WESTERN AUSTRALIA
POLICY FORUM

# Seawater Desalination: Is It The Answer To Our Water Crisis?


## Summary

In recent years, Western Australia has experienced substantial population growth and a drying climate and this has produced water supply shortages and permanent water restrictions.

Seawater desalination has emerged as the preferred option for future water supply and the Kwinana seawater desalination plant is now in operation and seems to be operating satisfactorily. However, there are clearly a set of environmental and social problems associated with desalination and these need to be carefully considered before we commit to the further use of this technology.

There are other promising options for addressing the water crisis that could provide more sustainable solutions than the use of desalination technology. They include: demand management, water use efficiency, wastewater recycling and desalination of brackish water. These options should be thoroughly researched before committing to further seawater desalination plants.

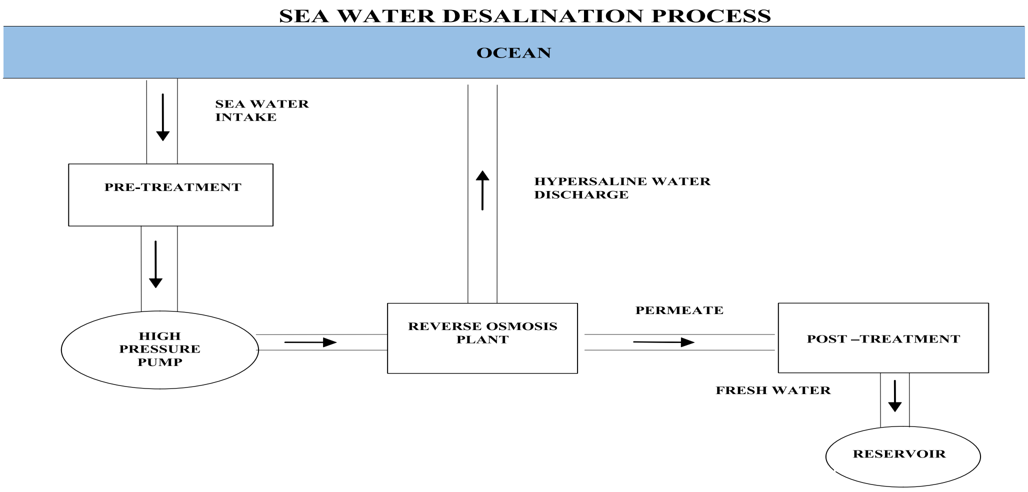
If seawater desalination is undertaken, a full range of safeguards and offsets should be put in place to ensure that the project is sustainable and the full cost of the water supplied is covered.


## 1. What Is Desalination?

Desalination is a process for producing potable water from saline water via a technique such as distillation or reverse osmosis. The former involves using a heat source such as the Sun or fossil fuels to evaporate saline water, which is subsequently condensed to separate it from the brine. The latter involves drawing water from a saline source, such as the ocean, filtering it and then passing it through a semi-permeable membrane under pressure to remove most of its salt content. Part of the intake water is returned to the ocean with an enhanced level of salinity, often double that of the original water. (Water Corporation, 2004)

Desalination requires a relatively clean supply of saline water, an appropriate site for the large processing plant and copious amounts of energy to drive the process.

The product is a high quality supply of water, equivalent to fresh water, and suitable for domestic and commercial use.



Reverse osmosis technology is generally the preferred method of supplying large quantities of desalinated water because of its cost effectiveness compared with other methods. It has been widely used in arid areas, such as the Middle East, and the technology is now mature and reliable. Several other Australian States are experiencing water supply problems and they are also investigating the possible use of seawater desalination to supplement their water supply.

## 2. Why Do We Need It?

It is no secret that our climate is changing. Some areas, such as south-west Australia, are becoming drier and others are becoming wetter. (Water Corporation, 2008a) This is in accordance with the predictions of global climate models that are used to simulate the effects of rising levels of greenhouse gases in the atmosphere. These global climate models predict that climate change will continue for at least the next century, even if we are successful in cutting emissions by 60% by 2050. (IPCC, 2007)

As a result of climate change, the runoff into Perth's dams has fallen by 70% over the past 30 years, forcing the Water Corporation to rely more heavily on groundwater supplies. (Water Corporation, 2008a) Recent studies have shown that this resource is limited and, unless it is carefully managed, it may be depleted and associated ecosystems such as wetlands, woodlands and caves are already suffering. The WA Government recently (2007) rejected the Water Corporation's application to extract groundwater from the south-west Yarragadee Aquifer, because of concerns about the potential impact on agriculture and biodiversity.

Perth now has permanent stage 4 water restrictions (sprinkler roster, 2 days per week) for scheme users and stage 3 restrictions (sprinkler roster, 3 days per week) for private bore owners. Some Australian cities (eg Sydney and Melbourne) have more severe restrictions.

The Water Corporation built its first 45GL per annum desalination plant at Kwinana in 2006 and this came on line early in 2007. It has operated satisfactorily from a technical perspective, but there have been ongoing concerns from the community about its environmental impacts, particularly on the marine environment of Cockburn Sound. This plant has been forced to shut down on several occasions due to the low levels of dissolved oxygen in the water in the Sound and because of its massive draw on power during the current gas crisis. There are ongoing concerns about the long-term impacts of discharging hypersaline water into the Sound and about its interaction with other effluent plumes and with the proposed major harbour developments in Cockburn Sound. There have been calls to extend the hypersaline effluent outfall further out into Cockburn Sound or even into the ocean beyond Garden Island but these suggestions have been rejected by the Water Corporation on economic grounds. Instead they have commissioned a series of technical studies which purport to show that the Kwinana desalination plant is unlikely to contribute to stratification in Cockburn Sound. (Water Corporation, 2008c)

Desalination is clearly a successful technology but it has some drawbacks and is by no means a perfect solution for water supply problems.

Despite these concerns, the Water Corporation has announced plans to develop another seawater desalination plant at Binningup, 200km south of Perth. This will produce 50GL of desalinated water per annum initially and may be upgraded to 100GL per year eventually. The water will be pumped into the metropolitan water supply via a new trunk line to a depot at Harvey. The plant will use an average of 50 MW of electricity in full production and the Water Corporation has promised that this will be obtained from renewable sources. (Water Corporation, 2008b) The estimated capital cost of the plant is around $800 million, with running costs of around $50 million per annum. The water from this plant is expected to cost around $2.50 per kL compared with less than $1 per kL for current surface and groundwater supplies. (Water Corporation, 2008a)

The issue of energy sources to run the plant is an important point. The Kwinana Seawater Desalination Plant is supposed to be powered by renewable energy and the Water Corporation has an arrangement with the operators of the Emu Downs Wind Farm to purchase electricity from them. However the Water Corporation neglected to purchase the Renewable Energy Certificates associated with this energy and they were sold to Synergy. (Harries, 2008) Therefore the Water Corporation is not actually purchasing renewable energy as it is not a certified green power product. What they are using is essentially fossil-fuel power because Synergy owns the greenhouse gas abatement from Emu Downs. This is a major concern because desalination is a highly energy intensive process and the Kwinana desalination plant is responsible for 231,000 tonnes of greenhouse gases per annum. (EPA, 2002, 2004)

As the climate in the south-west dries further and as the population on the Swan Coastal Plain increases, more desalination plants are likely to be required. It is important to recognize that this technology carries some significant risks and undesirable side effects and we will need to manage it carefully to avoid unwanted impacts on the environment and society.

## 3. Benefits of Seawater Desalination

At first glance, desalination appears to have many advantages that make it an ideal solution to the water supply crisis facing Western Australia.

It draws on a relatively clean and inexhaustible supply of seawater which is readily available along WA's vast coastline, close to most of our major population centres. It is not dependent on climate or annual rainfall and runoff, so it is a very reliable water source. One could imagine this technology being implemented at numerous small desalination plants along the WA coast, to supply local needs. It could assist regional development and decentralisation by providing a valuable supply of high quality water to support tourism, agriculture and domestic use.

If managed carefully, seawater desalination appears to have fewer adverse environmental impacts than building new dams or groundwater schemes. However, it is important to note that we still have only a limited knowledge of its long term impacts on the marine environment. In order to manage desalination effectively we need to be aware of all of its potential risks.

## 4. Risks and Concerns About Seawater Desalination

There are many potential environmental, social and economic risks associated with seawater desalination. Some of the most significant ones are discussed below.

### 4.1 Marine Impacts

Desalination plants discharge large quantities of hypersaline water (>60,000ppm of dissolved salts) into the marine environment. This can alter the salinity of the sea water near the outfall and disturb the ecological processes. It can disrupt the breeding of marine fauna such as fish, prawns and crabs. A serious concern is the possibility of stratification in calm conditions where the dense, hypersaline water falls to the ocean floor and smothers the seagrass meadows. This could eventually kill the seagrass and destroy an important marine habitat. Serious concerns were raised by several reputable marine scientists about the impact of the desalination plant on the natural stratification in Cockburn Sound. As a result trigger levels of dissolved oxygen were inserted into the licence for the Kwinana Plant and it has been shut down on several occasions when measured levels fell below these guidelines. (EPA, 2002, 2004) These licence conditions are now being challenged by the Water Corporation under section 46 of the Environmental Protection Act on the grounds that their technical studies indicate that these anoxic conditions in Cockburn Sound are due to natural causes. (Water Corporation, 2008c) Such plants clearly need to be carefully monitored and they should not be sited in protected waters such as bays or harbours or in the vicinity of marine parks. (Ockham's Razor, 2008)

### 4.2 Noise Impacts

Desalination plants involve pumps and heavy machinery which operate continuously, around the clock. The plants produce strong industrial noise that can increase background noise levels in the vicinity of the plant. (Water Corporation, 2008b) Such plants therefore should not be sited close to residential areas.

### 4.3 Biodiversity Impacts

The construction of desalination plants involves earthmoving, pipeline construction and road construction. High voltage power lines must also be brought to the site. Such operations can require the clearing of vegetation, disturbance to the sea bed, drift of sand plumes, destruction of coastal dunes and wetlands and loss of wildlife habitat. The Binningup plant will sit on the seawater/groundwater interface and any dewatering or pollution could affect the viability of vegetation near the plant. These are not minor impacts and the construction of such major industrial facilities in the fragile coastal zone requires a high level of environmental impact assessment and careful monitoring, and ongoing management during the operational phase.

### 4.4 Waste and Pollution

Desalination plants generate solid and liquid wastes that can pose a threat to people and the environment. The seawater must be filtered before desalination to remove sediment. This solid waste must then be carefully disposed of in order to avoid the risk of polluting the local environment. The filters and membranes and piping in the plant will accumulate deposits of waste material and these need to be disposed of also. Chemicals are often used in the cleaning process and these could pose a hazard to workers and to the marine and terrestrial environment. The workforce also will produce food waste and sewage that must be removed from the site to avoid contaminating the groundwater near the plant. The hypersaline water stream from the plant must also be returned to the ocean and dispersed as rapidly as possible. Spillages on land could eventually contaminate the groundwater and kill vegetation.

### 4.5 Energy Use

Seawater desalination is an energy-intensive process. The 45GL pa Kwinana desalination plant requires a power supply that averages 25MW to run it. This is equivalent to the power requirements for a town of 20,000 people. Such a power station, if run on coal, would produce about 250,000 tonnes of carbon dioxide per year. This is a significant contribution to the State's greenhouse gas emissions. Although the Water Corporation claims that the Kwinana Desalination Plant is run on renewable energy (Water Corporation, 2004), this has been disputed by energy experts (Harries, 2008), who point out that the Water Corporation is not buying an accredited green power product as it does not purchase the renewable energy certificates from its power supplier. Hence the Kwinana Desalination Plant is really powered by coal-fired electricity. The Water Corporation (2008b) seems to have accepted this argument and has promised to use genuine renewable energy, including emerging sources, for the Binningup project.

## 5. Management Issues

Although desalination has many benefits for our society, it clearly has substantial risks associated with it. The most important of these are:

### 5.1 Cost

Desalination is much more costly than water conservation and many existing sources such as surface water and groundwater. Unfortunately, most of the cheapest local sources of water supply have already been fully allocated and therefore desalination and water conservation are the best options now available to water resource planners. The cost of desalinated water from the Kwinana Plant is about three times that of local groundwater sources and five times that of local surface water. (Water Corporation, 2008a) Consequently there is pressure to cut costs wherever possible to avoid a consumer backlash. This must not be allowed to compromise the quality of environmental and social protection provided.

### 5.2 Environmental Impacts

There are major environmental issues associated with the construction and operation of desalination plants. They are often located in the sensitive coastal zone where they can impact adversely on coastal dunes, vegetation, groundwater and the marine environment. This imposes additional costs on the plant operator and the regulatory authorities and it is natural to expect that they will try to reduce the level of environmental monitoring once the plant is in operation (indeed this has already happened with the Kwinana Seawater Desalination Plant). Unless society is prepared to pay the full cost of these plants they may not be sustainable in the long term. Many of the long-term environmental impacts, especially on the marine environment, are still unknown.

### 5.3 Energy Use

Unless the operators commit to using genuine green energy for these plants they will significantly increase greenhouse gas emissions and help to accelerate climate change. Green power is currently 25% more expensive than fossil-fuel power and this puts further pressure on the price of desalinated water. Auditing is essential to ensure that plant operators keep their commitments to use only green power for plant operations.

### 5.4 Sustainability

In the context of water supply, sustainability means developing water sources that are cost-effective and that can be maintained in the long term without compromising important social and environmental values.

Desalination is not an ideal technical fix for climate change. It addresses one aspect of the problem and in turn creates other problems. It is independent of the climate, but it is expensive and has a host of associated environmental and social problems. There are several better options for future water supply and these need to be investigated thoroughly.

The most promising option is greater water efficiency through demand management, education and incentives. Water suppliers naturally prefer to develop new sources rather than manage demand because new sources contribute to a larger turnover and higher profits. This type of thinking is incompatible with sustainability.

Mandatory water conservation targets would obviate the immediate need for further desalination projects and provide the incentive for bulk water suppliers to reduce demand from their customers.

Another promising option is the re-use of wastewater for industry, agriculture and gardens. We should set a goal of phasing out ocean disposal of wastewater by 2020 and all wastewater should be recycled. This process is energy intensive and therefore it should also be powered by renewable sources of energy.

Tougher water restrictions could also be imposed, particularly a ban on sprinkler use during the winter months. The public has accepted the need for water restrictions and further, sensible adjustments to this policy could provide additional savings.

Another option is seasonal pricing of water, where the cost to consumers varies according to demand. Such methods are effective in demand management in the electricity supply industry.

Together, these initiatives could substantially reduce the need for additional sources of supply.

## 6. Policy Implications

From the preceding analysis it is clear that seawater desalination is not an ideal solution for water supply problems. It is a complex technology with many environmental and social impacts. These include biodiversity impacts, hypersaline water discharge, waste management and heavy energy use. Social impacts include loss of access to the coast, noise, vibration and aesthetic and heritage impacts. Potentially all of these impacts can be managed with technology which is currently available, but at an increased cost. As desalination is already very expensive compared with traditional surface and groundwater sources, we should regard desalination as a last resort after exploring other less costly and environmentally friendly options.

In WA we have several better options that should be vigorously pursued to address current water supply problems.

### 6.1 Water Efficiency and Demand Management

WA is one of the driest States in Australia and we are also amongst the highest per capita users of fresh water in the nation. In recent years the Water Corporation has developed an effective program of demand management, but this should be further developed into an ongoing water efficiency and conservation strategy. Education, regulations and incentives are very effective in reducing water use and they provide additional water at a lower cost than any other reasonable alternative. The public is receptive to water demand management provided it is carefully explained.

### 6.2 Wastewater Reuse

Most of WA's wastewater is discharged, after treatment, into the ocean, where it causes pollution and degradation of the marine environment. In other parts of the industrialised world, wastewater is frequently recycled or reused. The technology for this is mature and readily available and the costs are generally less than those of desalination. (Water Corporation, 2008a) Wastewater reuse also benefits the environment because it reduces the impact of pollution on the oceans. There is a public perception that recycled wastewater is not suitable for human consumption, but this is untrue, as many countries and inland cities have recycled wastewater for domestic use for decades. Education of the community about these facts could facilitate the wider use of recycled wastewater for domestic consumption in WA.

### 6.3 Desalination of Brackish Water

WA has large supplies of brackish surface water and groundwater that could be desalinated at lower cost than seawater. Brackish water needs less energy for desalination and the waste stream is generally less saline than the ocean so it will not produce stratification as seawater desalination is prone to do. The Wellington Dam, near Collie, contains a large amount of brackish water, equivalent to the output from the Kwinana Desalination Plant, which is currently discharged each year into the ocean. This supply should be investigated as a priority for future desalination projects. Likewise there are huge amounts of drainage water that are discharged into the ocean off the Swan Coastal Plain and some of this could be suitable for desalination, with lower risks than seawater desalination.

### 6.4 Sustainability Safeguards

If seawater desalination is used for domestic water supply, a full set of environmental, economic and social safeguards should be applied by the EPA and the Government. These will add to the cost of the water, but they are essential if we wish to achieve a sustainable water supply. The proposed measures should include:

- Thorough environmental impact assessment of the project ;
- Careful site selection to minimize social and environmental impacts;

- Renewable energy sources must be used for energy supply to minimize greenhouse gas emissions;
- An ongoing monitoring program to detect possible environmental and social impacts during operations;
- Remedial action to address problems caused by the operations of the plant;
- Environmental and social offsets to compensate for adverse impacts of the plant;
- Water pricing should reflect the real, lifecycle cost of operating the desalination plant.
- An environmental management plan for the Plant and its surroundings to cover issues such as biodiversity, waste management and noise.

### 6.5 Desalination Research

Seawater desalination technology is relatively mature but new products and processes are still being actively researched. There is a need for the Government and the EPA to keep abreast of this technology to ensure that the best choices are made for future desalination plants. This should not be left to proponents such as the Water Corporation. An independent, University-based desalination research centre should be established by the State and Commonwealth Governments. The role of this centre should be to investigate technical developments in desalination and the environmental, economic and social implications of this technology in the Australian context. The long term impacts of desalination plants on the Australian coastline are still unknown and ongoing research and monitoring is essential in order to avoid nasty surprises in the future. Many questions remain unanswered about seawater desalination and these should be thoroughly investigated to inform decision making about future proposals for the use of this technology.

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