water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP
NATIONAL DEVELOPMENT PLAN
Our Future - make it work

HIGH CONFIDENCE GROUNDWATER RESERVE DETERMINATION STUDY IN THE BERG CATCHMENT

PROJECT STEERING COMMITTEE MEETING

Presented by: Umvoto
Date: 22 November 2022



WATER IS LIFE - SANITATION IS DIGNITY

HIGH CONFIDENCE GROUNDWATER RESERVE DETERMINATION STUDY IN THE BERG CATCHMENT

UMVOTO

EARTH | WATER | SCIENCE | LIFE

PRESENTATION OUTLINE

1. Overview of study, phases and tasks
2. Delineation of Groundwater Resource Units
3. Reference Conditions and Present Status Assessment
4. Status Quo Assessment Example
5. Upcoming Study Programme

OVERVIEW OF STUDY, PHASES AND TASKS

SUMMARY OF PROJECT PHASES, TASKS AND DELIVERABLES

Phase 1	**Project inception**		
Task 1	Inception		Deliverable 1: Inception Report
Phase 2	**Review of water resource information and data**		
Task 2.1	Data collection and collation		Deliverable 2.1: Gap Analysis Report Deliverable 2.2: Inventory of Water Resource Models
Phase 3	**Reserve determination**		
Task 3.1	Step 1	Initiate Groundwater Reserve Study	Recorded in Deliverable 2.1 and Deliverable 2.2
Task 3.2	Step 2	Water RU Delineation	Deliverable 3.1: Delineation of Water RUs
Task 3.3	**Step 3**	**Present Status of GRU**	**Deliverable 3.2: Ecological Reference Conditions**
Task 3.4	Step 4	Determine BHN and EWR	Deliverable 3.3: BHN and EWR Requirement Report
Task 3.5	Step 5	Operational Scenarios & Socio-economic	Deliverable 3.4: Operational Scenarios & socio-economic and ecological consequences
Task 3.6	Step 6	Evaluate scenarios with Stakeholders	Deliverable 3.5: Stakeholder engagement of operation scenarios
Task 3.7	Step 7	Monitoring Programme	Deliverables 3.6: Monitoring Programme Report
Task 3.8	Step 8	Gazette & implement Reserve	Deliverable 3.7: Groundwater Reserve Determination Report Deliverable 3.8: Database Deliverable 3.9: Gazette Template

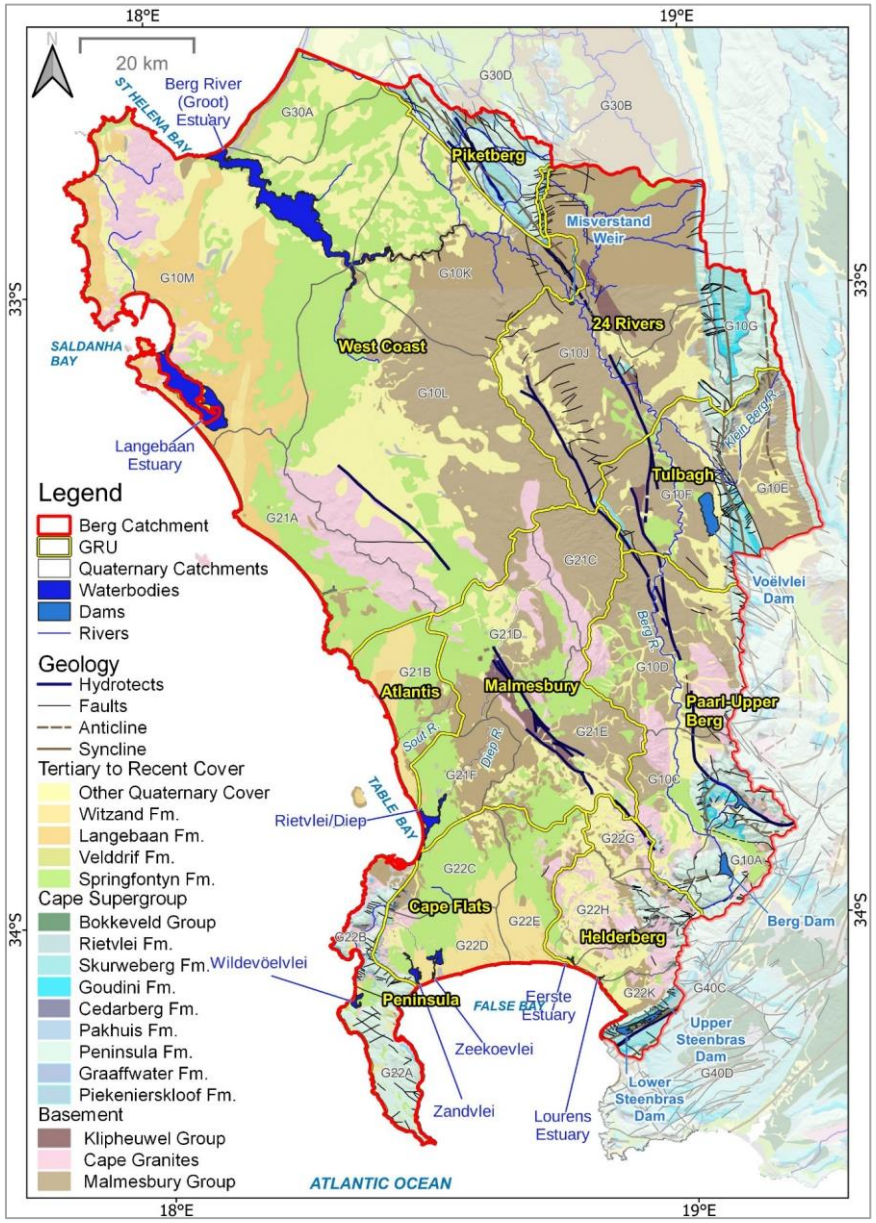
Delineation of Groundwater Resource Units

GROUNDWATER RESOURCE UNIT DELINEATION

In order to meet the Terms of Reference (TOR) for this study, the previous GRU delineation for the Berg catchment was **re-evaluated and updated** to ensure all groundwater resources are **aquifer specific**.

PREVIOUS DELINATION LIMITATIONS

1. GRUs delineated according to surface water catchments
2. Aquifer types were grouped
3. Important aquifers (i.e., TMGA) not included in study area
4. Surface geology assigned to point data (no “target” aquifer indicator)



GROUNDWATER RESOURCE UNIT DELINEATION

GRU extents where selected based on the physical geometry (predominantly controlled by geology), recharge areas, and aquifer boundary conditions, therefore, **a single GRU may contain multiple Resource Units (RUs).**

The GRU report (DWS, 2022d) outlines the approach for delineating aquifer-specific GRUs and provides detail around the criteria considered for selecting their extents.

PHYSICAL CRITERIA

a) Existing aquifer boundaries
b) Geology (Basement, TMG, Sandveld)
c) Structural geology (major faults, folds & hydrotects)
d) Aquifer boundary conditions (where water enters, flows through, and exits the systems)
e) Hydrology (major rivers, water bodies and quaternary catchments)

MANAGEMENT CRITERIA

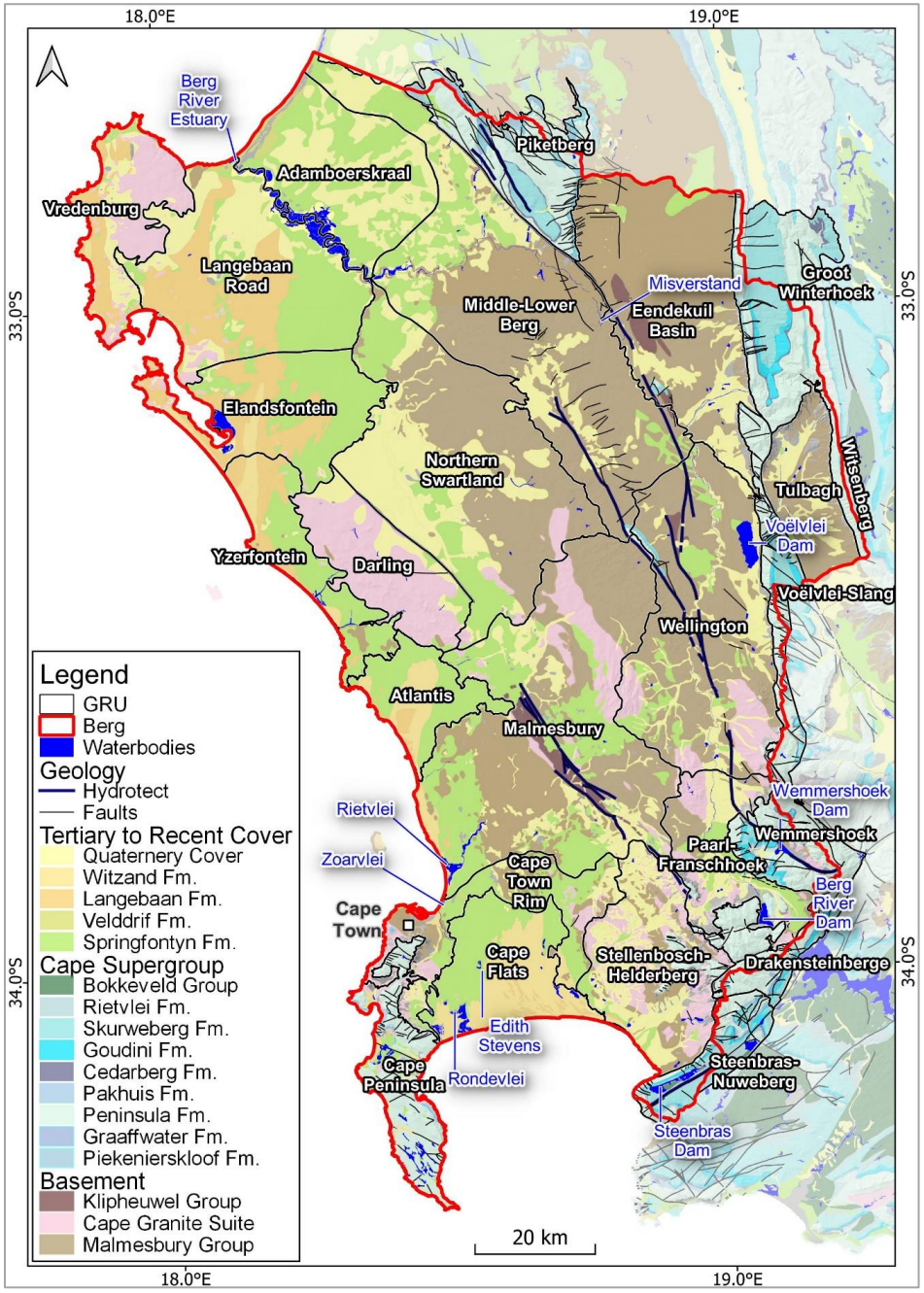
a) Existing river nodes, EWR sites, estuary nodes, estuary EWR sites, GRUs class
b) Groundwater use

FUNCTIONAL CRITERIA

a) Groundwater-surface water interactions (its role in sustaining hydrological, ecological conditions e.g., groundwater-dependent wetlands)

UPDATED GRUs

GRU name	Associated Surface Water Quaternary Catchment
Primary / Intergranular Aquifers	
Cape Flats	G22C, G22D and G22E
Atlantis	G21A, G21B and G21D
Yzerfontein	G21A
Elandsfontein	G10M and G10L
Langebaan Road	G10M and G10L
Adamboerskraal	G10M, G10K and G30A
Fractured Aquifers – Table Mountain Group (TMG)	
Cape Peninsula	G22A, G22B, G22C and G22D
Steenbras-Nuweberg	G40B, G40A, G40D, G22J, G22K, H60A and G40C
Drakensteinberge	G10A, G10C, G22F, G22J, H60A and H60B
Wemmershoek	G10B, G10A, G10C, H10J, H60B and H10K
Voëlvlei-Slanghoek	G10E, G10J, G10D, G10F, H10E, H10F and H10J
Witsenberg	G10E
Groot Winterhoek	G10J, G10E, G10H, E10C and G10G
Piketberg	G10M, G30D, G10K, G30A and G10H
Fractured and Intergranular Aquifers - Basement	
Cape Town Rim	G22C, G22E, G22B and G22D
Stellenbosch-Helderberg	G22G, G22H, G22F, G22J and G22K
Paarl-Franschhoek	G10C, G10A and G10B
Malmesbury	G201E, G21C, G21D, G21F and G21B
Wellington	G10D and G10F
Tulbagh	G10E and G10G
Eendekuil Basin	G10H, G10J, G10F and G10K
Middle-Lower Berg	G10J, G30A, G10K and G10M
Northern Swartland	G10L
Darling	G10L and G21A
Vredenburg	G10M



Reference Conditions and Present Status Assessment

REFERENCE CONDITIONS AND PRESENT STATUS

The Ecological Reference Conditions Report is **Deliverable 3.2** of Phase 3 of this study and is **Step 3 of eight-step groundwater Reserve determination procedure**. See summary of project phases, tasks and associated deliverables (Inception Report - DWS, 2022).

OBJECTIVES

1. Provide an overview of previous status quo for groundwater in the Berg catchment.
2. Outline the approach and criteria considered for the revised status quo assessment.
3. Describe the present state of groundwater based on updated aquifer-specific GRUs delineated as part of Step 2.

PREVIOUS STATUS QUO INFORMATION

Gazette No.42451:121 (DWS, 2019: 121) and DWS (2016) i.e., “Determination of Water Resource Classes and Resource Quality Objectives in the Berg catchment” **provides a status quo assessment of all significant water resources, for both surface water and groundwater, per IUA**. The outcomes will therefore be used as the foundational input for this study.

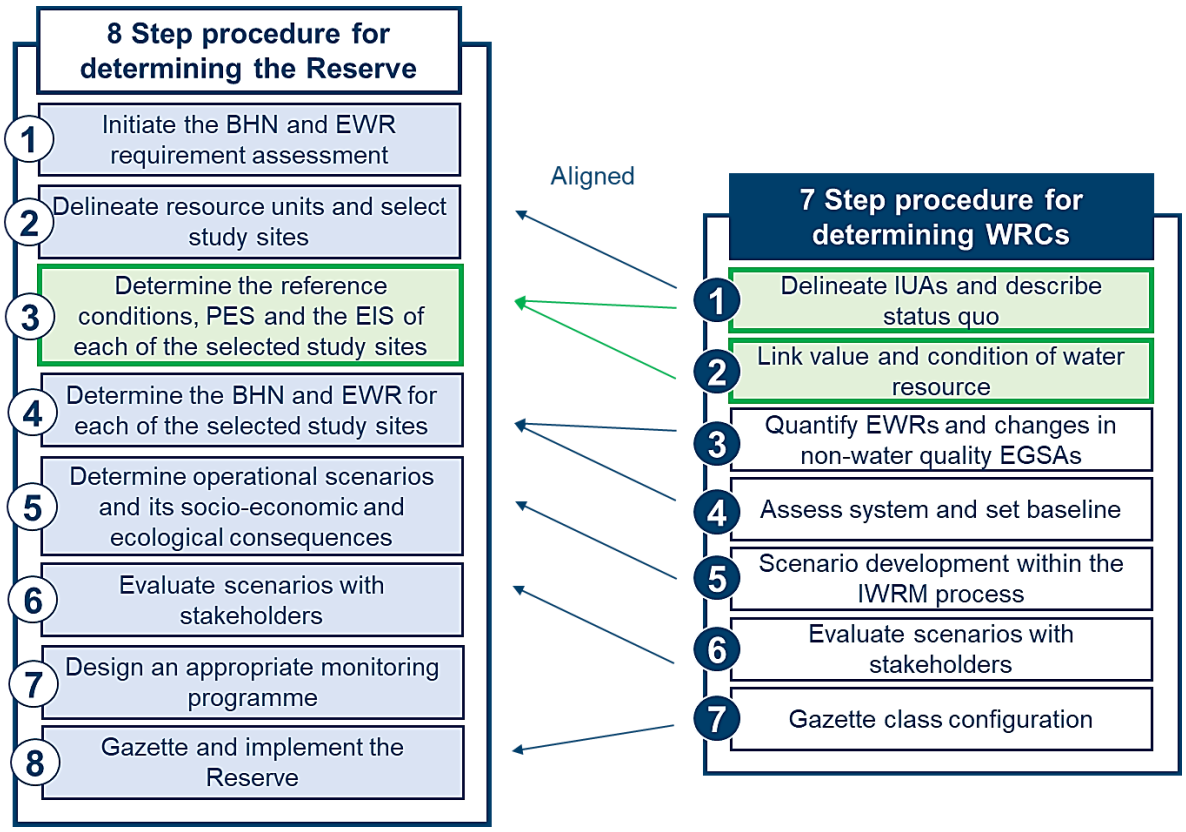
SURFACE WATER

- Present-day socio-economic status
- Present-day community wellbeing
- Value of water use
- Value of ecosystem use
- Network of significant water resources
- Biophysical nodes
- Allocation nodes
- Water Resource Class
- RQOs

GROUNDWATER

- 10 GRUs delineated
- Groundwater use (trend analysis)
- Groundwater quality (trend analysis)
- Groundwater supplied settlements
- Groundwater Resource Class
- RQOs

UPDATED APPROACH



COMPONENTS

Recharge
Groundwater Use
Discharge
Groundwater Quality
Aquifer Stress

OUTCOMES

Groundwater Present Status

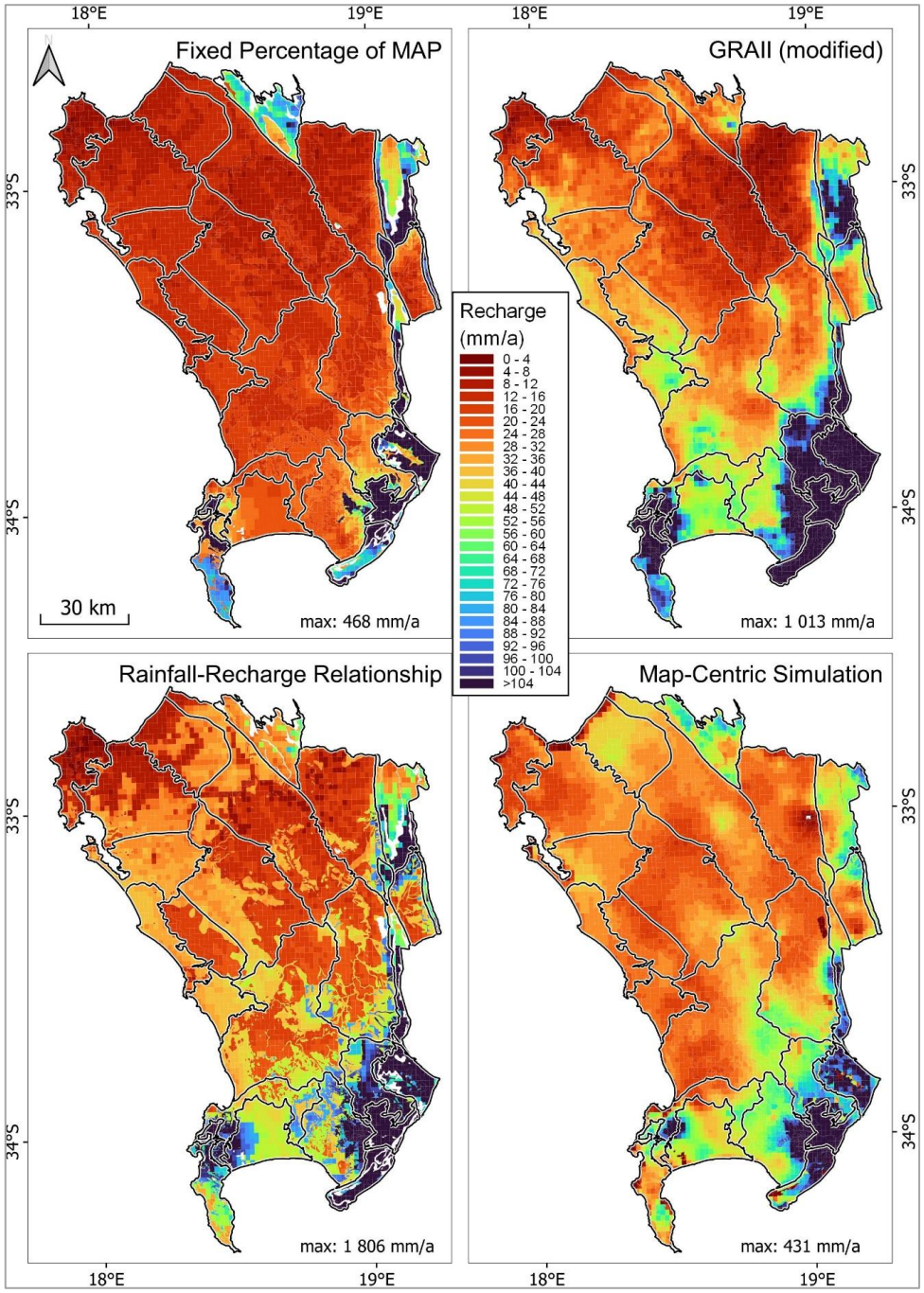
RECHARGE

Recharge estimations were selected from various methods to provide a summary per GRU.

CONSIDERATIONS

1. Level of confidence and associated limitations of the methodology
2. Amount, spread and availability of data across the GRU
3. Applicability of published datasets.

No second order recharge was necessary due to the validity of available literature data.



RECHARGE

Rainfall Comparison

Is the WR2012 rainfall dataset still relevant?

A rainfall comparison was undertaken with more recent available data in the Berg catchment.

30-year Climate Norm MAP is only available for two stations (CTIA and Atlantis). Other MAP is calculated for the available data range at other stations.

OUTCOME

WR2012 is still relevant (given the extreme weather events, i.e., the Western Cape drought)

1st Order Recharge

Four recharge estimation methods were selected:

1. Fixed Percentage of MAP
2. GRAII Spatial Distribution (Modified)
3. The Empirical Rainfall-Recharge Relationship
4. Map-Centric Simulation

OUTCOME

Regional recharge estimations per AU per GRU

Available Literature

Second-order recharge estimation results from available literature are used.

Main 2nd order recharge estimation methods used:

1. Chloride Mass Balance
2. Cumulative Rainfall Departure
3. Saturated Volume Fluctuation
4. Isotopes

OUTCOME

Local recharge estimations per AU per GRU

RECHARGE

GRU	Area (km²)	Rainfall Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)	Total Recharge Volume (M m³/a)
Primary / Intergranular Aquifers				
Cape Flats	421.94	41.25	97.76	55.85
Atlantis	255.68	22.74	88.94	27.85
Yzerfontien	320.33	9.20	28.72	9.20
Elandsfontien[6]	532.57	15.47	29.05	15.47
Langebaan Road[6]	903.71	23.28	25.76	23.28
Adamboerskraal[6]	612.30	21.61	35.29	21.61
Fractured Table Mountain Group Aquifers				
Cape Peninsula[6]	292.53	10.99	37.57	10.99
Steenbras-Nuweberg	150.24	58.76	391.11	58.76
Drakensteinberge[6]	164.95	27.60	167.32	27.60
Wemmershoek[6]	229.13	26.83	117.10	26.83
Voëlvlei-Slanghoek[6]	184.26	14.10	76.52	14.10
Witsenberg[6]	39.95	2.78	69.59	2.78
Grootwinterhoek[6]	379.26	22.50	59.33	22.50
Piketberg[6]	298.29	20.33	68.16	20.33
Fractured and Intergranular Basement Aquifers				
Cape Town Rim[6]	814.62	18.60	22.83	18.60
Stellenbosch-Helderberg[6]	570.58	41.52	72.77	41.52
Paarl-Franschoek[6]	368.50	26.61	72.21	26.61
Malmesbury[6]	1600.36	52.65	32.90	52.65
Wellington[6]	1068.81	39.49	36.95	39.49
Tulbagh[6]	291.38	10.87	37.31	10.87
Eendekuil Basin[6]	936.94	21.88	23.35	21.88
Middle-Lower Berg[6]	1485.40	42.49	28.61	42.49
Northern Swartland[6]	1257.65	31.85	25.33	31.85
Darling[6]	408.82	9.95	24.34	9.95
Vreedenberg[6]	376.18	7.43	19.75	7.43
Total	**13964.38**	**620.78**	**n/a**	**640.49**

GROUNDWATER USE

DATA SOURCES

A variety of data sources were collated to assess the current groundwater use in the study area.

DATA SOURCES

1) WARMS
2) NGA
3) All Towns Reconciliation Strategies for the Southern Planning Region
4) Water Reconciliation Strategy for the WCWSS
5) GRAII (urban & domestic)

OUTCOME

All sources used. GRAII not available to recalculate the results

ASSIGNING RESOURCE UNITS

The WARMS database is lacking as far as assigning registered volumes to an aquifer unit.

1. Liaison with various project specialists.
2. Linking WARMS to NGA and assigning registered volumes pro rata to the number of boreholes in different aquifers.

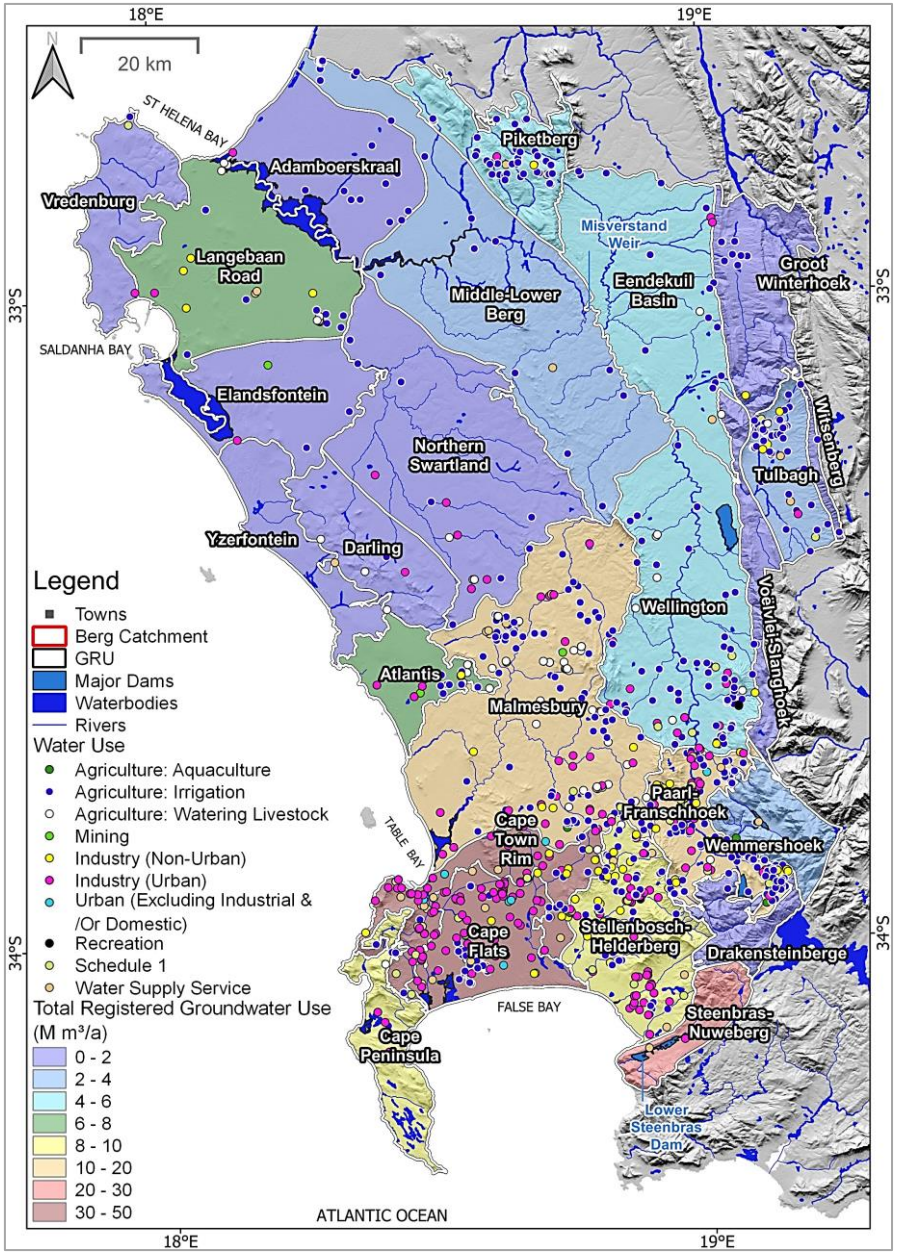
OUTCOME

WARMS was used as the main dataset. Summary of water use per sector, per AU, per GRU.

Existing WULs were also considered.

GROUNDWATER USE

GRU	No. of Registered Users	Total Volume (M m³/a)
Primary / Intergranular Aquifers		
Cape Flats	95	26.6
Atlantis	24	6.76
Yzerfontein	1	0.26
Elandsfontein	4	1.09
Langebaan Road	33	8.59
Adamboerskraal	12	2.13
Fractured Table Mountain Group Aquifers		
Cape Peninsula	8	0.07
Steenbras-Nuweberg	1	9.13
Drakensteinberge	2	0.05
Wemmershoek	15	0.81
Voëlvlei-Slanghoek	3	0.13
Witsenberg	3	0.08
Groot Winterhoek	11	1.39
Piketberg	52	5.58
Fractured and Intergranular Basement		
Cape Town Rim	161	6.21
Stellenbosch-Helderberg	163	8.81
Paarl-Franschhoek	268	9.82
Malmesbury	245	14.75
Wellington	117	4.48
Tulbagh	81	3.78
Eendekuil Basin	33	4.85
Middle-Lower Berg	32	2.23
Northern Swartland	19	1.79
Darling	9	0.76
Vredenberg	66	1.16
Total	**1406**	**121.05**



DISCHARGE

DIRECT DISCHARGE

The baseflow data from the GRDM was deemed suitable for a “groundwater contribution to baseflow”

Disadvantage: “baseflow” datasets in GRDM were quantified per quaternary catchment.

OUTCOME

‘Groundwater contribution to baseflow’ per aquifer (based on equivalent recharge after Berg WAAS) was **spatially disaggregated** and totalled to provide a **groundwater contribution to baseflow estimate per GRU and Aquifer Unit**.

Discharge will be further investigated in Step 4 (i.e., Determine BHN and EWR)

LATERAL DISCHARGE / RECHARGE

Groundwater can also discharge from one aquifer unit into another adjacent aquifer through lateral or vertical subsurface flow.

1. Geological interpretations and anecdotal evidence that support this being a relevant factor for several GRUs.
2. Potential hydraulic connection between the Peninsula and Nardouw aquifers (zones of direct geological contact that potentially lead to lateral flows)
3. Major fault structures (so-called hydrotects) that connect different aquifer units and potentially recharge aquifers in other GRUs

OUTCOME

Quantification of lateral discharge will be addressed in Step 4 (i.e., Determine BHN and EWR)

DISCHARGE

GRU	GW Contribution to Baseflow (M m^3/a)
Primary / Intergranular Aquifers	
Cape Flats	2.596
Atlantis	0.1802
Yzerfontein	0.185
Elandsfontein	0.000
Langebaan Road	0.000
Adamboerskraal	0.000
Fractured Table Mountain Group Aquifers	
Cape Peninsula	4.283
Steenbras-Nuweberg	25.428
Drakensteinberge	8.692
Wemmershoek	18.516
Voëlvlei-Slanghoek	9.692
Witsenberg	2.226
Groot Winterhoek	11.067
Piketberg	0.100
Fractured and Intergranular Basement Aquifers	
Cape Town Rim	5.874
Stellenbosch-Helderberg	7.652
Paarl-Franschhoek	8.257
Malmesbury	11.798
Wellington	7.906
Tulbagh	6.490
Eendekuil Basin	4.898
Middle-Lower Berg	3.359
Northern Swartland	0.019
Darling	0.084
Vredenberg	0.000
Total	**139.36**

WATER QUALITY

DATA SOUTCES

Monitoring data sources:

1. WMS
2. CoCT
- NWP (CFA, Atlantis, TMGA)
- Historical data (Steenbras-Nuweberg and Wemmershoek exploration)

OUTCOME

The WMS data was used as the primary dataset, with CoCT data used to supplement in GRUs where no WMS monitoring points were available.

BASELINE WATER QUALITY

Baseline concentrations were established using the 95th percentile of a representative borehole.

CONSIDERATIONS

1. Distance from PCAs
2. Length of data record
3. Spatial centrality within GRU.

OUTCOME

Only 14 parameters were selected (per aquifer type) for detailed analysis. Piper diagrams show distribution of water types

GAZETTE & RQO COMPARISON

Only 12 out of the 25 GRUs fall within a drainage region with established groundwater quality related RQOs.

It must be noted that RQOs have only been established for nitrate (NO_3). However, WMS data only includes combined NO_3 and NO_2, and this has been used as a proxy.

OUTCOME

Number of exceedances of Resource Quality of Objectives (RQOs) per drainage region was calculated.

WATER QUALITY

Water quality categories have been determined for each GRU based on the percentage exceedance of baseline threshold value per parameter and per GRU. **Adjusted water quality categories** have also been established taking into consideration that **natural variation** in water quality may lead to **elevated parameter concentrations** in some GRUs

WATER QUALITY CATEGORIES

Water Quality (Present Status) Category	Percentage exceedance	Description	Guide
A	<16.7 %	Unmodified, pristine conditions	Natural groundwater quality conditions prevail
B	16.7 – 33.4 %	Localised, low levels of contamination, but no negative impacts apparent	Largly natural groundwater quality conditions prevail
C	33.4 – 50.1 %	Moderate levels of localised contamination, but little or no negative impacts apparent	Some localised contamination detected; may impact the purpose for which groundwater is used
D	50.1 – 66.8 %	Moderate levels of widespread contamination, which limit the use of potential use of the aquifer	Groundwater contamination is quite widespread but levels are relitavly low; may impact the purpose for which groundwater is used
E	66.8 – 83.5 %	High levels of local contamination which render parts of the aquifer unusable	High levels of contamination detected in places; use of groundwater from impacted area to be restricted or prohibited
F	>83.5 %	High levels of widespread contamination which render the aquifer unusable	Very high levels of contamination widespread throughout the aquifer. Groundwater use to be restricted or prohibited

WATER QUALITY

GRU	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Primary / Intergranular Aquifers				
Adamboerskraal	Na-Cl	B, E	C	B
Atlantis	Na-Cl, Ca-Mg,Cl, Ca-HCO_3, Ca-Na-HCO_3, Ca-SO_4	A, B, C	B	C
Cape Flats	Na-Cl, Ca-Mg-Cl, Ca-HCO_3, Ca-SO_4	A, C, D	A	D
Elandsfontein	Na-Cl, Ca-Mg-Cl	A, B	A	B
Langebaan Road	Na-Cl, Ca-Mg-Cl	A, B, C	B	B
Yzerfontein	Na-Cl, Ca-Mg-Cl	A, C, D	B	A
Fractured Table Mountain Group Aquifers				
Cape Peninsula	Na-Cl, Ca-Mg-Cl, Ca-HCO_3	A, B, D, E, F	D	B
Drakensteinberge	No data available	No data available	-	-
Groot Winterhoek	No data available	No data available	-	-
Steenbras-Nuweberg	Na-Cl, Ca-Mg-Cl, Ca-HCO_3, Ca-Na-HCO_3	A, B, C	B	B
Piketberg	No data available	No data available	-	-
Wemmershoek	Na-Cl, Ca-HCO_3, Ca-Na-HCO_3	A, C	A	A
Witsenberg	No data available	No data available	-	-
Fractured and Intergranular Basement				
Cape Town Rim	Na-Cl, Ca-Mg-Cl	A, B, D, E, F	C	C
Darling	Na-Cl	B, C, D, E	D	C
Eendekuil Basin	Na-Cl, Ca-Mg-Cl, Ca-SO_4	A, C, D, E	C	C
Malmesbury	Na-Cl, Ca-Mg-Cl, Ca-SO_4	A, B, C, D	A	B
Middle-Lower Berg	Na-Cl	A, D, E	C	C
Northern Swartland	Na-Cl, Ca-Mg-Cl	B, C, D	C	C
Paarl-Franschhoek	Na-Cl	No data available*	-	-
Stellenbosch-Helderberg	Na-Cl, Ca-Mg-Cl	B, C, D, E, F	D	C
Tulbagh	Na-Cl	No data available*	-	-
Vredenberg	No data available	No data available	-	-
Wellington	Na-Cl	B	B	B

AQUIFER STRESS

In the context of this study, '**ecological reference conditions**' refer to the ambient or natural state of the groundwater system while the '**present status**' relates to the current status of the groundwater system. A **significant difference** between the ecological reference conditions and the present status **indicates a degrading state** of the groundwater water resource.

SUSTAINABLE USE

It is assumed that the 'limit' of sustainability is marked by what would be considered 'acceptable' verses 'unacceptable' groundwater use in terms of Reserve.

This, however, is an **outcome of this study** and therefore can only be properly **assessed once Steps 5 -7 of the groundwater Reserve determination procedure** is complete.

LEVEL OF STRESS

A groundwater Stress Index (SI) has been developed (after WRC, 2007), which considers **groundwater water availability** verses **water use**. The Stress Index is defined as follows

SI = GW Use / Recharge

After calculating the SI, the "Level of Stress" guidance table is used to set the **groundwater PS** category per GRU.

GROUNDWATER QUALITY

WRC (2007) provides a guidance table that is used to provide a **PS category based on groundwater quality.**

This has been adapted to include categories based on the percentage exceedance of baseline threshold values for each parameter and per GRU. As well as taking into account natural variation in water quality and spatial masking of localised contamination.

AQUIFER STRESS

After calculating the Stress Index, the “Level of Stress” guidance table is used to set the groundwater present status category per GRU.

Present Status Category	Description	Stress Index (GW use / Recharge)
A	Unstressed or slightly stressed	<0.05
B		0.05 – 0.20
C	Moderatly stressed	0.20 – 0.40
D		0.40 – 0.65
E	Highly stressed	0.65 – 0.95
F	Critically stressed	>0.95

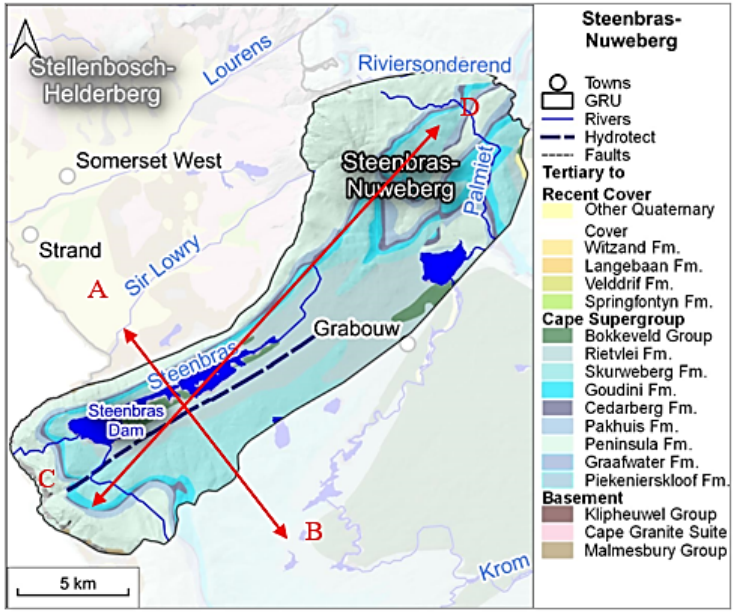
PRESENT STATUS

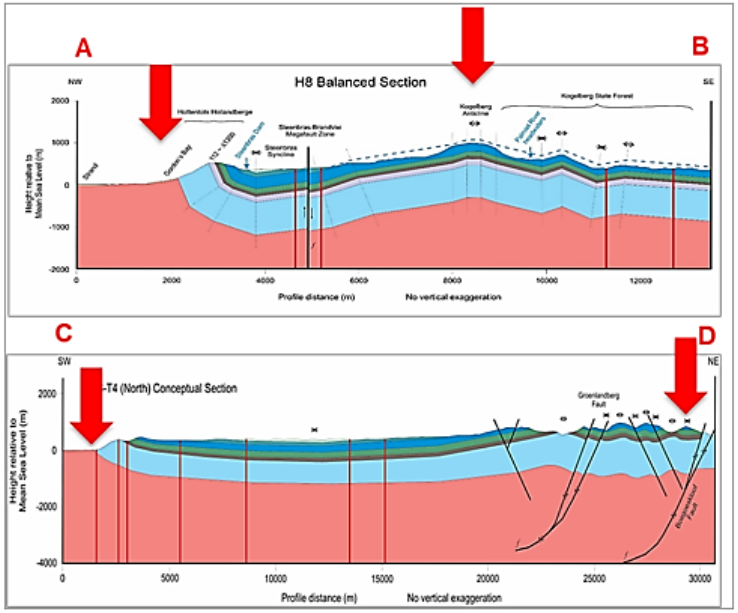
GRU	Total Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
Primary / Intergranular Aquifers					
Cape Flats	55.85	26.60	0.48	D	D
Atlantis	27.85	6.76	0.24	C	C
Yzerfontien	9.20	0.26	0.03	A	A
Elandsfontien	15.47	1.09	0.07	B	B
Langebaan Road	23.28	8.59	0.37	C	B
Adamboerskraal	21.61	2.13	0.10	B	B
Fractured Table Mountain Group Aquifers					
Cape Peninsula	10.99	0.07	0.01	B	B
Steenbras-Nuweberg	58.76	9.13	0.16	B	B
Drakensteinberge	27.60	0.05	0.00	A	-
Wemmershoek	26.83	0.81	0.03	A	A
Voëlvlei-Slanghoek	14.10	0.13	0.01	A	-
Witsenberg	2.78	0.08	0.03	A	-
Grootwinterhoek	22.50	1.39	0.06	B	-
Piketberg	20.33	5.58	0.27	C	-
Fractured and Intergranular Basement					
Cape Town Rim	18.60	6.21	0.33	C	C
Stellenbosch-Helderberg	41.52	8.81	0.21	C	C
Paarl-Franschhoek	26.61	9.82	0.37	C	-
Malmesbury	52.65	14.75	0.28	C	B
Wellington	39.49	4.48	0.11	B	B
Tulbagh	10.87	3.78	0.35	C	-
Eendekuil Basin	21.88	4.85	0.22	C	C
Middle-Lower Berg	42.49	2.23	0.05	B	C
Northern Swartland	31.85	1.79	0.06	B	C
Darling	9.95	0.76	0.08	B	C
Vredenberg	7.43	1.16	0.16	B	-

Status Quo Assessment Example

PRESENT STATUS – Steenbras-Nuweberg GRU

GRU	**GRU Name: Steenbras-Nuweberg**	
	Main Towns: Grabouw	
	Total Area (km²): 195.18	
GRU Boundary Description	The CoCT (2021) aquifer model boundary is used for the extent of the Steenbras-Nuweberg GRU. It is bound by TMGA outcrop in the Steenbras and Theewaterskloof areas, the La Motte Fault in the northern recharge area (DWAF,2008a; CoCT, 2004), and the Kogelberg and Stettyns anticlines including portions of the G40A surface water catchment boundary) on its eastern margin. The northern extent of the GRU is bound by the extent of interpolated basement lithologies (Malmesbury Group and the Cape Granite Suite outcrop) and the False Bay coastline to the west.	
Quaternary Catchments	G40C, G40A, G40D, G22J, G22K, H60A and G40B	
Resource Unit	**Fractured Table Mountain Group Aquifer**	
	Peninsula	**Nardouw**
Description	The Table Mountain Group Super aquifer is composed of the larger Peninsula Aquifer (apparent thickness approximately 600 - 700 m in this area) and the lesser Nardouw Aquifer (with its component sub-aquifers). The Peninsula Aquifer and the Skurweberg Sub-aquifer are the main deep aquifer targets.	The TMG syncline exposes the Goudini, Skuwerberg and Rietvlei formations of the Nardouw Sub-group within the valley of the syncline. The aquifers consist of the Skuwerberg and Rietvlei formations. (~700 – 800m thick)



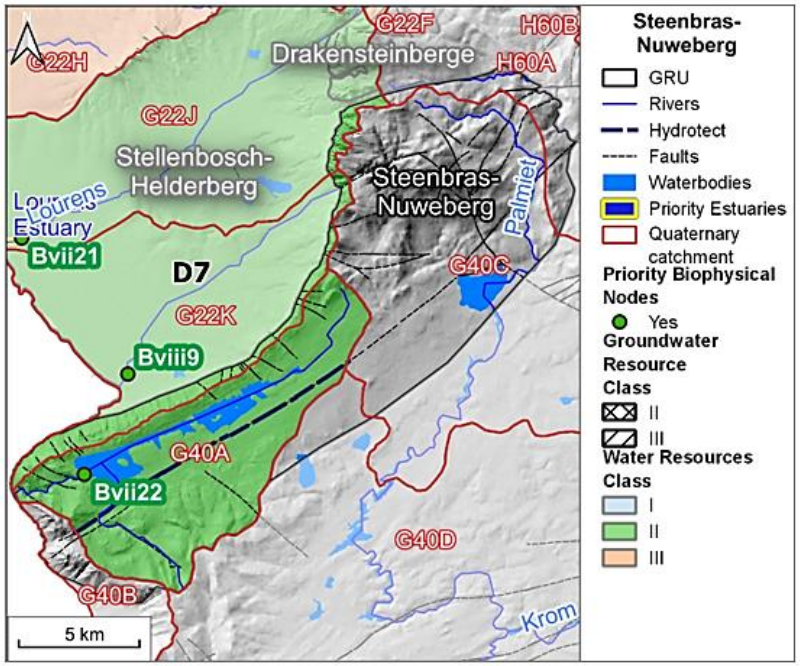


water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP
NATIONAL DEVELOPMENT PLAN
Our Future - make it work

PRESENT STATUS – Steenbras-Nuweberg GRU

GRU	**GRU Name: Steenbras-Nuweberg** **Main Towns: Grabouw** **Total Area (km²): 195.18**
	The confining unit that overlies the Peninsula Aquifer and separates it from the overlying Nardouw Aquifer, consists of a conformable package of three aquitard units (Goudini, Cedarberg, and Pakhuis) named the Winterhoek Mega-aquitard. Hydrogeologically, the entire Pakhuis – Goudini sequence is an effective aquitard, although the Goudini Formation is considered part of the Nardouw Subgroup. The TMG has been folded into a syncline, exposing the Peninsula Formation in the limbs forming steep mountainsides alongside the valley. The Peninsula, Pakhuis, Cedarberg and Goudini Formations outcrop in the topographically elevated synclinal/anticlinal limbs in the mountainous regions adjacent to the dam area
Surface Water System	The major surface water bodies of this GRU include the Steenbras dam that forms part of the Western Cape Water Supply System (WCWSS) as well as the Eikenhof and Nuweberg dams along with the Palmiet River. Surface water runoff follows topography, flowing from a north-east to south-west, namely the Steenbras River.
Water Resource Classes & RQOs	Only a portion of the GRU is in the Sir Lowry's IUA (D7), while the rest of the GRU lies outside of the D7 IUA as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the GRU that fall within the D7 IUA (catchments G40A and G22K) has a Water Resource Class of II and has no Groundwater Resource Class. This GRU has no EWR sites, although it hosts 1 priority biophysical site - the Steenbras estuary node with a TEC of B/C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D7 Sir Lowry's	II	G40A	D7-R20	Steenbras	Bvii22	B/C	23

PRESENT STATUS – GRU EXAMPLE

GRU	
	GRU Name: Steenbras-Nuweberg
	Main Towns: Grabouw
	Total Area (km²): 195.18

Recharge

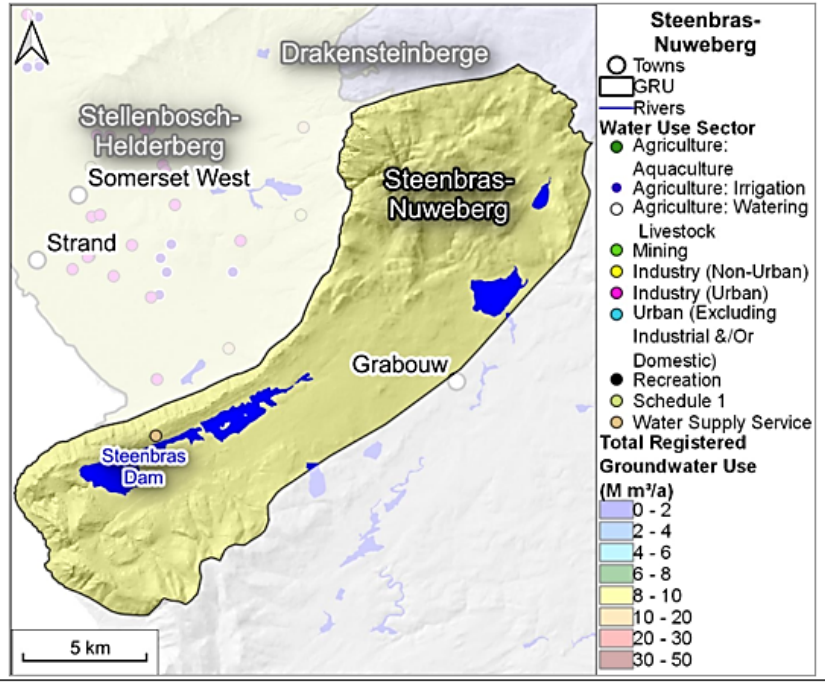
An estimated recharge of **58.76 M m³/a** was determined from GRAII based on the hydrogeological technical assessment (CoCT, 2022). This recharge value was carried over into the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **391.11 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
After (CoCT, 2022) hydrogeological technical assessment for IWULA	150.24	58.76	391.11

Groundwater Use

Water Supply services is the only registered groundwater user in this GRU using a total of **9.13 M m³/a** (see **Section 4.3.3** for detail). This is split by **3.65 M m³/a** in the Peninsula Aquifer and **5.48 M m³/a** in the Nardouw Aquifer.

Water Use Sector	No. of Users	Total Volume (M m³/a)
Water Supply service	1	9.13
Total	**1**	**9.13**



PRESENT STATUS – GRU EXAMPLE

<table>
<tr><td rowspan="3">GRU</td><td colspan="2">GRU Name: Steenbras-Nuweberg</td></tr>
<tr><td colspan="2">Main Towns: Grabouw</td></tr>
<tr><td colspan="2">Total Area (km²): 195.18</td></tr>
<tr><td>Discharge</td><td colspan="2">Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>7.93 M m³/a</u> (see Section 4.4.1 for details).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m3/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.08</td></tr>
<tr><td>Nardouw Aquifer</td><td>3.94</td></tr>
<tr><td>Peninsula Aquifer</td><td>2.31</td></tr>
<tr><td>Fractured and Intergranular Other (TMG & Bokkeveld)</td><td>1.37</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.24</td></tr>
<tr><td>Total</td><td>7.93</td></tr>
</table></td></tr>
<tr><td>Water Quality</td><td>The main water types in the Peninsula Aquifer are Na-Cl, Ca-Na-HCO_3 and Ca-HCO_3 type. The Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall. Ca-HCO_3 type waters are due to the dissolution of carbonate minerals, while Ca-Na-HCO_3 type water are due to ion exchange between Ca^+ ions from Ca-HCO_3 and Na^+ ions in the lithology.

Exceedance of baseline concentrations was observed for all parameters except dissolved arsenic, chromium, lead and mercury, with 50% of samples exceeding baselines for sulphate and EC. The adjusted water quality category is B, indicating that largely natural water quality conditions prevail, although natural, acidic pH, elevated iron and manganese are water quality concerns.</td><td>The main water types in the Nardouw Aquifer are Na-Cl, with 3 samples showing Ca-Na-HCO_3 and Ca-Mg-Cl type. The Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall.

EC and pH are lower than in the Peninsula Aquifer, with the more acidic pH being the result of dissolution of humic compounds from overlying plants, dissolution of CO_2 (which forms carbonic acid) in recharge water and limited presence of basic ions (compared to Peninsula Aquifer) to buffer acidic waters. Exceedance of baseline concentrations were observed for all parameters except fluoride, orthophosphate, dissolved chromium and mercury. The adjusted water quality category is B, indicating that largely natural water quality conditions prevail, although natural, acidic pH, elevated iron and manganese are water quality concerns.</td></tr>
</table>

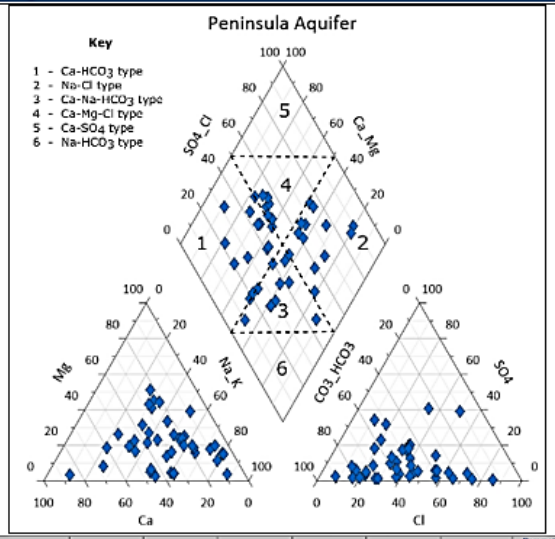
PRESENT STATUS – GRU EXAMPLE

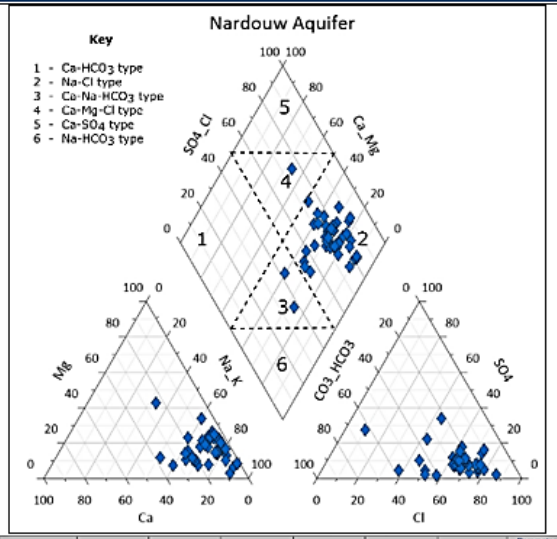
GRU

GRU Name: Steenbras-Nuweberg

Main Towns: Grabouw

Total Area (km²): 195.18





GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Steenbras-Nuweberg (Peninsula)	Sulphate (mg/l)	1.49	0.20	61.00	6.25	4.2	Na-Cl, Ca-Mg-Cl, Ca-HCO3, Ca-Na-HCO3	E	D	B
	Electrical conductivity (mS/m)	14.00	2.47	38.00	14.14	13		D		
	pH	7.58	4.87	9.35	7.01	6.8		C		
	Ammonia (mg/l)	0.12	0.00	12.00	0.42	0.1		C		
	Nitrate + nitrite (mg/l)	1.05	0.00	1.20	0.12	0.1		A		
	Fluoride (mg/l)	0.28	0.10	0.76	0.40	0.5		C		
	Orthophosphate (mg/l)	0.32	0.00	0.97	0.15	0.1		A		
	Dissolved Aluminium (mg/l)	0.012	0.001	0.080	0.040	0.04		A		
	Dissolved Arsenic (mg/l)	0.003	0.001	0.010	0.007	0.01		-		
	Dissolved Chromium (mg/l)	0.007	0.007	0.020	0.015	0.02		-		
	Dissolved Iron (mg/l)	7.755	0.004	12.06	4.998	2.153		A		
	Dissolved Lead (mg/l)	0.007	0.001	0.010	0.008	0.01		-		
	Dissolved Manganese (mg/l)	0.527	0.006	3.162	0.625	0.387		B		
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.004	0.005		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Steenbras-Nuweberg (Nardouw)	Sulphate (mg/l)	6.50	0.40	17.70	3.66	3.35	Na-Cl, Ca-Mg-Cl, Ca-Na-HCO3	A	B	B
	Electrical conductivity (mS/m)	10.0	2.00	24.20	10.60	9		B		
	pH	5.91	4.63	8.61	5.75	5.57		B		
	Ammonia (mg/l)	2.58	0.01	12.22	0.64	0.1		A		
	Nitrate + nitrite (mg/l)	0.20	-	3.66	0.30	0.2		A		
	Fluoride (mg/l)	0.50	0.05	0.50	0.21	0.1		-		
	Orthophosphate (mg/l)	0.20	-	0.20	0.10	0.1		-		
	Dissolved Aluminium (mg/l)	0.040	0.001	0.074	0.024	0.012		A		
	Dissolved Arsenic (mg/l)	0.010	0.001	0.040	0.006	0.003		A		
	Dissolved Chromium (mg/l)	0.020	0.001	0.020	0.010	0.007		-		
	Dissolved Iron (mg/l)	0.024	0.024	5.266	0.363	0.024		A		
	Dissolved Lead (mg/l)	0.010	0.001	0.040	0.008	0.007		A		
	Dissolved Manganese (mg/l)	0.025	0.019	0.700	0.063	0.019		A		
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.005	0.005		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'B, indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of 'B' indicating **localised, low levels of contamination, but no negative impacts apparent.**

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
58.76	9.13	0.16	B	B

Upcoming Study Programme

PROGRAMME OF UPCOMING ACTIVITIES

November 2022

- **Management:**
    1. Project Steering Committee Meeting held on 22nd November 2022
- **Tasks:**
    1. Task 3.4: BHN and EWR Determination

December 2022

- **Tasks:**
    1. Task 3.4: BHN and EWR Determination

January 2023

- **Tasks:**
    1. Task 3.4: BHN and EWR Determination

February 2023

- **Management:**
    1. Project Steering Committee Meeting (date TBC)
- **Deliverable:**
    1. D3.3 BHN and EWR Determination Report

2022										2023												2024	
Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
				Step 1: Initiate the BHN and EWR requirement assessment																			
					X	Step 2: Groundwater resource unit delineation report																		
							X	Step 3: Ecological status & reference conditions per RU report															
											X	Step 4: Determine BHN & EWR report											
														X	Step 5: Operational scenarios & socio-economic and ecological consequences report								
Step 6: Evaluate scenarios with stakeholder's report																	X						
Step 7: Monitoring programme report																			X				
Step 8: Gazette & implement reserve - groundwater reserve determination report																					X		
Database																					X		
Gazette template																					X		
General project management, capacity building and stakeholder engagement																							
PSC					X			X			X				X				X			X		

THANK YOU