THEME 1: Dual Strategy for Desalination of Groundwater and Surface (sea) water

MINISTERIAL INTERACTIVE SESSION
WITH WATER & SANITATION SECTOR

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1. Background

- Seawater desalination can supply an unlimited quantity of high-quality, fully assured fresh water at a predictable price. This attribute effectively converts water from an economic constraint to an uncapped economic commodity;

- Desalination technology is mature, and is being implemented by a vibrant and growing industrial sector. World-wide, around 75,000 mega-litres (Ml/day) of fresh water is produced by some 18,000 desalination plants, with some 4,500 Ml/day capacity being added each year.

- In South Africa, as of October 2018, **30** desalination plants have been built over the past few years, for both surface and groundwater treatment, and are in various states of operation, with installed capacity of 208 Ml/day as shown in Annexure 1.

- Another **four** plants were under construction, and a further **19** were in various stages of planning. Cape Town was, in the early half of 2018, exploring the viability of a desalination plant in the 150-450 Ml/day range, to supplement water supply to a demand in the region of 950 Ml/day

- Seawater provides 60% of the global feed water, with most of the balance being brackish groundwater and wastewater..

- Two desalination technologies are used in large-scale plants: **Reverse osmosis** dominates with a 65% market share, largely due to better energy efficiency. Less efficient **thermal desalination** technology is usually co-located with a coastal power plant, and is largely confined to the Middle East and North Africa regions.

- Desalination is an essential technology in the development of **climate resilience** within the urban context. With climate change being manifested by *inter-alia* an increase in the severity and frequency of both floods and droughts, there is evidence that desalination can be used to mitigate potable water supply disruption caused by either event, by virtue of desalination being a secure, closed, potable water system.

- Simulation studies have demonstrated that when desalination plants are used continuously, they allow the water levels in existing dams to be kept at a lower level, without reducing security of supply, and hence raise the effectiveness of the dams as flood protection infrastructure. The biggest risk for many of the constructed plants in South Africa is the intermittent operation, which occurs when cheaper water is available.

- The National Desalination Strategy of 2011 indicated that metropolitan municipalities, larger municipalities and water boards could have the capacity to implement large-scale desalination projects. It would be prudent to ensure that the implementing agents are fully cognisant of the implementation considerations and operational requirements.

- Data from 210 large-scale seawater reverse osmosis (SWRO) plants completed over the past two decades indicate that the capital cost for desalination plants is in the range **US$600 – $1600/m^3/day** capacity, which is effectively the second and third quartiles of the benchmark population.

- The product cost is a factor of the capital cost and the operational cost, and the benchmark indicates a range of **US$0.60 – $1.20/m^3**. (At 1US$ = R13.00, a 150 Mega-litre/day SWRO plant should be in the range ZAR1.2 - ZAR3.1 billion, while the product would be between ZAR7.80 and R15.60/m^3. It is important to note that costs within these parameters can only be achieved when projects are well-designed, the site is suitably located to allow cost-effective construction, and risks are adequately mitigated.

- Arguably the single most important factor in desalination project design is the specific site chosen to locate the plant. This will determine whether significant construction costs could be avoided or not, and pre-determine long-term operational costs. Desalination plants are usually only viable near large urban hubs, where it often has to compete with other land use for a finite number of coastal sites, which could lead to a sub-optimal choice.

- Favourable site characteristics include ease of water and power grid integration, an industrial precinct, direct access to a sterile beachfront, geophysical conditions that allow cost-effective seawater intake and outlet structures, and a previously disturbed site. Where it is possible to co-locate the desalination plant with a coastal power plant, as may be the case at Koeberg NPS, further benefits accrue like significantly lower capital outlay, since seawater intake and outlet structures already exist, and lower specific energy consumption, due to the feed-water taken from the power plant being slightly warmer than ambient.

2. Facilitating Desalination Implementation

a. A climate of **policy certainty**, underpinning a firm, long-term commitment to adopting desalination, is conducive to lowering the real or perceived risk of a project. Conversely, policy uncertainty will result in the technology partners, typically comprising private sector consortia, adding a risk premium to their bids

b. The adoption of an **appropriate contracting regime**. Since desalination infrastructure is vastly more complex than conventional surface water infrastructure, it requires the demarcation of roles and placement of risk to be fundamentally reconsidered. The traditional **engineering-procurement-construction (EPC)** approach, popular with conventional water infrastructure, is inappropriate for larger desalination implementations, as it fails to allocate roles and risks appropriately, and will probably elicit objections from potential project financiers.

c. The skills required for the design, construction, operation and maintenance of a large desalination plant resides largely in the private sector, and it is deemed a good practice to procure the entire suite of services from a single consortium, to allow for continuity.

d. Following this approach, two contracting regimes exist:

   i. The design-build-operate-maintain (DBOM) regime, wherein the implementing agent funds the project, and hence retains ownership, but all design, construction and operational risk is placed with the technology partner, for an extended period after completion.

   ii. The alternative contract regime is the build-operate-transfer (BOT), whereby the chosen technology partner funds the project, normally through a concession, and hence carries all operational and financial risk over a period of typically 20 years. The technology partner will rely on a robust *"take-or-pay"* water purchase agreement with the local authority, to ensure a long-term revenue stream, and so redeem the capital and operational outlay. At the end of the contract term, the facility would typically be transferred to the local authority.

   iii. Both DBOM and BOT contract regimes are commonly used to procure large-scale desalination; DBOM places more control and currency risk with the local authority, can run over a shorter contract period, and could facilitate a structured knowledge transfer, to capacitate the local authority for sole operation, after the contract ends. A BOT contract places more control and risk with the consortium, and usually runs for a longer period to allow for capital redemption. Policy uncertainty and political risk will be fully priced.

e. Plant **operation regime** is important, as desalination plants are at risk that the demand for desalinated water may not be sustained, once dam levels have been restored after a drought or low water availability event.

   i. This prompts a key decision whether the desalination plant should continue operation, even when cheaper water resources have become available, or whether it should be mothballed until the next drought?

   ii. Demand-side risk cannot be transferred to a technology partner or service provider, as design and operational risks usually are. In both the DBOM and BOT contract regimes, the cost of having the desalination plant available, even when it is not being used, is carried by the local authority, and recovered from the consumer through tariffs.

iii. Continued operation, albeit more costly in the short term, yields benefits in the longer term: Incremental improvement of plant operations, the local development of a supplier base and a skilled resource pool, and a clear indication that the city has adopted a substantial element of climate resilience. Hence, the notion that a desalination plant should continue operation, regardless of circumstances, is increasingly being supported.

ANNEXURE A

Table 1: Desalination plants in operation, under construction and being planned

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
	(a) Desalination plants – constructed							
1	Sedgefield	WC	Sedgefield	Knysna	2.00	Direct potable	Implemented	Operational
2	Knysna	WC	Knysna	Knysna	2.00	Direct potable	Implemented	Shut down for maintenance and repairs. During normal operation, the plant is used at the discretion of the municipality.
3	Plettenberg Bay	WC	Plettenberg Bay	Bitou	1.50	Direct potable	Implemented	Operational
4	Mossel Bay	WC	Mossel Bay	Mossel Bay	15.00	Direct potable	Implemented	Plant is currently on standby as the dams in the area are full. 5Ml/day is for PetroSA and 10 Ml/D allocated to municipality
5	Bitterfontein	WC	Bitterfontein	Matzikama	0.15	Direct potable	Implemented	Groundwater treatment
6	Lamberts Bay	WC	Lamberts Bay	Cederberg	1.70	Direct potable	Implemented	Sources seawater from boreholes

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
								drilled near the shore – close to Muisboss kerm
7	Strandfontein	WC	Cape Town	City of Cape Town	7.00	Direct potable	Implemented	Currently producing 3 Ml. An additional 4 Ml/day to be brought on line
8	V&A Waterfront	WC	Cape Town	City of Cape Town	2.00	Direct potable	Implemented	Operational supplying potable water
9	Koeberg Desalination Plant	WC	Koeberg	City of Cape Town	0.004	Direct potable	Implemented	Small mobile plant that treats groundwater for Eskom requirements
10	Robben Island	WC	Robben Island	City of Cape Town	0.50	Direct potable	Implemented	Operational to supplement Robben Island water sources
11	Bushman's River Mouth/ Albany Coast	WC	Kenton-on-Sea/ Bushmans River Mouth	Ndlambe	1.80	Direct potable	Implemented	Refurbished in 2010. Currently producing at full capacity. Operating more than 8 years. Conjunctive use

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
								with ground water
12	Cannon Rocks	EC	Kenton-on-Sea/ Bushmans River Mouth	Ndlambe	0.75	Direct potable	Implemented	Currently producing at full capacity. Operating for 12 years, conjunctive use with ground water
13	Emalahleni Water Reclamation Plant	MP	Emalahleni	Emalahleni	50.00	Direct potable	Implemented	Treats impacted water from local collieries to potable standard. 1.Initially 30ML/day 2.Upgraded to 50 ML/Day in 2013
14	Robert Clarke Water Treatment (Matla Coal Mine)	MP	Kriel	Steve Tshwete	10.00	Environment, direct potable and industrial	Implemented	Treats Coal Mine Water
15	Tweefontein Water Treatment Plant	MP	Phola, Ogies and Welge	Steve Tshwete	15.00	Environment and direct potable	Implemented	Treats Coal Mine Water
16	South32 Water Treatment Plant (Middelburg Water Reclamat	MP	Middelburg	Steve Tshwete	20.00	Environment and direct potable	Implemented	Treats Coal Mine Water

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
	ion Project)							
17	Optimum Water Reclamation Plant	MP	Hendrina	Steve Tshwete	15.00	Direct potable, Environment	Implemented	Treats Coal Mine Water. Currently not operational
18	Durban combined Wastewater and desalination	KZN	Durban	Durban	47.50	Direct potable	Implemented	Combined wastewater and seawater treatment plant
19	Richards Bay	KZN	Richards Bay	Umhlathuze	10.00	Direct potable	Implemented	Plant commissioned in 2016 an emergency scheme for drought alleviation for the City of Mhlatuze. Operating at 6 Ml/day
20	Transnet, Saldanha	WC	Saldanha Bay	Saldanha Bay	2.40	Direct Industrial	Implemented	Industrial water for use in dust suppression
21	Garies	NC	Garies	Kamiesberg	1.54	Direct potable	Implemented	Groundwater treatment
22	Paulshoek	NC	Paulshoek	Kamiesberg	0.11	Direct potable	Implemented	Groundwater treatment
23	Spoegrivier	NC	Spoegrivier	Kamiesberg	0.15	Direct potable	Implemented	Groundwater treatment

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
24	Soebatsfontein	NC	Soebatsfontein	Kamiesberg	0.05	Direct potable	Implemented	Groundwater treatment
25	Klipfontein	NC	Klipfontein	Kamiesbereg	0.03	Direct potable	Implemented	Groundwater treatment
26	Kheis	NC	Kheis	Kamiesberg	0.03	Direct potable	Implemented	Groundwater treatment
27	Leliefontein	NC	Leliefontein	Kamiesberg	0.03	Direct potable	Implemented	Groundwater treatment
28	Van Wyksvlei	NC	Van Wyksvei	Kareeberg	0.32	Direct potable	Implemented	Groundwater treatment
29	Swartkopdam	NC	Swartkopdam	Dawid Kruiper	0.01	Direct potable	Implemented	Groundwater Treatment
30	Die Keldars	WC	De Kelders	Overstrand	1.6	Direct potable	Implemented	Groundwater Treatment
	Total				**208.18**			
	(b) Desalination plants under construction							
1	Monwabisi	Western Cape	Cape Town	City of Cape Town	7.00	Direct potable	Construction	
2	Witsand	Western Cape	Witsand	Hessequa	0.30	Direct potable	Construction	Normal production of 100 kL/day, rising to 300 at peak periods
3	Port Alfred	Eastern Cape	Port Alfred	Ndlambe	5.50	Direct potable	Construction	This plant is to treat brackish water and improve existing water quality.

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
4	Loxton	Northern Cape	Loxton	Ubuntu	0.29	Direct Potable	Construction	
	Total				**13.09**			
	(c) Desalination plants under various stages of attention							
1	Tongaat plant - KZN North Coast	KZN	Tongaat	Ethekwini	150.00	Direct potable	Planned	Mgeni Water completed feasibility investigations for the desalination of sea water at the Tongaart site. Need for this plant is in question. EIA is under way.
2	Illovo Plant - KZN South Coast	KZN	Illovo	Ethekwini	150.00	Direct potable	Planned	Mgeni Water completed feasibility investigations for the desalination of sea water at Illovo, and currently an EIA is under way.
3	Krugersdorp, (Western Basin AMD Works)	Gauteng	Krugersdorp	Randfontein	40.00	Environment	2020	Feasibility Study for a Long-Term Solution

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
								to address the Acid Mine Drainage (AMD) associated with the East, Central and West Rand underground mining Basins was completed in 2013.
4	Germiston, (Central Basin AMD Works)	Gauteng	Germiston	Germiston	86.00	Environment	Planned	Feasibility Study for a Long-Term Solution to address the Acid Mine Drainage (AMD) associated with the East, Central and West Rand underground mining Basins was completed in 2013.
5	Springs, (Eastern Basin AMD Works)	Gauteng	Springs	Springs	108.00	Environment	Planned	Feasibility Study for a Long-Term Solution

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
								to address the Acid Mine Drainage (AMD) associated with the East, Central and West Rand underground mining Basins was completed in 2013.
6	Hout Bay	Western Cape	Cape Town	City of Cape Town	4.00	Direct potable	Planned	Put on hold due to budget constraints
7	Granger Bay	Western Cape	Cape Town	City of Cape Town	8.00	Direct potable	Planned	Put on hold due to budget constraints
8	Red Hill/Dido Valley	Western Cape	Cape Town	City of Cape Town	2.00	Direct potable	Planned	Put on hold due to budget constraints
9	Harmony Park	Western Cape	Cape Town	City of Cape Town	8.00	Direct potable	Planned	Put on hold due to budget constraints
10	Cape Town Harbour	Western Cape	Cape Town	City of Cape Town	50.00	Direct potable	Planned	Put on hold due to budget constraints
11	City of Cape Town: Koeberg / Atlantis	Western Cape	Cape Town	City of Cape Town	150.00	Direct potable	Planned	Put on hold due to budget constraints

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
12	Universal sites	Western Cape	Cape Town	City of Cape Town	20.00	Direct potable	Planned	Put on hold due to budget constraints
13	Mhlatuse Phase 2	KZN	Richards Bay	Umhlathuze	12.00	Direct potable	Planned	Put on hold due to budget constraints
14	Nelson Mandela Bay Metro (Port Elizabeth western side)	Eastern Cape	Port Elizabeth	Port Elizabeth	15.00	Direct potable	Planning phase	Emergency package plant design on the Western side as a drought mitigation measure, if drought conditions persist.
15	Nelson Mandela Bay Metro (Port Elizabeth Western side)	Eastern Cape	Port Elizabeth	Port Elizabeth	60.00	Direct potable	Planning phase	Feasibility level investigations done on site selection. Concept and detailed design not yet done. To be compared with costs of new dams in Kouga/Kromme catchments.

No	Name of Desalination plant	Location			Capacity (ML/ Day)	Product end use	Status	Comments
		Province	Nearest town	Local Municipality				
16	Marina Salt - Nelson Mandela Bay Metro (Port Elizabeth Eastern side near Swartkops River)	Eastern Cape	Port Elizabeth	Port Elizabeth	26.00	Direct potable	Pre-planning phase	Marina Salt approached NMBM with possible potable water provision through construction of a sea water desalination plant. NMBM is investigating the contractual and legal implications of an agreement between the two parties.
17	Kouga Desalination	Eastern Cape	Port Elizabeth	Kouga municipality	2.00	Direct potable	Planned	Seawater Desalination
18	Port Nolloth	Northern Cape	Port Nolloth	Richtersveld	1.20	Direct potable	Planned	Seawater Desalination
19	Merriman	Northern Cape	Port Nolloth	Ubuntu	0.04	Direct potable	Planned	Groundwater Desalination
					892.24			

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