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

Determination of Ecological Water Requirements for Surface Water (Rivers, Estuaries and Wetlands) and Groundwater in the Lower Orange WMA: WP10974

16 November 2016

GROUNDWATER EWR

Karim Sami: WSM Leshika Consulting Engineers

WATER IS LIFE, SANITATION IS DIGNITY

RESOURCE UNITS: WHERE DOES IT FIT?

1. Initiate the BHN and EWR assessment
How will be study be executed?

2. Delineate RU, select study sites
Where will detailed work be undertaken?

4. Determine BHN and EWR
How much water do you need for basic human needs and to maintain a certain ecological status?

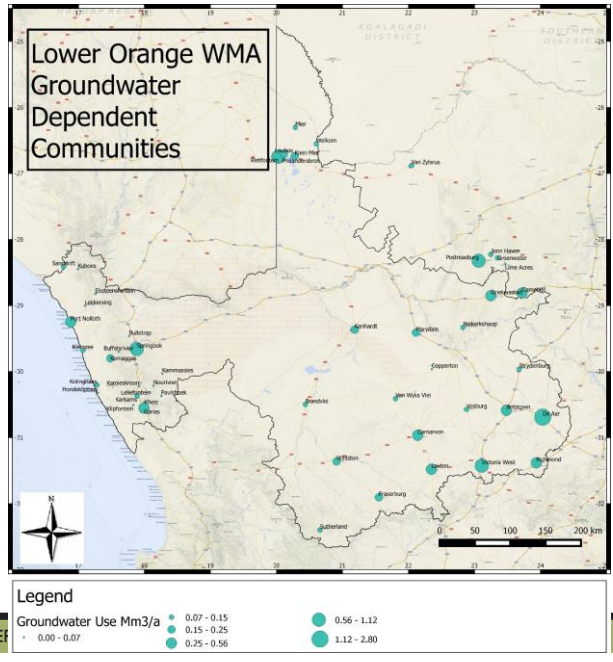
3. Determine reference condition, PES and EIS
What are the ecological status, importance and future ecological objectives?

5. Determine operational scenarios and evaluate consequences
How will the current state and ecological objectives be influenced by future changes in operation?

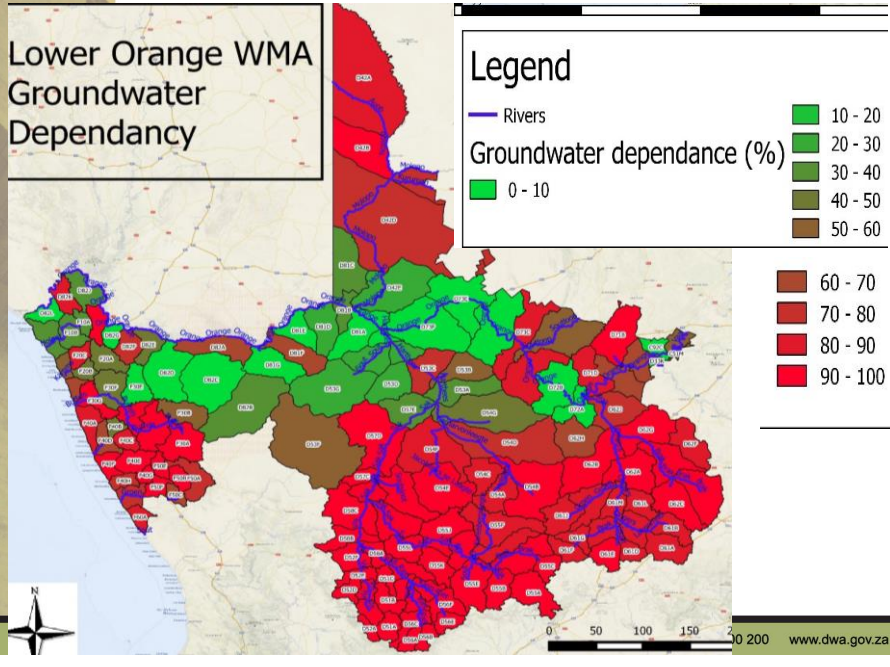
6. Ecological specification, monitoring and implementation information
How do we know that we will achieve our objectives

WATER IS LIFE - SANITATION IS DIGNITY Toll Free: 0800 200 200 www.dwa.gov.za

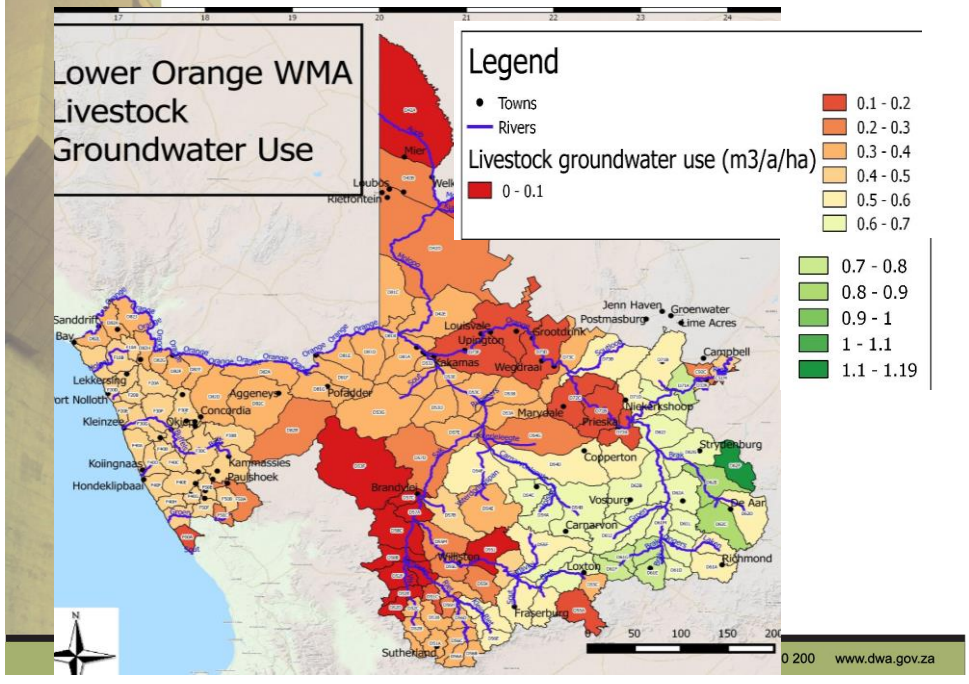
GROUNDWATER DEPENDENCY - DOMESTIC



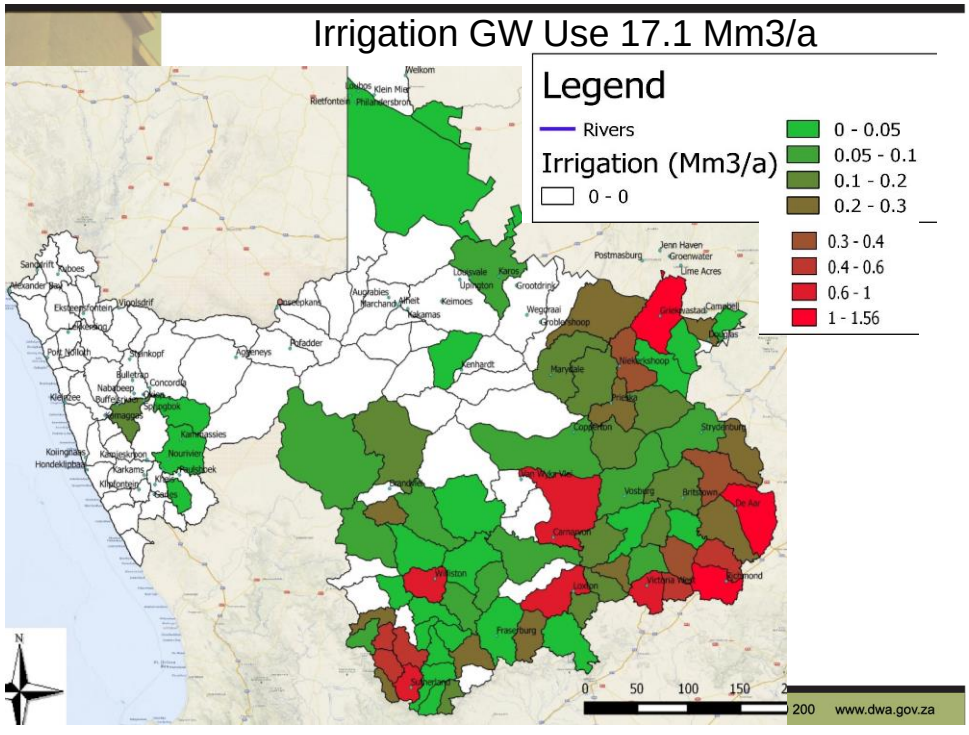
GW Dependency – Schemes + Schedule 1



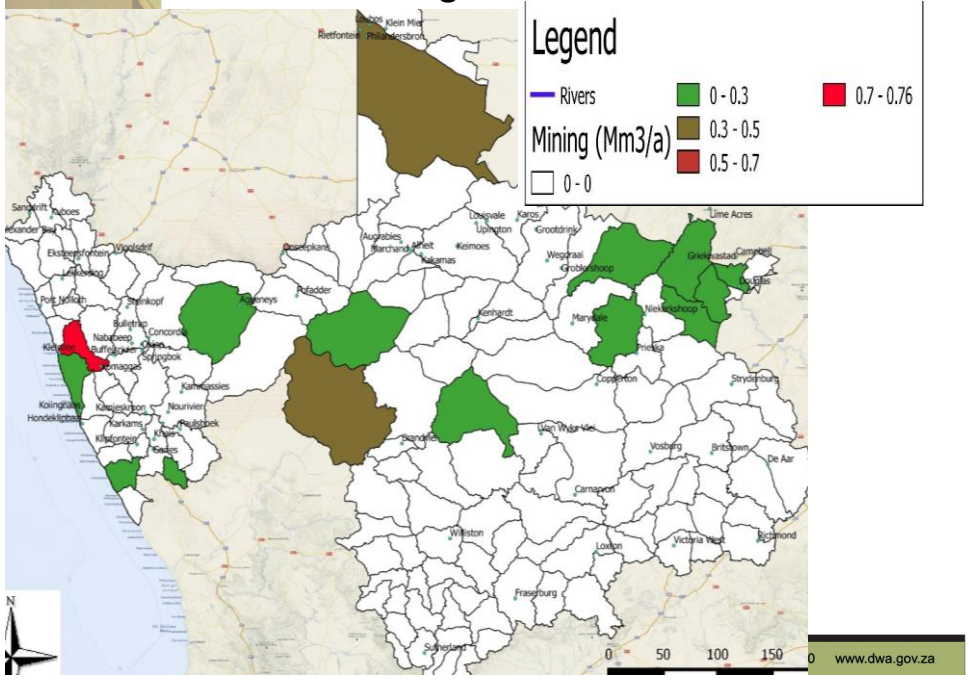
Livestock GW Water Use 9.87 Mm3/a



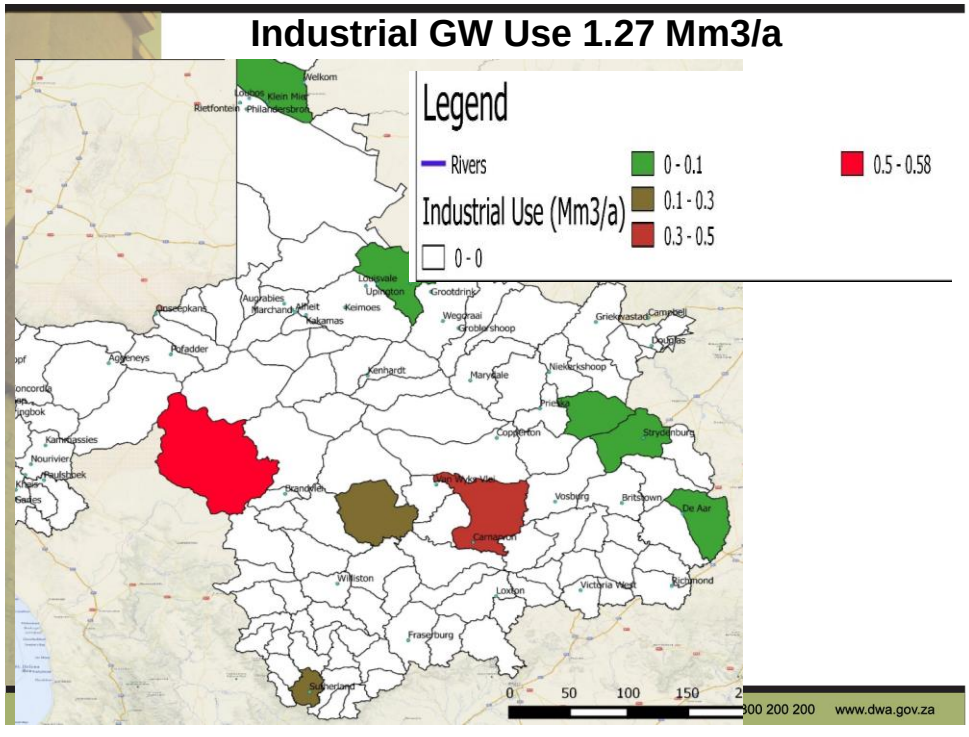
Irrigation GW Use 17.1 Mm3/a



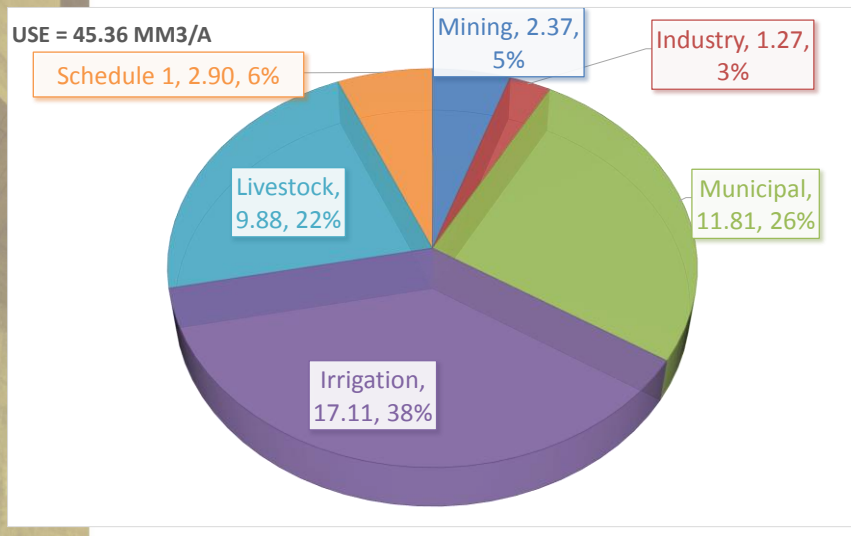
Mining Water Use 2.37 Mm/a



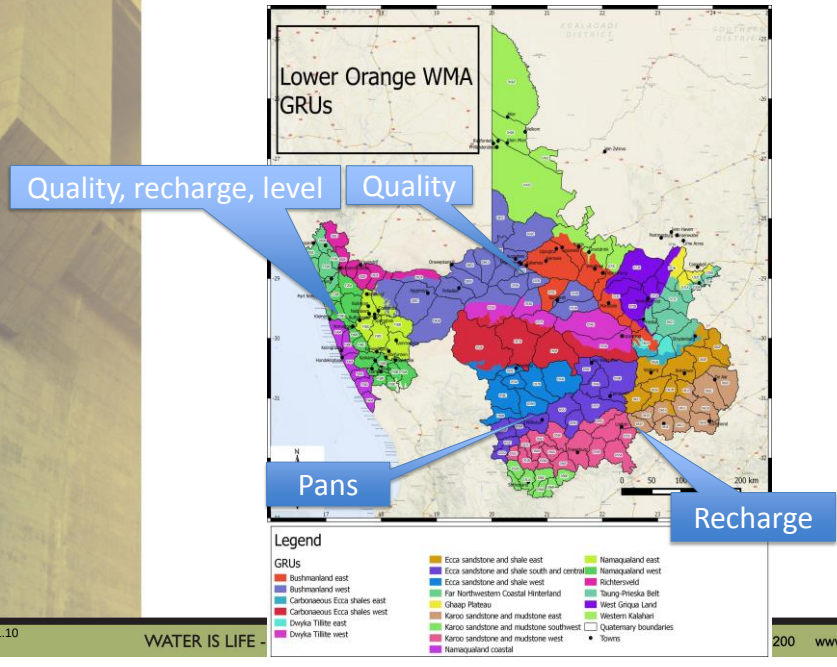
Industrial GW Use 1.27 Mm3/a



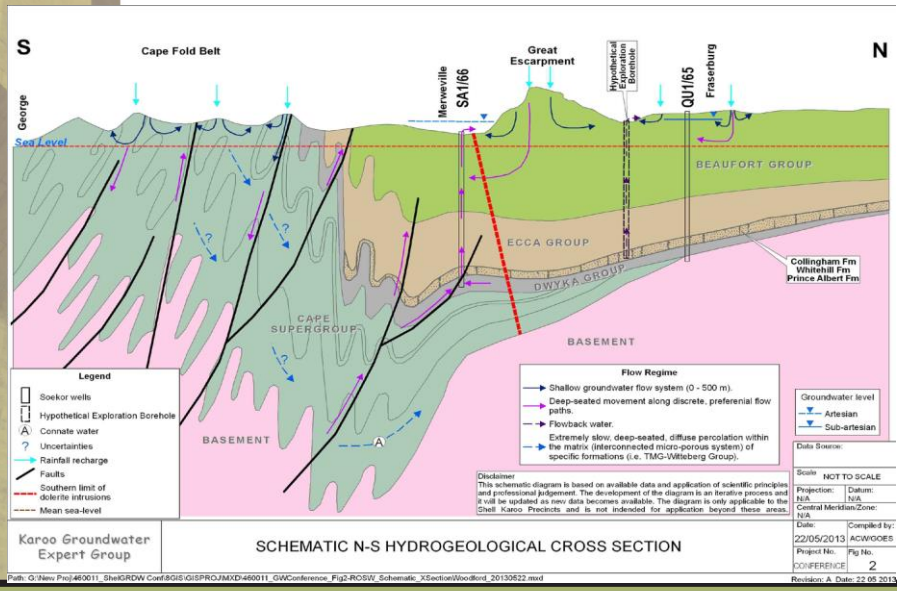
GW Use Summary



GRUs – Criteria for subdivision



Geological Cross-section of the Karoo and Fracking

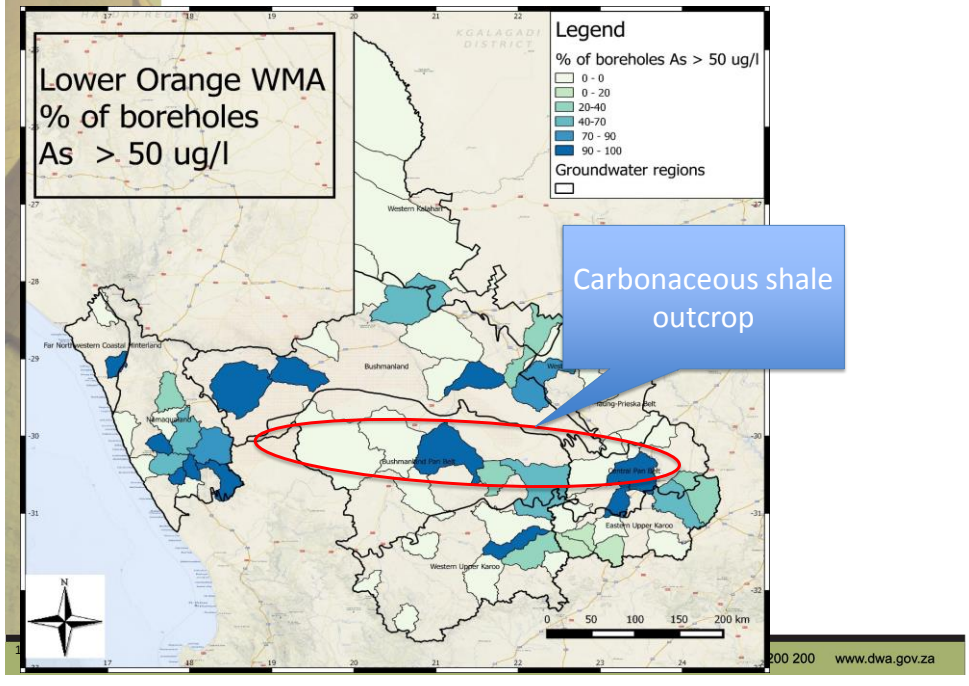


GW Chemistry and Implications for Fracking - Arsenic

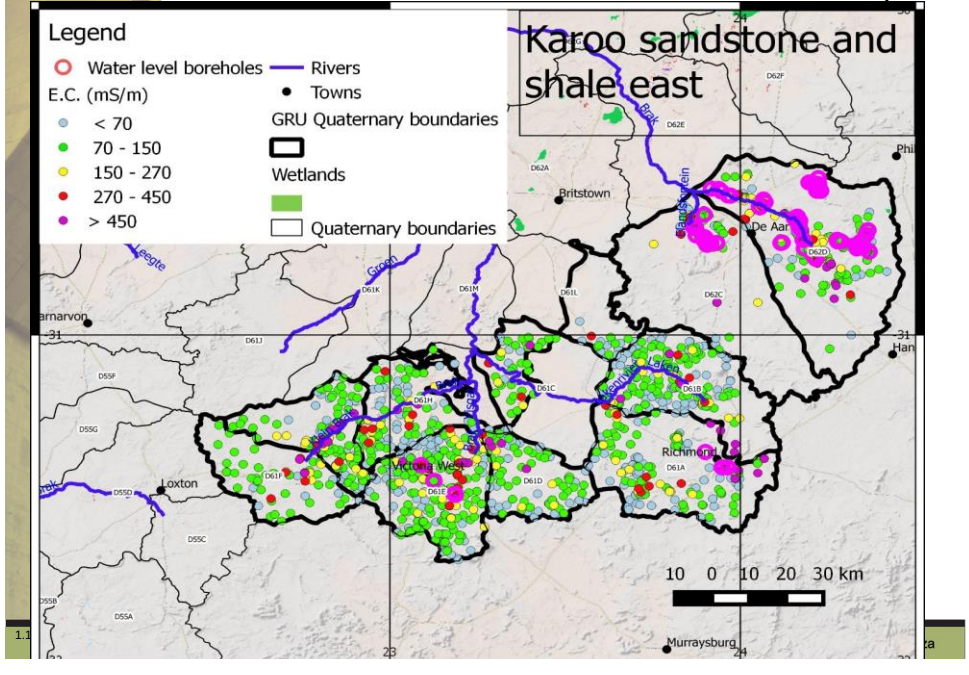
- occurs in sulphide rich mineralised areas
- geothermal springs
- volcanic rocks of intermediate (andesites) to felsic (rhyolites) but far less is (basaltic/doleritic) rocks.
- Only found in sedimentary rocks, such as the Karoo, where sulphide mineralisation occurs under reducing conditions, such as black carbonaceous shales.

- Significant occurrences of As the eastern Western Upper Karroo and the Eastern Upper Karroo cannot be explained by the geology, which does not contain As minerals.
- As could be an indicator of upwelling deeper ground water from the underlying carbonaceous shales.
- Associated with higher TDS yet these are zones of higher recharge
- This is potentially of concern as it suggests that groundwater from the carbonaceous shales potentially targeted for fracking could be upwelling into the shallow aquifer, and conduits between the deep and shallow groundwater could exist.

Arsenic



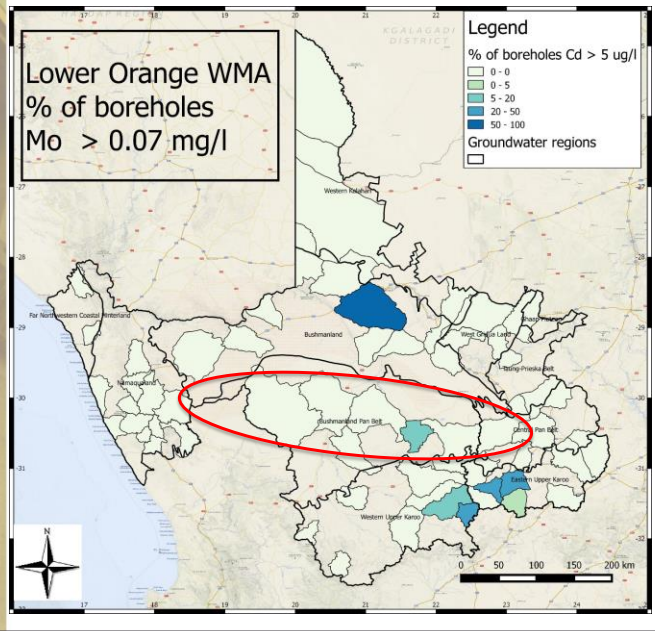
Karoo Sandstone and Shale Electrical Conductivity



GW Chemistry and Implications for Fracking - Molybdenum

- widely present at trace levels in association with organic matter and sedimentary sulphide minerals, notably in black shale.
- sparingly incorporated in major rock-forming silicates (ie sandstones).
- Mo can be an indicator of groundwaters in contact with carbonaceous shales or copper

Molybdenum



Implications for Fracking

- The contamination from fracking would consist of:
- High TDS groundwater & methane captured in the organic Ecca shale
- the fracking fluids that will be used during the process
- the existing elements in the shale that will be released due to input of fracking fluids (As, Mo, elements associated with organic sediments).
- Contamination from deep hydraulic fracturing requires:
- An upward hydraulic gradient
- a pre-existing hydraulic connection between the shales and shallow groundwater via faults, fractures or dyke contact zones, or
- that fracking may create such hydraulic connection and allow deep saline groundwater and fracking chemicals to migrate upward into shallow groundwater. (failed caps or casings in boreholes)

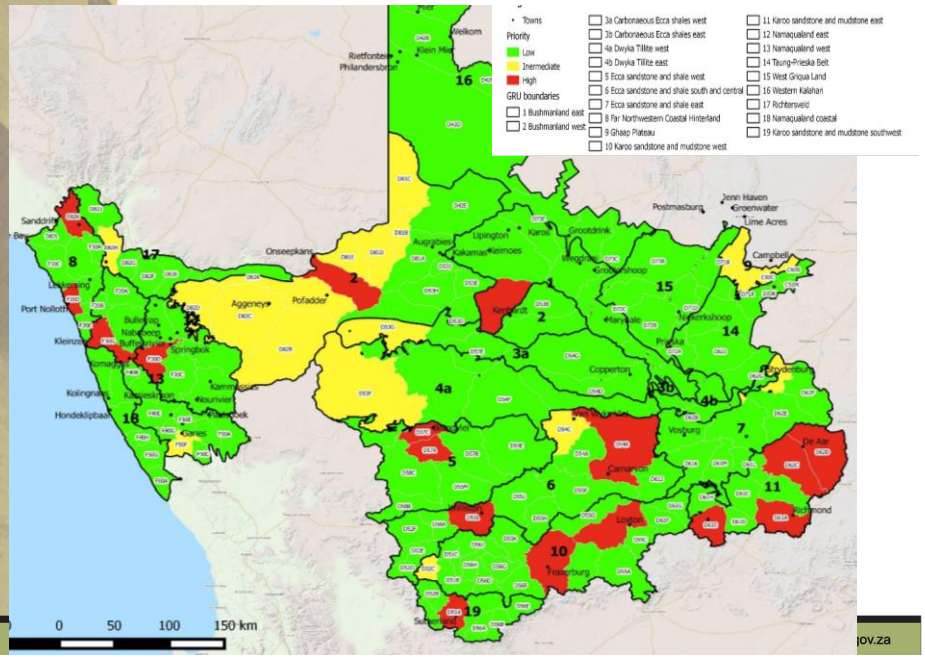
Implications for Fracking

- Due to the depths involved and the low vertical permeabilities of the rocks involved, upwelling is slow.
- If pressures do not recover because the shales exist as a closed system with impermeable boundaries and there will be no water pollution from depth.
- The above assumes that the entire fracked reservoir is successfully plugged to prevent rapid upward migration of contaminants through the fracking wells.

Criteria for Prioritisation of Catchments

- Importance of the RU to users (degree of groundwater dependence);
- Threat posed to water resource quality for users (aquifer vulnerability)
- Threat posed to water resource quality for the environment (baseflow);
- Degree of use (stress index)

Priority Catchments



Priority Catchments - Example

GRU	Catchment	Priority	Groundwater dependency (%)	Stress index	Main stresses	PSC	Water level decline (m)
Carbonaceous Shale	D53F	Intermediate	51	1.47	Mining Industry	F	
Ecca Sandstone and Shale West	D57A	High	92	0.86	Irrigation	E	3
	D57C	High	98	0.75	Regional schemes	E	
Ecca Sandstone and Shale Central and Southwest	D54B	High	98	0.26	Irrigation Regional schemes	C	15
	D54C	Intermediate	87	0.22	Regional schemes	C	0
	D55L	High	99	0.56	Irrigation	D	10
Ecca Sandstone and Shale East	D62G	Intermediate	95	0.05	Regional schemes	B	5
Far Northwestern Coastal Hinterland	D82K	High	82	2.63	Regional schemes	F	
	F20D	High	55	2.78	Regional schemes	F	
Ghaap Plateau (dolomitic)	C92B	Intermediate	52	0.06	Dolomites	B	
	C92C	Intermediate	6	0.22		C	

Groundwater Component of the Reserve

- Reserve = (EWRgw + BHNgw)
- Where:
- BHNgw = basic human needs derived from groundwater
- EWRgw = groundwater contribution to EWR

- Groundwater contributions for the EWR include:
- • Baseflow to rivers and springs
- • Seepage to wetlands and groundwater dependent ecosystems

Basic Human Needs

- The BHN component of the Reserve (BHN) are set by the Water Services Act (Act No. 108 of 1997) at 25 ℓ/p/d.
- The definition of the Reserve refers to people who are now or who will - in the reasonably near future - be reliant on a resource for water.
- The BHN component of the Reserve was calculated by multiplying the number of people WITHOUT A CURRENT FORMAL SOURCE OF WATER SUPPLY by 25, 60 and 100 ℓ/d.
- Where people already has access to a formal regional water system, setting aside a BHN for this portion and adding it to existing lawful groundwater use would result in a double accounting

Basic Human Needs

- Based on census 2011 and adjusted to 2015 by district growth rate
- Analysed by household water source by Quat (regional scheme, borehole, spring, rainwater, run of river, water vendors, water tanks etc
- Those receiving water from a scheme were excluded, as where does dependent on boreholes (Schedule 1)
- Calculated 0n 25, 60 and 100 l/c/d

Total Population	**451,650**
Population not serviced	95,957
Population not serviced excluding borehole	55,901
Population borehole dependant	40,056
BHNR 1: 25 l/c/d excluding borehole dependant	1,397,525
BHNR 2: 60 l/c/d excluding borehole dependant	3,354,060
BHNR 3: 100 l/c/d excluding borehole dependant	5,590,100

Allocable Groundwater

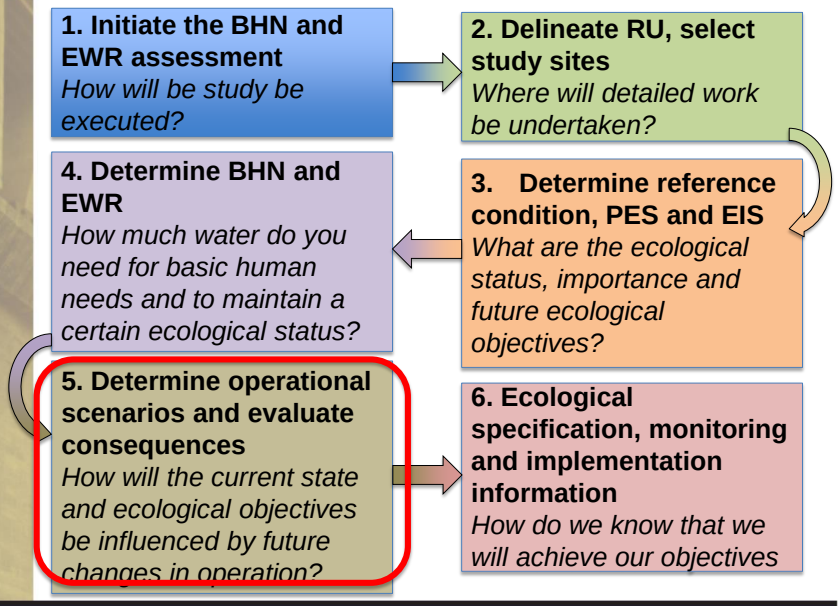
- The allocable groundwater is the difference between recharge and the Reserve (minus current lawful use including livestock and Schedule 1 users).
- Due to the variability of recharge in arid and semi-arid areas, allocable groundwater should not exceed 65% of recharge.
- take into account Schedule 1 usage and Existing Lawful Users before new license applications can be considered.

Karoo sandstone and shale (Sutherland area) Example of Reserve calculation

QUAT	MAP	Area	Recharge	Groundwater use (Mm3/a)									PSC
		km²	Mm³/a	Irrigat	Stock	mining	indust	Sched1	Reg sch	TOT	Dom	Stress Index	
D51A	312	797	5.05	0.818	0.028	0.000	0.130	0.012	0.150	1.138	0.162	0.23	C
D52A	319	378	3.06	0.266	0.013	0.000	0.000	0.003	0.000	0.282	0.003	0.09	B
D52B	267	660	3.29	0.428	0.023	0.000	0.000	0.004	0.000	0.455	0.005	0.14	B
D56A	292	510	3.00	0.024	0.018	0.000	0.000	0.004	0.000	0.045	0.004	0.02	A

QUAT	Recharge	Current Use	GW EWR	BHN	GW Component of the Reserve	Allocable groundwater
	Mm³/a	Mm³/a	Mm³	Mm³	Mm³	Mm³
D51A	5.05	1.138	0.1594	0.00347	0.16287	2.438
D52A	3.06	0.282	0	0.00078	0.00078	1.808
D52B	3.29	0.455	0	0.00130	0.00130	1.840
D56A	3.00	0.045	0	0.00104	0.00104	1.922

GROUNDWATER COMPONENT: WAY FORWARD TO NEXT MEETING



QUESTIONS FOR CLARIFICATION