Optimising desalination feed water quality using subsurface intakes

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Introduction

Water shortages in coastal NSW regions have prompted local councils to consider desalination for supplementing existing water supplies. Subsurface seawater intakes have a number of advantages over open seawater intakes; including enhanced water quality through natural aquifer filtering, minimising clogging and impacts on marine biota, improved visual amenity and smaller construction footprint. WRL assessed the feasibility of temporary (1 - 8 ML/d) and permanent (50 -170 ML/d) desalination plants at a number of locations including Lakes Beach NSW, in 2004 to 2007.

The water quality results are important determinants in the size and design of the pre-treatment components of the desalination plant. Preliminary testing showed subsurface intakes may deliver an improved and more homogenous water quality, potentially reducing pre-treatment costs and chemical usage.

Aims

To determine the groundwater quality at Lakes Beach NSW; hence, the feasibility of using sub-surface intakes for desalination plants. Specific aims included:

- Assess existing groundwater quality and temporal variations;
- Investigate the subsurface intake orientation likely to deliver optimal water quality;
- Compare groundwater with ocean water quality; and
- Determine sub-surface setting for positioning and orientation of sub-surface intakes.

Investigation Techniques

- Drilling and installation of production bores, water table wells deep and mini-piezometers;
- Pump testing and water quality analysis; and
- Surface water quality sampling and analysis

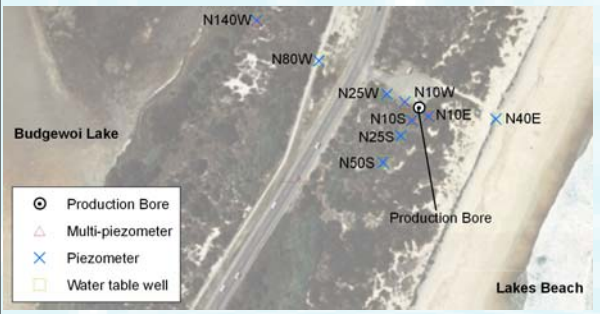

Figure 1. Groundwater sampling locations

Groundwater Sampling and Quality

Samples were taken from locations shown in Figure 1. Results for key parameters for desalination process showed:

- Salinity profiles showed fresh groundwater, overlying a thin transition zone and saline groundwater at depth similar to seawater.
- Temperature at depth was generally slightly higher for ocean water or shallow groundwater. This may lower power demand during the desalination process.
- A dominance of chloride and monovalent ions, which may reduce the requirement for antiscalant additives in pre-treatment
- Total iron concentrations ranged from 0.2 to 7.6 mg/L , which may cause fouling of equipment. Concentrations above 2 mg/L are generally accepted as requiring additional pre-treatment steps.
- TSS ranged from 9 to 24 mg/L (relatively low).

Comparison of Seawater with Groundwater Quality

Seawater samples were collected beyond the breaker zone. Summary of results are shown in Table 1. It can be seen that:

- Many water quality parameters appear more favourable for groundwater including higher temperature, lower SDI, TDS, most metals and true colour.
- Iron concentrations are clearly higher in groundwater

Table 1. Summary of seawater and groundwater quality

Parameter	Units	Seawater	Pump Bore	Treated Water Quality Standard	Bore supply compared with seawater
pH	-	7.56	7.46	7.8-8.2	Lower
Conduct.	µS/cm	58000	55000	-	Fresher
Temp	°C	15.8	19.3	-	Higher*
TDS	mg/L	37900	32371	≤500	Lower
Turbidity	NTU	0.9	0.9	≤ 0.3	Equal
SDI		18	9	-	Lower
Cl	mg/L	23100	20649	≤250	Lower
Na	mg/L	12800	9430	180	Lower
Al	mg/L	< 0.1	0.08	≤ 0.1	Inconclusive
B	mg/L	3.57	3.15	≤4	Lower
Br	mg/L	75	54.8	-	Lower
F	mg/L	0.9	0.3	0.95-1.05	Lower
Fe	mg/L	< 0.5	0.7	≤ 0.02	Higher
Mn	mg/L	< 0.01	0.006	≤ 0.02	Inconclusive

* Indicates potential reduction in pre-treatment costs.

Locating Intakes to Optimise Water Quality

Lateral subsurface intakes (LIs) may be preferable to vertical intakes. LIs draw saline water directly below the seabed, without the risk of drawing on shallow fresh groundwater below the beach and dune system found in water quality testing. Figure 2 shows conceptually how intake orientation, location and depth may affect water quality.

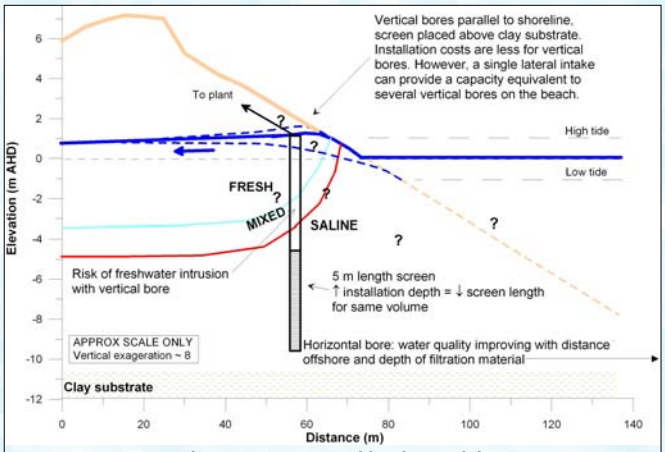

Figure 2. Conceptual intake model

For LIs, ocean currents must be sufficient to prevent accumulation of sediments on the seabed that could reduce infiltration rates. Installation via horizontal drilling requires relatively small construction footprints set back from the beach, without the requirement to disturb beach sands or preclude public access.

Conclusions

Site investigations at Lakes Beach provided information to assess the feasibility of harvesting saline groundwater for desalination. Preliminary results show that the quality of groundwater is generally more favourable for desalination intake water than open seawater, with implications for desalination plant design. Using naturally filtered saline groundwater could lower desalination power requirements and need for antiscalant additives, however, relatively high iron concentrations can be detrimental. Additional samples obtained over a longer time period are required for further assessment and verification of these findings.