The Determination Of Water Resource Classes, Reserve And Resource Quality Objectives For Secondary Catchments (A5-A9) Within The Limpopo WMA And Secondary Catchment B9 in the Olifants WMA

Project Steering Committee meeting no. 2

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Designation: Groundwater
Directorate: Delta-H

Date: 14 March 2024

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Water and Sanitation
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GROUNDWATER (EWR Report)

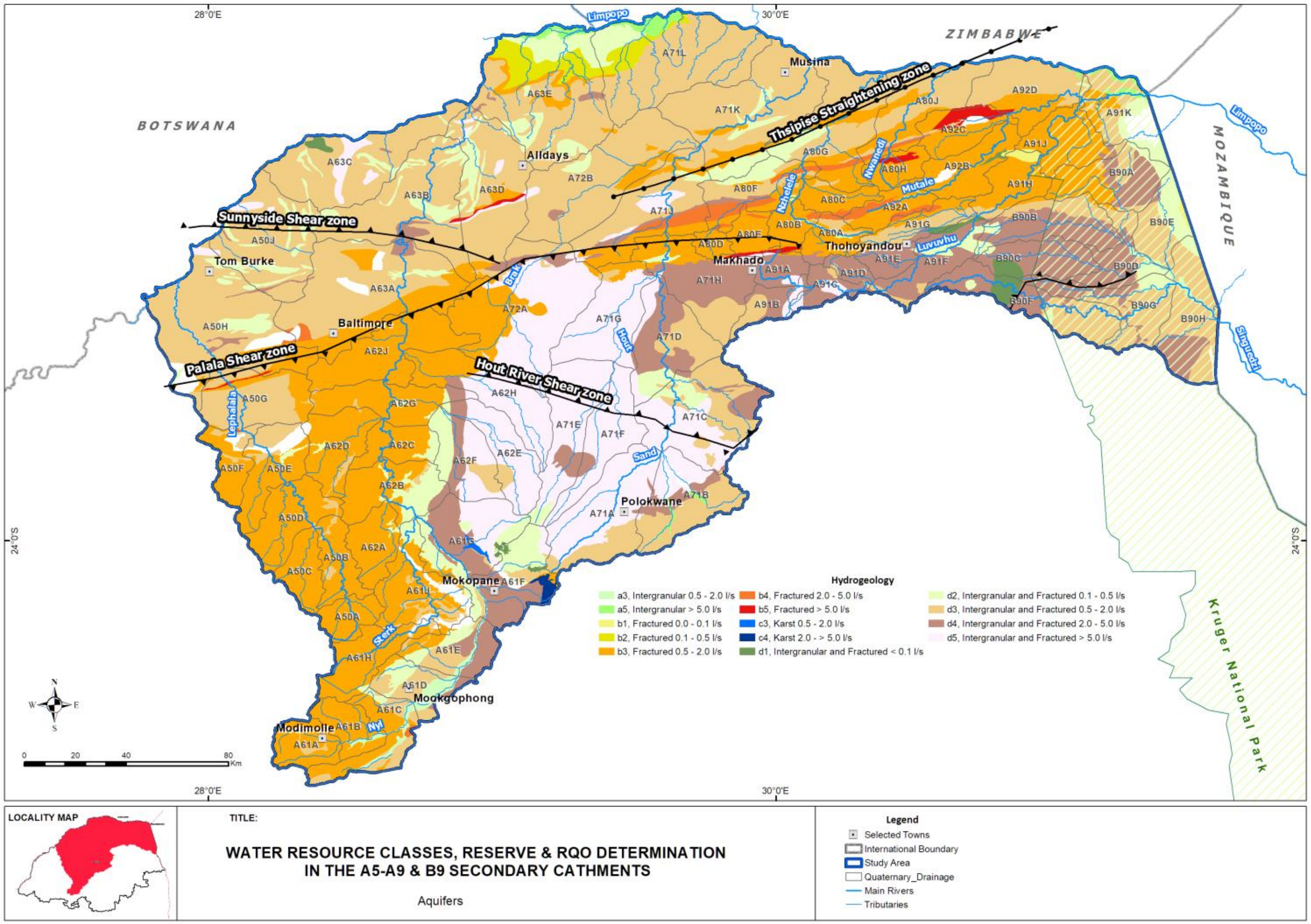
- The aim is to determine the groundwater component of the BHN and EWR Reserve

- Groundwater's contribution to the EWR (as groundwater contribution to baseflow) is presented and where sufficient data is available,
  - this determination is supported by numerical groundwater flow models, as well as the WRSM

- This study also describes the BHN requirements for the current population, who are reliant upon taking water from the groundwater resource.

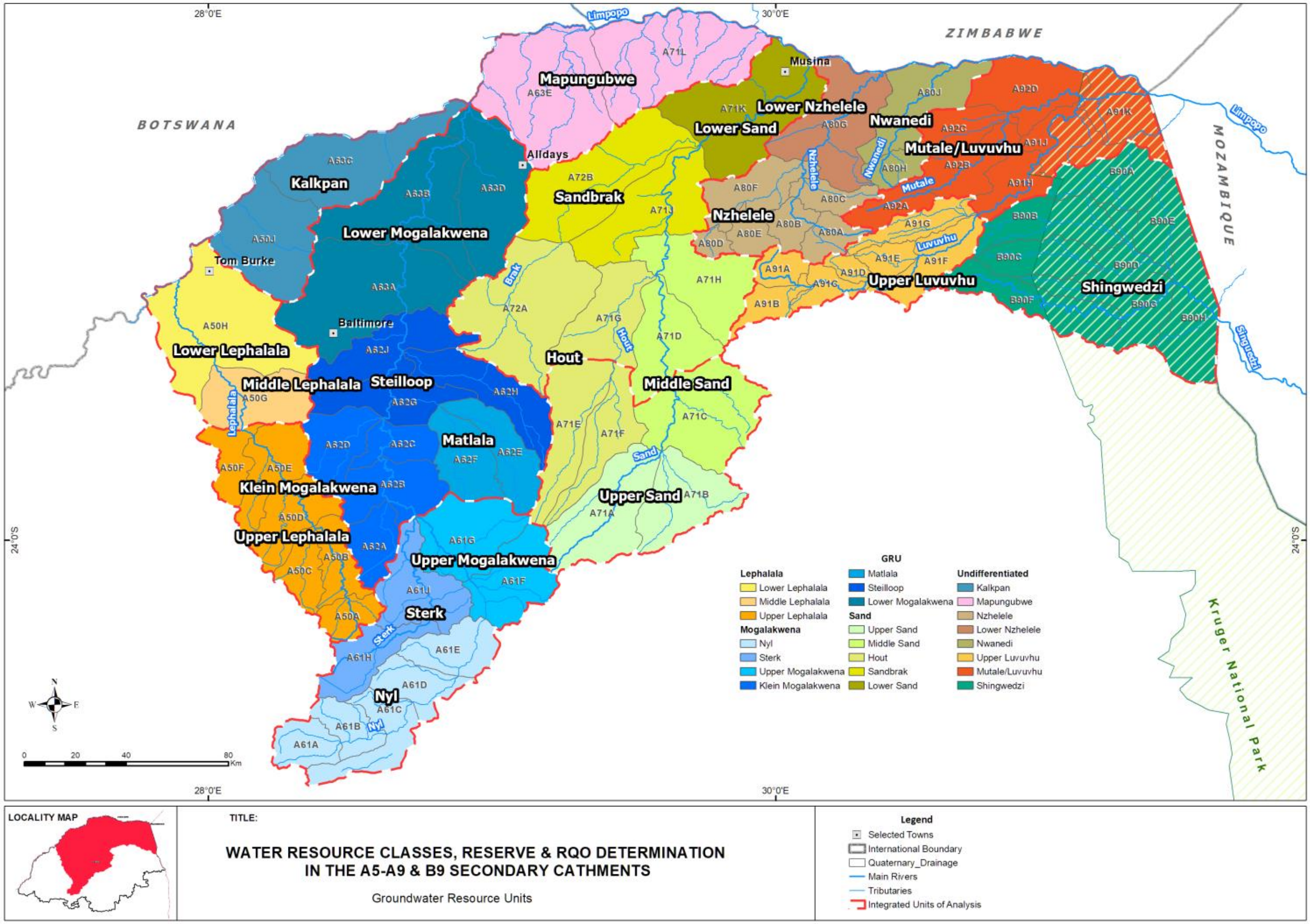
AQUIFERS

- The study area is dominated by Intergranular and fractured aquifer systems with borehole yields between 0.1 and > 5 L/s
- Unconfined Aquifers - Groundwater table mimics the surface topography at the regional scale →



Groundwater Resource Units (GRU)

- The delineated GRUs generally combine a couple of quaternary catchments so that the integration of surface water and groundwater systems can be achieved → groundwater must be considered in terms of an integrated water resource 23 GRU (comprise of 76 quaternary catchments)



GROUNDWATER (EWR) Data

- Vast literature, because groundwater is significantly used in the Limpopo WMA, there is also extensive point data for the region (i.e., information from boreholes), held in databases including:
  - the Limpopo Groundwater Resource Information Project (GRIP), the NGA, and Hydstra databases, all held at the DWS and containing borehole information such as coordinates, geology, yield, groundwater level and in some cases groundwater quality.
  - WMS containing groundwater quality information from boreholes.
  - WARMS containing a register of all licenses for groundwater abstraction.
  - The DWS long-term monitoring data were assessed and described in the Status Quo assessment regarding water levels in the catchments, and trends within that dataset

- Local municipalities and wellfields info. (from consultants)
- Site visit and selected sampling

GROUNDWATER (EWR)

Groundwater Reserve Determination

The groundwater component of the Reserve is the part of the groundwater resource that sustains basic human needs and contributes to EWR (i.e., groundwater contribution to baseflow). To be able to quantify the groundwater component of the Reserve, the volume of groundwater needed for BHN and contributing to EWR needs to be quantified.

The groundwater component of the Reserve is defined by the following relationship:

$$Reserve(\%) = \frac{EWR_{gw} + BHN_{gw}}{Re} \times 100$$

Where:

Re = recharge

BHN_{gw} = basic human needs derived from groundwater

EWR_{gw} = groundwater contribution to EWR

Groundwater should only be allocated to users and potential users once the volume of groundwater that contributes to sustaining the Reserve has been quantified and Resource Quality Objectives have been met.

Groundwater (Recharge example)

2.1.5 Lower Mogalakwena

Mean annual precipitation varies from 600 mm in the south to less than 400 mm in the north (Table 2-5). In lower lying areas the low and variable rainfall together with evaporation rates (2 000 mm) considerably exceeding rainfall result in a low expectation of natural recharge to groundwater. Recharge vary spatially from as high as 18 mm/a in the Waterberg region to less than 3 mm/a at the confluence with the Limpopo River. Groundwater recharge volumes for each of the quaternaries constituting the unit of analysis and are summarised in Table 2-5.

Table 2-5. Recharge estimation (Lower Mogalakwena).

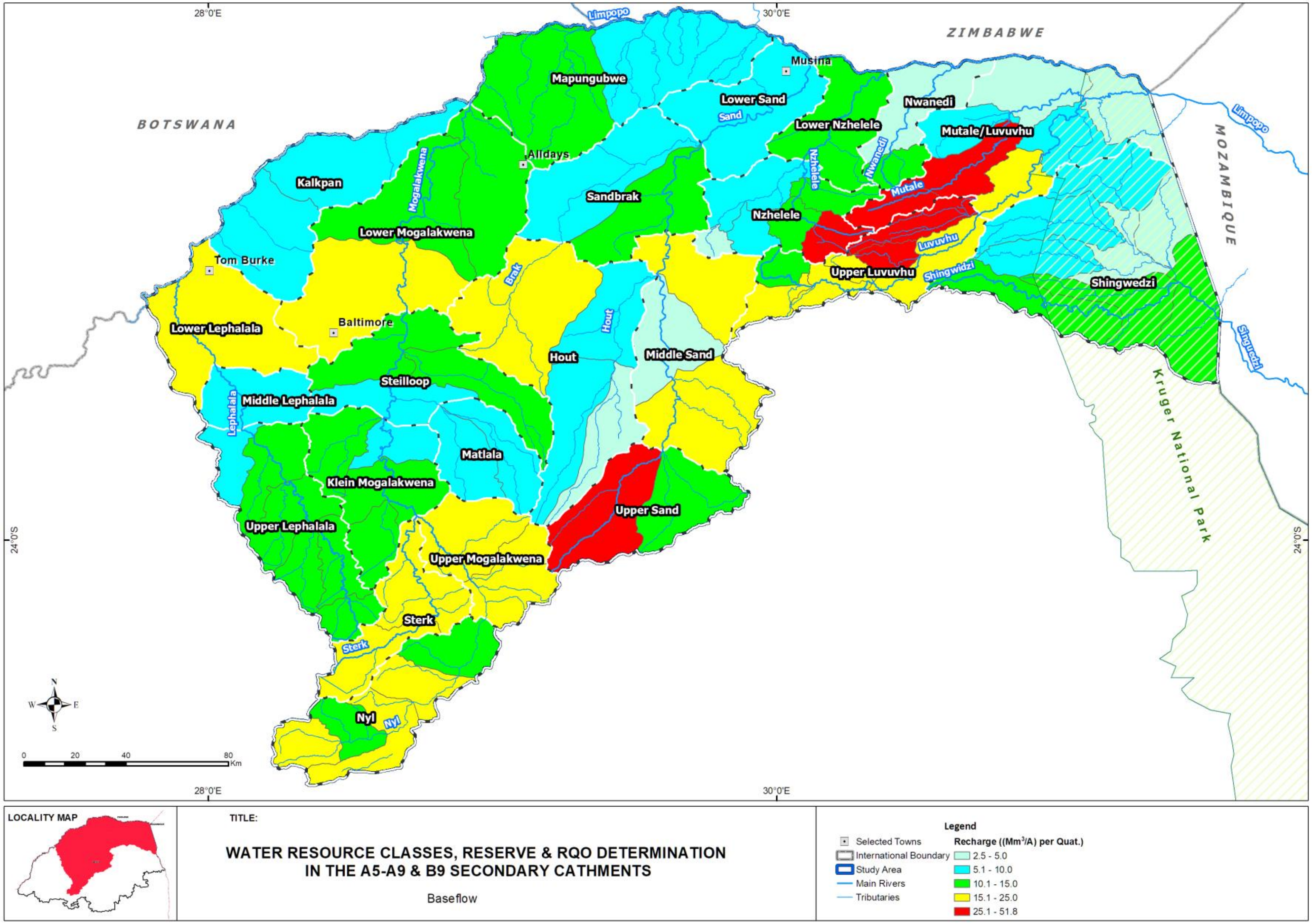
Description	GRU	Quat	MAP (mm)	Area (km²)	GRA II		Applied
					(Wet) Mm³	(Dry) Mm³	Mm³
Klein Mogalakwena	A62-1	A62A	610.2	428	11.07	7.98	12.16
		A62B	528.7	710	14.20	9.96	14.74
		A62C	478.3	385	6.53	4.50	6.71
		A62D	488.8	603	10.15	7.02	10.54
Matlala	A62-2	A62E	460.4	621	8.59	5.88	8.56
		A62F	478.1	620	9.18	6.33	9.06
Steilloop	A62-3	A62G	437.3	627	8.25	5.63	8.26
		A62H	439.3	871	10.94	7.45	10.78
		A62J	450.1	930	12.44	8.50	12.38
Lower Mogalakwena	A63-1	A63A	433.1	1928	18.20	12.36	17.83
		A63B	393.9	1505	11.35	7.61	11.17
		A63D	412.3	1319	13.99	9.43	13.59

- Recharge distribution is largely controlled by the precipitation distribution, which in turn is related to the topography→

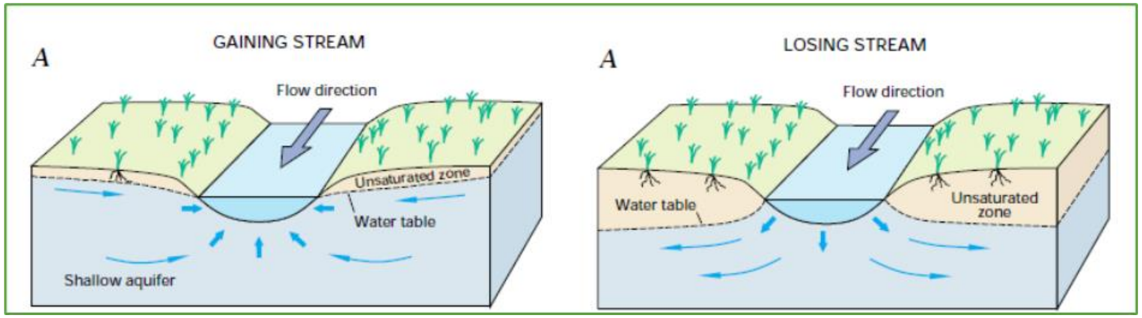
the correlation is not direct and the underlying geology, and aquifer type, influences the recharge

- Recharge rates were based on collated recharge values from previous studies, the GRA II project, Vegter's (1995) and modelled priority areas

Groundwater (Maps – RE)



Groundwater (Baseflow)



Groundwater contributing to baseflow to be sustainable include:

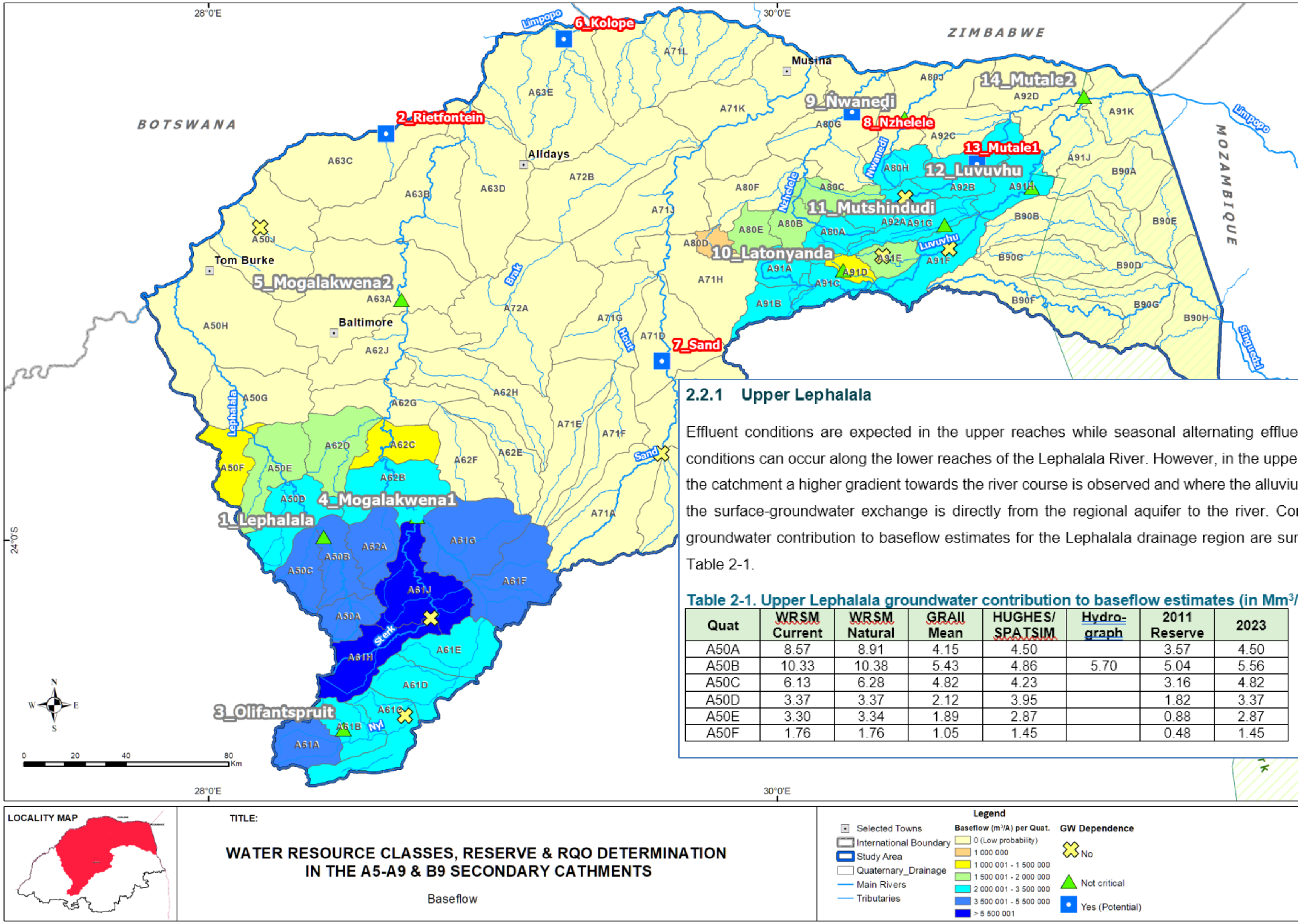
a) the draining aquifer must be recharged seasonally with adequate amounts of water;

b) the water table must be shallow enough to be intersected by the stream; and

c) the aquifer's size and hydraulic properties must be sufficient to maintain flows throughout the dry season.

- The study area comprises a nearly 50% split between perennial and ephemeral rivers
- Overall low baseflow potential
- The distribution of groundwater contribution to baseflow closely correlates with the distribution of recharge.
- Limited EWR sites with a degree of groundwater dependence

Groundwater (Maps – GW to BF)



2.2.1 Upper Lephalala

Effluent conditions are expected in the upper reaches while seasonal alternating effluent / influent conditions can occur along the lower reaches of the Lephalala River. However, in the upper reaches of the catchment a higher gradient towards the river course is observed and where the alluvium is lacking the surface-groundwater exchange is directly from the regional aquifer to the river. Comparison of groundwater contribution to baseflow estimates for the Lephalala drainage region are summarised in Table 2-1.

Table 2-1. Upper Lephalala groundwater contribution to baseflow estimates (in Mm³/a).

Quat	WRSM Current	WRSM Natural	GRAII Mean	HUGHES/ SPATSIM	Hydro-graph	2011 Reserve	2023
A50A	8.57	8.91	4.15	4.50		3.57	4.50
A50B	10.33	10.38	5.43	4.86	5.70	5.04	5.56
A50C	6.13	6.28	4.82	4.23		3.16	4.82
A50D	3.37	3.37	2.12	3.95		1.82	3.37
A50E	3.30	3.34	1.89	2.87		0.88	2.87
A50F	1.76	1.76	1.05	1.45		0.48	1.45

Groundwater (BHN Reserve)

- BHNR → 25 litres per person per day, higher allocations can be motivated
  - This was then converted into an annual volume (m^3/year).
  - In 2022, → 851 000 households (~3 063 515 people) living in the 76 quaternary catchments. Of these, just over 131 000 households were dependent on the BHNR with 11.1% reliant on groundwater resources.

Groundwater (Use)

- Groundwater quantity ranking approach was applied using the stress index (SI) principle.
  - The stress index provides a measure of the groundwater balance in a groundwater unit, indicating the fraction of how much of the groundwater recharge [volume] is used, i.e.

(i) the amount required for BHN,

(ii) (ii) the volume of groundwater supporting the base flow (i.e. the baseflow requirement of the quaternary catchment), and

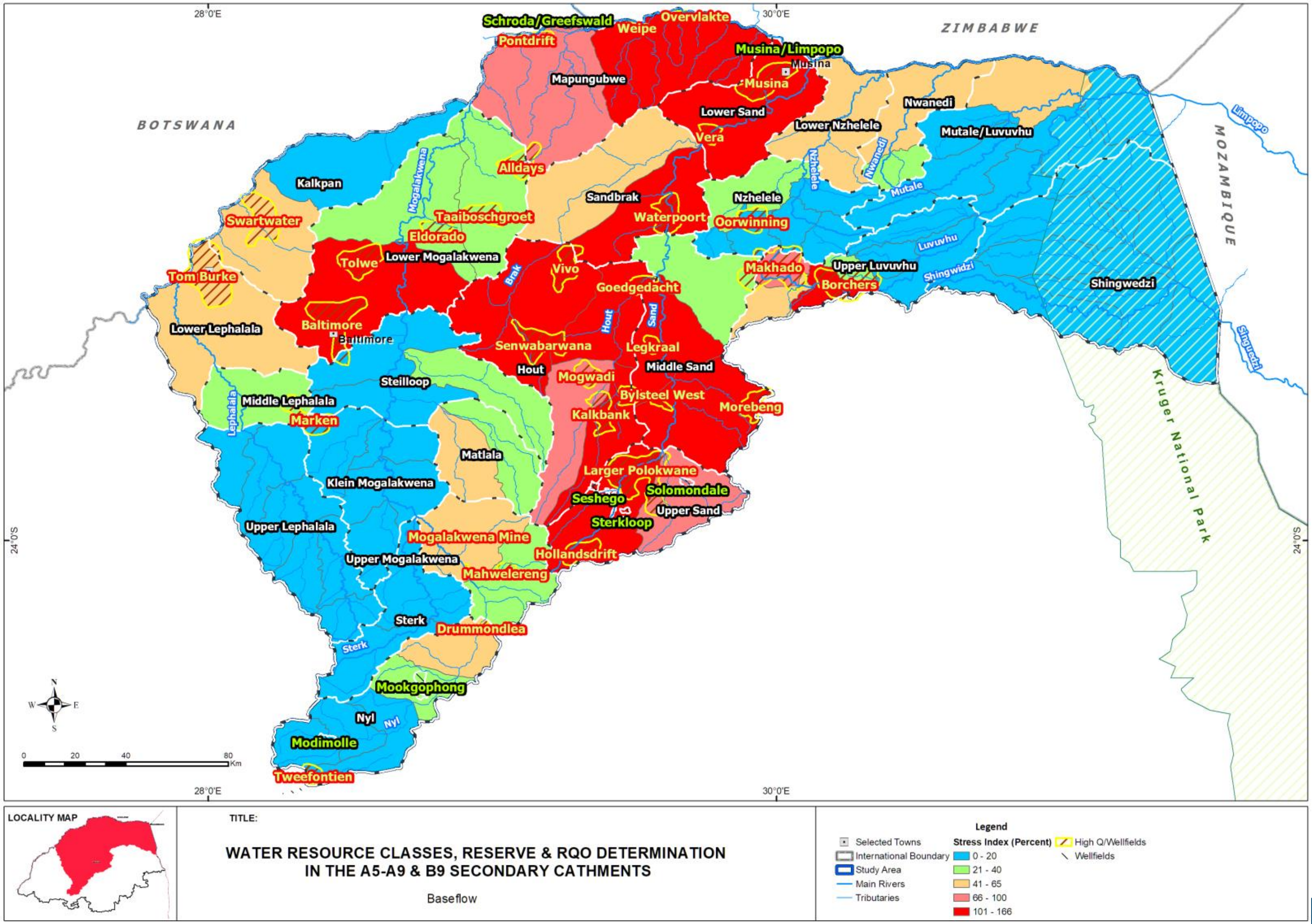
(iii) (iii) the actual groundwater use /abstraction.

The "safe" cut-off is 0.65 or 65% of the groundwater recharge.

Index	Description
< 0.20 (20 %)	Low
0.20 (20 %) - 0.40 (40 %)	Moderate
0.40 (40 %) - 0.65 (65%)	Moderate to High
0.65 (65 %) - 0.95 (95%) High	High
> 0.95 (95 %)	Critical

Groundwater (Maps – Stress Index)

- GRIP data was filtered to include the listed production boreholes equipped and tested above 0.3 L/s with a recommended duty cycle of 24 hrs (and converted to m^3/year).
- WARMS dataset (provided in m^3/year) was filtered to include active registrations.
- Local town groundwater abstraction data (i.e., Musina and Polokwane)

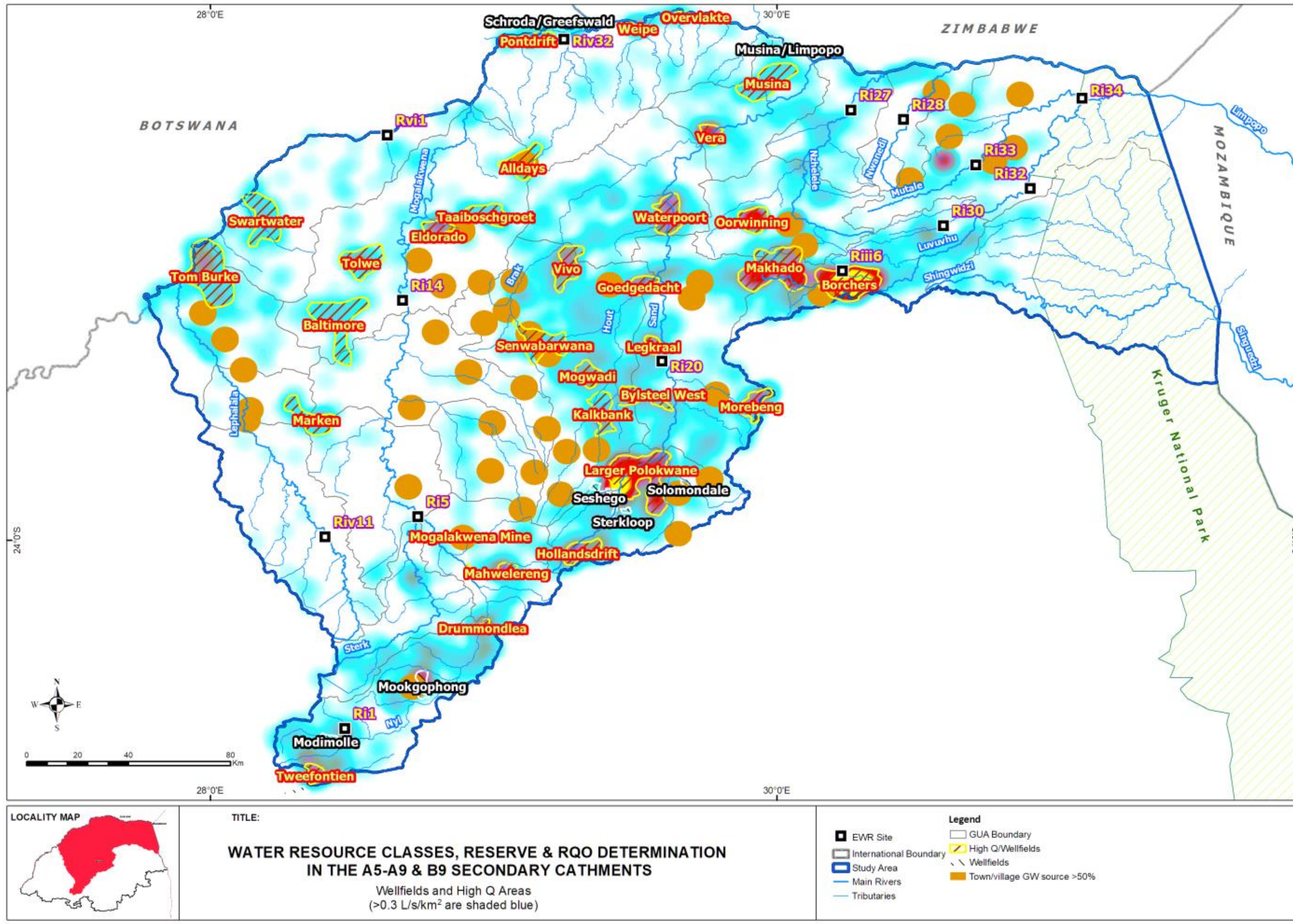


Groundwater (High abstraction zones and wellfields)

- Venetia Mine wellfields Greefswald and Schroda (1990), that lies at the confluence of the Limpopo and Shashe River, located within the Mapungubwe National Park. The management (i.e., abstraction) of the wellfields are driven by the Mine.

- Polokwane 6.6 m3/year Groundwater(WWTW/AR Scheme) provides a large component of the bulk water supply to Polokwane, surface water resource remains the main water supply

- Musina Reservoir/Wells Water requirements expected to increase from 10 Mm3/a to 21.5 Mm3/a Current yield (< 90 % level of assurance)



Groundwater (Allocable)

Balance (groundwater) referred to in the tables below reflect:

Recharge – EWR and BHN (i.e., Total) – Groundwater Use

- Allocable (groundwater) indicates the component of the annual recharge that is still available after BHN, baseflow (EWR) and use is subtracted from recharge.
- 11 Quaternary Catchments (A63A; A71L; A71A; A71C; A71D; A71F; A71G; A72A; A71J; A71K; A91C) (>100%) → **No Allocable GW**
- 4 Quaternary Catchments (A63E; A71B; A71E; A91A) (>65%) → **High/Critical Stressed**

Groundwater (Allocable)

Description	GRU	Quat	Area	MAP	Recharge	Population	BHN	GW Cont. BF	Total Reserve	GW Use	Balance	Allocable	Stress Index/factor
Unit			(km^2)	mm	Mm^3/a	GW Based	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	
Upper Lephalala	A50-1	A50A	298	654	12.95	486	0.004	4.50	4.50	0.15	8.29	5.29	1%
		A50B	406	599	13.52	501	0.005	5.56	5.57	0.18	7.77	4.95	1%
		A50C	362	593	11.00	504	0.005	4.82	4.82	0.28	5.90	3.68	3%
		A50D	637	558	13.95	554	0.005	3.37	3.38	0.29	10.28	6.47	2%
		A50E	629	517	11.71	522	0.005	2.87	2.87	0.24	8.60	5.41	2%
		A50F	372	496	6.14	321	0.003	1.45	1.45	0.14	4.56	2.86	2%
Middle Lephalala	A50-2	A50G	821	435	9.20	3645	0.033	0.02	0.05	2.02	7.12	3.07	22%
Lower Lephalala	A50-3	A50H	1945	407	15.11	6208	0.057	0.03	0.09	6.20	8.82	2.12	41%
Kalkpan	A50-4	A50J	1255	391	9.29	1133	0.010	0.06	0.07	4.25	4.97	0.95	46%
		A63C	1323	378	9.21	1237	0.011	0.06	0.07	1.58	7.56	3.62	17%
Nyl River Valley	A61-1	A61A	381	629	15.01*	906	0.008	4.87	4.88	2.04	8.09	4.16	14%
		A61B	362	629	13.70*	634	0.006	5.08	5.08	0.61	8.01	4.85	4%
		A61C	587	633	18.00*	1081	0.010	4.81	4.82	3.26	9.93	4.65	18%
		A61D	456	630	15.23*	978	0.009	5.01	5.02	4.66	5.55	1.91	31%
		A61E	547	625	14.72*	779	0.007	4.08	4.09	9.32	1.32	0.02	63%
Sterk	A61-2	A61H	585	636	19.99	905	0.008	5.73	5.74	2.79	11.46	5.85	14%
		A61J	818	631	24.28	1197	0.011	9.20	9.21	1.72	13.35	7.73	7%
Upper Mogalakwena	A61-3	A61F	789	597	22.30*	16675	0.152	4.76	4.91	5.99	11.41	4.35	27%
	A61-3	A61G	927	585	19.31	14651	0.134	4.24	4.37	10.67	4.27	0.42	55%
Klein Mogalakwena	A62-1	A62A	428	610	12.16	1727	0.016	4.55	4.56	0.70	6.90	4.09	6%
		A62B	710	529	14.74	6544	0.060	2.89	2.95	0.98	10.81	6.31	7%
		A62C	385	478	6.71	937	0.009	1.10	1.11	0.26	5.34	3.27	4%
		A62D	603	489	10.54	1044	0.010	1.22	1.23	1.20	8.11	4.35	11%
Matlala	A62-2	A62E	621	460	8.56	6366	0.058	0.24	0.30	3.18	5.08	1.42	37%
		A62F	620	478	9.06	6224	0.057	0.09	0.15	5.22	3.69	0.27	58%
Steilloop	A62-3	A62G	627	437	8.26	2344	0.021	0.12	0.14	0.79	7.32	4.06	10%
		A62H	871	439	10.78	6527	0.060	0.15	0.21	3.07	7.51	2.75	28%
		A62J	930	450	12.38	3427	0.031	0.13	0.16	0.79	11.43	6.70	6%
Lower Mogalakwena	A63-1	A63A	1928	433	17.83	7557	0.069	0.01	0.08	18.72	-0.97	0.00	105%
		A63B	1505	394	11.17	6611	0.060	0.01	0.07	2.81	8.29	3.30	25%
		A63D	1319	412	13.59	4816	0.044	0.00	0.04	4.68	8.87	2.71	34%
Limpopo Tributaries	A63/ 71-3	A63E	1992	358	13.67	3103	0.028	0.06	0.09	12.18	1.40	0.00	89%
		A71L	1765	288	9.62	2673	0.024	0.04	0.06	11.35	-1.79	0.00	118%
Upper Sand	A71-1	A71A	1144	468	40.16*	23585	0.215	0.20	0.42	43.88	-4.14	0.00	109%
		A71B	882	450	14.38*	10147	0.093	0.12	0.21	10.36	3.81	0.00	72%
Middle Sand	A71-2	A71C	1331	418	19.69*	18235	0.166	0.09	0.26	28.39	-8.95	0.00	144%
		A71D	892	390	4.64	2620	0.024	0.12	0.14	6.51	-2.01	0.00	140%
		A71H	1012	491	16.97	16244	0.148	0.16	0.31	4.83	11.83	4.32	28%
Hout	A71-3	A71E	893	421	8.66	4895	0.045	0.32	0.37	7.87	0.42	0.00	91%

Groundwater (Allocable)

Description	GRU	Quat	Area	MAP	Recharge	Population	BHN	GW Cont. BF	Total Reserve	GW Use	Balance	Allocable	Stress Index/factor
Unit			(km^2)	mm	Mm^3/a	GW Based	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	
		A71F	683	400	4.38	16147	0.147	0.31	0.45	7.30	-3.37	0.00	166%
		A71G	875	427	9.23▪	4531	0.041	0.06	0.10	13.84	-4.71	0.00	150%
		A72A	1908	465	21.69▪	17744	0.162	0.07	0.23	23.63	-2.18	0.00	109%
Sandbrak	A71-4	A71J	1162	396	11.88	2972	0.027	0.40	0.42	16.49	-5.03	0.00	139%
		A72B	1554	344	8.81	3167	0.029	0.28	0.31	5.47	3.03	0.09	62%
	A71-5	A71K	1668	305	9.44	2787	0.025	0.20	0.22	13.97	-4.76	0.00	148%
Upper Nzhelele	A80-1	A80A	287	938	26.68	4627	0.042	7.64	7.68	1.64	17.35	10.21	6%
		A80B	251	659	11.87	4802	0.044	4.40	4.45	1.84	5.58	2.76	16%
		A80C	294	576	10.95	3413	0.031	2.90	2.94	1.84	6.17	2.97	17%
		A80D	128	622	4.70	336	0.003	1.49	1.50	0.06	3.14	2.00	1%
		A80E	247	622	9.91	4980	0.045	2.46	2.51	1.29	6.11	3.18	13%
		A80F	630	388	7.77	1669	0.015	0.34	0.36	3.08	4.33	1.10	40%
Lower Nzhelele	A80-2	A80G	1230	333	10.44	3439	0.031	0.12	0.15	5.72	4.58	0.47	55%
Nwanedi	A80-3	A80H	266	621	10.41	2272	0.021	2.16	2.18	2.28	5.95	2.56	22%
		A80J	870	292	4.10	7073	0.065	0.58	0.65	2.07	1.38	0.20	51%
Upper Luvuvhu	A91-1	A91A	232	696	10.04	748	0.007	3.41	3.42	9.16	-2.53	0.00	91%
		A91B	275	620	17.96▪	4043	0.037	3.14	3.17	8.22	6.56	1.26	46%
		A91C	250	866	22.59▪	5985	0.055	5.34	5.39	29.21	-12.01	0.00	129%
		A91D	132	1287	22.99	2476	0.023	4.71	4.73	6.96	11.29	3.92	30%
		A91E	223	1078	28.17	6259	0.057	7.97	8.03	0.80	19.34	12.02	3%
		A91F	580	662	19.80▪	9016	0.082	6.63	6.71	1.44	11.64	6.72	7%
		A91G	406	950	51.83	11144	0.102	10.21	10.31	0.86	40.66	25.76	2%
Mutale/Luvuvhu	A91-2	A91H	450	722	17.17	4030	0.037	1.58	1.62	1.21	14.34	8.31	7%
		A91J	570	450	7.02	151	0.001	0.81	0.81	0.21	5.99	3.72	3%
		A91K	669	373	3.66	92	0.001	1.50	1.50	0.00	2.16	1.40	0%
		A92A	329	997	51.34	7505	0.068	1.76	1.83	0.50	49.01	31.38	1%
		A92B	565	711	28.07	1973	0.018	3.55	3.57	0.64	23.86	14.97	2%
		A92C	455	423	5.94	1399	0.013	0.15	0.16	1.07	4.70	2.21	18%
		A92D	805	301	2.46	4237	0.039	0.24	0.28	1.29	0.90	0.11	52%
Shingwedzi	B90-1	B90A	693	465	7.06	93	0.001	0.03	0.03	0.04	6.99	4.51	1%
		B90B	754	470	8.56	1966	0.018	0.09	0.10	0.69	7.77	4.43	8%
		B90C	535	498	6.32	2897	0.026	0.08	0.11	0.79	5.41	2.84	13%
		B90D	447	471	4.60	10	0.000	0.05	0.05	0.00	4.55	2.96	0%
		B90E	474	466	4.48	10	0.000	0.02	0.02	0.00	4.45	2.90	0%
		B90F	819	539	11.28	8561	0.078	0.11	0.19	0.75	10.34	6.03	7%
		B90G	698	535	12.46	292	0.003	0.07	0.07	0.07	12.32	7.94	1%
		B90H	890	538	14.93	92	0.001	0.13	0.13	0.00	14.80	9.62	0%

Note 1: Quaternary catchments with no allocable groundwater are highlighted.

Note 2: Quaternary catchments with high to critical (>65 %) groundwater use indexes are highlighted. Further allocation should consider current stressed status.

Groundwater (Quality)

- The groundwater Reserve does not address groundwater quality issues directly, these will be addressed as part of the Water Resource Classification and RQOs in the study area

- Approximately 2100 groundwater quality samples were collated from the available databases (e.g., GRIP and WMS).

- Major elements (pH, EC, Ca, Mg, Na, K, SO4 Cl, NO3 as N and F) were compared to the water quality guidelines for acceptable drinking water specified by the Department of Water and Sanitation

- The most noticeable elements of concern for water consumption are nitrate (measured as nitrogen (N), with some exceedances observed for fluoride, and sodium.
  - BHN quality is regarded as the Upper limit of Class I water quality.

Groundwater (Quality)

Description	GRU	Quat	pH	N	EC (mS/m)	N	Calcium	N	Magnesium	N	Sodium	N	Potassium	N	Chloride	N	Sulphate	N	Nitrate as N	N	Fluoride	N
Class 0			6-9		0-70		0-80		0-30		0-100		0-25		0-200		0-100		0-6		0-0.7	
Class I			5-6 or 9-9.5		70-150		80-150		30-70		100-200		25-50		200-400		100-200		6-10		0.7-1	
Class II			4-5 or 9.5-10		150-370		150-300		70-100		200-400		50-100		400-600		200-600		10-20		1-1.5	
Class III			<4 or >10		>370		>300		>100		>400		>100		>600		>600		>20		>1.5	
Upper Lephalala	A50-1	A50A	6.9	1	310.0	1	29.0	1	12.9	1	31.0	1	0.7	1	9.2	1	4.9	1	0.00	0	0.32	1
		A50B	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00	0	0.00	0
		A50C	7.8	2	34.2	2	25.6	2	15.2	2	18.0	2	0.8	2	20.9	2	5.0	2	0.00	0	0.12	2
		A50D	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00	0	0.00	0
		A50E	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00	0	0.00	0
		A50F	7.8	3	174.0	3	95.1	3	53.9	3	173.0	3	6.5	3	324.2	3	27.4	3	0.57	1	3.06	3
Middle Lephalala	A50-2	A50G	8.1	67	127.0	67	72.0	67	48.7	67	137.8	67	2.9	67	157.8	67	39.4	67	115.06	11	1.21	67
Lower Lephalala	A50-3	A50H	8.1	48	126.1	48	69.9	48	58.6	48	106.9	48	9.0	48	110.4	48	30.5	48	48.91	13	0.96	48
Kalkpan	A50-4	A50J	8.1	3	142.3	3	56.8	3	69.1	3	86.6	3	14.0	3	186.1	3	73.8	3	81.40	1	0.70	3
		A63C	7.8	8	234.8	8	129.3	8	0.9	8	365.1	8	7.9	8	437.3	8	497.9	8	0.10	4	5.25	8
Nyl River Valley	A61-1	A61A	7.6	5	43.0	5	39.1	5	15.9	5	17.1	5	1.2	5	10.7	5	11.5	5	0.31	3	0.10	5
		A61B	8.7	3	30.0	3	19.8	3	3.3	3	18.4	3	1.0	3	15.7	3	9.0	3	3.20	1	0.17	3
		A61C	7.8	3	9.6	3	4.9	3	2.3	3	2.8	3	0.5	3	5.7	3	4.0	3	0.00	0	0.18	3
		A61D	7.8	11	57.2	11	41.8	11	22.5	11	37.7	11	1.8	11	30.2	11	12.0	11	0.94	9	0.50	11
		A61E	8.4	2	36.5	2	29.6	2	1.9	2	39.8	2	0.6	2	12.2	2	4.8	2	0.00	0	4.18	2
Sterk	A61-2	A61H	8.3	2	83.2	2	49.0	2	29.1	2	63.8	2	3.0	2	151.8	2	23.0	2	0.00	0	7.50	2
		A61J	8.2	5	58.0	5	51.8	5	19.0	5	24.2	5	1.2	5	21.3	5	12.1	5	0.00	0	0.39	5
Upper Mogalakwena	A61-3	A61F	8.1	63	101.0	63	59.5	63	74.2	63	43.7	63	1.4	63	49.9	63	20.6	63	72.20	9	0.28	62
	A61-3	A61G	8.2	76	117.5	75	61.2	75	67.9	74	89.1	74	3.0	75	94.1	75	38.8	74	103.73	3	0.44	76
Klein Mogalakwena	A62-1	A62A	8.2	23	56.2	23	46.8	23	14.7	23	39.2	23	1.2	23	28.4	23	6.7	23	0.00	0	0.35	23
		A62B	8.1	77	116.5	77	77.5	77	39.3	77	90.4	77	1.8	77	138.0	77	12.4	77	12.66	6	0.79	77
		A62C	8.1	25	101.0	25	68.1	25	47.3	25	102.2	25	2.1	25	125.3	25	14.3	25	34.35	4	0.45	25
		A62D	7.8	27	144.5	28	99.4	28	68.5	28	99.6	28	4.7	28	198.3	28	15.4	28	95.85	11	0.37	28
Matlala	A62-2	A62E	8.1	96	109.8	96	46.2	96	33.0	96	117.8	96	8.3	96	120.5	96	25.5	96	59.88	9	0.52	96
		A62F	8.1	59	206.0	59	88.4	59	56.3	59	207.1	59	9.6	59	359.1	59	27.2	59	10.06	2	1.15	59
Steilloop	A62-3	A62G	8.1	34	153.0	34	94.5	34	70.4	34	119.3	34	3.9	34	236.4	34	14.9	34	83.42	12	0.51	34
		A62H	8.2	101	109.0	101	52.2	101	35.1	101	126.7	101	11.8	101	144.5	101	23.9	101	0.30	5	0.34	101
		A62J	7.8	36	280.0	36	92.1	36	98.6	36	258.8	36	7.0	36	642.0	36	46.9	36	28.31	5	0.25	36
Lower Mogalakwena	A63-1	A63A	8.0	78	157.9	78	69.9	78	63.8	78	102.5	78	2.7	78	205.5	78	33.3	78	74.14	10	0.39	78
		A63B	8.1	30	119.4	30	72.3	30	59.8	30	92.8	30	2.6	30	106.8	30	26.5	30	85.09	5	0.82	30
		A63D	8.2	41	96.8	41	73.6	41	58.5	41	66.8	40	2.4	41	77.4	41	17.8	41	44.46	2	0.54	41
Limpopo Tributaries	A63/ 71-3	A63E	8.1	6	185.5	6	58.2	6	79.6	6	124.5	6	3.9	6	215.5	6	41.1	6	0.10	2	0.47	6
		A71L	7.7	4	195.5	4	79.5	4	48.5	4	268.5	4	0.9	4	411.0	4	45.5	4	0.10	4	0.35	4
Upper Sand	A71-1	A71A	8.1	92	78.5	92	41.3	92	31.5	92	69.1	92	5.8	92	59.6	92	24.6	92	7.19	23	0.32	92
		A71B	8.1	119	97.2	119	41.1	119	38.6	119	96.6	119	6.7	119	87.2	119	27.6	119	35.93	15	0.56	119
Middle Sand	A71-2	A71C	8.0	115	114.8	115	51.4	115	45.1	115	130.0	115	8.6	115	102.0	115	34.9	115	81.23	10	0.43	115
		A71D	8.2	2	134.5	2	59.6	2	60.4	2	159.5	2	3.3	2	253.8	2	52.5	2	56.50	2	0.59	2

Groundwater (Quality)

Description	GRU	Quat	pH	N	EC (mS/m)	N	Calcium	N	Magnesium	N	Sodium	N	Potassium	N	Chloride	N	Sulphate	N	Nitrate as N	N	Fluoride	N
Class 0			6-9		0-70		0-80		0-30		0-100		0-25		0-200		0-100		0-6		0-0.7	
Class I			5-6 or 9-9.5		70-150		80-150		30-70		100-200		25-50		200-400		100-200		6-10		0.7-1	
Class II			4-5 or 9.5-10		150-370		150-300		70-100		200-400		50-100		400-600		200-600		10-20		1-1.5	
Class III			<4 or >10		>370		>300		>100		>400		>100		>600		>600		>20		>1.5	
		A71H	8.1	51	158.0	51	70.9	51	85.4	51	120.2	51	6.4	51	167.4	51	34.2	51	41.03	18	0.24	51
Hout	A71-3	A71E	8.1	100	90.2	100	42.9	100	26.3	100	93.4	100	9.2	100	89.9	100	23.4	100	40.99	6	0.40	100
		A71F	8.1	59	70.2	59	31.7	59	19.5	59	77.5	59	6.0	59	57.4	59	18.1	59	41.28	2	0.43	59
		A71G	8.3	22	134.5	22	63.9	22	67.6	22	117.6	22	12.8	22	190.1	22	39.0	22	20.76	4	0.28	22
		A72A	8.1	209	157.5	210	59.4	209	76.4	209	133.5	210	10.9	209	218.3	209	33.4	210	23.41	28	0.28	209
Sandbrak	A71-4	A71J	7.8	2	95.3	2	51.3	2	39.8	2	62.0	2	2.0	2	173.7	2	41.9	2	0.00	0	0.39	2
		A72B	7.7	1	110.0	1	66.1	1	45.0	1	112.0	1	2.8	1	109.0	1	25.6	1	34.70	1	0.66	1
	A71-5	A71K	7.8	7	146.0	7	102.0	7	79.8	7	80.2	7	4.5	7	183.1	7	101.6	7	18.60	2	0.74	7
Upper Nzhelele	A80-1	A80A	7.8	51	34.1	51	18.2	51	12.1	51	19.3	51	0.4	51	16.3	51	4.9	51	2.87	3	0.14	51
		A80B	7.9	33	104.9	33	67.2	33	63.2	33	63.3	33	0.8	33	65.9	33	13.4	33	57.74	3	0.32	33
		A80C	7.7	44	35.2	44	18.9	44	15.6	44	21.3	44	0.8	44	23.2	44	6.2	44	7.55	5	0.21	42
		A80D	6.9	1	8.0	1	3.1	1	5.9	1	3.5	1	0.1	1	4.9	1	0.8	1	0.30	1	0.10	1
		A80E	7.9	15	143.0	15	71.0	15	57.2	15	102.3	15	1.0	15	137.5	15	24.6	15	0.30	1	0.28	15
		A80F	8.1	3	1092.0	3	385.7	3	793.2	3	918.9	3	19.6	3	3593.1	3	965.9	3	0.00	0	0.51	3
Lower Nzhelele	A80-2	A80G	8.0	16	152.1	16	73.4	16	59.7	16	140.9	16	1.5	16	197.3	16	60.1	16	0.00	0	0.41	16
Nwanedi	A80-3	A80H	7.0	27	11.0	27	3.1	27	2.7	27	8.5	27	0.6	27	12.1	27	4.0	27	6.54	1	0.16	26
		A80J	8.0	27	117.0	27	50.1	27	52.9	27	105.6	27	5.3	27	154.0	27	24.2	27	21.54	6	0.50	27
Upper Luvuvhu	A91-1	A91A	7.3	1	25.0	1	21.7	1	11.3	1	12.7	1	1.1	1	10.1	1	1.3	1	5.09	1	0.10	1
		A91B	8.1	17	46.0	17	29.0	17	28.4	17	21.5	17	1.8	17	19.3	17	8.5	17	13.26	5	0.20	17
		A91C	8.0	33	28.2	33	18.0	33	15.0	33	11.2	33	1.7	33	14.8	33	5.4	33	20.88	7	0.19	33
		A91D	7.4	7	14.4	7	9.6	7	6.3	7	6.1	7	1.8	7	6.6	7	4.0	7	0.30	1	0.16	7
		A91E	7.8	49	28.6	49	23.6	49	14.1	49	12.5	49	0.7	49	12.6	49	5.2	49	12.42	10	0.16	49
		A91F	8.1	169	74.9	169	56.0	169	38.5	169	40.6	169	1.2	169	48.3	169	11.1	169	6.28	28	0.31	169
		A91G	7.7	66	38.5	66	35.6	66	19.0	66	15.0	66	0.4	66	15.4	66	4.5	65	10.00	18	0.15	63
Mutale/Luvuvhu	A91-2	A91H	8.0	55	42.5	55	30.9	55	20.7	55	21.2	55	0.5	55	22.6	55	5.7	55	7.52	7	0.20	55
		A91J	7.9	5	33.9	5	14.6	5	10.3	5	38.5	5	1.6	5	32.8	5	8.3	5	5.51	1	0.24	5
		A91K	8.6	2	612.3	2	36.7	2	53.7	2	90.7	2	1.1	2	100.1	2	9.9	2	0.00	0	0.65	2
		A92A	7.6	31	14.2	31	8.4	31	5.7	31	7.1	31	0.6	31	9.4	31	5.4	31	11.20	2	0.15	30
		A92B	7.6	55	22.0	55	10.2	55	7.0	55	16.2	55	0.7	55	17.5	55	4.4	55	1.16	10	0.18	54
		A92C	8.1	47	107.9	47	32.3	47	54.4	47	99.5	46	1.9	47	156.9	47	24.6	47	10.15	9	0.45	45
		A92D	8.1	67	145.0	67	46.4	67	74.6	67	164.5	67	3.6	67	185.3	67	26.6	67	62.96	6	0.61	67
Shingwedzi	B90-1	B90A	8.1	7	94.0	7	69.9	7	49.8	7	68.7	7	0.9	7	68.9	7	6.0	7	4.82	2	0.37	7
		B90B	8.0	38	97.6	38	70.1	38	47.2	38	71.3	38	1.0	38	76.0	38	10.3	38	70.03	5	0.34	38
		B90C	8.1	34	144.0	34	77.0	34	62.1	34	141.4	34	1.8	34	154.7	34	25.0	34	235.39	7	0.53	34
		B90D	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00	0	0.00	0
		B90E	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00	0	0.00	0
		B90F	8.0	82	123.4	82	64.3	82	74.4	82	103.2	82	3.0	82	119.6	82	15.8	82	56.66	22	0.38	82
		B90G	8.4	2	205.0	2	92.3	2	146.8	2	86.8	2	1.7	2	280.4	2	44.3	2	0.00	0	0.21	2
		B90H	7.9	4	489.1	4	57.4	4	61.9	4	99.1	4	1.0	4	118.2	4	10.9	4	0.00	0	0.54	4

Groundwater (Reserve Quality example)

2.2.1 A50-2

Table 2-3. Groundwater Quality Reserve - Quaternary catchment A50G.

Parameter	Unit	No. of Samples	5th Percentile	Median	95th Percentile	BHN Limit	Reserve
pH		67	7.7	8.07	8.5	5-6 & 9-9.5	7.3-8.9
EC	mS/m	67	58.3	127.0	304.4	<150	139.7
Calcium as Ca	mg/l	67	16.5	72.0	141.1	<150	79.2
Magnesium as Mg	mg/l	67	6.4	48.7	108.1	<70	64.5
Sodium as Na	mg/l	67	26.0	137.8	315.5	<200	151.5
Potassium as K	mg/l	67	0.8	2.9	10.1	<50	3.2
Chloride as Cl	mg/l	67	22.6	157.8	473.7	<200	173.5
Sulphate as SO4	mg/l	67	17.6	39.4	180.0	<400	43.4
Nitrate as N	mg/l	11	0.17	115.06	178.75	<10	115.1
Fluoride as F	mg/l	67	0.39	1.21	5.77	<1.0	1.21

2.2.2 A50-3

Table 2-4. Groundwater Quality Reserve - Quaternary catchment A50H.

Parameter	Unit	No. of Samples	5th Percentile	Median	95th Percentile	BHN Limit	Reserve
pH		48	7.5	8.1	8.3	5-6 & 9-9.5	7.4-8.9
EC	mS/m	48	60.8	126.1	310.2	<150	138.7
Calcium as Ca	mg/l	48	28.9	69.9	143.1	<150	76.9
Magnesium as Mg	mg/l	48	16.8	58.6	138.5	<70	64.5
Sodium as Na	mg/l	48	53.4	106.9	234.1	<200	117.6
Potassium as K	mg/l	48	3.1	9.0	17.7	<50	9.9
Chloride as Cl	mg/l	48	37.7	110.4	618.5	<200	121.4
Sulphate as SO4	mg/l	48	14.7	30.5	141.3	<400	33.6
Nitrate as N	mg/l	13	0.55	48.91	182.09	<10	48.9
Fluoride as F	mg/l	48	0.41	0.96	2.00	<1.0	1.0

54 out of 76 (quaternary catchments)

BHN quality is regarded as the Upper limit of Class I water quality.

The Groundwater Quality Reserve is based on the median plus 10 % (which is the approach followed by the Reserve Directorate)