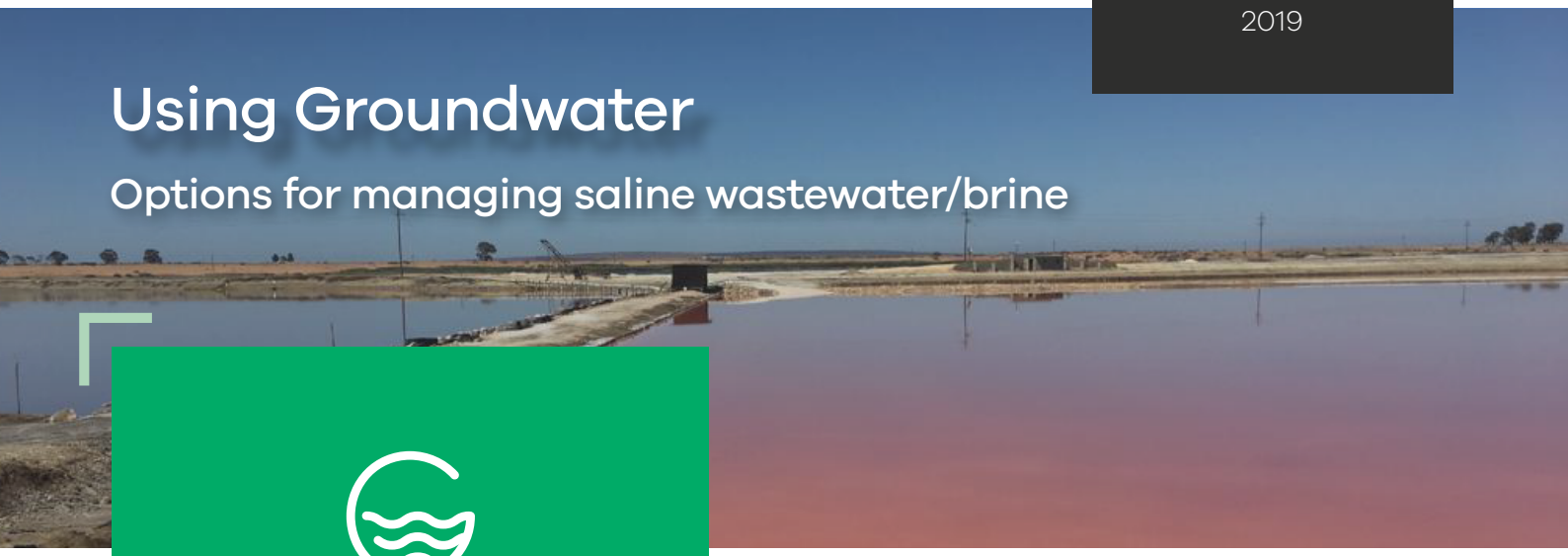
GreenCape

Industry brief
2019

Using Groundwater

Options for managing saline wastewater/brine



Main insights

The level of salinity of groundwater may affect the feasibility of using it as an alternative water source.

There are many options for the treatment and handling of brine derived from saline groundwater. However, few of them are financially viable or easy to implement.

The main barriers to implementation include high capital and operational costs and regulatory requirements.

Water users should investigate partnering with other organisations to improve the business case for treatment of brine.

This industry brief provides information on saline wastewater treatment and disposal options for businesses that are making use of on site groundwater.

Context

- Due to the recent drought in the Western Cape, many companies in Cape Town have turned to groundwater exploration to ensure security of water supply.
- Geological factors influence groundwater quality and geohydrologists have identified some key industrial areas as having a high risk of saline groundwater (conductivity of >170 mS/m or salts concentration of >1200 mg/l[1]).

The Challenge

- Treatment of saline groundwater before use with technologies such as reverse osmosis (RO) membranes leaves a highly concentrated, saline wastewater termed 'brine'.
- Several factors make the discharge and treatment of brine complex and expensive, and companies have been struggling to find well-suited solutions to handle it.

The Solutions

Brine handling options can be grouped into two broad categories (also see figure 1):

1. **Direct discharge –** When brine is discharged directly into the environment or infrastructure without applying any treatment process to it.
2. **Brine treatment –** When brine is subjected to a treatment process in an effort to either minimise the brine volume, to recover a solid waste or to recover valuable salts.

[1] Classification of salinity based on SANS 241 drinking water standards.

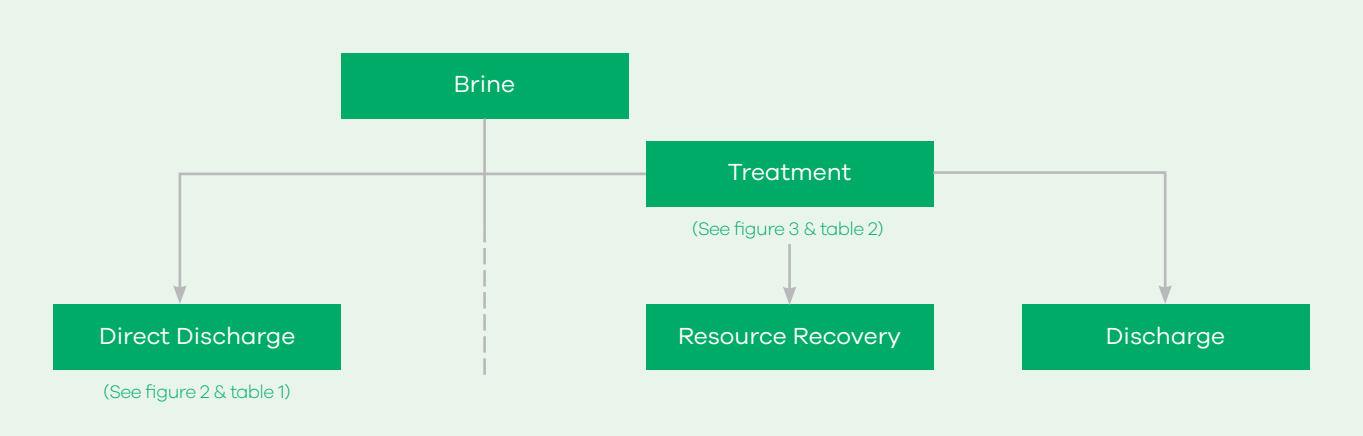


Figure 1
Illustration of the two broad categories of brine handling.

Discharge options for brine

The options available for discharge are limited and some of these are dependent on space availability and location. Figure 2, below, shows the ways companies have been discharging brine and the final endpoint of the brine. In most cases, discharge of brine is detrimental to the environment and municipal infrastructure, which is why several regulations apply to the handling of brine. Table 1, on the next page, details the regulation associated with each of the discharge methods, and the associated barriers.

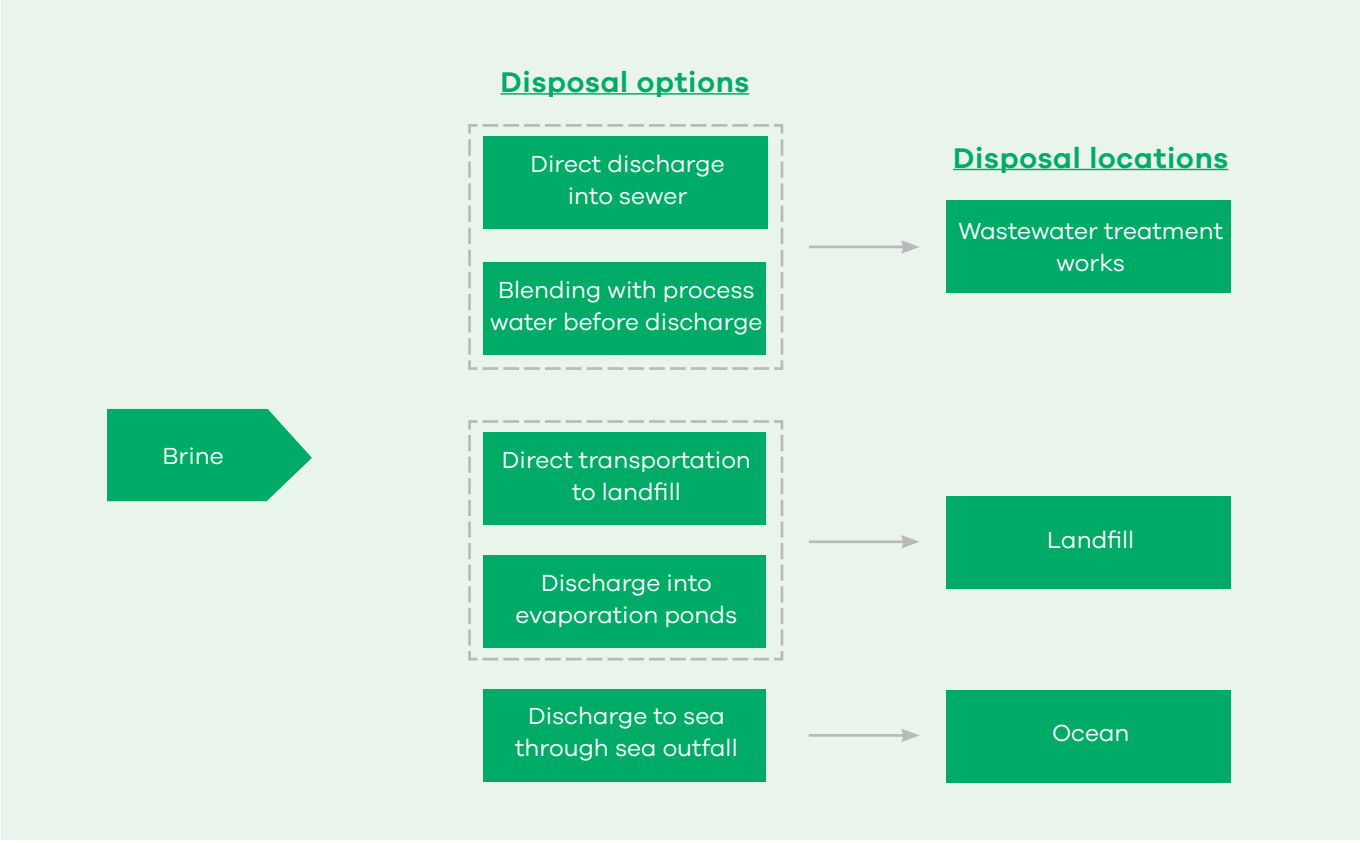


Figure 2
Summary of options available for discharge of brine

Treatment of brine for resource recovery and/or disposal

Whilst many technologies have been developed to treat brine, the main limitation with most of them is the high capital and operational costs. However the potential revenue from the recovered products might offset some of these costs. Figure 3 shows some of the popular technologies available to treat brine and Table 2, on page 4, details the capital and operational costs and limitations of these technologies.

Table 1
Brine handling options

Discharge option	Description	Regulations and potential barriers/limitations to implementation
Direct discharge into sewer	Brine can be discharged directly down the drain, but only if it meets the allowable regulatory requirements.	• Strict regulatory discharge requirements (brine must be below an electrical conductivity of 500mS/m). • System needs constant monitoring and might be prone to spikes in concentrations that are above the regulatory requirements. • A discharge permit is not guaranteed, even if the brine is below regulatory requirements.
Blending with process or clean water before discharge into sewer	Brine can be mixed with process water (with a low concentration of salts) before being discharged into the sewer. This lowers the salinity of the wastewater to a concentration below regulatory requirements.	
Direct disposal to landfill	Currently, brine can be discharged directly to a hazardous Class A landfill. In the City of Cape Town, Vissershoek is the only landfill that accepts hazardous waste, which includes brine sludges and brine wastewater.	Landfill disposal costs range between R1 500/kl and R2 550/kl in the City of Cape Town. • Transportation and logistical complexities. • A liquids-to-landfill ban will come into effect in August (2019) that prohibits the discharge of any wastewater to landfills. Discharge of brine in an almost-solid form, however, will still be permitted until 2021, after which brine waste will no longer be accepted at landfills.
Evaporation ponds	Evaporation ponds are designed to facilitate the process of solar evaporation of wastewater. The ponds are required to have a lining material to prevent leakage of toxic substances underground and to make it easier to remove the solid residue after evaporation.	• Evaporation ponds require a significant amount of land with the size occupied by each pond ranging between 100m^2 to as much as 4km^2 depending on the volume of brine to be treated. • The remaining sludge and solid waste (after evaporation) still needs to be transported to a hazardous waste landfill and the same limitations associated with discharge to landfill will apply.
Discharge to sea through a sea outfall	Companies close to the ocean may have the option of implementing a sea outfall pipeline where the brine is pumped directly into the sea.	Companies need to apply for a sea outfall licence to be able to discharge brine. The maximum allowable concentrations for the brine will be stipulated in the licence but are likely to be less stringent than those for discharging into the sewer. • Capital costs associated with building the sea outfall are relatively high (R10 million/km). • Brine parameters need to be below the regulatory requirements stipulated by the sea outfall licence.

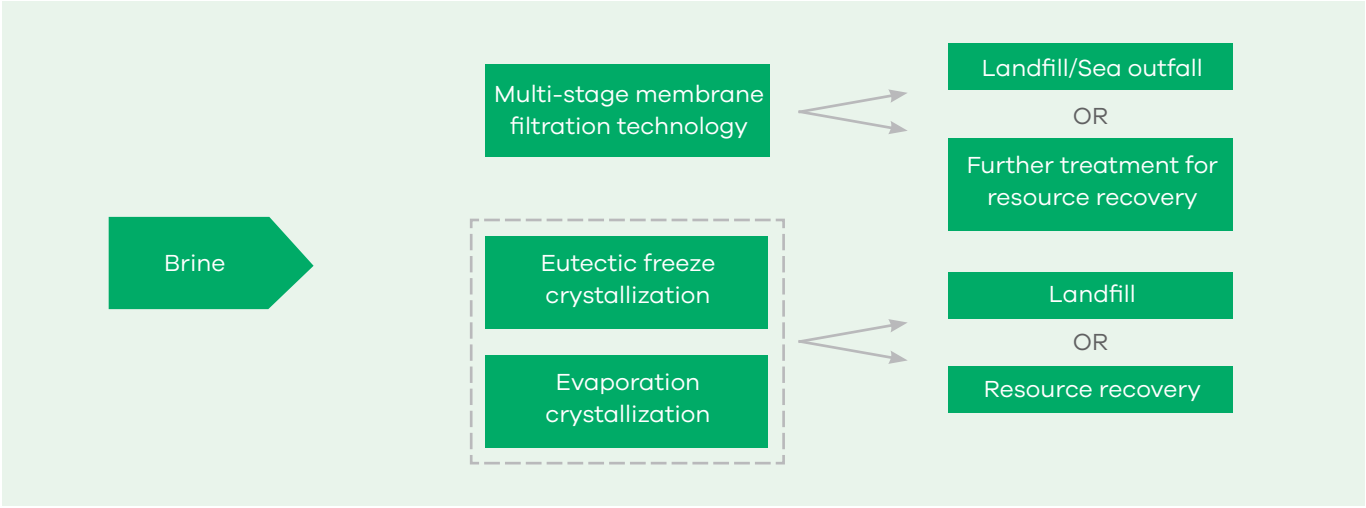


Figure 3
Summary of the popular methods available for treating brine

Table 2
Treatment options, indicative capital costs and potential barriers / limitations to implementation

Brine handling options	Description	Indicative capital cost, and potential barriers / limitations to implementation
Multi-stage membrane filtration technology	Brine is passed through a series of membrane filters to extract as much water as possible, resulting in a low-volume and highly concentrated brine, that either could be treated further using other technologies or be transported to landfill or the sea.	• Capital requirements include R1,5–3 million/MLD for every stage of the membrane filtration unit. Treatment stages might be as many as four. • The remaining highly concentrated brine still needs to be treated further or discharged.
Eutectic freeze crystallisation	This involves the lowering of the temperature of the wastewater until the eutectic point[2] is reached so that the water freezes and the salts crystallize out of the solution.	• High capital requirements (R80-100 million/MLD). • High energy demand (~R100-R150/kl of brine treated).[3] • The market for the individual recovered salts will still need to be sourced. • If a mixture of salts is recovered, which is unlikely to have much market value, this mixture will still need to be transported to landfill.
Evaporative crystallisation	The concept is similar to eutectic freeze crystallisation except that the temperature of the solution is increased until the water evaporates and the salts crystallize out of the solution.	

[2] A eutectic point is the point where an equilibrium exists between ice, salt and a solution with a specific concentration. This specific concentration is called the eutectic concentration and the temperature at which this equilibrium is found is the eutectic temperature.
[3] Eutectic freeze crystallisation allows separation of the salts from water with a lower energy demand than traditional evaporative methods.

Key Takeaways

- When brine treatment or handling is considered, the business case for saline groundwater use may only be strong in a limited number of cases. Brine discharge and treatment in most cases is either too costly and/or constrained by the cost of meeting regulatory requirements. Businesses that extract saline groundwater (>170 mS/m or >1200 mg/l[4]) should consider using the water in a fit-for-purpose manner without any substantial treatment such as RO systems which would result in the generation of brine. An example would be using it for general cleaning purposes or as a cooling agent, depending on the composition and concentration.
- Since there are few financially viable solutions that enable treatment to the level required by regulations, businesses should consider partnering and investing in decentralised treatment solutions to improve the business case.
- In light of the impending liquids-to-landfill ban (set for August 2019) that will prevent the discharge of the wastewater to landfill and the popularity of groundwater as an alternative water source, there will be a growing demand for financially viable and sustainable solutions for brine management.
- As a result, there is an opportunity for suppliers to develop innovative brine management solutions, especially in Cape Town, where many companies, when looking for alternative water sources, are extracting saline groundwater.

[4] Classification of salinity based on SANS 241 drinking water standards

Next Steps
To find out more, contact GreenCape: water@greencape.co.za, (021) 811 0250
For additional information visit GreenCape's Drought Business Support and Water Resilient Businesses pages.

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