

Step 5: Scenarios evaluation



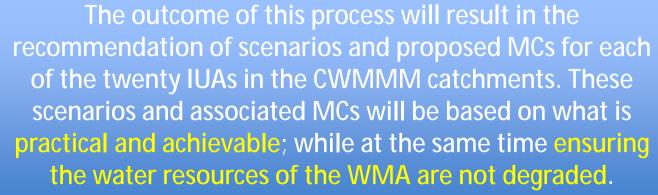




Scenarios evaluation (1)

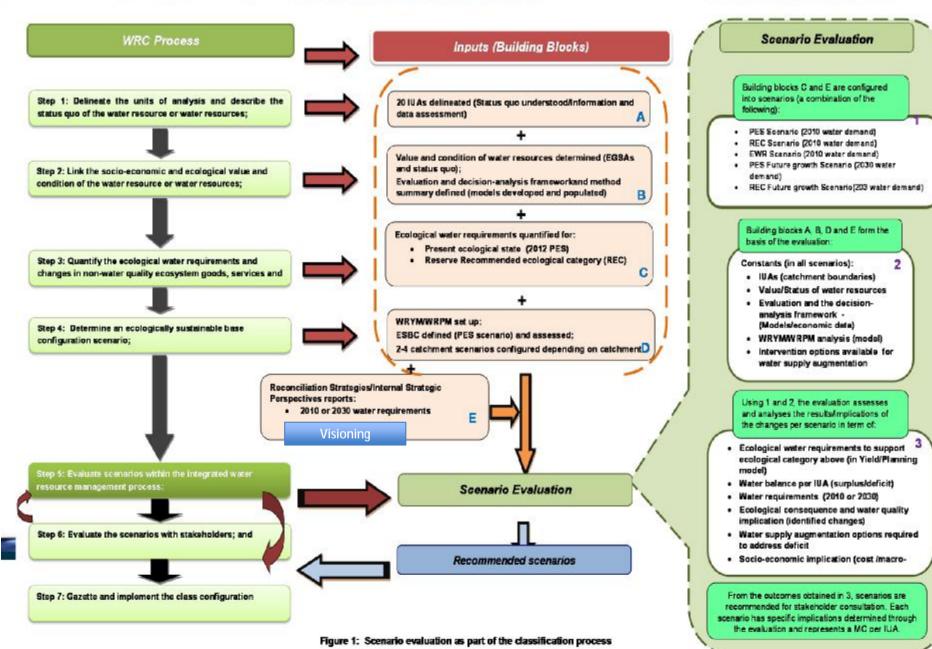
Three alternate scenarios were subsequently taken forward:

- WRPM and WRYM;
- Ecological consequences (assessment of responses to various flow scenarios were based on the approach developed by Kleynhans for application in the Habitat Flow Stressor Response Model); and
- Economic implications of each were assessed.











Objectives of Step 5 of the WRCS

The following activities were undertaken as part of finalisation of Step 5 of the WRCS process:

- Inclusion of the additional three scenarios (except for Matlabas which has only one additional scenario) proposed;
- Water Resources Planning and Water Resource Yield Model analysis and adjustment;
- Reporting of ecological consequences and IUA- level ecological condition;
- Assessment of water quality implications;
- Description of the macro-economic implications;
- Evaluation of the overall scenario implications for the WMAs, and
- Selection of a subset of recommended scenarios.





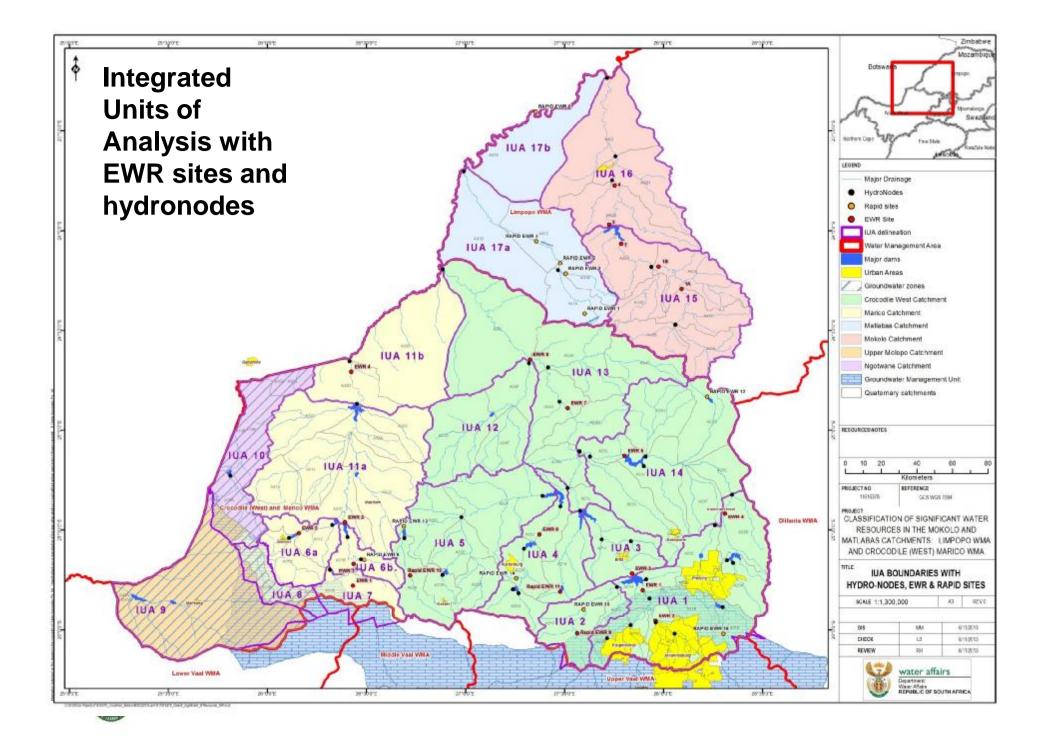


Visioning

- A visioning exercise was undertaken at the second PSC meeting held on the 12th September 2012;
- Helped to translate stakeholder issues and concerns;
- The vision will ultimately be translated into management objectives that will drive operational management; and
- It will help link management actions to the vision and ensure that societal values and management objectives are linked and realised.

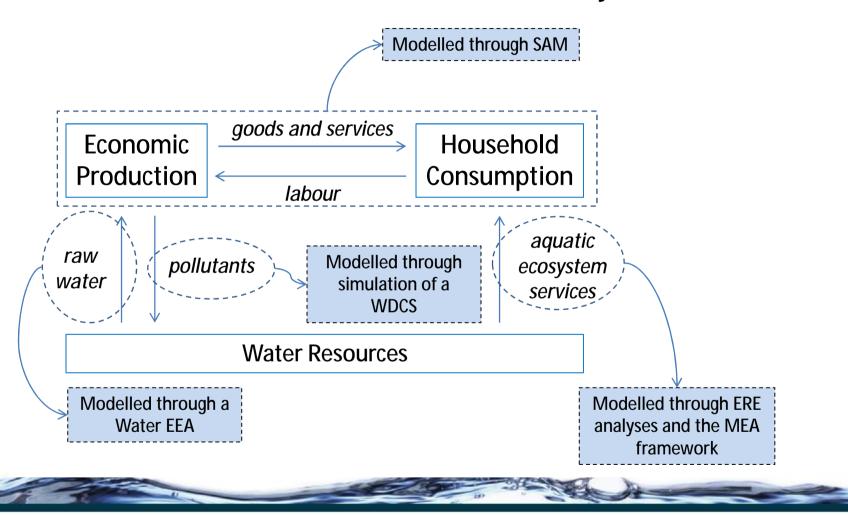




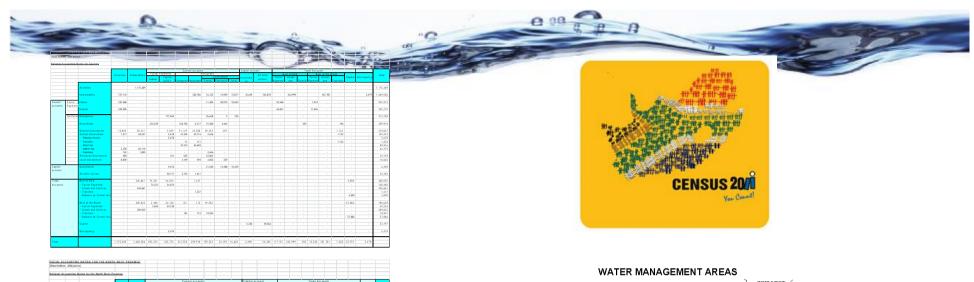


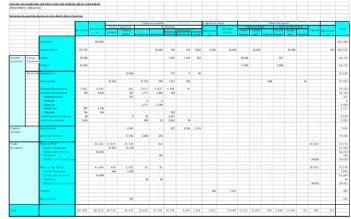


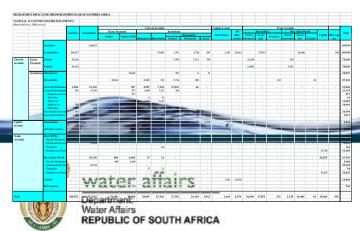
Socio-economic evaluation and decision analysis framework







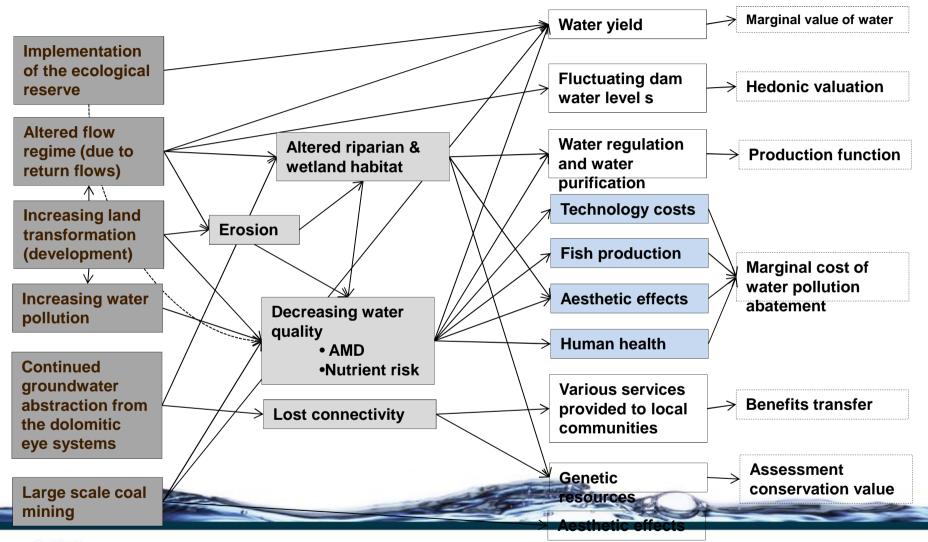






Integrated SAM for the study area













Ecological water requirements quantification

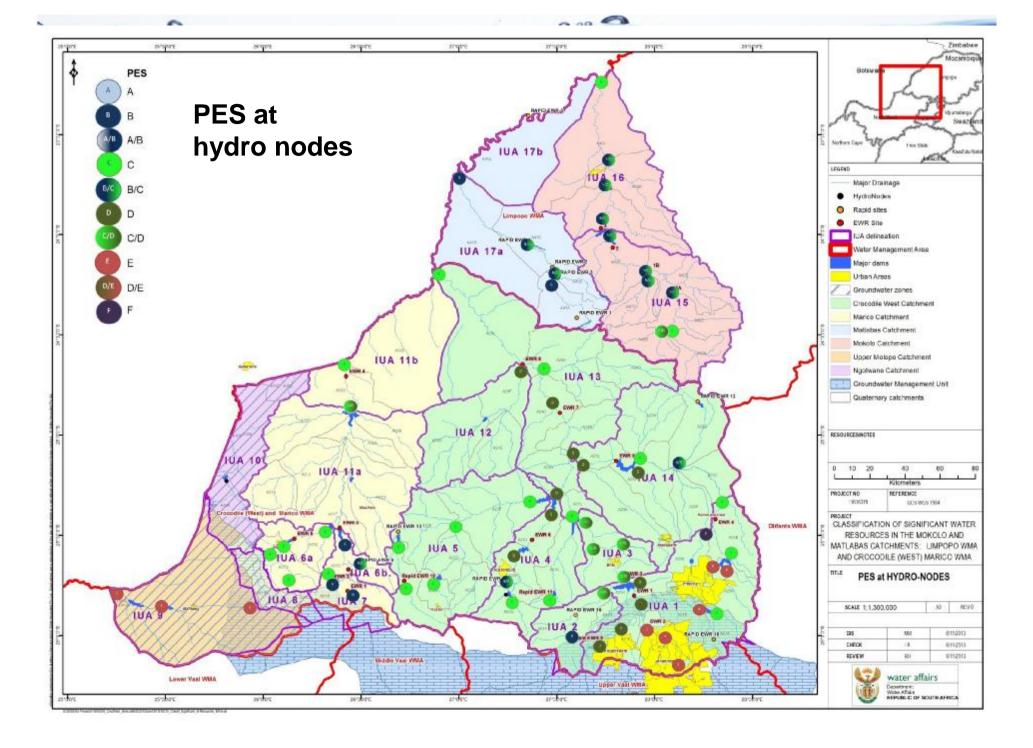
The classification process requires the quantification of ecological water requirements (EWRs) (previous Reserve studies; additional Rapid III; extrapolation).

See table handed out showing EWR data; and

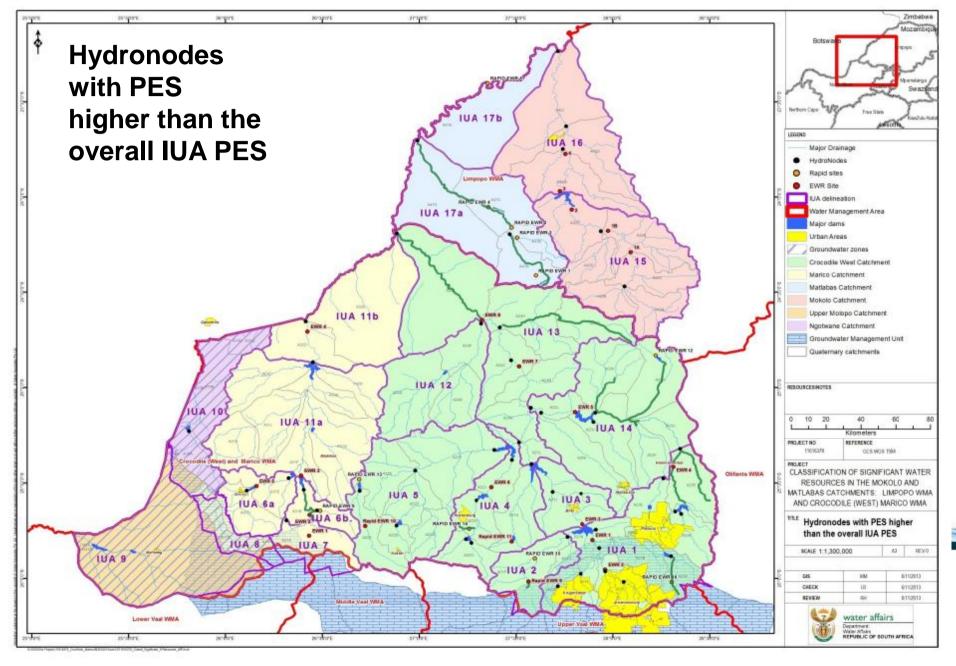
The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) per hydro-node were provided by the Reserve determination studies and the DWA desktop PES, EI and ES study that was undertaken for the Crocodile West/Marico WMA and Limpopo WMAs during 2012 (DWA, 2012). In situations where the selected hydro-node is an existing EWR site from a previous Reserve study, the PES and EIS information provided was obtained from these studies.

See table showing hydronodes and PES per hydronode











Catchment scenarios



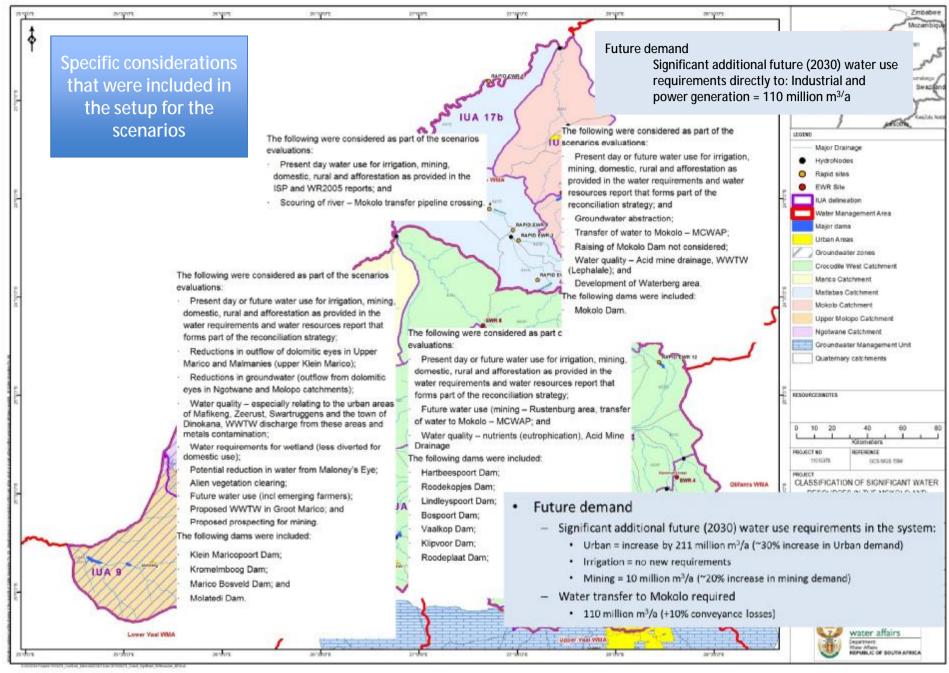




Alternate scenarios description

МоІоро	Klein Marico
ESBC: Ecological = PES, present water use	ESBC: Ecological = PES, present water use
1) Reductions in groundwater (outflow from dolomitic eye), PES, present water use	1) PES, future water use
2) Reductions in groundwater (outflow from dolomitic eye), REC, present water use	2) REC, present water use
3) Reductions in groundwater (outflow from dolomitic eye), PES, future water use	3) REC, future water use
Ngotwane	Groot Marico
ESBC: Ecological = PES, present water use	ESBC: Ecological = PES, present water use
1) Reductions in groundwater (outflow from dolomitic eye), PES, present water use	1) PES, future water use
2) Reductions in groundwater (outflow from dolomitic eye), REC, present water use	2) PES, AIP clearing, future water use (including emerging farmers)
3) Reductions in groundwater (outflow from dolomitic eye), PES, future water use	3) REC (MAR_EWR3 from C/D to C), AIP clearing, future water use (incl emerging farmers)
Crocodile West	Mokolo
ESBC: Ecological = PES, present water use	ESBC: Ecological = PES, present water use
1) PES, future water use (mining – Rustenburg area, transfer of water to Mokolo – MCWAP)	1) PES, future water use (groundwater abstraction, transfer of water to Mokolo – MCWAP)
2) REC, present water use	2) REC, present water use
3) REC, future water use (mining – Rustenburg area, transfer of water to Mokolo – MCWAP)	3) REC, future water use (groundwater abstraction, transfer of water to Mokolo – MCWAP)
Water quality – nutrients, AMD	
Matlabas	
ESBC: Ecological = PES, present water use	

1) REC, present water use



Impact of EWR (PES) at major dams

Major Dam	Catchment	Yield without EWR (million m³/a)	Yield with EWR (million m³/a)	
Klein Maricopoort	A31D	5.38	3.98	
Kromelmboog	A31E	2.61	2.44	
Marico Bosveld	A31B	21.54	9.19	
Molatedi	A32C	11.37	11.9	
Mokolo	A42F	Depending on operating rules	3.48	
Hartbeespoort	A21H	237.9	231.0	
Roodekopjes	A21L	59.0	55.0	
Lindleyspoort	A22E	3.4	2.7	
Bospoort	A22H	1.3	0.9	
Vaalkop	A22J	6.5	3.4	
Roodeplaat	A23A	37.5	35.0	
Klipvoor	A23J	24.5	28.0	

This configuration of ecological categories ensures that a sustainable level of ecosystem functioning is maintained in the study catchments







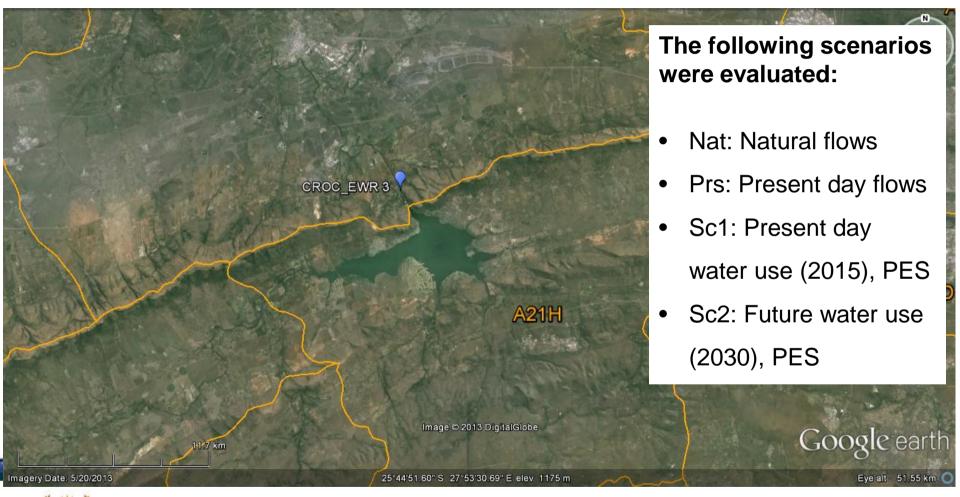
Alternate Scenarios methodology used per EWR site







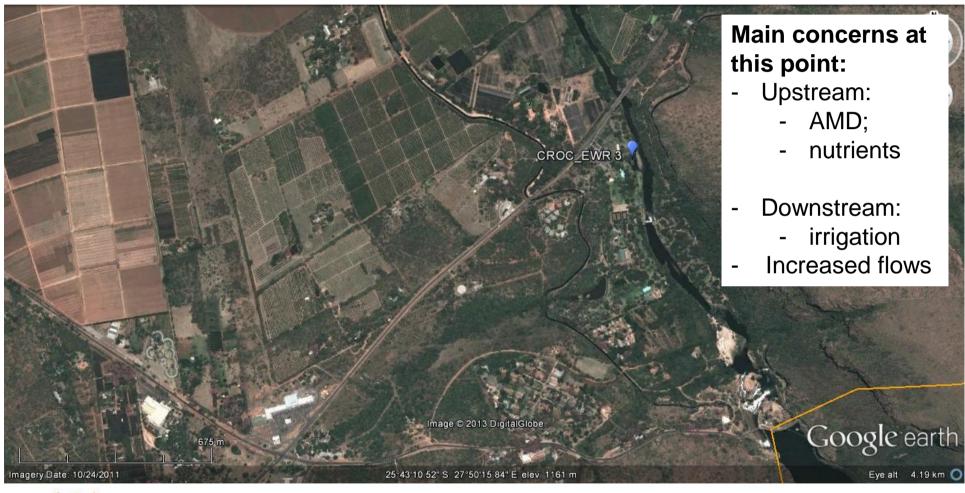
CROC_EWR Site 3: below Hartbeespoort Dam







CROC_ EWR Site 3: main concerns

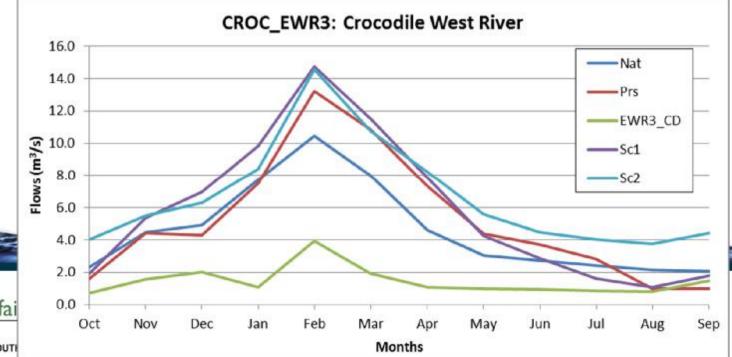






CROC_ EWR Site 3: hydrology

Optimun base flo	ws - May (wet for F	eb) and Aug (dry)					
		February			August		
	Average	Percentile	%				
Nat	10.439	7.357	30	2.154	4.421	0.1	
Prs	13.228	11.080	30	0.967	5.066	0.1	
EWR3_CD	3.941	5.228	30	0.810	0.915	0.1	
Sc1	14.720	12.657	30	1.131	6.075	0.1	
Sc2	14.424	9.745	30	3.792	7.536	0.1	



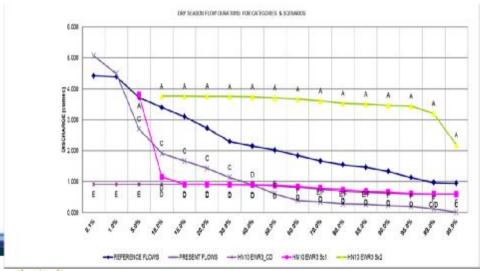


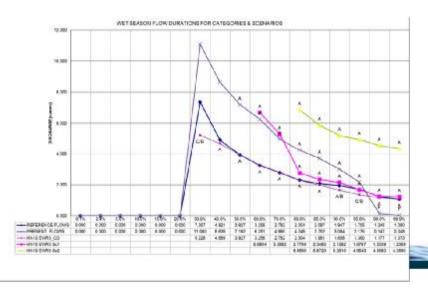




CROC_EWR 3: Ecological Consequences

	Natural	Present	EWR 3_C/D	Sc 1	Sc 2
Fish dry	Α	D	D	D	A
Fish wet		А	А	Α	A
Fish integrated		Α	С	Α	Α
Invert Dry	Α	D/E	D	D	Α
Inver wet		А	Α	С	А
Invert integrated		С	С	C/D	Α
		В	С	B/C	Α









Socio-economic consequences

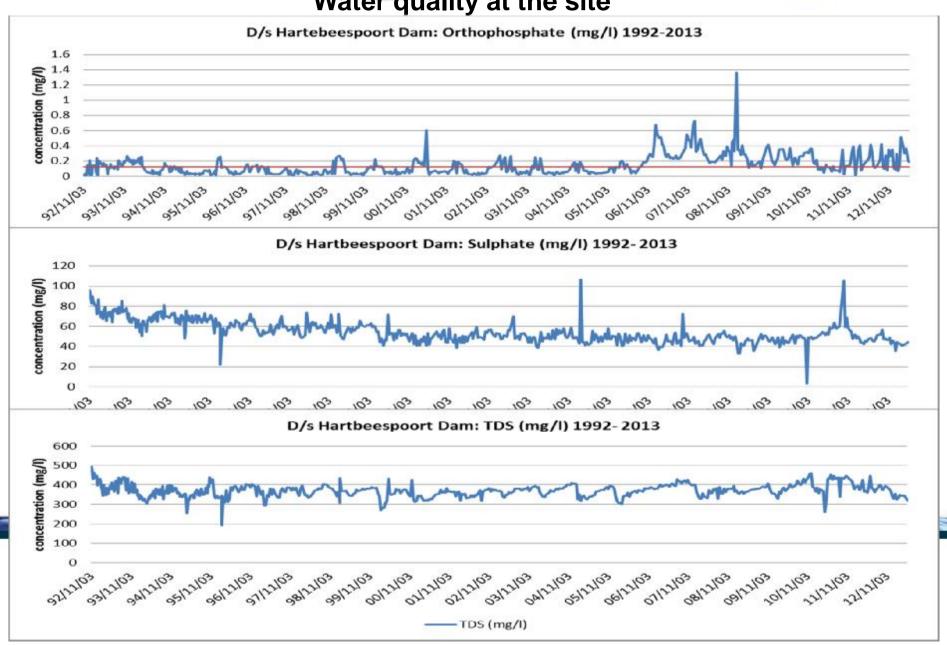
- WRCS study has found that PES and REC are very similar
- Resultant scenarios:
 - ESBC: PES/REC + present water use
 - Scenario 1/3: PES/REC + future water use
- Socio-economic consequences of these scenarios:
 - Water supply do not constrain the economy (excl Agriculture)
 - No additional water supply costs (flow)
 - No trade-offs required
 - No negative impacts on long term GDP
 - Dam levels to fluctuate
- Water quality costs:
 - Cost of water treatment
 - AMD treatment





R'million/a CWM PE future wa (minir Rustenbu transfer o to Mok MCW	ater use ng – rg area, of water colo –
Agriculture 31,500	42,016
Mining 225,857 2	260,997
Manufacturing 1,392,602 1,8	309,046
Utilities 47,427	59,845
Other commerce 822,990 1,0)52,696
Value added 664,839 8	346,976
Value Added 100%	127%

Water quality at the site

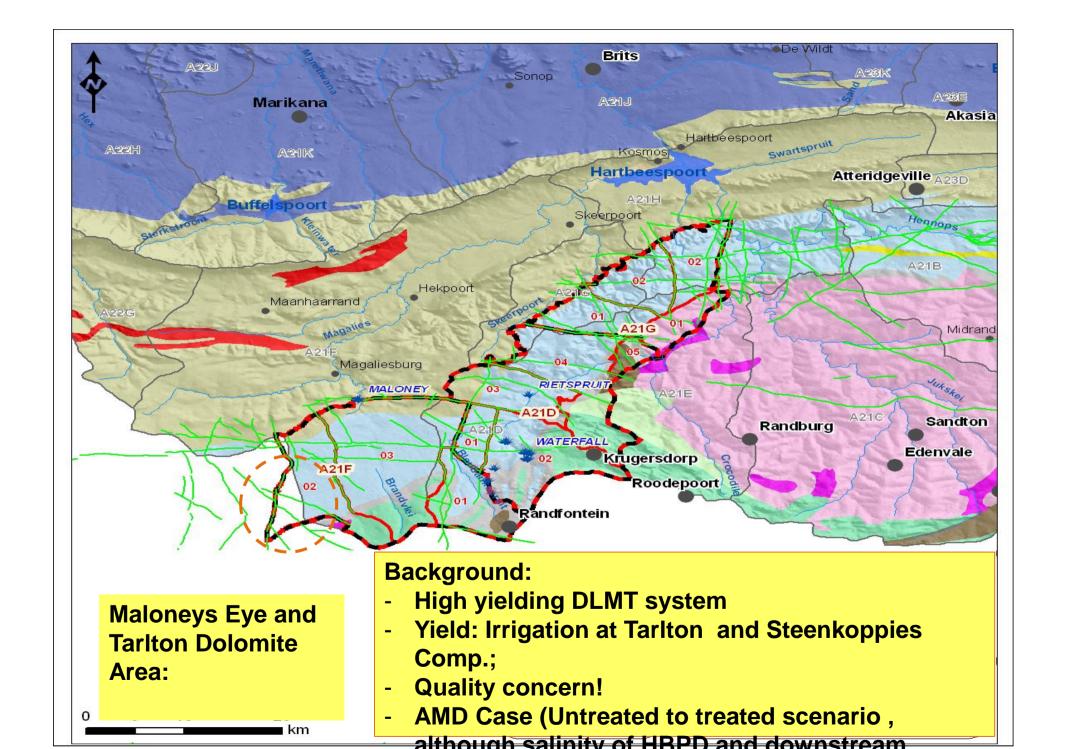




Water quality implications related to AMD and nutrients

- Sub-scenarios:
 - Neutralise AMD to 2776mg/L resulting in
 - 15% salinity increase in the Hartbeespoort Dam corresponding to
 - 50 000tons/a salinity load and 50mg/L TDS concentration increase in the long term
 - Neutralise AMD to 100mg/L resulting in
 - 4 5% increase in salinity levels in the dam
 - Significant reduction in impacts
- The findings of the considerations for the implementation of the WDCS in the Hartbeespoort Dam catchment are:
 - An interim phosphorous concentration of 0,085mg/L in the dam
 - A final phosphorous concentration of 0,055mg/L in the dam, corresponding to a phosphorous load reduction of 81% from 348,000kg/a to 68,000kg/a.







Implications for Management Class

- Proposed Class: III
- Hard working system
- Key RQO considerations:
 - Water quality targets related to AMD and nutrients







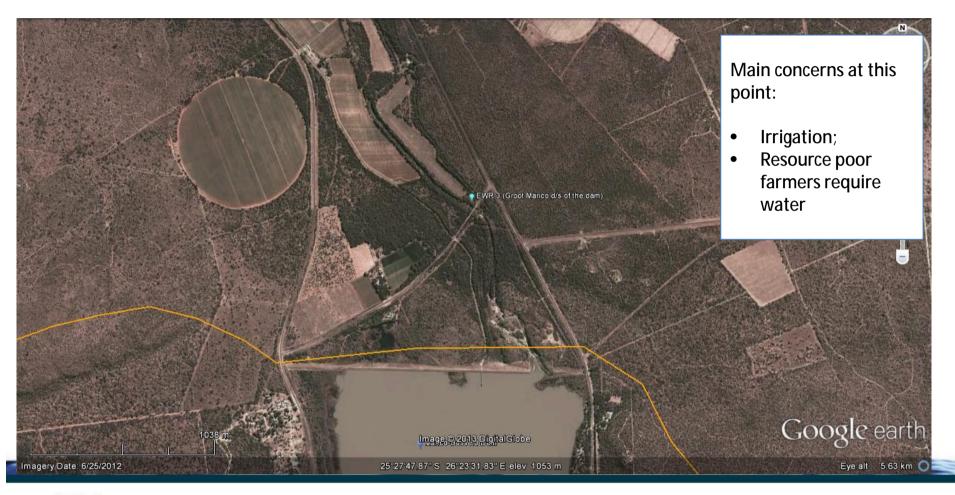
MAR EWR 3: below Marico Bosveld Dam







MAR__EWR 3: below Marico Bosveld Dam

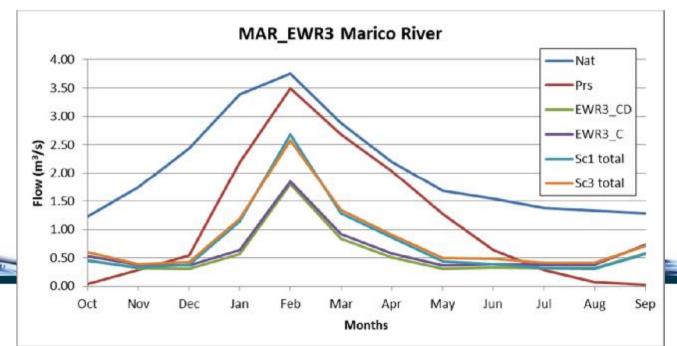






MAR_ EWR Site 3: hydrology

Optimun base flows - June (wet for Feb) and Sep (dry)						
	February			September		
	Average	Percentile	%	Average	Percentile	%
Nat	3.747	4.252	20	1.286	1.915	1
Prs	3.496	2.442	20	0.022	0.180	1
EWR3_CD	1.796	2.477	20	0.576	0.647	1
EWR3_C	1.847	2.633	20	0.733	0.833	1
Sc1 total	2.666	2.483	20	0.566	0.646	1
Sc3 total	2.510	2.617	20	0.652	0.831	1

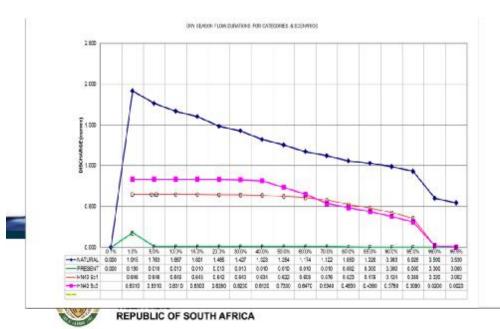


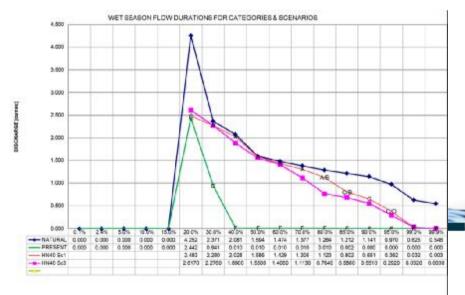




MAR_EWR 3: Ecological Consequences

	Present	EWR3_CD	EWR3_C	Sc1	Sc3
Fish dry	F	С	B/C	С	С
Fish wet	E/F	Α	Α	A/B	В
Fish integrated	F	В	A/B	C/B	C/B
Invert Dry	F	C/D	C/D	C/D	С
Inver wet	F	Α	C/D	A/B	С
Invert integrated	F	С	B/C	С	С
	F	С	С	С	С







Socio-economic consequences

Scenarios:

- Klein Marico: REC and PES is the same at EWR 5, thus ESBC is maintained
- Klein Marico: No additional future use possible
- Groot Marico: Scenario 2 (PES, AIP clearing, future water use (incl resource poor farmers))
- Groot Marico: Scenario 3 (REC (MAR_EWR3 from C/D to C), AIP clearing, future water use (incl resource poor farmers))
- Socio-economic consequences of these scenarios:
 - No additional future use possible
 - Water constrained local economy
 - PES and REC will require trade-off with other water users (~11 million m³/a)
 - Major risk to local economy
- Other considerations:
 - Risk to supply of dolomitic water
 - Nutrient pollution from WWTWs





Supply of dolomitic water

- Risk to water supply and ecological health
- Important to manage dolomitic water much better than we currently do







Klein and Groot Marico: Water quality implications related to nutrient pollution

Zeerust WWTW Information (from: Green Drop Report 2012):

Treatment design capacity: 3,5ML/d

Operational % in terms of capacity: >100%

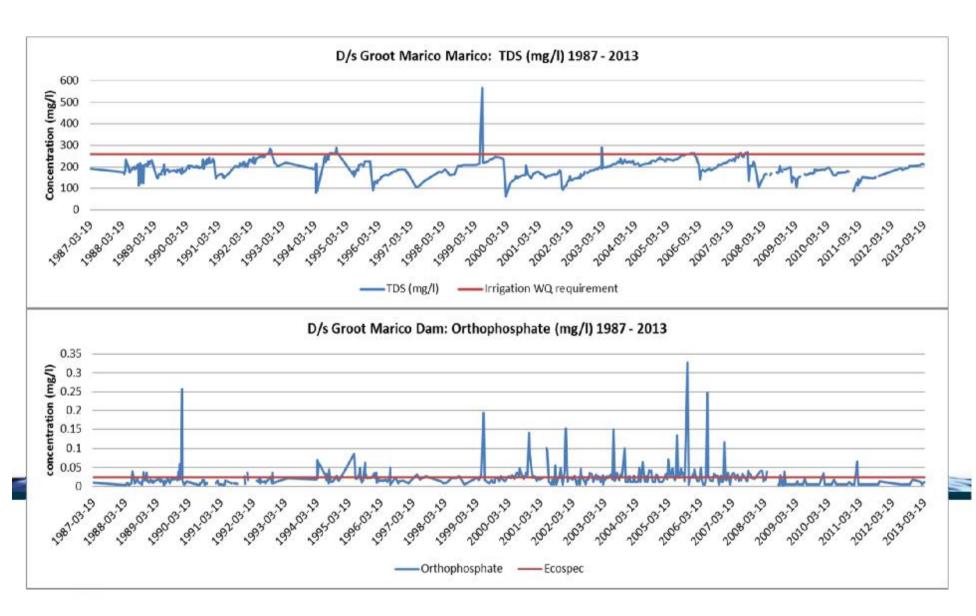
Wastewater risk rating: >100%

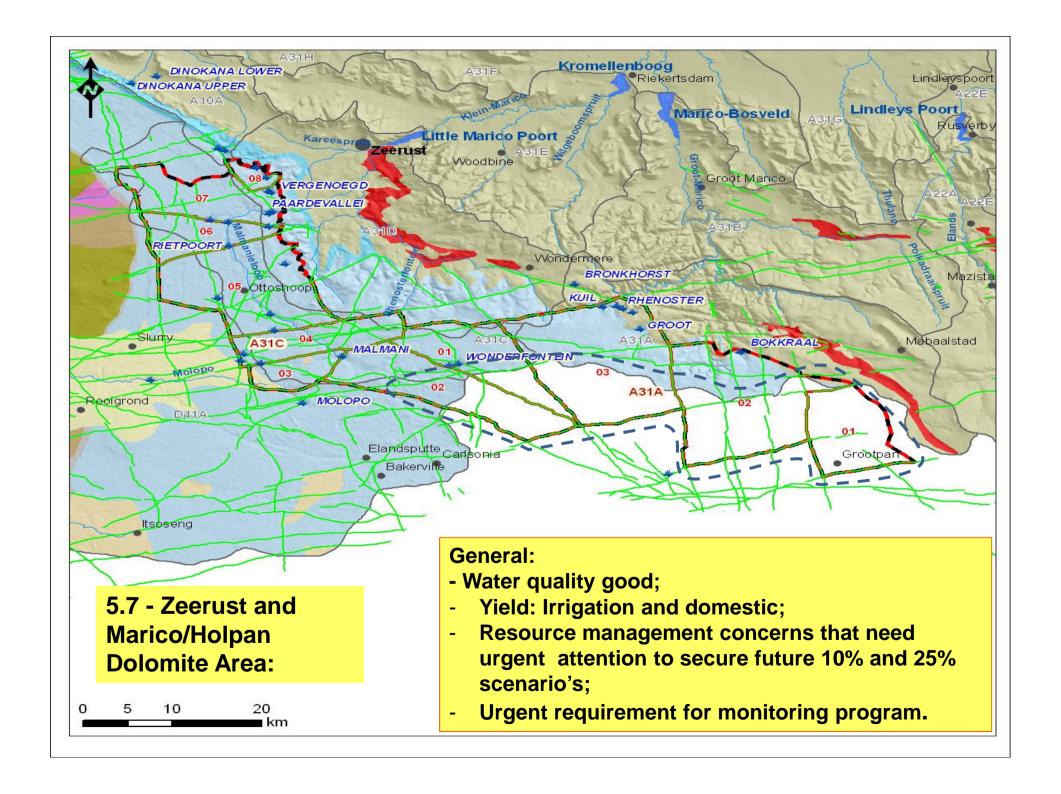
Highest risk area: Poor effluent compliance with no flow monitored













Implications for Management Class

- Both Klein and Groot Marico MC: II
- However:
 - Alternative EWR permutations to be assessed
 - Strict water quality RQOs required







Ecological Consequences overall summary







EC overall summary: Crocodile West

IUA	Water Resource	EWR sites	Nat: Natural flows		Prs: Present day flows			Sc1: Present day water use (2010), PES			Sc2: Future water use (2030), PES			
			EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation
	Jukskei	CROC_EWR 2 (A21C)	Ш	Α	٧	Ш	В	٧	Е	В	٧	Е	В	٧
1	Pienaars	CROC_EWR 4 (A23B)	С	C/D	х	С	B/C	٧	С	Α	٧	С	Α	٧
2	Upper Magalies	CROC_EWR 9 (A21F)	В	1	٧	В	В	٧	В	А	٧	В	А	٧
3	Crocodile	CROC_EWR 3 (A21J)	C/D	В	٧	C/D	C	٧	C/D	B/C	٧	C/D	А	٧
4	Нех	CROC_EWR 6 (A22J)	D	D	Х	D	С	٧	D	С	٧	D	С	٧
5	Elands	CROC_EWR 13 (A22E)	С	na	Х	С	С	٧	С	E	Х	С	E	Х
13	Crocodile	CROC_EWR 7 (A24C)	D	na	Х	D	D	Х	D	B/C	٧	D	А	٧







EC overall summary: Marico

	Water Resource	EWR sites	Natural flows		Present day flows without EWR			Present d as Sc1), P	lay water ι ES	ıse (same	Future water use, PES			
IUA			EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation
6a	Klein Marico	MAR_EWR 5 (A31E)	С	F	Х	С	C/D	٧	С	Е	Х	С	Е	х
6b	Groot Marico	MAR_EWR 2 (A31B)	В	В	٧	В	Α	٧	В	А	٧	В	В	٧
OD	Polkadraais pruit	MAR_EWR 6 (A31B)	B/C	D	Х	B/C	D	х	B/C	D	Х	B/C	D	Х
11a	Groot Marico	MAR_EWR 3 (A31F)	C/D	F	Х	C/D	B/C	٧	C/D	В	٧	C/D	B/C	٧
11b	Groot Marico	MAR_EWR 4 (A32D)	С	F	Х	С	С	٧	С	С	٧	С	-	х







EC overall summary: Mokolo/Matlabas

	Water Resource	EWR sites	Natural flows		Present day flows		Present day water use, PES			Future water use, PES				
IUA			EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation	EC at EWR site (PES)	Ecological Con- sequence of flows	Recomme ndation
15	Mokolo	MOK_EWR 1A (A42C)	C/D	E	Х	C/D	(B/C) F (C/D) D	Х	C/D	E	Х	C/D	E	Х
15	Sterkstroom	MOK_EWR 10 (A42D)	B/C	В	٧	B/C	В	٧	B/C	В	٧	B/C	na	Х
16	Mokolo:	MOK_EWR 3 (A42G)	B/C	F	Х	B/C	D	٧	B/C	D	Х	B/C	D	х

			Present o	lay water ι	use, PES	REC, present water use			
IUA	Water Resource	EWR sites	EC at EWR site (PES)	Ecologica I Con- sequenc e of flows	Recomm endation	EC at EWR site (PES)	Ecologica I Con- sequenc e of flows	Recomm endation	
17a	Matlabas Zyn Kloof	MAT_ EWR 1 (A41A)	В	А	٧	В	А	٧	
17b	Matlabas	MAT_EWR 2 (A41C)	С	А	٧	С	А	٧	





Water Quality







Summary of water quality

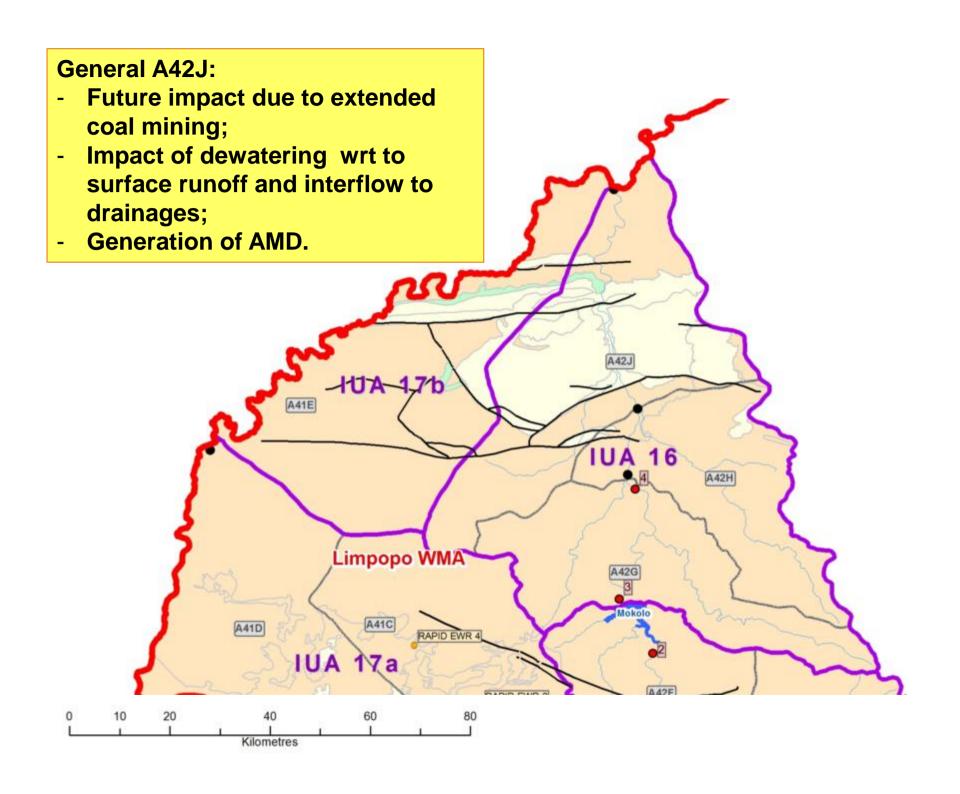
	EWR site	River	Quat	PES	EIS	REC	WQ
	EWR 1	Crocodile: Upstream of the Hartbeespoort Dam	A21H	D	Mod	D	D
	EWR 2	Jukskei: Heron Bridge School	A21C	E	Mod	D	D
	EWR 3	Crocodile: Downstream of Hartbeespoort Dam in Mount Amanzi	A21J	C/D	High	C/D	D
	EWR 4	Pienaars: Downstream of Roodeplaat Dam	A23B	С	High	С	B/C
	EWR 5	Pienaars/Moretele: Downstream of the Klipvoor Dam in Borakalalo National Park	A23J	D	High	С	C/D
WEST	EWR 6	Hex: Upstream of Vaalkop Dam	A22J	D	Mod	D	C/D
×	EWR 7	Crocodile: Upstream of the confluence with theBierspruit	A24C	D	Mod	D	D
CROCODILE	EWR 8	Crocodile downstream the confluence with Bierspruit in Ben Alberts Nature Reserve	A24H	С	Mod	С	С
8	EWR 9	Magalies: Downstream of Malony's Eye	A21F	В	V High	В	В
8	EWR 10	Elands: Upstream Swartruggens Dam	A22A	С	High	B/C	С
8	EWR 11	Sterkstroom: Upstream Buffelspoort Dam	A21K	С	High	С	С
	EWR 12	Buffelspruit before confluence with Plat	A23G	B/C	Mod	B/C	В
	EWR 13	Elands downstream Lindleyspoort Dam	A22E	С	Low	С	С
	EWR 14	Waterkloofspruit downstream Rustenburg Nature Reserve	A22H	B/C	Low	B/C	В
	EWR 15	Lower Magalies before confluence with Skeerpoort	A21F	C/D	Low	C/D	С
	EWR 16	Rietvlei upstream Rietvlei Dam	A21A	С	Low	С	D
	EWR 1	Kaaloog-se-Loop: Below gorge	A31A	В	V High	В	A/B
0	EWR 2	Groot Marico: Upstream confluence with Sterkstroom	A31B	В	V High	В	В
MARICO	EWR 3	Groot Marico: Downstream Marico Bosveld Dam	A31F	C/D	High	C/D	B/C
₹	EWR 4	Groot Marico: Downstream Tswasa Weir	A32D	С	High	С	В
_	EWR 5	Klein Marico Downstream Klein Maricopoort Dam	A31E	С	Mod	С	С
	EWR 6	Polkadraaispruit before confluence with Marico	A31B	B/C	Mod	В	С
	EWR 1a	Mokolo at Vaalwater	A42C	C/D	High	В	В
0	EWR 1b	Mokolo at Tobacco	A42E	B/C	High	В	В
MOKOLO	EWR 2	Mokolo at Ka'ingo	A42F	B/C	V High	В	В
<u> </u>	EWR 3	Mokolo below Mokolo Dam in the Gorge	A42G	B/C	V High	В	В
2	EWR 4	Mokolo: Malalatau	A42G	С	V High	В	В
	EWR 10	EWR 10 Sterkstroom			High	B/C	В
S	EWR 1	MatlabasZynKloof	A41A	В	V High	А	В
MATLABAS	EWR 2	Matlabas at Haarlem East (A4H004)	A41C	С	High	B/C	В
ATL	EWR 3	Mamba River Bridge	A41B	B/C	Mod	B/C	В
Σ	EWR 4	Matlabas at Phofu	A41C	В	Mod	В	В



Discussion on: Mokolo future concerns?









Socio-economic consequences

- Scenarios:
 - ESBC: Ecological = PES, present water use
 - REC, present water use
- Socio-economic consequences of these scenarios:
 - Very large future growth in coal mining, industrial and urban economic sectors
- Other considerations:
 - Risk to ecosystem services due to coal mining effects
 - Changes in streamflow as a result of dewatering
 - Future AMD
 - Aesthetic effects

	Mokolo - present	Mokolo - future
	water use	water use
D/ M:II: a.c./a		
R' Million/a		
Agriculture	358	540
Mining	2,327	6,291
Manufacturing	2,077	4,071
Utilities	966	10,187
Other commerce	4,089	9,141

2,778

9,757

Value Added





Proposed Management Class per IUA







MC Descriptions

	Management Class Descriptions									
Class I	Minimally used Water resource is one which is minimally used and the overall condition of that water resource is minimally altered from its pre-development condition									
Class II	Moderately used Water resource is one which is moderately used and the overall condition of that water resource is moderately altered from its pre-development condition									
Class III	Heavily used Water resource is one which is heavily used and the overall condition of that water resource is significantly altered from its pre-development condition									







Preliminary guidelines for determining the IUA class for a scenario

		Percentage (%) of nodes in the IUA falling into the indicated EC groups							
		> = A/B	>= B	> = C	> = D	< D			
Class I		40	60	80	99				
Class II			40	70	95				
Class III	Either			30	80				
	Or				100				

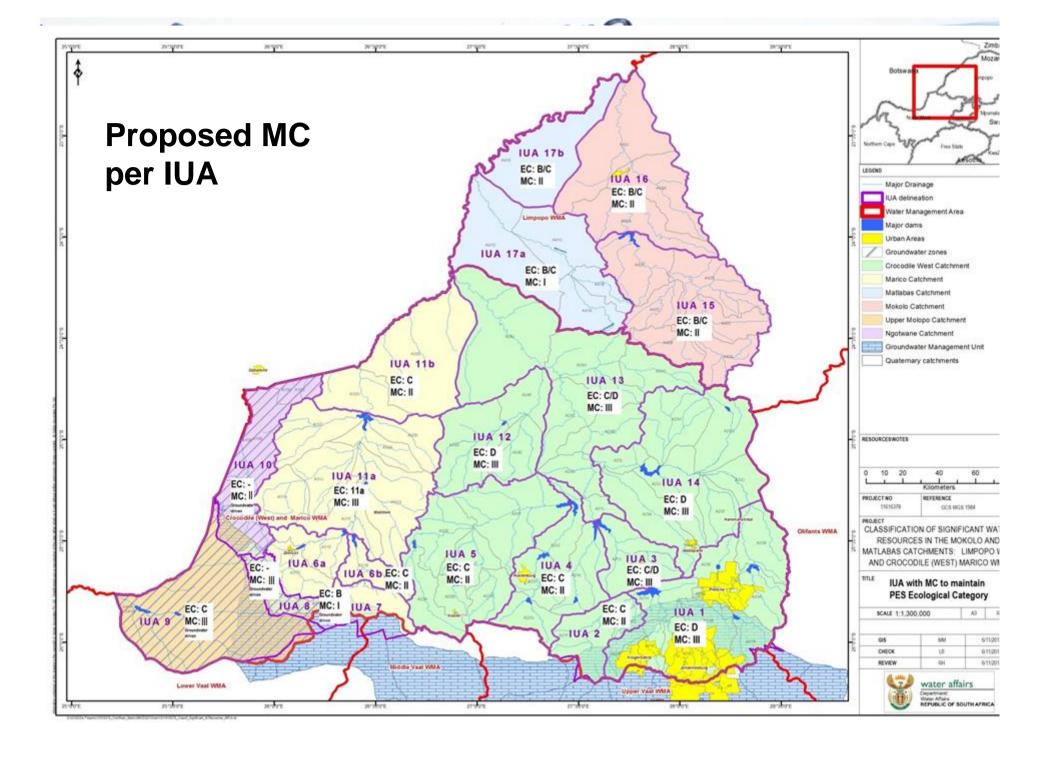






_			400.7				
		Percentage (%)	ed EC groups	IUA Class for ESBC Scenario			
	IUA	> = A/B	>= B	> = C	> = D	< D	
١	1			20%	33.3%	46.6%	III
	2		50%	50%			II
	3			100%			III
Ī	4		14.2%	42.9%	42.9%		II
Ī	5			100%			II
Ī	6a			100%			II
Ī	6b		66.7%	33.3%			II
Ī	7		100%				I
Ī	8						*
Ī	9					100%	*
Ī	10						*
Ī	11a			100%			II
Ī	11b			100%			II
Ī	12				100%		III
Ī	13			75%	25%		III
Ī	14		25%	25%	50%		III
	15		66.7%	33.3%			II
	16		66.7%	33.3%			II
Í	17a		100%				1
1	17b		100%	_		_	II
4			•	•	•	•	

*Relates to groundwater use





Questions?



