Reserve determination study for selected Surface Water, Groundwater, Estuaries and Wetlands in the F60 and G30 Catchment within the Berg-Olifants Water Management Area (WP11340):

Integration Workshop September 2022

DEPARTMENT: WATER AND SANITATION

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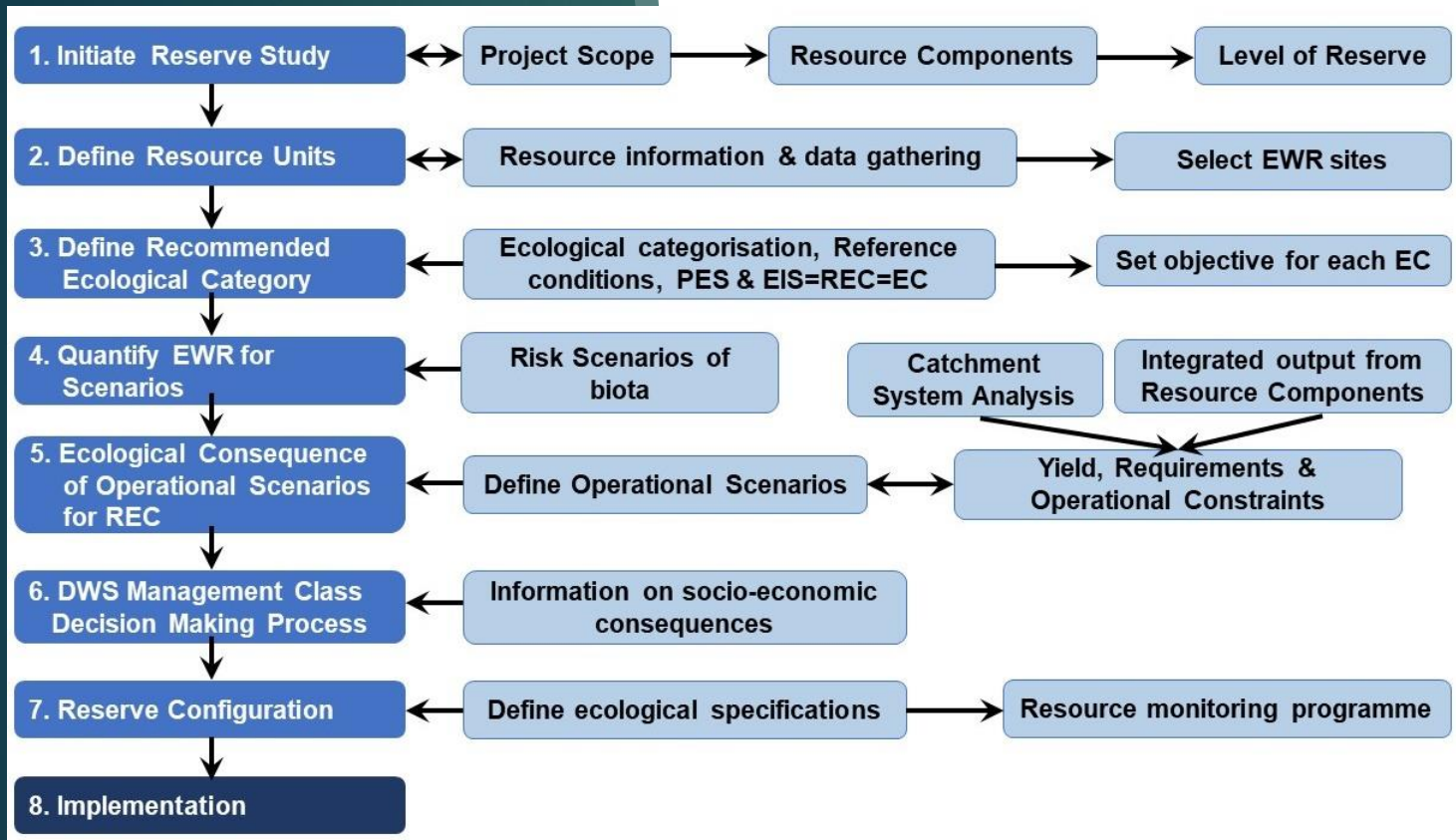
The Reserve Determination Process



water & sanitation
Department: Water and Sanitation
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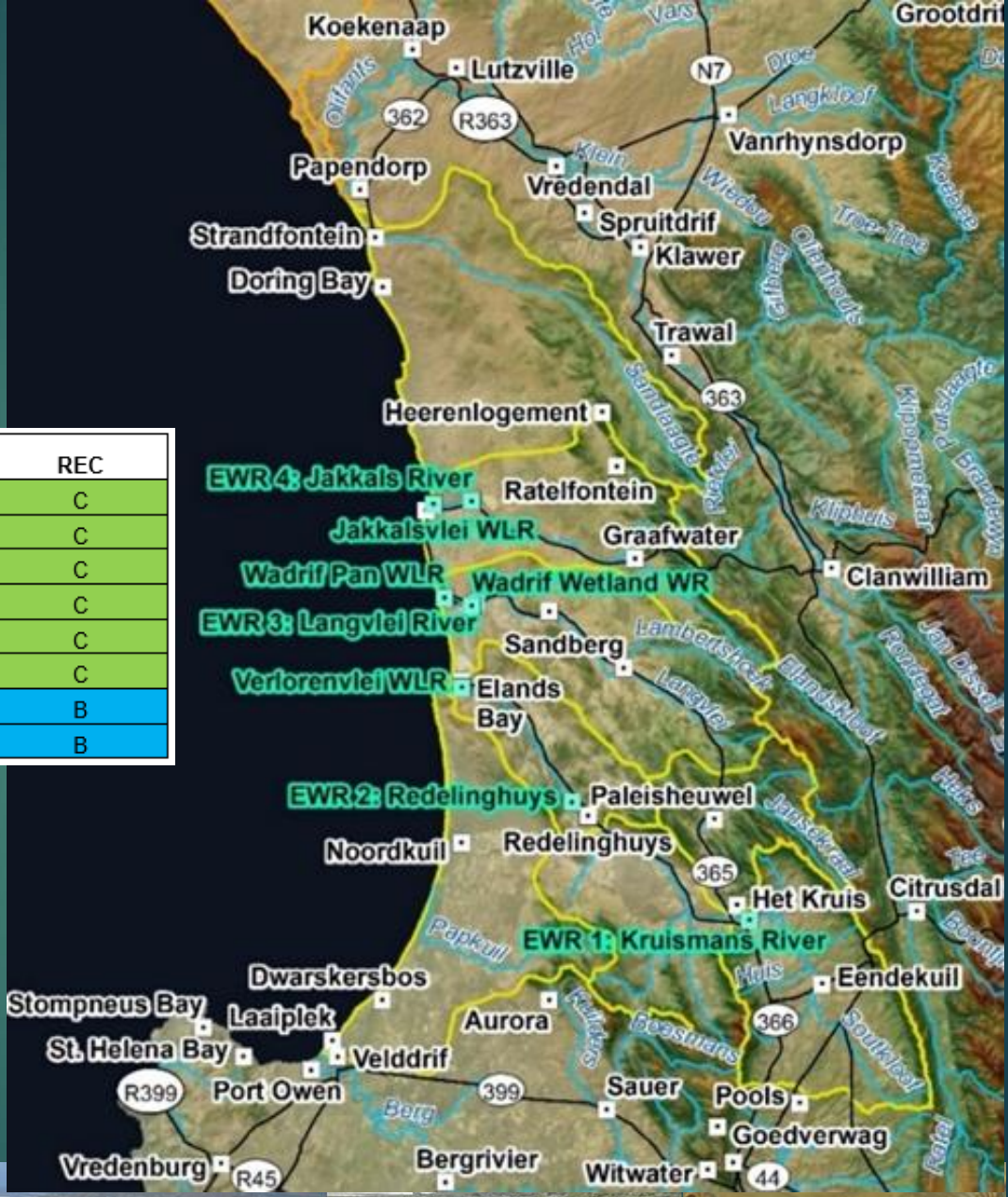
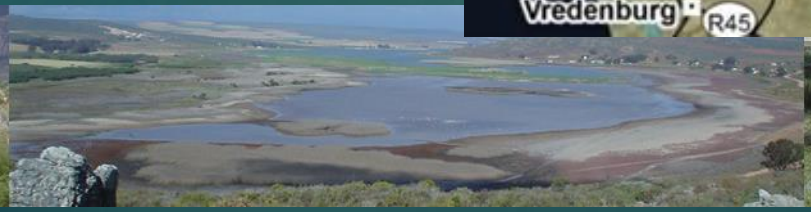
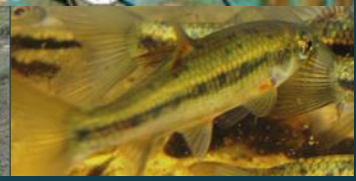
2003 Sandveld Ecological Reserve Determination

EWR Location	Quaternary	PES	EIS	REC
Langvlei River	G30F	E/F	Moderate	C
Wadrif Wetland	G30F	F	High	C
Wadrif Pan	G30F	E	Moderate	C
Jakkals River	G30G	D	Moderate	C
Jakkalsvlei/Estuary	G30G	E	Moderate	C
Verlorenvlei (Kruis)	G30D	C	High	C
Verlorenvlei (Redelinghuys)	G30E	C	High	B
Verlorenvlei Lake/Estuary	G30E	C	High	B

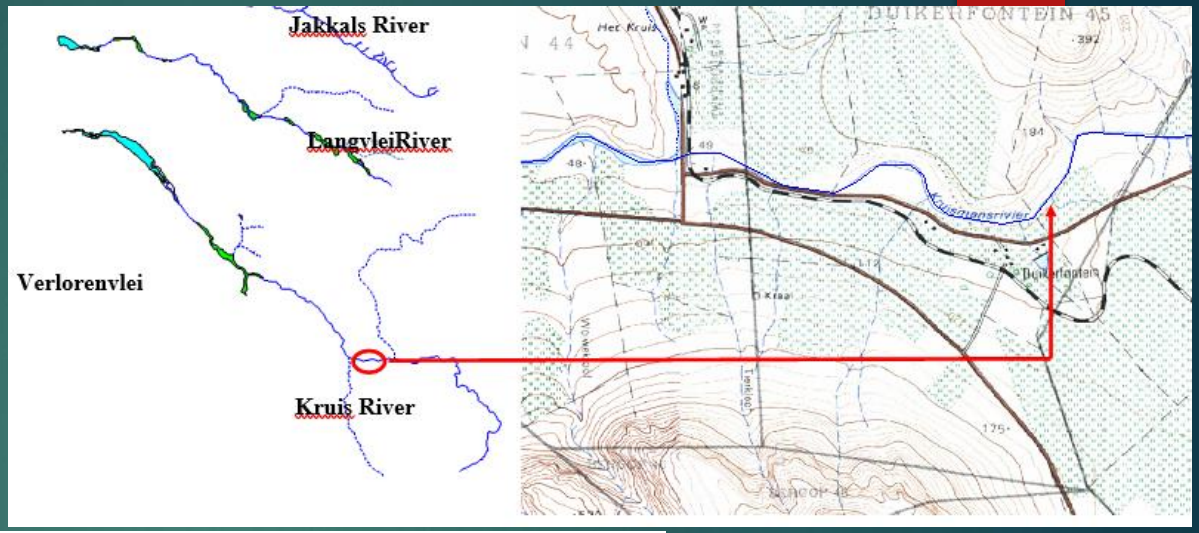


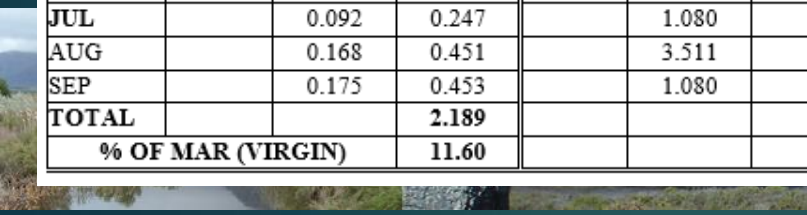


VERLORENVLEI IFR 1: KRUISMANS RIVER AT DUIKERFONTEIN (Category C)
ASSURANCE OF MAINTENANCE LOW FLOWS: 50 % (summer) and 50 % (winter)
MAR (VIRGIN): 18.869 (10^6 m^3) MAR (PRESENT): ~ 12 (10^6 m^3)

PESC	C
EISC	B
TEC	C
MAR (Virgin)	=6.817 MCM a^{-1}
Total IFR (% MAR)*	=1.957 MCM.a^{-1} (28.71%)

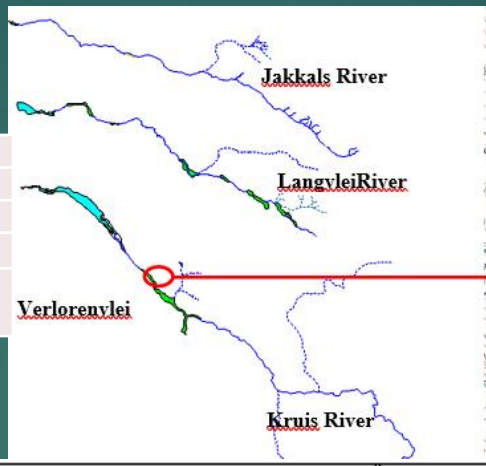


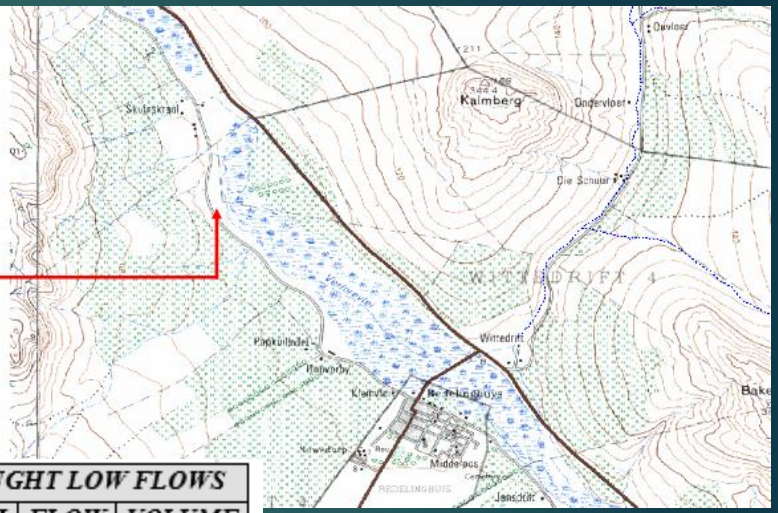
MONTHS	MAINTENANCE LOW FLOWS			HIGH FLOWS				DROUGHT LOW FLOWS		
	DEPTH (m)	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)	DEPTH (m)	FLOW $m^3 s^{-1}$ Daily average	DURATION (days)	VOLUME ($10^6 m^3$)	DEPTH (m)	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)
OCT		0.172	0.460		0.527	3	0.082		0.073	0.195
NOV		0.093	0.241						0.040	0.102
DEC		0.019	0.050						0.008	0.021
JAN		0.002	0.005						0.001	0.002
FEB		0.001	0.002						0.000	0.001
MAR		0.001	0.002						0.000	0.001
APR		0.006	0.014						0.002	0.006
MAY		0.023	0.061		0.865	3	0.135		0.010	0.026
JUN		0.078	0.202		1.956	4	0.355		0.033	0.086
JUL		0.092	0.247		1.080	4	0.196		0.039	0.105
AUG		0.168	0.451		3.511	5	0.719		0.071	0.191
SEP		0.175	0.453		1.080	4	0.196		0.074	0.192
TOTAL			**2.189**				**1.683**			**0.930**
% OF MAR (VIRGIN)			**11.60**				**8.92**			**4.93**



VERLORENVLEI IFR 2: VERLORENVLEI RIVER AT REDELINGHUYS (Category B)
ASSURANCE OF MAINTENANCE LOW FLOWS: 50 % (summer) and 50 % (winter)
MAR (VIRGIN): 40.897 (10^6 m^3) MAR (PRESENT): ~ (10^6 m^3)

PESC	C
EISC	B
TEC	B
MAR (Virgin)	18.869 MCM a^{-1}
Total IFR (% MAR)	3.872 MCM.a^{-1} (20.52%)

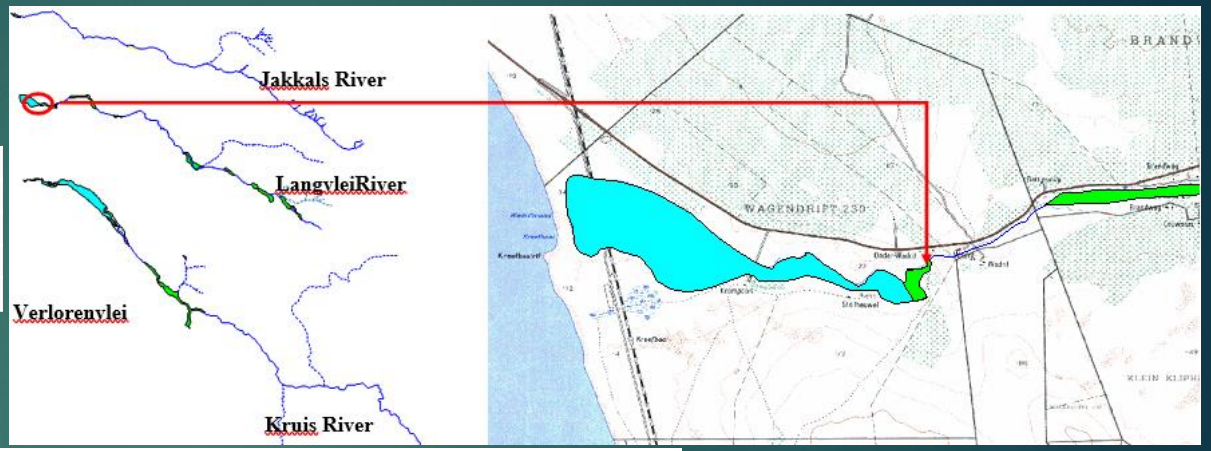




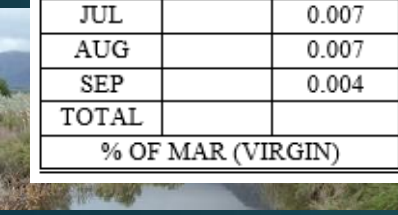
MONTHS	MAINTENANCE LOW FLOWS			HIGH FLOWS				DROUGHT LOW FLOWS		
	DEPTH	FLOW	VOLUME	DEPTH	FLOW	DURATION	VOLUME	DEPTH	FLOW	VOLUME
	(m)	(m^3 s^{-1})	(10^6 m^3)	(m)	m^3 s^{-1} Daily average	(days)	(10^6 m^3)	(m)	(m^3 s^{-1})	(10^6 m^3)
OCT		0.281	0.754		1.831	4	0.332		0.039	0.104
NOV		0.147	0.381						0.020	0.052
DEC		0.026	0.070						0.004	0.010
JAN		0.001	0.003						0.000	0.000
FEB		0.000	0.000						0.000	0.000
MAR		0.001	0.002						0.000	0.000
APR		0.012	0.032						0.002	0.004
MAY		0.057	0.152		4.000	5	0.819		0.008	0.021
JUN		0.190	0.493		9.000	6	2.061		0.026	0.068
JUL		0.228	0.610		4.872	5	0.998		0.031	0.084
AUG		0.424	1.136		14.000	7	3.532		0.058	0.156
SEP		0.348	0.903		4.872	5	0.998		0.048	0.124
TOTAL			4.537				8.739			0.623
% OF MAR (VIRGIN)			11.09				21.37			1.52

LANGVLEI IFR 1: LANGVLEI RIVER AT WADRIF (Category C)
ASSURANCE OF MAINTENANCE LOW FLOWS: 50 % (summer) and 50 % (winter)
MAR (VIRGIN): 1.740 (10^6 m^3) MAR (PRESENT): ~ (10^6 m^3)

PESC	F
EISC	C
TEC	C
MAR (Virgin)	=6.817 MCM a^{-1}
Total IFR (% MAR)*	=1.957 MCM.a^{-1} (28.71%)

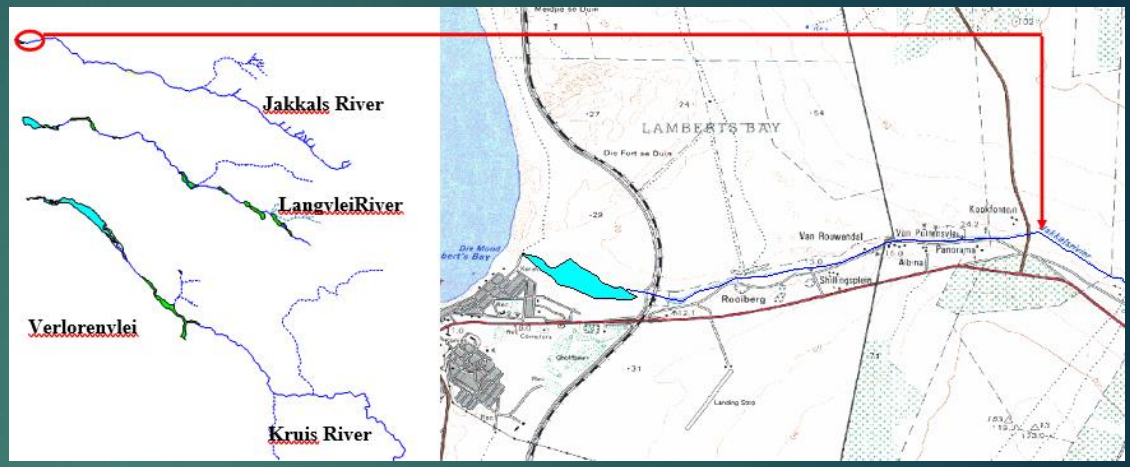


MONTHS	MAINTENANCE LOW FLOWS			HIGH FLOWS				DROUGHT LOW FLOWS		
	DEPTH	FLOW	VOLUME	DEPTH	FLOW	DURATION	VOLUME	DEPTH	FLOW	VOLUME
	(m)	(m^3 s^{-1})	(10^6 m^3)	(m)	m^3 s^{-1} Daily average	(days)	(10^6 m^3)	(m)	(m^3 s^{-1})	(10^6 m^3)
OCT		0.001	0.002		0.034	2	0.004		0.000	0.000
NOV		0.001	0.002						0.000	0.000
DEC		0.000	0.001						0.000	0.000
JAN		0.000	0.000						0.000	0.000
FEB		0.000	0.000						0.000	0.000
MAR		0.000	0.000						0.000	0.000
APR		0.000	0.001						0.000	0.000
MAY		0.002	0.005		1.000	3	0.156		0.000	0.000
JUN		0.012	0.030		4.000	4	0.726		0.000	0.000
JUL		0.007	0.020		2.500	3	0.389		0.000	0.000
AUG		0.007	0.018		0.450	2	0.054		0.000	0.000
SEP		0.004	0.009		0.900	2	0.109		0.000	0.000
TOTAL			0.089				1.437			0.000
% OF MAR (VIRGIN)			5.09				21.09			0.00

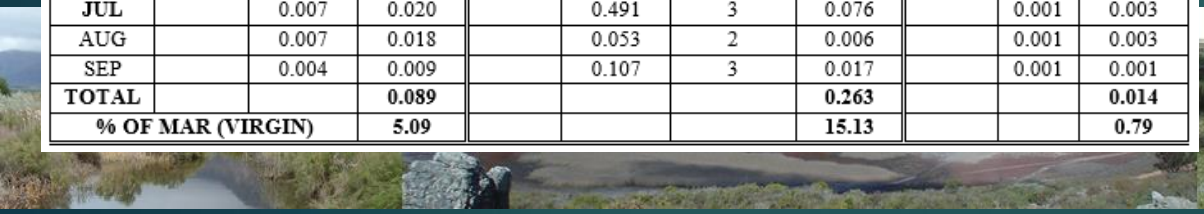


JAKKALS IFR 1: JAKKALS RIVER AT KOOKFONTEIN (Category C)
ASSURANCE OF MAINTENANCE LOW FLOWS: 50 % (summer) and 50 % (winter)
MAR (VIRGIN): 1.740 (10^6 m^3) MAR (PRESENT): ~ (10^6 m^3)

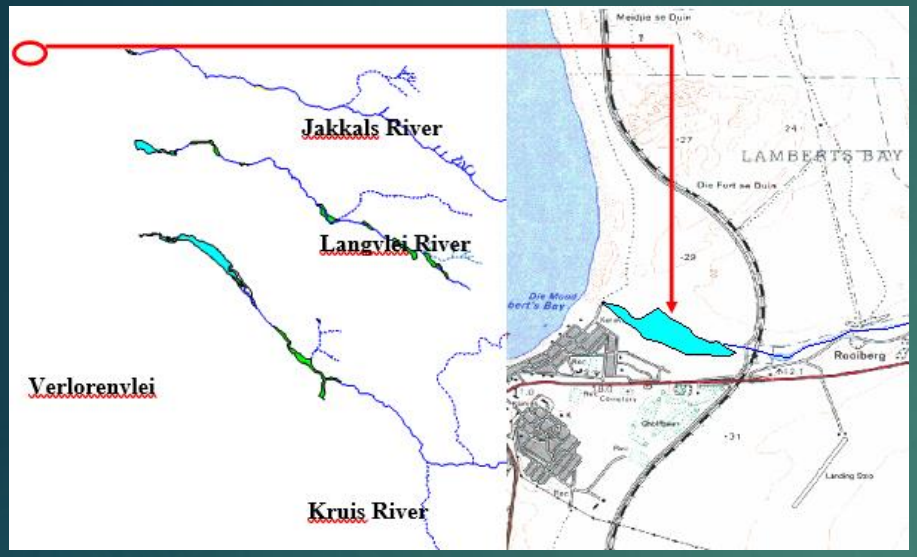
PESC	D
EISC	C
TEC	C
MAR (Virgin)	=1.740 MCM a^{-1}
Total IFR (% MAR)*	=0.352 MCM.a^{-1} (20.22%)

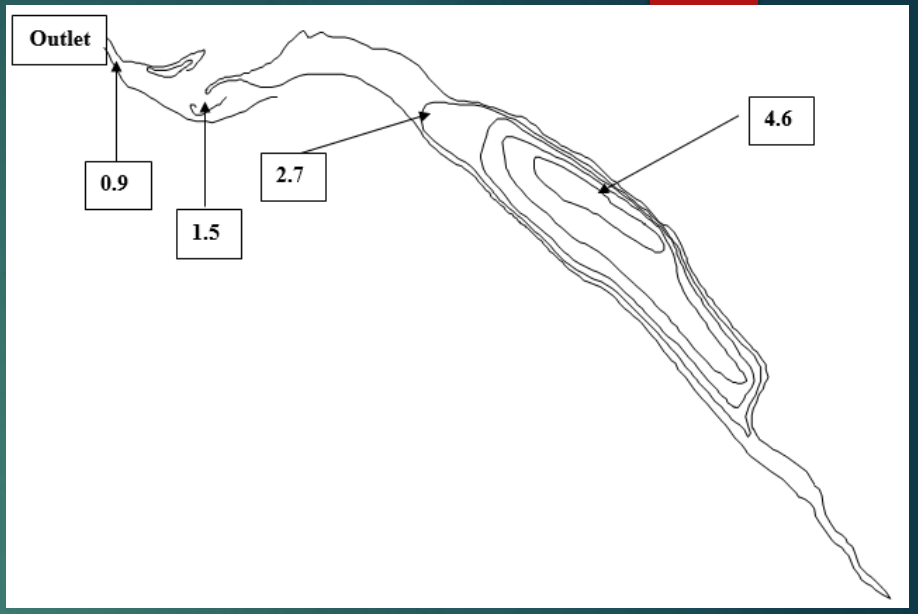


MONTHS	MAINTENANCE LOW FLOWS			HIGH FLOWS				DROUGHT LOW FLOWS		
	DEPTH (m)	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)	DEPTH (m)	FLOW $m^3 s^{-1}$ Daily average	DURATION (days)	VOLUME ($10^6 m^3$)	DEPTH (m)	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)
OCT		0.001	0.002		0.007	2	0.001		0.000	0.000
NOV		0.001	0.002						0.000	0.000
DEC		0.000	0.001						0.000	0.000
JAN		0.000	0.000						0.000	0.000
FEB		0.000	0.000						0.000	0.000
MAR		0.000	0.000						0.000	0.000
APR		0.000	0.001						0.000	0.000
MAY		0.002	0.005		0.193	3	0.030		0.000	0.000
JUN		0.012	0.030		0.734	4	0.133		0.002	0.005
JUL		0.007	0.020		0.491	3	0.076		0.001	0.003
AUG		0.007	0.018		0.053	2	0.006		0.001	0.003
SEP		0.004	0.009		0.107	3	0.017		0.001	0.001
TOTAL			**0.089**				**0.263**			**0.014**
% OF MAR (VIRGIN)			**5.09**				**15.13**			**0.79**



JAKKALSVLEI and VERLORENVLEI





PESC	-
EISC	Moderate
TEC	C
MAR (Virgin)	-
Total IFR (% MAR)*	-

PESC	-
EISC	High
TEC	B
MAR (Virgin)	-
Total IFR (% MAR)*	-

TABLE G3: JAKKALSVLEI: PRELIMINARY RESERVE WATER SPECIFICATION

Component	*Requirement*
Period of inundation	July to November/December
Depth	1 m average depth
Volume at average depth	0.155 MCM
Surface area at average depth	25 ha
Downward seepage losses	Negligible (estimated <0.001 m d^{-1})
Evaporation loss	1.2 m a^{-1}
Contribution from groundwater	Undetermined
PWR Volume requirement	0.5 MCM
Interannual frequency for meeting PWR	1 in 2 years (provisional)

Component	*Requirement/Motivation*
Frequency and duration of opening	Twice in any single year (autumn, early winter and spring), or alternatively; A single extended period from winter through into spring.
Mouth open conditions	"Semi-closed", i.e. continuous outflow with minimal seawater intrusion.
Water level (Mouth open)	2.20 m MSL
Water level (	1.95 m MSL
Water level (Breaching)	Unknown but less than 2.5 m MSL

2003 Sandveld Groundwater Reserve

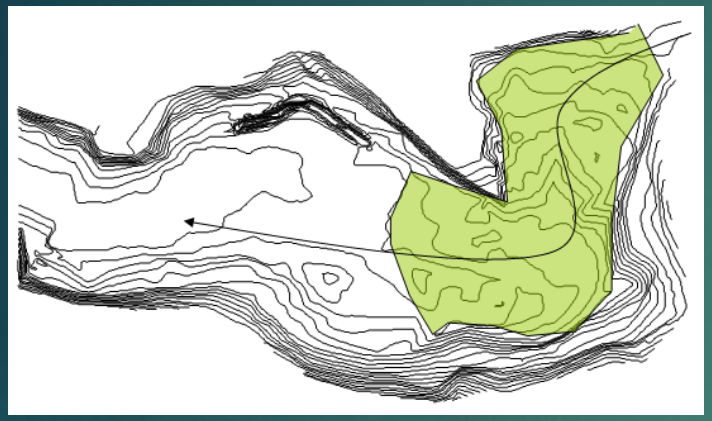
SANDVELD GROUNDWATER RESERVE SUMMARY												
Quaternary Catchment	*Area km²*	*Rainfall mm/a*	*Recharge %*	*Recharge Mm³/a*	*Population dependent on GW*	*Basic Human Need Mm³/a*	*Baseflow required by IFR*	*Reserve as % of recharge*	*Maint. Low Flow IFR Mm³/a [Source]*	*Existing Abstraction Mm³/a*	*Can GW supply IFR*	*Extra GW Allocation Mm³/a*
G30B	658	394	6.5	16.8514	712	0.0065	3.3488	19.9	2.189 [Verlorenvlei IFR site 1]	0.494	Yes	12.9520
G30C	351	410	6.4	9.2102	60	0.0005	1.8499	20.1	1.583 [RESDSS]	2.7767	Yes	4.5831
G30D	534	384	6.4	13.1236	504	0.0046	0.1794	1.4	1.131 [RESDSS]	4.0044	No	8.9352
G30E	352	249	5.2	4.5577	1414	0.0129	0.0308	1.0	0.160 [RESDSS]	2.8976	No	1.6164
G30F	780	285	6.4	14.2272	526	0.0048	0.0951	0.7	0.520 [Langvlei IFR Site 1 (Wadrif)]	14.031	No	0.0462
G30G	647	253	6.9	11.2947	5929	0.0541	0.0595	1.0	0.089 [Jakkals River IFR Site 1]	6.7384	No	4.4427

Recharge percentages calculated by J. Nel (2003) G30B = 2.3%; G30C = 3.7%; G30D = 0.7%; G30E = 0.4%; G30F = 1.2%; G30G = 0.9




Jakkalsvlei and PAN

PESC	-
EISC	High
TEC	C
MAR (Virgin)	-
Total IFR (% MAR)*	-



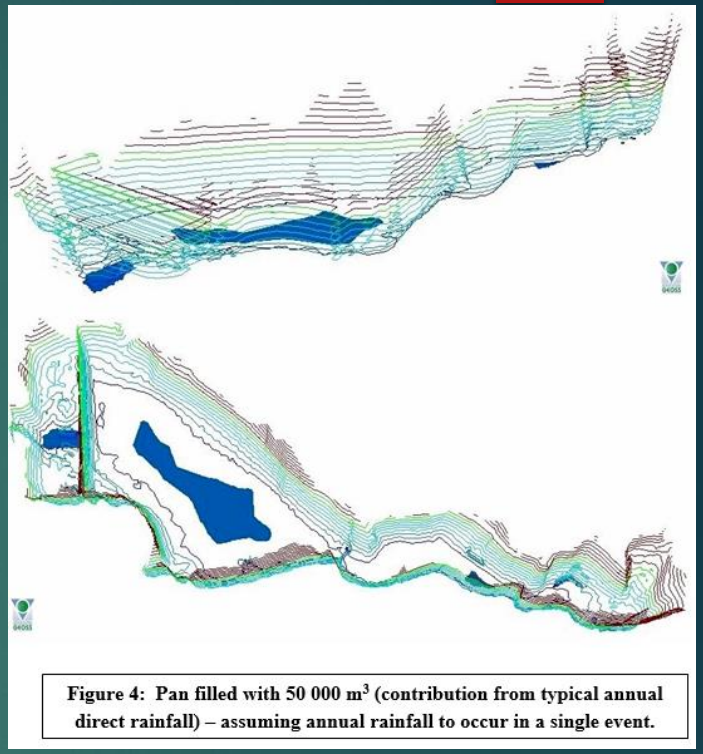


Figure 4: Pan filled with 50 000 m^3 (contribution from typical annual direct rainfall) – assuming annual rainfall to occur in a single event.

Component	*Requirement*
Period of inundation	Perennial wetness to surface. Standing pools of water within the stands of palmiet.
Depth	Not relevant. Wetland is essentially on a descending bend in the river and should evidence groundwater discharge.
Downward seepage losses	Moderate to high
Groundwater discharge	High, quantity undetermined.
Evaporation loss	Exacerbated by evapotranspiration
Contribution from groundwater	Significant
PWR Volume requirement	Surface component will be met by IFR. However, a significant proportion of the EFR will be required from groundwater. This is to be addressed following integration with groundwater component. Volume of the groundwater component has crucial and important implications for the Wadrif Pan.
Interannual frequency for meeting PWR	Annually.

Component	*Requirement*
Period of inundation	July to December, with water entering the system from April (standing water present for between six and eight months of the annual cycle).
Depth	Wet season maximum 1.5 m AMSL (1.0 m above lowest point of pan). This depth to be achieved during July to August. Wet season minimum. 0.8 m AMSL (provisional). Dry season maximum. 0.55 m AMSL (0.15 m above lowest point of pan during 1st week of December).
Downward seepage losses	Negligible (estimated <0.001 m d^{-1})
Evaporation loss	1.2- 1.6 m a^{-1}
Contribution from groundwater	Undetermined
PWR Volume requirement	5 MCM (wet year), 1.5-2.5 MCM dry year.
Interannual frequency for meeting PWR	2/3 years (provisional)

Classification and RQOs F60 and G30 catchments

Quaternary	PES (2011)	REC - Incremental	REC - Cumulative
F60A	B	B	B
F60B	B	B	B
F60C	B	B	B
F60D	B	B	B
F60E	B	B	B
G30A	C	C	C
G30B	C	C	C
G30C	C	C	C
G30D	C	C	C
G30E	C	C	B
G30F	C	C	C
G30G	C	C	C
G30H	C	C	C

VERLOREVLEI RIVER IN G30D

Mean flow in driest month (March): 0.019 m^3/s
Even in extreme drought flow should not drop below: 0.001 m^3/s.

The water should be oligotrophic and should comply with the Target Water Quality Ranges for aquatic ecosystem (DWAF 1996a).

Indigenous species should dominate and *Pseudobarbus burgi* (Verlorenvlei), *Galaxias zebratus* and *Sandelia capensis* should be present.

Quaternary	Recharge (hm^3/a)	Total Usage (hm^3/a)	EWR Low Flow (hm^3/a)	Groundwater Reserve [% of Re]	Water Balance (hm^3/a)	GW Stress Index	PS
G30D	13.12	7.56	1.27	10%	5.56	58%	D

VERLOREVLEI RIVER IN G30E

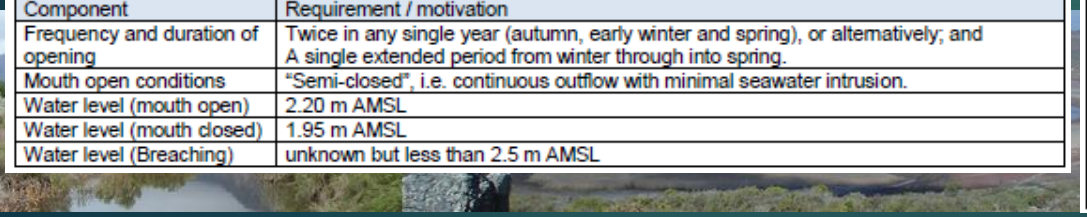
Mean flow in driest month (March): 0.29 m^3/s
Even in extreme drought flow should not drop below: 0.04 m^3/s.

Quaternary	Recharge (hm3/a)	Total Usage (hm3/a)	EWR Low Flow (hm3/a)	Groundwater Reserve [% of Re]	Water Balance (hm3/a)	GW Stress Index	PS
G30E	4.56	7.53	0.60	13%	-2.97	165%	F

VERLORENVLEI

Component	Requirement / motivation
Frequency and duration of opening	Twice in any single year (autumn, early winter and spring), or alternatively; and A single extended period from winter through into spring.
Mouth open conditions	"Semi-closed", i.e. continuous outflow with minimal seawater intrusion.
Water level (mouth open)	2.20 m AMSL
Water level (mouth closed)	1.95 m AMSL
Water level (Breaching)	unknown but less than 2.5 m AMSL

Component	RQO
Salinity	Salinity concentrations in the estuary < 35 ppt Salinity concentrations in the Verlorenvlei < 10 ppt
Dissolved Oxygen	Dissolved oxygen concentrations in Verlorenvlei >= 4 mg/l
Turbidity	Average suspended solid concentrations in river inflow should not increase by more than 10% of present conc's (to be determined)
Inorganic nutrients	Average DIN concentrations in river inflow < 300 ug/l Average DIP concentrations in river inflow < 50 ug/l
Toxins	Toxic substance concentrations (e.g. trace metals) in river inflow and the water column of Verlorenvlei < South African Water quality guidelines for coastal marine waters (DWAF 1995)



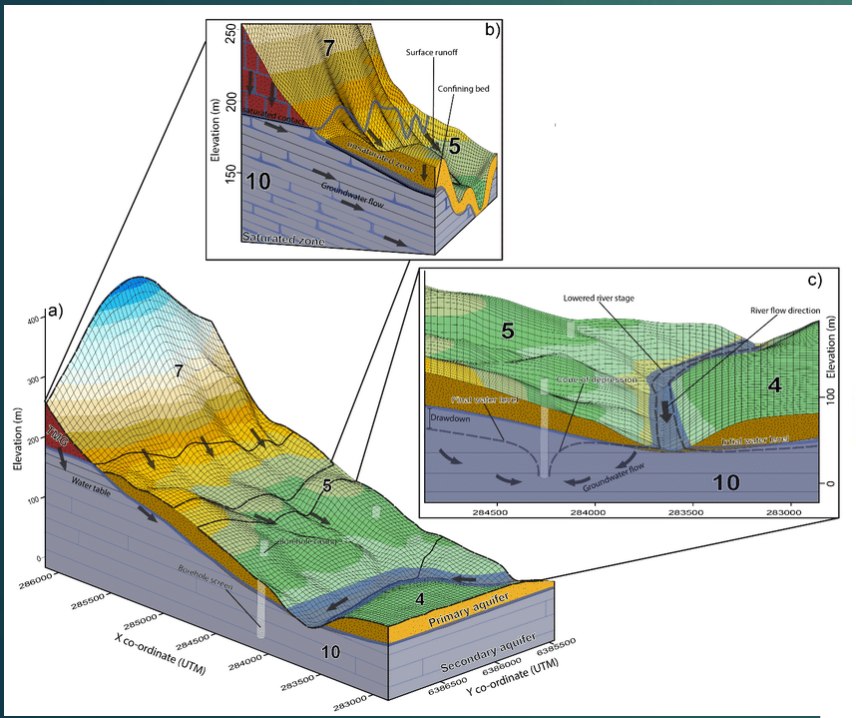
EWR sites

EWR Formal site names	Resource Unit
EWR1 RW-F60A BRAK STRAN	Brak River RU; Lower Brak River VB Wetland RU
EWR2 W-F60A DEPR NUWEB	NW Fynbos depression Wetland RU
EWR3 RW-F60B GRGO KOMKA	Sout/Groot-Goerap River RU
EWR4 W-F60C DEPR ADOON	Knersvlakte depression Wetland RU
EWR5 W-F60E DEPR ELSIE	Sandveld depression Wetland RU
EWR6 RW-G30H SAND HOLLE	Sandlaagte River RU
EWR7 RW-G30G JAKK KOOKF	Jakkals River RU; Lower Jakkals River VB Wetland RU
EWR8 RW-G30F LANG BRAND	Langvlei River RU; Lower Langvlei VB Wetland RU
EWR9 W-G30F WADR WAGEN	Wadrift VB Wetland RU
EWR10 RW-G30D VERL EENHE	Upper Verlorenvlei River RU; Upper Verlorenvlei River VB Wetland RU
EWR11 RW-G30D KROM GOERG	Krom Antonies River RU; Krom-Antonies River FP Wetland RU
EWR12 RW-G30E VERL WITTE	Lower Verlorenvlei River RU; Lower Verlorenvlei River FP Wetland RU
EWR13 W-G30A DUNE FA277	West Strandveld duneslack Wetland RU
EWR14 W-G30A ROSH FA272	Rocherpan Wetland RU
EWR15 RW-G30A PAPK BOOKR	Papkuils River RU; Lower Papkuils FP Wetland RU
EWR16 W-G30A PAPK RIETF	Upper Papkuils seep Wetland RU




Integration

- Delineating boundaries for each discipline
- Understanding inter-relationships between disciplines
- Understanding ground and surface water interaction
- Conceptual modelling of ground and surface interaction



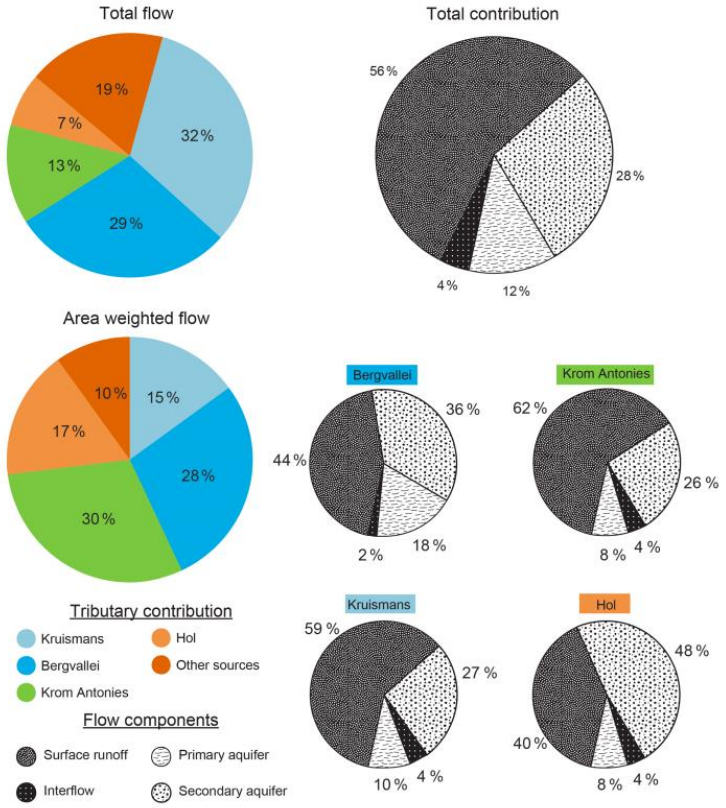


Figure 10. The Verlorenvlei reserve flow contributions (total flow and area-weighted flow) of Kruismans, Bergvallei, Krom Antonies and Hol as well as flow component separation into surface runoff (RD1), interflow (RD2), primary aquifer flow (RG1) and secondary aquifer flow (RG2).








THANK YOU