet/Dry: Feb/July_Indicators: BAEN/Perlidae										
EWR ESBC (REC): B/C										
Fish Wet	B	C	A/B	C/D	A/B	C	A/B	C	A//B	
Fish Dry	B/C	C/D	A/B	C/D	B	C	B/C	C/D	B	Inverts requirements not met - possibly due to habitat limitation. Trade-off for invertebrates in wet and dry.
Inverts Wet	D	D/E	C	D/E	C	D/E	C	D/E	C	
Invers Dry	C/D	D	B/C	D	C	D	C	D/E	C	
IUA3: EWR04 (Vioolsdrift)_Wet/Dry: Feb/Aug_Indicators: BAEN/Tricorythidae										
EWR ESBC (REC): B/C										
Fish Wet	C/D	E	C	E	D	D/E	C	E/F	D	EWRs are inadequate to meet the REC for any of the scenarios (flow requirements set are too low). Trade-off for biota is required.
Fish Dry	A/B	C/D	B	C/D	B	C/D	B	C/D	B	
Inverts Wet	E/F	E	D	E	D/E	E	E/F	F	D/E	
Inverts Dry	C	D/E	C/D	E	C	D/E	C/D	E	C/D	
IUA4: EWR05 (Sendelingsdrift)_Wet/Dry: Feb/Aug_Indicators: BAEN/Tricorythidae										
EWR ESBC (REC): B										
Fish Wet	D/E	E	C/D	D/E	D/E	D/E	E	E	D	EWRs are inadequate to meet the REC for any of the scenarios (flow requirements set are too low). Trade-off for biota is required.
Fish Dry	C	C/D	C	D	C	D	C/D	D	C	
Inverts Wet	D/E	E	C/D	D/E	D/E	D/E	D/E	E	D	
Inverts Dry	C/D	D	C	D	C	D	C/D	D	C	

Orange	Half a category lower than the flows to meet the REC
Red	Full category or more lower than the flows to meet the REC
Blue	REC Flow requirements achieved

Table 7: Orange Estuary Present Ecological status

Variable	Weight	EHI score	Confidence
Hydrology	35	45	Low/Medium
Hydrodynamics and mouth condition	91	70	Low
Water quality	62	54	Medium
Physical habitat alteration	59	59	Medium
Habitat (abiotic) health score		62	
Microalgae	53	40	Low
Macrophytes	50	50	Medium
Invertebrates	45	45	High
Fish	50	50	Medium
Birds	22	22	Medium
Biotic health score		44	
OVERALL ESTUARY HEALTH SCORE		53	
ECOLOGICAL CATEGORY (PES)		**D**	**Medium**

Table 8: Comparison between PES categories and REC for the various abiotic and biotic components in the Orange Estuary, as well as key interventions needed for improvement

Component	PES	REC	Key intervention required for improvement
Hydrology	E	D	Decrease base flows in winter.
Hydrodynamics	B	B	Facilitate mouth closure in winter 2 to 4 times in 10 years.
Water quality	C/D	C	Reduce nutrient input in the lower Orange River catchment.
Physical habitat alteration	C/D	B	Remove earth moving equipment at mouth, allow back flooding
Microalgae	D	D	Reduce base flows in winter and decrease nutrient input.
Macrophytes	D	C	Reduce soil salinities, reduce nutrient input, remove causeway, and control grazing and alien vegetation.
Invertebrates	D	B	Reduce base flows in winter and facilitate mouth closure.
Fish	D	C	Reduce baseflows in winter and facilitate mouth closure, control fishing.
Birds	E/F	D	Reduce baseflows in winter and facilitate mouth closure.
Overall	**D**	**C**	**Reduce flows, facilitate mouth closure, and improve vegetation cover and food sources (invertebrates and fish).**

Figure 9: Lower Orange catchment – Study area

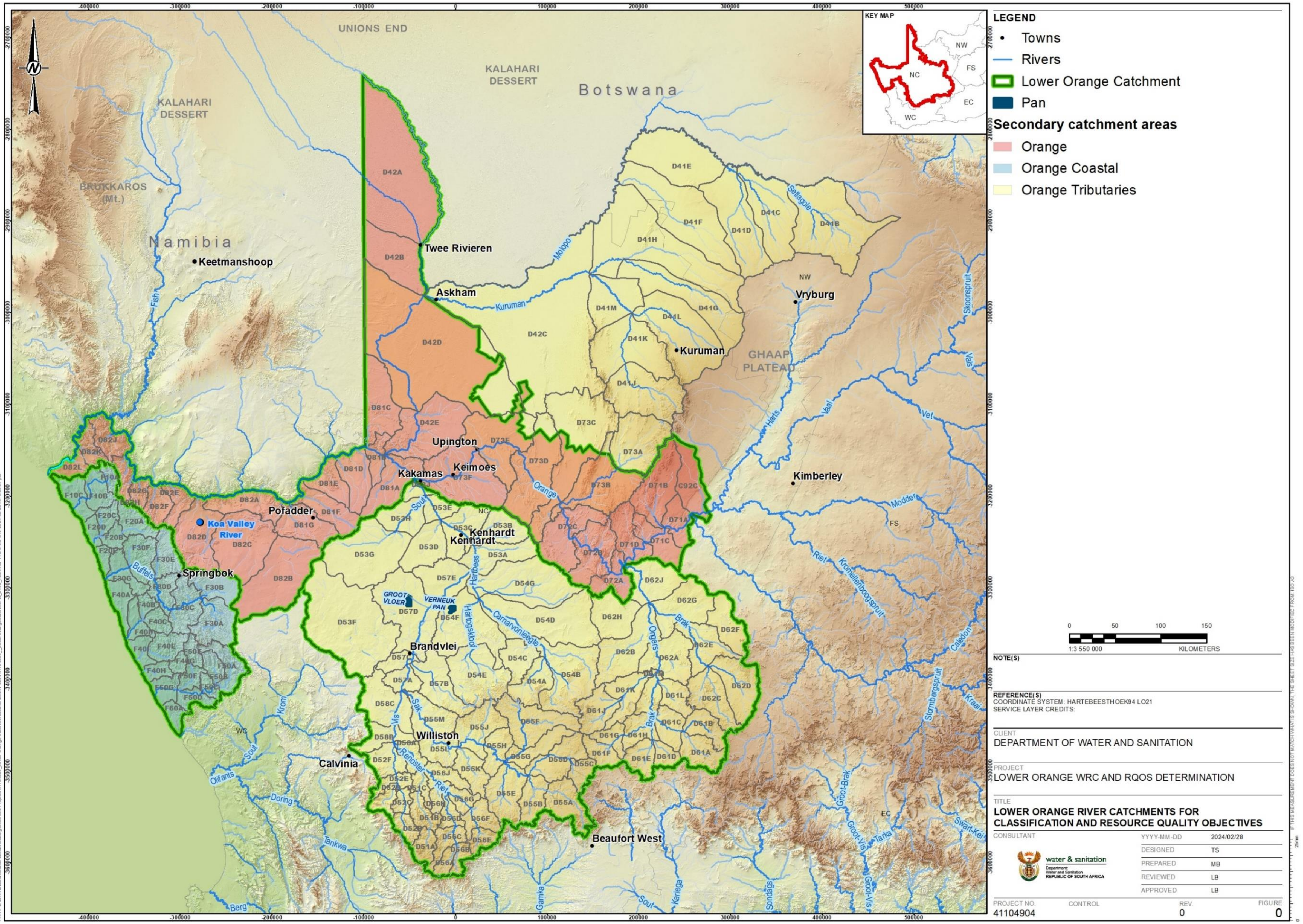


Figure 10 : Groundwater Resource Units delineated for the Lower Orange Catchment

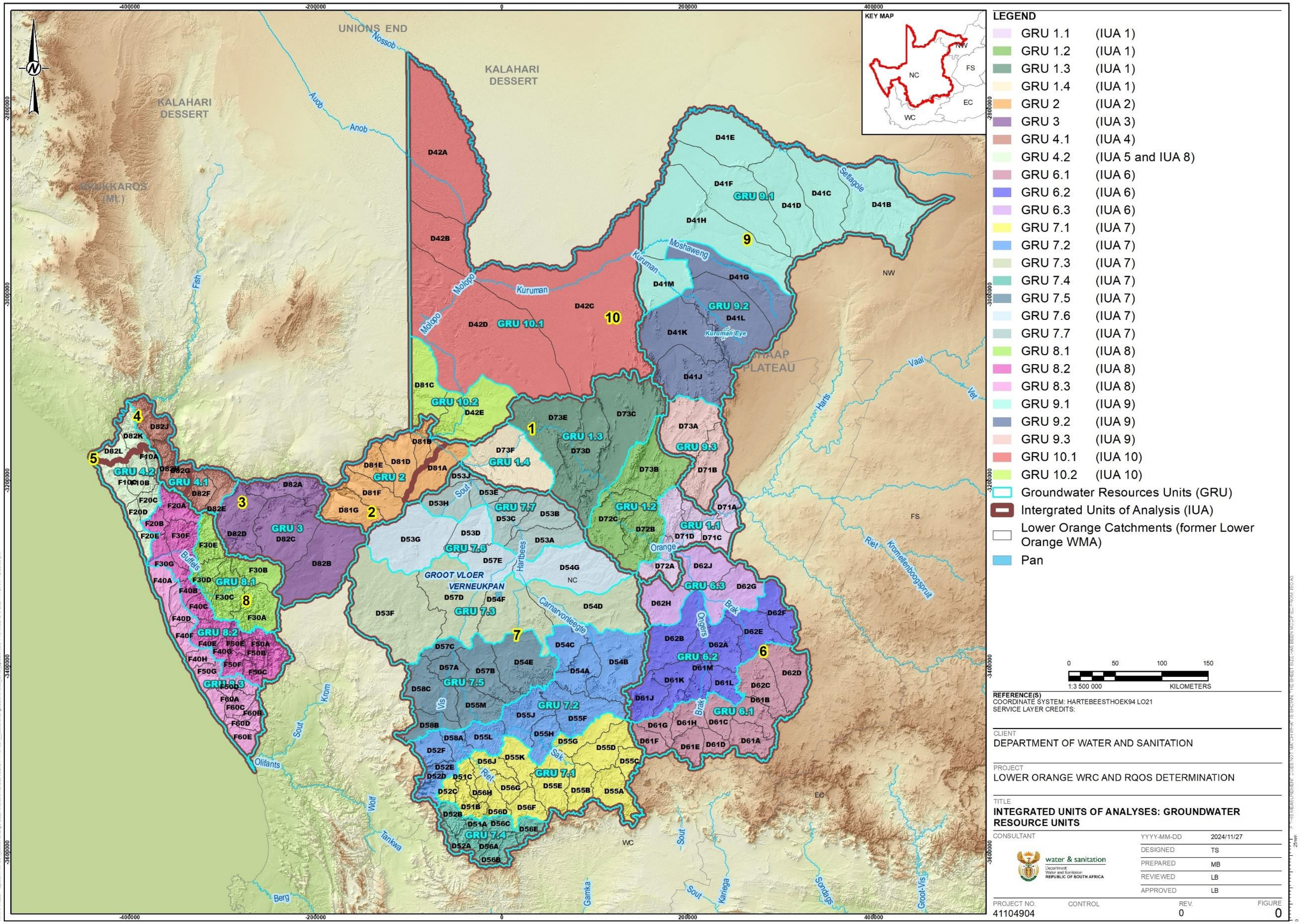


Figure 11: Groundwater Resource Units where Allocable Yield are under Stress (Stress Indices are above 60%)