Department of Primary Industries
primefact

Desalination of Bore Water

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Agriculture NSW Water Unit

Many producers may have access to a supply of water from a bore; however, this water is too high in salts for use either in the house or garden, or for their stock to consume. Desalination of this water is an option which some producers may consider feasible in order to utilise their water resources most effectively.

What is desalination?

Desalination is most often considered to be the process of removing salts from water. There are several methods of desalination; however, this Primefact is focused on 'reverse osmosis' desalination.

The process of desalination does not always completely remove all salts from the water. Sometimes very low levels of salts remain in the water after desalination. The salinity of the water before desalination influences how much salt can be removed. You should always check this with the manufacturer of the unit.

What is 'reverse osmosis'?

In order to understand reverse osmosis, it is important to understand osmosis. Osmosis is a natural process where liquid will flow from a dilute source to a solution of greater concentration, across a semi-permeable membrane in order to establish a nil gradient of concentration (or equilibrium). The semi-permeable membrane only allows passage of water (solvent) and not the salts.

Osmosis is a process which can work in reverse. If the bore water (salty solution) is placed under an external pressure which is greater than the osmotic pressure then the water will move in the opposite direction, from the solution of greater concentration to the dilute source. As the salts cannot pass through the semi-permeable membrane they are left behind. The result is potable water on one side of the osmotic membrane, and very salty water (brine) on the other side, where the pressure was applied.

This is what a reverse osmosis desalination unit does. The diagram below outlines how a reverse osmosis unit works.

Water quality

There are several ways to refer to the salinity of water; however, in this Primefact, all references to salinity are made on the basis of 'total dissolved solids' (TDS), represented by the unit of milligrams of salt per litre of water (mg/L). This is a reference to how salty the water is, and not to what the particular salts are that are present in the water, or how they behave chemically (or electrically).

For more information about water quality measurements and parameters, please refer to Primefact 1337 Farm water quality and treatment.

Figure1. How a reverse osmosis unit works.

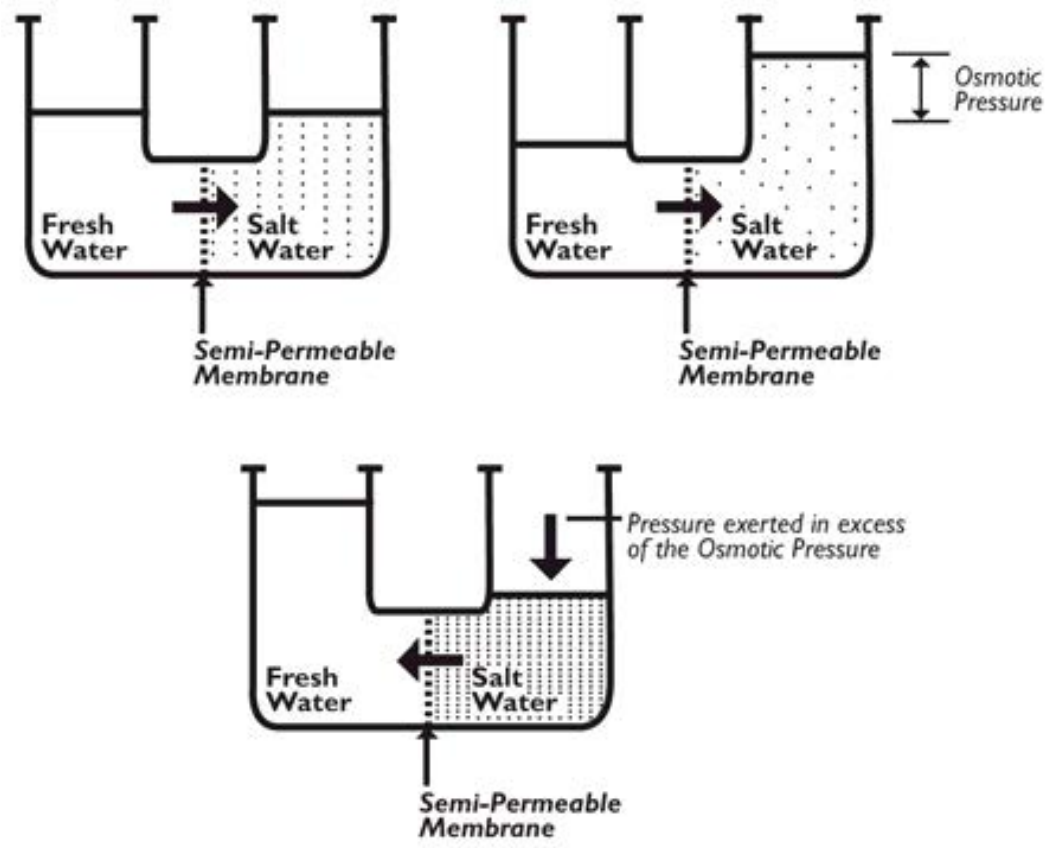


Table 1. Total Dissolved Solids (TDS) mg/L for stock drinking water.

Stock Type	Desirable maximum concentration for healthy growth	Maximum concentration at which good condition might be expected*	Maximum concentration that may be safe for limited periods*
Sheep	5000	5000 to 10 000	10 000 to 13 000
Beef Cattle	4000	4000 to 5000	5000 to 10 000
Dairy Cattle	2500	2500 to 4000	4000 to 7000
Horses	4000	4000 to 6000	6000 to 7000
Pigs	4000	4000 to 6000	6000 to 8000
Poultry	2000	2000 to 3000	3000 to 4000

* The tolerance level particularly depends on the type of feed available.

Stock water quality

Stock water requirements and maximum advisable levels of salinity vary widely according to season, stock type and type of feed on offer. Table 1 outlines the maximum TDS for water suitable for optimum and below-optimum growth/conditions for livestock.

Primefact 326 Water requirements for sheep and cattle gives more detailed information about all aspects of watering stock (see address at the end of this Primefact).

Domestic water quality

Many rural households use bore water in their homes for domestic purposes, including drinking. The Australian Drinking Water Guidelines (1996) state that 500 mg/L is the upper value for TDS; however, levels up to 1000 mg/L are acceptable. Above 1000 mg/L may be associated with excessive scaling, corrosion (of pipes etc), and unacceptable taste.

What to do next

If you have water which exceeds the recommended levels of total dissolved solids (TDS), for either your stock water or domestic water, desalination may be worth considering for your situation.

There are important issues to consider when investigating the feasibility of this technology for your situation:

1. Find a supplier of desalination equipment, and discuss your situation and plans. This will assist you in making some informed decisions, as well as making sure that you are aware of any processes that are important to follow.
2. Obtain a detailed laboratory test of your bore water. This test will need to be extensive, to determine the TDS, as well as the breakdown of the different types of salt present in your water. The presence of some elements may require pre-treatment of your water so as to prevent scaling and damage to the osmotic membrane.
3. Once you know the TDS of your water you should work out what your daily maximum water requirements are. Table 2 outlines the water requirement for the various classes of stock. Indicative household consumption rates are given in the section on domestic water.
4. Seek quotes from suppliers who will design a system specifically for your situation.
5. Cost the process of desalination.
6. Plan for the disposal of the waste product (brine) from desalination.

Please note that stock water consumption may be increased significantly under extremely hot conditions. Consumption may increase by up to 80% under these conditions.

Sheep can drink 40% more in summer than in winter, and 50–80% more if their water contains more than 2000 mg/L in TDS.

For more information on stock water please refer to Primefact 269, Stock water – a limited resource. (see address at the end of this Primefact)

Primefact 1337 Farm *water quality and treatment* also provides information on water quality and methods of treatment (see address below).

Table 2. Stock water requirements

Stock type	Consumption (l) per da per head
SHEEP	
Weaners	2–4
Adult dry sheep:	
Grassland	2–6
Saltbush	4–12
Ewes with lambs	4–10
CATTLE	
Lactating cows:	
Grassland	40–100
Saltbush	40–140
Young stock	25–50
Dry stock (400kg)	35–80
HORSES	40–50

Domestic water

When considering your household water consumption, a base level would be 200 litres per day per person.

Desalination units are designed to deliver a product of potable drinking water of very high quality. It is important to check that this is the case when scoping a suitable product for your situation.

In some instances you may require an ultra violet steriliser to ensure that microbial content is treated, eliminating health risks posed by microbes present in the water.

Desalination units

Reverse osmosis desalination units can broadly be classified into three categories:

1. The first is for **low salinity** source water of TDS of 0 to 4000 mg/L. These operate under a pressure of around 1200 kPa and require minimal power, ranging from 0.2 kW to 3 kW, depending on how much water is processed.
2. The second is for **brackish water** with TDS of 4000 to 15 000 mg/L. These units operate with a required pressure of around 3000 kPa. Their energy requirements depend again on how much water is to be processed and range from 1.5 to 5 kW either single phase or three phase.
3. The third is for **seawater**, of TDS from 15 000 to 35 000 mg/L. Pressure for operation is much higher, around 6000 kPa because of the high concentration of salts in the water. Power requirements are also considerably higher, 1.5 kW to 5.5 kW in single phase or three phase.

Running Costs

The running costs of desalination will vary according to the salinity of the water you are wishing to desalinate, and the amount of water you are treating.

The larger the desalination unit, the cheaper per litre of water treated, but the more expensive it is overall to run.

You can calculate the cost of desalination by the following method:

What is the power usage per day for each powered component of your system, including the energy cost of pumping the salty water from the bore, desalination energy costs, and further pumping energy requirements?

Once you have these in kilowatt hours, you simply multiply this by the cost per unit of energy that you pay for power from your power supplier.

When watering stock, you may be able to keep costs down, by using a shandying valve which will enable you to mix the potable water with the untreated bore water, to a concentration suitable to your stock type. If you are using the water for domestic purposes, then shandying of the water will not be an option.

The use of pipelines, troughs and tanks will optimise the efficiency of a watering system, making the water being treated go further. Evaporation losses will be minimised, and friction losses in the pipeline system can be incorporated into the design of your system.

Waste

There will be a certain amount of waste product as a result of desalination. This waste product is called brine, and it is simply extra-concentrated bore water. The concentration of this brine will depend on the initial salinity of the water you are treating.

As a general guide, you can expect the following conversions:

Low salinity desalination units (0–4000 mg/L TDS) will produce 50% potable water, 50% reject water, which will be around 50% saltier than the original bore water.

With brackish desalination units (4000–15 000 mg/L TDS) you could expect around 30% potable water, 70% reject water, which will be around 25% saltier than the original bore water.

In seawater desalination units, (15 000–35 000 mg/L TDS) you should expect around 15% potable water, 85% reject water, which will be 35% saltier than the original bore water.

On low salinity and some brackish water units recycle valves may be built to improve recovery rates. This will decrease the amount of waste product for disposal.

On medium to large capacity plants, a chemical anti-scale treatment will improve recovery rates. This will decrease the amount of waste produced. The waste will therefore be higher in salinity.

Waste disposal

Disposal of waste product is an important issue which should be a significant part of the planning process of undertaking a desalination project. It is important to plan the waste disposal carefully, so as to ensure that you comply with all relevant legislation.

NSW Planning, Environment & Heritage may require your waste disposal site to be licensed because of the volume of waste produced or if the location is near environmentally sensitive areas.

Section 120 of the *Protection of Environment Operations Act 1997* states that you cannot pollute waterways, or bury solid waste product (in this case it would be salt produced by evaporation) from this process. Given this, a lined evaporation pond is most appropriate. Bearing in mind your obligations to contain this waste site, you should consider all issues such as pond size, banks to prevent natural runoff from entering the area, lining material quality.

Using the figures quoted in this Primefact, you should be able to calculate the amount of water to be treated, and then the amount of brine that will be produced in the desalination process. Simply multiply this by the number of days the system will be running, and take into account an evaporation factor to determine the surface area of the pond.

Contact an irrigation/stock and domestic system designer who will be able to ensure that the pond is adequately designed to meet all of your requirements and obligations.

You should also contact your local council to check that your evaporation pond complies with the local environment plan. They will also be able to advise of any health issues and regulations should you be intending using the desalinated water for household use.

Working out some figures

If you are watering 1000 ewes with lambs per day, you will require up to 10 000 litres of water for them to drink, at 10 litres per head per day.

If your source water is 10 000 mg/L TDS, you will require a brackish water desalination unit.

Given that for brackish desalination units you can expect a reject component of 70%, you will require 33 333 litres of source water per day to produce 10 000 litres of potable water per day.

You will require storage for waste of 23 333 litres per day. In 43 days you will have produced 1 megalitre of waste!) This is the same volume as an olympic pool every 6 weeks!

If you have a shandying valve, you could make the 10 000 litres go further; sheep will still do well on 5000 mg/L TDS, so your 10 000 litres of potable water once shandied will last for two days.

To supply 10 000 litres of potable water per day, if you have low salinity water, the cost could be around $21 000.

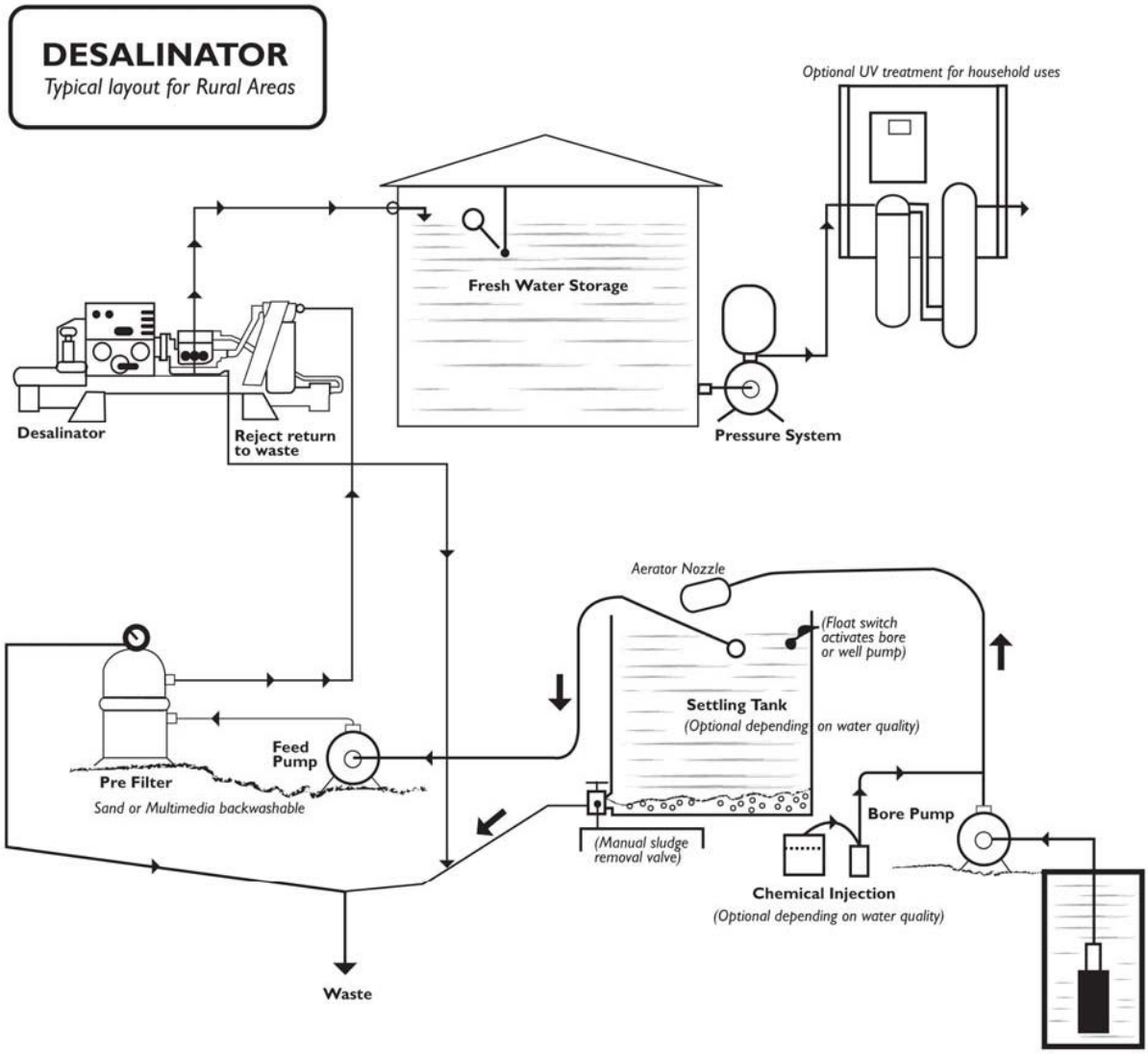
If you have brackish water, for the same amount of potable water you could expect a desalination system to cost about $25 000.

If you have high salinity water then the cost could be in the order of about $57 000.

These figures are intended as a guide only, and include some installation and all component costs. Different suppliers will have different costs associated with their systems. As the technology becomes more readily available, costs may change. You will need to factor installation and running costs into your plan.

Your waste water may also be useful in watering salt tolerant species including saltbush and puccinellia, both of which will grow well in moderately drained soils with high levels of salt present, up to 6400 TDS. If you are considering utilising this method of waste disposal, you will find further information regarding suitable species, soil types and water quality on the DPI website under salinity (see address below).

Figure 2. A typical desalination layout for rural areas



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Further reading

- Primefact 326 Water requirements for sheep and cattle
- Primefact 269, Stock water – a limited resource

- Primefact 1337 Farm Water Quality and Treatment

http://www.environment.gov.au/system/files/resources/53cda9ea-7ec2-49d4-af29-d1dde09e96ef/files/nwqms-guidelines-4-vol1.pdf

These publications and other NSW DPI factsheets are available from the NSW DPI website at: www.dpi.nsw.gov.au/primefacts

- Salinity page on the NSW DPI website: http://www.dpi.nsw.gov.au/salinity

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