



FINAL REPORT

DESALINATION

(PORT BONYTHON)

SIXTY FOURTH REPORT OF THE
**ENVIRONMENT, RESOURCES AND DEVELOPMENT
COMMITTEE**

Published pursuant to s17(7) and s17(8) of the Parliamentary Committees Act 1991

Hon JJ Snelling, Speaker 5 August 2009

Third Session, Fifty-first Parliament

Committee's Foreword

The Environment, Resources and Development Committee commenced its inquiry into the environmental impacts of the proposed desalination plants at Port Stanvac and Port Bonython in August 2008. As part of the inquiry, 33 submissions were received and 11 witnesses were heard. Submissions and witnesses included key players from state and local government, industry, academics, non-government organisations and community groups, providing a cross-section of views, ideas and information on environmental issues arising from the proposed development of the desalination plants at Port Stanvac and Port Bonython.

The Committee extends its thanks for the effort made by those involved in preparing and presenting evidence to the Committee. It provided Committee members with a better understanding of the process of desalination, and highlighted some of key environmental issues facing the development of desalination in both Spencer Gulf and Gulf St Vincent.

Due to the release of the Environmental Impact Statement by SA Water for the proposed plant at Port Stanvac, an interim report was prepared in December 2008 focusing on impacts in Gulf St Vincent. This was the sixty third report of the Committee and it was published on the 16th December 2008. The publication of an interim report enabled the Committee to submit the report as comment on the proposed Adelaide Desalination Plant Environmental Impact Statement (EIS). The deadline for submission of comments on the EIS to the Department of Planning and Local Government was 24th December 2008.

This final report, the sixty fourth, focuses on impacts in Spencer Gulf, following the release of that Environmental Impact Statement in May 2009 by BHP Billiton. The deadline for comment on this EIS is 7th August 2009.

A handwritten signature in black ink, appearing to be 'Lyn Breuer', with a long horizontal line extending to the right.

Ms Lyn Breuer, MP
Presiding Member

5 August 2009

Committee Summary of Findings

Our knowledge of environmental impacts from desalination is largely based on limited research from relatively small plants operating in relative isolation from each other across the globe. Cumulative impacts, both over time and including other inputs in a particular region, are only now beginning to be investigated.

Complicating our lack of knowledge here in South Australia are the site specific conditions of building a large scale desalination plant in an inverse estuary where the lack of adequate circulation could amplify impacts on marine ecosystems.

None of the submissions received or any of the witnesses that appeared were totally opposed to desalination *per se* but were concerned with the issue of adequate dispersal conditions, particularly in Spencer Gulf, and many suggested alternative siting outside of Gulf waters.

The Committee agrees that the key issue for Spencer Gulf focuses on the adequacy of brine dispersion and the accuracy of the modelling undertaken to ascertain dispersion profiles, particularly during the occurrence of “dodge tides”. The site selected for the desalination plant is in upper Spencer Gulf within a region believed to experience slow turnover and also recognised as the site of the only known mass aggregation of spawning Giant Australian Cuttlefish (*Sepia apama*) in the world, the eggs of which would be impacted by increased salinity.

The Committee believes that further investigations are required into alternative siting of the desalination plant and that this process requires a regional engagement strategy with an emphasis on local, regional, company and Governmental collaboration.

The release of the Environmental Impact Statement (EIS) by BHP Billiton addressed a number of design questions raised during the inquiry. The only strategy to prevent entrainment of larvae, eggs and plankton is the use of a low speed intake. Backwash sludge will be dewatered and disposed of on land, and modelling has been used to design the diffuser system to ensure that dispersion of brine should occur efficiently. Salinity toxicological studies were undertaken on a sample of cuttlefish eggs sourced from the site and on a small number of other local species, including Western King Prawns, a species also known to use this area as a breeding ground.

The Committee believes that desalination can be a beneficial technology if established and used in a sustainable and environmentally aware way. Due to the paucity of information, the Committee has concerns regarding the dispersive behaviour of the brine stream during the twice monthly event of “dodge tides”, and recommends stringent monitoring take place during these periods to obtain actual live data to validate the modelling that has been used as the basis for the current plant design. The original proposal discussed the option of storing “return water” on land during these periods of low dispersion but no mention of this occurs in the current EIS.

The Committee suggests that consideration be given to suspending processing during periods of “dodge tides” or at other times when water or weather conditions may give rise to increased risk to the marine environment.

The Committee is also of the opinion that all monitoring regimes should be designed to include provision for measuring cumulative impacts as Spencer Gulf is already considerably impacted by industrial, stormwater and waste water discharges.

Given the likely increase in interest in desalination plants, the Committee also believes that reforms are needed to environmental legislation and policies to ensure that proponents have clear direction as to appropriate locations and operation of future desalination plants in South Australia, and that a framework should be established with explicit site selection criteria that includes the assessment of environmental, economic and social factors.

Committee Recommendations

Term of Reference 1: The introduction of additional salts and chemicals into the marine environment.

1. The Committee recommends that the Government require BHP Billiton to conduct further investigations into alternative sites for a desalination plant because of the high potential risk to the marine environment at Point Lowly. The Government should establish a framework for explicit site selection criteria including an assessment of environmental, economic and social factors.
2. The Committee recommends that as part of the process of investigating alternative sites, a regional engagement strategy is developed using the IAP2 process (International Association for Public Participation) with an emphasis on local, regional, company and government collaboration. The Committee further recommends that BHP Billiton and the State Government undertake this process with a maximum of public participation including the investigation of alternatives and identification of preferred solutions.
3. The Committee recommends that Schedule 1 of the *Environment Protection Act 1993* be amended to include desalination plants as a licensable activity under the Act to ensure that brine discharge can be regulated regardless of whether a particular plant would be caught by any existing provision of Schedule 1.
4. The Committee recommends that the Environment Protection (Water Quality) Policy 2003 be amended to include specific requirements for desalination plants including provisions relating to mixing zones and limits beyond which measurable impacts should not occur.
5. The Committee recommends that the EPA implement a monitoring program to validate that the plant is achieving the discharge concentrations stated.
6. The Committee recommends that the EPA and BHP Billiton implement a long term targeted monitoring regime to monitor movement of the brine stream over time.

Term of Reference 2: The adequacy of tidal movements to disperse brine and chemicals.

7. The Committee recommends that the Government, SA Water and BHP Billiton work with modellers from Flinders University and SARDI Aquatic Sciences to collect further localised data over the ensuing 12 months, and to use the “live” monitoring data recorded during “dodge tides” to validate dispersion modelling in both Spencer Gulf and Gulf St Vincent.
8. The Committee recommends that the Government include monitoring parameters to account for cumulative environmental impacts in both gulfs over time.

Term of Reference 3: The potential impact on a range of marine flora and fauna.

9. The Committee recommends that further ongoing localised salinity and current profile data be collected by BHP Billiton at Port Bonython over the following 12 month period and applied to the hydrodynamic model used to predict brine stream dispersion for the current EIS.
10. The Committee recommends that if a desalination plant is constructed at Point Lowly, then the Government should require BHP Billiton to construct and operate the plant in such a way that the discharge of waste brine and chemicals to the marine environment can be suspended if necessary during periods of “dodge tides” or at other times when water or weather conditions may give rise to increased risk to the marine environment.
11. The Committee recommends that the Government work with South Australian universities using the baseline data already collected to continue to monitor local reef areas and seagrass beds within the area. Utilising the before and after desalination data for comparison, this should include a trigger point for the operation to stop if impacts are detected on local populations at these sites. This is particularly important from May to September during the breeding season of the Giant Australian Cuttlefish.
12. The Committee recommends that BHP Billiton adopt the advice from Associate Professor John Middleton to install a live telemetry ocean observing system near the brine outfall site and also near the cuttlefish habitat to enable adequate response actions in the event that brine levels in this area exceed environmentally safe levels.
13. The Committee recommends that Point Lowly, Stony Point, Black Point, False Bay and Fitzgerald Bay should be included by Government as regular salinity data collection sites at depths from three to ten metres (the main cuttlefish egg laying reef depth), and that data also be collected from the eastern side of the gulf from Port Germein and Port Davis for comparison.
14. The Committee recommends that BHP Billiton contribute to an annual Giant Australian Cuttlefish monitoring program to provide an ongoing annual assessment of the fecundity of the local population in partnership with the University of Adelaide and/or SARDI Aquatic Sciences.

15. The Committee recommends that BHP Billiton develop a strategy to minimise the amount of eggs, larvae and plankton that will be trapped on the intake screens or taken into the plant.

Term of Reference 4: The potential impact on commercial and recreational fishing sectors.

16. The Committee recommends that the Government and BHP Billiton collect data from the intake screens of the species being caught on the screens and the larvae and eggs of local species that are actually taken into the plant with the intake water.

17. The Committee recommends that the Government and BHP Billiton regularly monitor inshore from the discharge site for phytoplankton blooms.

Term of Reference 5: The potential impact of contamination leachate from the location.

18. The Committee recommends that BHP Billiton ensure secure containment of sludge during de-watering and during transport to land fill.

Term of Reference 6: Any other matter

19. The Committee recommends that the Government works within the energy guidelines of South Australia's Strategic Plan and sources all energy for the desalination plant from renewable energy sources, including acquiring renewable energy certificates.

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The Environment, Resources and Development Committee

The Environment, Resources and Development Committee (the Committee) was appointed pursuant to the *Parliamentary Committees Act 1991* (the Act) on 27 April 2006. Its membership during the reporting period was:

Ms Lyn Breuer MP, Presiding Member
Hon Michelle Lensink MLC
Hon Mark Parnell MLC
Hon Dr Bob Such MP
Mr. Ivan Venning MP
Hon Russell Wortley MLC

Executive Officer to the Committee: Mr Philip Frensham

Research Officer for the Inquiry: Ms Val Day

Functions of the Committee

Pursuant to section 8 of the Act, the terms of reference for the Committee are:

- (a) to inquire into, consider and report on such of the following matters as are referred to it under this Act:
 - (i) any matter concerned with the environment or how the quality of the environment might be protected or improved;
 - (ii) any matter concerned with the resources of the State or how they might be better conserved or utilised;
 - (iii) any matter concerned with planning, land use or transport;
 - (iv) any matter concerned with the general development of the State;
- (b) to perform such other functions as are imposed on the Committee under this or any other Act or by resolution of both Houses.

Referral Process

Pursuant to section 16(1) of the Act, any matter that is relevant to the functions of the Committee may be referred to it in the following ways:

- (a) by resolution of the Committee's appointing House or Houses, or either of the Committee's appointing Houses;
- (b) by the Governor, or by notice published in the Gazette; or
- (c) of the Committee's own motion.

The Inquiry

The Inquiry was referred to the Committee by the Legislative Council on 23 July 2008.

Pursuant to section 16(1) (a) of the *Parliamentary Committees Act 1991* the Committee has been called on to inquire into the environmental impacts of the proposed desalination plants at Port Stanvac and Port Bonython, and in particular—

1. the introduction of additional salts and chemicals into the marine environment;
2. the adequacy of tidal movements to disperse brine and chemicals;
3. the potential impact on a range of marine flora and fauna;
4. the potential impact on commercial and recreational fishing sectors;
5. the potential impact of contamination leachate from the location; and
6. any other matter.

Abbreviations

ABS	Australian Bureau of Statistics
ACWS	Adelaide Coastal Waters Study
AMLR NRM	Adelaide Mount Lofty Ranges Natural Resources Management
BHP	Broken Hill Proprietary
BHPB	BHP Billiton
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EIA	Environmental Impact Statement
EDTA	Ethylenediaminetetraacetic acid
EIS	Environment Impact Statement
EPA	Environment Protection Authority
GL	Gigalitre (1,000 Megalitres)
KL	Kilolitre (1,000 Litres)
ML	Megalitre (1,000 Kilolitres)
MOU	Memorandum of Understanding
PIRSA	Primary Industries and Resources South Australia
PPT	Part per thousand (salinity)
RO	Reverse Osmosis
SA	South Australia
SARDI	South Australian Research & Development Institute

Introduction

The demand for potable water has become a major issue worldwide. Over one third of the world's population is already facing problems due to poor water quality and fresh water being either unavailable or extremely limited (Danoun 2007).

Increasing population and increasing global industrialization, particularly in coastal regions in different countries around the world, has lowered ground water tables. Erratic weather patterns linked to global climatic changes seem to have affected rainfall volume and patterns causing drought conditions in many parts of the world, including Australia.

Seawater is freely available and exists close to coastal lands where around 39 per cent of the world's population reside, hence desalination of sea water can be an attractive and logical option for an alternative potable water supply.

Desalination is a widespread technology that has been used to address water scarcity in many countries around the world. Historically, desalination on a small scale has been used by ships at sea since the early 1800's and, more recently, numerous countries worldwide have commissioned desalination plants where natural good quality water is insufficient or is extremely limited.

Many countries in the Middle East, North Africa and Central Asia rely almost entirely on desalination for their potable water needs; this proven technology has helped alleviate freshwater scarcity in the Middle East for more than 20 years. Despite the many benefits the technology has to offer, concerns arise over the potential negative impacts on the environment.

Negative effects on the marine environment can occur, especially when high waste water discharges coincide with sensitive ecosystems (Lattemann & Hoepner 2008). Enclosed and shallow sites with abundant marine life can generally be assumed to be more sensitive to desalination plant discharges than exposed, high energy, open-sea locations which are more able to dilute and disperse the discharges (Lattemann & Hoepner 2008).

Although negative impacts have been reported at existing plants, equally positive aspects exist in that desalination aids and maintains industry and agricultural production, and helps preserve natural water resources.

History has shown in the last 50 years that Australia has experienced a widespread drought throughout the country, such that has never before been seen (Danoun 2007). All states in Australia are facing similar water scarcity problems. The clear inability to cope with the present shortages has led Queensland, Western Australia and New South Wales to build large desalination plants, even though they have been opposed by a number of environmental groups.

These environmentalists argue that desalination is relatively expensive, energy intensive, pollutes the environment and the long term impacts of the pollutants are yet unknown.

Two large plants are currently proposed for South Australia, one commissioned by SA Water in Gulf St Vincent at Port Stanvac, and one commissioned by BHP Billiton in Spencer Gulf at Port Bonython. Due to the release of the Environmental Impact Statement (EIS) for the Port Stanvac region, an interim report to investigate the possible impacts the plant proposed for Port Stanvac may have on the marine environment of Gulf St Vincent was released in December 2008.

This final report has therefore focused on environmental impacts that may occur in the marine environment of Spencer Gulf, and follows the release of the EIS for Spencer Gulf by BHP Billiton in May 2009.

1.1 Principles of Desalination

Desalination of seawater refers to the removal of salt from seawater so that it is drinkable (potable) (Water Proofing Adelaide 2008). This can be achieved by either condensation or reverse osmosis.

1.2 Reverse Osmosis

Reverse osmosis (RO) is the system most commonly used and is the system proposed for the two desalination plants at Port Stanvac and Port Bonython.

The process consists of four main stages:

- The incoming seawater is pre-treated to remove suspended solids, such as plankton, sand, shells or seaweed, which would clog the membranes. The pH is adjusted, and an inhibitor is used to control the scaling caused by the chemical content of the water.
- This feedwater is then pressurised to an appropriate pressure for the separating membranes being used.
- The permeable membranes prevent the passage of salts whilst allowing the desalinated water to pass through. This results in two streams, a freshwater product stream and a concentrated brine stream.
- The freshwater produced using this method usually requires a pH adjustment to decrease the acidity resulting from the removal of the alkaline salts before it can be released for use as drinking water.

The permeable membranes require frequent cleaning due to fouling.

Context

2.1 South Australia

South Australia is regarded as the driest state in one of the driest continents, where a reliable supply of available potable water has become an issue.

Australian Bureau of Statistics (ABS) 2002 data shows that more than 85 per cent of South Australians live within 25 km of the coast. This has led to increased urban development, greater stormwater and treated wastewater discharges into the marine environment, and an ever escalating requirement for fresh water that the Murray River is no longer able to provide.

In order to address this problem, the South Australian Government has recently committed to the building of a large desalination plant at Port Stanvac, south of Adelaide, to provide a reliable, non-climate dependent, potable water source for metropolitan Adelaide.

2.2 South Australia's Strategic Plan

South Australia's Strategic Plan is a Government commitment to make this State "prosperous, environmentally rich, culturally stimulating" and consists of targets that reflect the Plan's priorities.

Objective 3, "Attaining sustainability" targets a Sustainable water supply at T3.9 (Government of South Australia 2007:2008), states that "South Australia's water resources are managed within sustainable limits by 2018". The first strategy from the Plan is to "Implement Water Proofing Adelaide.....and develop additional water sources such as stormwater, recycled wastewater and desalination, including a 50 gegalitre (GL) desalination plant for Adelaide". This has now been expanded to 100 GL following additional funds supplied by the Federal Budget for 2009.

2.3 Water Proofing Adelaide

Water Proofing Adelaide is the South Australian Government's 20 year blueprint for a sustainable water supply in our state (Water Proofing Adelaide 2008). It contains "63 specific strategies aimed at fostering responsible water use, better managing existing resources and securing additional water supplies."

Strategy 59 states "The SA Government will develop a State policy towards desalination that addresses planning issues, access to saline water, disposal of brine and management of other environmental impacts", with SA Water the lead agency responsible for this strategy.

Strategy 60 states that "The SA Government will ensure that its long-term water infrastructure plans remain flexible enough to enable the integration of desalination plants as and when they become viable in the future".

The current Gulf St Vincent proposal is for the construction of a metropolitan desalination plant at Port Stanvac that will supply Adelaide with 50 gigalitres of water per year, with the capability to later expand this capacity to 100 gigalitres per year. Originally proposed to be operational in 2012, this has now been brought forward and tenders have been called for the construction of the plant to be operational by December 2010. The construction of this plant has now been expanded to 100 GL following an investment of funds from the Federal Budget for 2009.

On 18 December 2008, the Development Assessment Commission issued *Guidelines for the preparation of an Environmental Impact Statement for the Port Stanvac (Adelaide) Desalination Plant Proposal at Lonsdale* in order to ensure sensitive issues such as the potential impact on the marine environment and global warming "are thoroughly addressed as part of a rigorous assessment process".

The current proposal for Spencer Gulf was initiated by BHP Billiton in order to supply the additional 280 ML per day required for the proposed expansion of the Olympic Dam mine at Roxby Downs. Initially it was suggested that it may have the potential to supply 80 ML potable water per day to towns in upper Spencer Gulf and Eyre Peninsula. The Government has indicated that this is increasingly unlikely to occur.

2.4 Gulf St Vincent

Gulf St Vincent and Spencer Gulf have very similar tidal regimes and marine environmental impact issues which, along with the issues surrounding the proposed desalination plant at Port Stanvac, have been discussed in full in the previous interim report.

2.5 Spencer Gulf

The Spencer Gulf is categorised as an inverse estuary that stratifies periodically at times of neap (dodge) tides and light winds, with an estimated yearly accumulation of salt of approximately 700 million tonnes (Mohammed *et al* 1997). The salinity levels exceed the open ocean due to very little fresh water input and high evaporation, particularly in summer when there is limited circulation and restricted water exchange with the open ocean. This is even more so for the upper Spencer Gulf region, north of Point Lowly, where it is considered a much longer water exchange period exists due to the narrowing of the area available for water exchange, by Ward's Spit, and it has been suggested that species living in this region are probably already at the limit of their salt tolerance. Salinity ranges from 37 ppt to 48 ppt, with seawater temperature ranging from 10 degrees in winter to 24 degrees in summer. Salinity alteration is thought to play a significant role on marine species size, population and behaviour (Danoun 2007), with several studies showing a direct negative correlation between the number of marine species and the salinity increment in seawater.

The upper Spencer Gulf region is recognised as a highly productive marine ecosystem supporting a rich and diverse range of commercially and recreationally important species. Approximately 50 per cent of the State's marine scalefish and blue crab catches come from this area and it is recognised as the main breeding area for the Western King Prawn. A number of yellowtail kingfish farms operate in Fitzgerald Bay, just north of Point Lowly.

This area is also the only known aggregation site of the Giant Australian Cuttlefish, a species with egg and embryo stages sensitive to variations in salinity and, therefore, at risk of impact from the brine released from the proposed desalination plant. It is also an important nursery/breeding area for many commercial and recreational species, many sensitive in larval and juvenile stages to changes in salinity.

The upper Spencer Gulf has been recognised by the Department for Environment & Heritage as a region of particularly high biodiversity and has been identified as consisting of both Ecologically Rated 1 and 2 zones in the draft *Spencer Gulf Marine Plan* (Government of South Australia 2006) for which the recommended impact levels are “negligible” and “minor”. It has also been earmarked as a focus location for one of 19 proposed marine parks within State waters (SA Strategic Plan T3.4).

The upper Spencer Gulf region has international, national and State significance as a habitat for waterbirds, in particular waders, and is one of the most important sites in South Australia due to species diversity and abundance. Potential impacts are likely to occur to these species if the hypersaline discharge water from the proposed plant affects the eggs and larvae of the small fish that the birds require for food.

2.6 Port Bonython

A large scale desalination plant, described as possibly the largest in the southern hemisphere producing in excess of 100 GL per annum, has been proposed by BHP Billiton to be built at Port Bonython, 15 km north east of Whyalla, in order to supply increased demands for fresh processing water required by the expansion of the Olympic Dam mine at Roxby Downs. Initial discussions included the proposal that additional water be processed to meet the future demands of Eyre Peninsula, an area that has little natural water supply and currently relies on a pipeline delivering water from the Murray River. The production of an estimated 250 ML potable water per day would have supplied both Olympic Dam and the towns on Eyre Peninsula. This would entail a total volume of 580 ML per day be drawn from Spencer Gulf, with a 350 ML brine stream returned to the gulf at a concentration of between 70 to 80 ppt.

The power required for this process has been quoted as approximately 30 megawatts for every 125 ML fresh water (Arup website 2007), suggesting that the daily power requirement for this particular plant will be approximately 60 megawatts. However, according to the EIS, a total of 35 megawatts is all that will be required. Assuming this will initially be supplied using coal fired power, the cost economically and environmentally will make it difficult to reconcile with State carbon footprint targets.

There has been a considerable amount of publicity surrounding the proposed plant. The majority of concerns focus on the apparent lack of adequate circulation during times of low flow and “dodge tides” at this site to disperse the large quantities of brine and chemicals in the discharge water and the risk this could pose to the Giant Australian Cuttlefish population that is known to breed only at this site and has been described as “genetically unique” (Hansard p 24).

This area has been an established marine “closed area” by PIRSA Fisheries for the protection of the cuttlefish species for a number of years and has been included as part of a proposed larger marine protected area (Department of Environment and Heritage 2004).

Steedman and Associates (1983) emphasise the effects of the eddy at Point Lowly, stating that “if significant amounts of water are ‘trapped’ by the eddy, they may be returned to the northern gulf relatively undiluted and hence have a significant effect on the total water exchange of the northern Spencer Gulf”. This would suggest that the vast quantities of additional brine to be discharged by the desalination plant in this area may have implications for the salinity of northern Spencer Gulf.

BHP Billiton has conducted an extensive Environmental Impact Assessment (EIA) within the region proposed for the siting of the desalination plant; establishing a baseline species inventory; establishing the appropriate areas for the extraction of seawater and discharge of hypersaline waste water; and collecting additional data used in the modelling to predict dispersion properties of Spencer Gulf’s tidal movement.

The accuracy of the impact and risk assessment of siting a large desalination plant within this inverse estuary relies on the accuracy and comprehensive range of the data used to model the dispersion of the plume of highly saline waste water.

The Process

Pre-treatment of the intake water includes coagulation and filtration and requires the addition of chemicals to remove suspended solids and other particles in the feedwater. Algae and bacteria can grow on the membranes, requiring the addition of a biocide (usually chlorine, but sometimes ozone or ultraviolet light) which then has to be neutralised. Because of the highly corrosive nature of salt, metals are also found in the discharge water, the concentration varying with what was already in the feedwater and the amount of corrosion in the pipes.

The upper Spencer Gulf has been highly impacted by heavy metals over the past 100 years from the processing plant at Port Pirie and the iron ore processing pellet plant and ship building at Whyalla. This could have implications due to the likely presence of increased heavy metal levels already in the feed water.

The filters used for pre-treatment must be cleaned every few days, by backwashing, to clear accumulated sand and solids. Alkaline cleaners are used to remove organic fouling and acid to remove scale and inorganic particles. Scaling and corrosion of pipes is caused by the high salt content of the water; generally this will increase with temperature.

3.1 What are the potential impacts?

- Energy use and resulting green house gas production – the energy used in the desalination process is primarily electricity and heat. Large amounts of greenhouse gasses can be produced by desalination plants due to their high energy requirements.
- Entrainment (sucking in) or impingement (sucked up against screens at the intake area) of marine life: molluscs, weeds, algae, fish. Fish eggs, larvae and juveniles as well as plankton are especially susceptible to entrainment. Impinged organisms, typically juvenile or adult fish, usually die or suffer injury as a result of starvation, exhaustion, descaling by screen wash sprays, or asphyxiation.
- Waste – a heavily concentrated brine solution. After the brine solution is discharged into the sea, it has the potential to kill marine organisms through pollution (chemical and metal content) as well as rise in the salinity and temperature of coastal waters near the outlet.

3.2 Energy

Desalination is recognised as an energy intensive process that can have an indirect impact on the environment by using energy from the local grid. The burning of fossil fuels and increased energy consumption allows more air pollution and gas emissions to occur. Significant energy consumption in the desalination process would lead to greenhouse gas emissions into the atmosphere. These would include carbon monoxide, nitric oxide, nitrogen dioxide and sulphur dioxide (Younos 2005).

3.3 Entrainment and Impingement

The impacts of the brine discharge are widely known but very little consideration is given to the loss of larvae and small organisms that are contained within the vast amounts of seawater extracted to feed the plant on a daily basis. Recent analyses suggest that impingement and entrainment of marine life associated with intake screens may represent the most significant direct adverse environmental impact of seawater desalination (Pankratz 2004).

Entrainment occurs when smaller organisms pass through an intake screen and into the processing equipment resulting in mortality. Fine mesh screens are usually deployed to minimise this but these do tend to require frequent cleaning due to the build up of eggs and larvae and other matter.

Impingement occurs when marine organisms are trapped against the intake screens by the velocity and force of the water flowing through them which usually results in the death of the organism.

Loss of large numbers of any of these organisms can impact on the fecundity of localised populations and on the species further up the food chain reliant upon these organisms as a source of food.

3.4 Waste

Sabine Lattemann on the Clean Ocean website explains “the process of desalination is not *per se* environmentally friendly and seawater desalination plants also contribute to the wastewater discharges that affect coastal water quality. This is mostly due to the highly saline brine that is emitted into the sea which may be increased in temperature and contain residual chemicals from the pre-treatment process, heavy metals from corrosion, and intermittently used cleaning agents. The effluent from desalination plants is a multi-component waste with multiple effects on water, sediment and marine organisms. It therefore affects the quality of the resource it depends on”.

Salinity is approximately doubled in the brine stream.

Temperatures are generally higher in the brine stream.

Also, pH is generally higher in the brine stream.

Density is correlated with salinity which will potentially cause the salinity to have its largest effect on benthic communities, as the brine will sink to the sea floor, with implications in Spencer Gulf for the Western King Prawn populations breeding in this area.

Oxygen depletion in the brine stream can have devastating effects on marine organisms. With increased temperature and salinity, oxygen (which has already decreased during the separation process) becomes less soluble in seawater. If sodium bisulphate is used to neutralize the chlorine, there will be even less dissolved oxygen available in the brine stream.

Chlorine is a strong oxidant and a highly effective biocide, often used to prevent biological growth in the desalination process, but this will depend on the type of membranes used as some membranes are sensitive to chlorine. Residual levels of chlorine in the brine stream can be toxic to marine life, although this is often neutralised by the addition of sodium bisulphate.

Heavy metals are often contained in low amounts in the brine as they can pass into the stream when the interior surfaces corrode. The brine stream can contain traces of iron, nickel, chromium and molybdenum, although levels are generally low. Heavy metals tend to accumulate in the sediments and the many benthic invertebrates that feed here are at risk of accumulating low levels of heavy metals that are then passed on up the food chain by their predators. This area is likely to experience increased heavy metal levels due to the spread from the Port Pirie smelter discharge area.

Antiscalants such as sodium hexameta phosphate are commonly added to the feedwater to prevent scale formation. Although risks from antiscalants are low for marine life due to their low toxicity, they have long residence times in the environment due to a poor degradability.

Coagulants and flocculants such as ferric chloride and aluminium chloride are used to remove suspended material from the feedwater. This matter is discharged to the sea usually as filter backwash and, although not generally toxic, tends to increase turbidity in the outlet area.

Sulfuric acid or hydrochloric acid is used to adjust the pH of the intake seawater.

Cleaning chemicals are used every couple of months for the removal of silt deposits and biofilms, metal oxides and scales. Detergents, oxidants and biocides such as citric acid, ethylenediaminetetraacetic acid (EDTA) and sodium polyphosphate are also used for disinfection. Most cleaning agents are harmful to marine life whether acidic or alkaline and need to be closely monitored.

Crystalline acid EDTA is used to remove the carbonate deposits from the desalination facilities.

Turbidity can be caused by the disturbance of sediment at the outflow and can coincide with algal blooms at the outlet. This can inhibit the amount of light available for seagrass to photosynthesise. It is, however, only likely to occur during periods of low flow across “dodge tide” regimes.

Terms of Reference

4.1 The introduction of additional salts and chemicals into the marine environment.

The desalination process produces large quantities of brine at generally twice the concentration of the receiving environment. The brine stream will also contain residues of chemicals used for treatment against biofouling, suspended solids, scale deposits, and traces of heavy metals due to corrosion. Whether alone or cumulatively, these products can have a negative impact on the species residing within the vicinity of the waste product outflow.

It is widely recognised that enclosed shallow systems can generally be assumed to be more sensitive to desalination plant discharges than exposed, high energy, open-sea locations, which are more capable of diluting and dispersing discharges (Lattemann & Hopner 2008). The impacts from any discharges into an ocean site “will not produce measurable effects”, whereas discharge into an area with limited exchange will need to be considered on an ecosystem basis and include cumulative impacts of other local discharges along with the brine discharge (Hoepner & Lattemann 2002).

Lattemann & Hopner (2008) discuss the issue of site selection with reference to minimizing impacts on the environment and state “Ecosystems or habitats should be avoided, if they are unique within a region or worth protecting on a global scale, inhabited by protected, endangered or rare species, important in terms of their productivity or biodiversity, or if they play an important role as feeding or reproductive areas in the region”. Tsiourtis (2008) discusses criteria and site selection, addressing all requirements for a desalination plant and includes within the recommendations “*Plant site must not be within environmentally sensitive areas:*” explaining that plants should not be located in regions with a limited capacity to flush with the open ocean.

Typically the brine product stream will be low in oxygen, higher in alkalinity and considerably heavier than the surrounding seawater, causing it to sink to the seafloor and generally spread out into a broad plume, depending on the geography and physical oceanography of the region. Most organisms can adapt to minor changes in their environment, and some can tolerate extreme changes, but not to continuous exposure to unfavourable conditions (Lattemann & Hopner 2008). Due to the distribution of the brine plume on the seafloor, the benthic organisms that live there will be affected by the brine discharge. Impacts can range from metabolic stress to the death of the organism and can have impacts across a whole range of life stages, with grave implications for the survival of species endemic to an area selected for brine disposal. A recent study of the movement of the desalination plant saline plume in Cockburn Sound, Western Australia, found that the brine plume spread across the seafloor, permanently filling the shipping channel to two to three metres above the bed (Okely *et al.*, 2007).

The discharge of the brine product into the marine environment was the main area of concern for many of the witnesses who appeared before the Committee and in the majority of submissions that were received. From the 33 submissions received, only four did not list this as their main concern. Submissions also questioned why alternative sites outside of the gulf had not been considered. The Committee believes that further investigations are required into alternative siting of the desalination plant and that this process requires a regional engagement strategy with an emphasis on local, regional, company and Government collaboration.

Dr. Kirsten Benkendorff, School of Biological Sciences, Flinders University, spoke to the Committee on the impacts from the various constituents contained in brine discharge and the potential impacts that may be experienced on local invertebrate communities at both of the proposed sites (Hansard p 33). This was followed by a discussion of the hypersalinity tolerance research conducted by her laboratory on local squid species *Sepioteuthis australis*, which has demonstrated a high mortality in squid eggs when exposed to salinities ranging from 45ppt to 55ppt, after only two hours exposure (Hansard p 36). Her recommendations included applying the "Precautionary Principle" to brine disposal in both gulfs and setting in place some very clear monitoring regimes prior to any brine release (Hansard p 37).

Salinity alteration is thought to play a significant role on marine species size, population and behaviour (Danoun 2007), with a number of studies showing a direct negative correlation between the number of marine species and the salinity increment in seawater.

A considerable amount of research has been undertaken on the Spencer Gulf prawn fishery over the years. It has been established that the main recruitment area for Western King Prawn, *Melicertus latisulcatus*, lies along the coast from the tip of Point Lowly, southwards to the end of Middle Bank, half way to Cowell (Carrick & Ostendorf, 2007). Karen Hollamby, Executive Officer, Spencer Gulf and West Coast Prawn Fishermen's Association, spoke to the Committee regarding concerns over the possible impacts the brine discharge could have on prawn recruitment (Hansard p 27). Concerns included both the "salinity and chemical build-up" and the belief that there "would not be enough water movement to sufficiently distribute the highly saline water out of the gulf" (Hansard p 27). Ms Hollamby cited the value of the fishery that contributed "\$42 million to the region in the 2006-07 year" and directly employed 217 full-time employees (Hansard p28).

The Hon. M. Parnell established from Ms Hollamby that Western King Prawns are bottom dwellers and are therefore at greatest risk from the "highest salinity areas" of the brine as it moves along the seafloor (Hansard p 29).

The fate of the Giant Australian Cuttlefish was the subject of concern in 14 submissions and was discussed by several of the witnesses, including Mr Greg Curnow of the Cuttlefish Coast Coalition and Associate Professor Bronwyn Gillanders from the Southern Seas Ecology Laboratories at the University of Adelaide. Their concerns arise from the fact that this species is genetically unique and is highly localised along the 8 kilometre stretch of coastline south of Point Lowly, the only known breeding area for this species which breeds only once in its short annual lifetime.

Extensive laboratory work has shown that eggs and juveniles demonstrated reactions to different concentrations of brine and were impacted at salinities above 45 ppt (Hansard p 23). Ms Gillanders quoted “around a 7 per cent decrease in survival for every one part per thousand increase in salinity” and explained that this was a potential issue for the proposed desalination brine outfall, as gulf waters are known to increase up to 45 ppt during summer (Hansard p 23). She also explained to the Committee that her main concern was the significant risk to the survival of the species if the circulation patterns predicted within the EIS were wrong; then “the potential consequences are that a globally unique species may go extinct” (Hansard p 24).

Mr Peter Dolan, Director of Science and Sustainability, Environment Protection Authority (EPA), informed the Committee that both proposed plants would require a licence under the Environment Protection Act as they would be discharging chemicals into the marine environment with the discharge exceeding 50,000 litres per day (Hansard p 47). However, the EPA could only monitor and measure within the “mixing zone” of 100 metres; without the definition of the “mixing zone”, the EPA was unable to set standards at this stage (Hansard p 46). Mr Dolan went on to explain that currently the EPA has no standards for brine, only the chemicals that are added for cleaning and anti scaling, and that it was difficult to set standards as there are no known plants “that are discharging into shallow, narrow areas like the upper Spencer Gulf” (Hansard p 48).

Mr Richard Yeeles, representing BHP Billiton, has said that the current proposal will require the production of 185 ML of potable water per day for Olympic Dam and 65 ML per day to supply upper Spencer Gulf communities (Hansard p 71). To provide this amount of potable water, a total extraction of 580 ML seawater per day from Spencer Gulf will be required by the processing plant. Once desalinated, this will result in the return of 330 ML brine to Spencer Gulf per day, at a concentration of approximately double that of the receiving environment.

The Committee noted that operation of a desalination plant is not a “prescribed activity of environmental significance” under the *Environment Protection Act 1993*. There are also currently no standards under the *Environment Protection Act 1993* or any relevant Environment Protection Policy for the discharge of brine to the marine environment. As a consequence, proponents of desalination plants have little legislative or policy guidance as to appropriate or maximum levels of discharge or impact. Given the likely increase in applications for approval for both large and small desalination plants, the Committee believes that appropriate regulatory standards should be developed. This will provide certainty to future proponents as to the expected standards of environmental performance.

Summary

Water desalination should be considered as a manufacturing process, subject to quality and environmental standards. Clearly a framework will be required within which to conduct monitoring activities in order to investigate the environmental impacts on gulf ecosystems and the establishment of criteria for evaluating and assessing the monitoring data. The responsibility for this would sit with the EPA as, within the *Environment Protection Act 1993*, there is an obligation under the Act to “prevent, reduce, minimise and, where practicable, eliminate harm to the environment”.

The monitoring framework should be developed to the satisfaction of the EPA prior to the commencement of the operation of the plant and should:

- utilise before and after data,
- have suitable control sites for comparison, and
- include a trigger for the operation to stop if there is other than negligible impact detected on the localised marine environment.

To monitor the brine composition and movement/diffusion over the seafloor over time, a long term monitoring regime will need to be developed that will target temperature, salinity, dissolved oxygen and pH within:

- the discharge zone
- at Near Field
- Mid Field and,
- Far Field

Recommendations:

1. The Committee recommends that the Government require BHP Billiton to conduct further investigations into alternative sites for a desalination plant because of the high potential risk to the marine environment at Point Lowly. The Government should establish a framework for explicit site selection criteria including an assessment of environmental, economic and social factors.
2. The Committee recommends that as part of the process of investigating alternative sites, a regional engagement strategy is developed using the IAP2 process (International Association for Public Participation) with an emphasis on local, regional, company and government collaboration. The Committee further recommends that BHP Billiton and the State Government undertake this process with a maximum of public participation including the investigation of alternatives and identification of preferred solutions.
3. The Committee recommends that Schedule 1 of the *Environment Protection Act 1993* be amended to include desalination plants as a licensable activity under the Act to ensure that brine discharge can be regulated regardless of whether a particular plant would be caught by any existing provision of Schedule 1.
4. The Committee recommends that the Environment Protection (Water Quality) Policy 2003 be amended to include specific requirements for desalination plants including provisions relating to mixing zones and limits beyond which measurable impacts should not occur.
5. The Committee recommends that the EPA implement a monitoring program to validate that the plant is achieving the discharge concentrations stated.
6. The Committee recommends that the EPA implement a long term targeted monitoring regime to monitor movement of the brine stream over time.

4.2 The adequacy of tidal movements to disperse brine and chemicals

Concerns around inadequate tidal movement to disperse brine and chemicals for both proposed plants was addressed by several of the witnesses and by 29 of the submissions received.

Dr Toby Bolton, Director, Lincoln Marine Science Centre, described Spencer Gulf as “an inverse estuary characterised by shallow depths, elevated ambient salinity levels, and highly restricted water exchange”, with the anomaly of “dodge tides” every two weeks. He spoke of modelling recently undertaken by himself and Dr Jochen Kaempf that illustrated that the flushing of this particular gulf took more than two years (Hansard p 16). He further suggested that “the oceanographic environment of the northern Spencer Gulf makes it among the least suitable locations along the coast of South Australia for situating a brine outflow of the scale being proposed by BHP Billiton” (Hansard p 16).

Dr Jochen Kaempf, Oceanographer, School of Chemistry, Physics and Earth Sciences, Flinders University, demonstrated to the Committee hydrodynamic computer modelling for both Spencer Gulf and Gulf St Vincent. Based on currents, tides and density differences, the model demonstrated that flushing times for upper Spencer Gulf were more than two years (Hansard p 42). Model information was validated against field observations and Dr Kaempf concluded that “upper Spencer Gulf is the worst choice of location for any type of discharge of pollutants, because it has the longest flushing times, it is farthest away from the open sea, and it has the longest exposure of pollutants in this region” (Hansard p 42).

BHP Billiton was represented by Mr Richard Yeeles and Mr Kym Winter-Dewhirst, who appeared before the Committee to discuss some of the issues and concerns surrounding the proposed desalination plant to be built by that company in Spencer Gulf. When approached regarding computer modelling and the adequacy of tidal movements to disperse brine and chemicals, Mr Yeeles assured the Committee that the modelling used for the Spencer Gulf EIS displayed quite different results, ensuring dispersal of the brine stream within 100 metres of the outlet (Hansard p 74). Mr Yeeles assured the Committee that “the desalination plant can be designed and constructed so that it would not have any adverse impact on the general marine environment, cuttlefish, commercial fisheries and aquaculture and recreational fisheries” (Hansard p 70).

The Committee had serious concerns regarding conflicting flushing assessment rates for Spencer Gulf and invited Dr Kaempf to return and discuss his concerns with the brine dispersion modelling following his review of the EIS released by BHP Billiton on May 1 2009. Dr Kaempf discussed the modelling data applied and his concerns regarding insufficient input parameters, resulting in his lack of confidence that the model accurately predicted reality (Hansard p 84). He reiterated to the Committee his opinion that “upper Spencer Gulf is the worst choice of location” (Hansard p 83) and his concerns regarding the 10:1 dilution mentioned in the EIS for the Point Lowly region during “dodge tides” when the mixing zone/ “zone of ecological effect” can extend out to 2.5 kilometres (Hansard p 86).

Following the appearance of Dr Kaempf, the Committee invited Associate Professor John Middleton, a senior oceanographer with SARDI Aquatic Sciences, to provide feedback on the validity of the modelling information provided in the EIS. Mr Middleton presented the Committee with a summary of the reviews he had provided to BHP Billiton and SA Water on the Spencer Gulf and Adelaide desalination plants. He advised the Committee that the modelling used for Gulf St Vincent was conducted using a “poor set of conditions” and that inadequate data was available to validate the model (Hansard p 96). However, for Spencer Gulf, he stated that the modelling “was of a very good technical standard” (Hansard p 92), but that “the data used to validate the hydrodynamic modelling of the brine dispersal are inadequate”.

Lattermann & Hoepner (2008) when discussing site selection to minimise impacts, state that the site selected should “provide sufficient capacity to dilute and disperse the salt concentrate and to dilute, disperse and degrade any residual chemicals”. They continue to discuss the obvious mitigating factors: “the load and transport capacity of a site will primarily depend on water circulation and exchange rate as a function of currents, tides, surf, water depth and shoreline morphology”. They recommend siting plants in areas with strong currents, surf and exposed coastlines rather than in “shallow sheltered sites with little water exchange”.

Summary

Kaempf, Brokensha & Bolton (2008) employed the hydrodynamic model (COHRENS) to predict the fate of desalination brine in both gulfs. Using a salinity gradient twice that of the ambient seawater, they found that the flushing times for Gulf St Vincent were between three to six months. The results for Spencer Gulf, however, were much slower due to the proposed discharge being further north into upper Spencer Gulf where the sheltered nature and associated slow flushing would likely be in excess of two years.

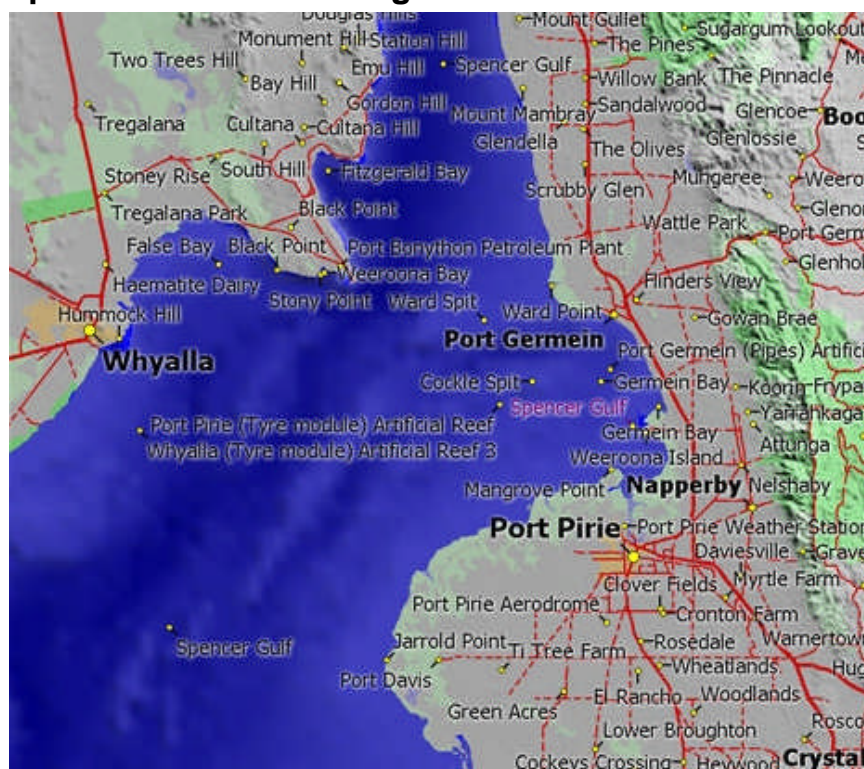
They concluded that “owing to a sheltered nature and associated slow flushing and given that the marine ecosystems in adjacent marine regions are already under stress, discharge of desalination brine into South Australian gulfs might have severe and irreversible negative impacts on the marine and benthic environments”.

Recognising that the “dodge tide” regime appears to be when the dispersion qualities of the water column will be limited, dispersion of the brine stream will obviously require monitoring during these fortnightly events. Current work by Flinders University and SARDI Aquatic Sciences should be built upon using “live” monitoring data taken from fixed sites in Near field, Mid field and Far field sites during “dodge tide” conditions to verify that the plant is achieving targeted diffusion/dispersion targets during these periods of low mixing. The Committee believes that consideration must be given to suspending the discharge of waste brine and chemicals to the marine environment during periods of dodge tide or at other times when water or weather conditions may give rise to increased risk to the marine environment.

The Committee accepts that the model used for the Spencer Gulf EIS is appropriate, but has concerns that further input of localised data needs to be applied to the model before there can be full confidence in the modelling results. Information provided by Associate Professor John Middleton clearly advised that “we need at least a year of data collected so that we can actually look at the climatology and brine concentrations – what is actually happening there now” (Hansard p 92).

Due to the highly impacted nature of the marine environment along the coastline, a monitoring regime that includes cumulative impacts over time will need to be designed to incorporate the brine stream with industrial, storm and wastewater inputs, and measure cumulative environmental impacts over time. This should encompass fixed sites in the Near field, Mid field and Far field zones and include Fitzgerald Bay, False Bay, Black Point, Stony Point and Point Lowly. Sites on the eastern side of Spencer Gulf should also be monitored, such as Port Davis and Port Germein, for comparison of changes with other sites.

Map 1. Spencer Gulf monitoring sites



Recommendations:

7. The Committee recommends that the Government, SA Water and BHP Billiton work with modellers from Flinders University and SARDI Aquatic Sciences to collect further localised data over the ensuing 12 months and use the “live” monitoring data recorded during “dodge tides” to validate dispersion modelling in both Spencer Gulf and Gulf St Vincent.

8. The Committee recommends that the Government include monitoring parameters to account for cumulative environmental impacts in both gulfs over time.

4.3 The potential impact on a range of marine flora and fauna

Our knowledge of impacts is largely based on limited research from relatively small plants operating in relative isolation from each other. Cumulative impacts, both over time and including other inputs into a particular region, are only now beginning to be investigated.

It has been suggested that adverse impacts on species from both impingement and entrainment on the intake screens can cause direct depletion of species that rely on a region for breeding purposes. Seawater is also a habitat and contains an entire ecosystem of phytoplankton, fishes and invertebrates (Dickie 2007). The impacts of the brine discharge are widely known but very little consideration is given to the loss of larvae and small organisms that are contained within the vast amounts of seawater extracted to feed the plant on a daily basis. Clearly this issue must also come under scrutiny when considering the environmental assessment.

The potential impact on a range of flora and fauna in both gulfs was discussed by several of the speakers and was foremost in the concerns of 27 submissions. 15 of the submissions were concerned that the brine outflow from the proposed plant at Point Lowly would impact on the Giant Australian Cuttlefish eggs and juveniles, moving towards the coast during periods of “dodge tide” [or delete “ round all references to dodge tide for consistency] when there is little or no flow.

Associate Professor Bronwyn Gillanders explained to the Committee that if this were to occur, “the potential consequences are that a globally unique species may go extinct” (Hansard p 24). Mr Greg Curnow, representing the Cuttlefish Coast Coalition, travelled to Adelaide from Whyalla to express the concern of the Coalition that the “outlet for the desalination plant will actually run within 200 metres of the cuttlefish spawning grounds” which would then be at risk every time there was a “dodge tide” (Hansard p 61). BHP Billiton has stated that during this period the brine would be stored on land but the Cuttlefish Coast Coalition doubted that there would be the facility to store the amount of brine produced over a five day period every two weeks. There is no mention of brine storage on land in the latest Environmental Impact Statement (May 09).

Both Dr Toby Bolton and Ms Karen Hollamby also expressed concern that the lack of adequate circulation would cause the brine to impact on the cuttlefish population at Point Lowly and risk the extinction of the whole population. The cuttlefish are known to reside only along this particular piece of coast in three to six metres of water from May to September.

A number of submissions discussed the value of the breeding area of the Giant Australian Cuttlefish in tourist dollars, stating that film crews from around the world visited the area to film the phenomenon and that thousands of divers from around the state, interstate and around the world come to dive the area and experience this annual event. These tourists inject annually a large amount of money into the region when they visit. A submission from the Scuba Divers Federation of South Australia voiced "grave concerns in relation to the detrimental effect the heavy low oxygen desalination brine may have on the seabed and marine life" and the possible impact on the cuttlefish.

Mr Richard Yeeles, representing BHP Billiton, assured the Committee that "based on the work undertaken so far, the desalination plant can be designed and constructed so that it would not have any adverse impact on the general marine environment, cuttlefish, commercial fisheries and aquaculture and recreational fisheries" (Hansard p 70).

The Committee invited Dr Kaempf to discuss his concerns regarding the hydrodynamic modelling following his review of the EIS released by BHP Billiton on May 1 2009. Dr Kaempf demonstrated computer based modelling that illustrated dispersal rates in Spencer Gulf and discussed his concerns for the cuttlefish eggs being exposed to periods of increased salinity during periods of "dodge tides", when upwelling events could draw the saline brine layer along the bottom of the sea floor towards the cuttlefish breeding grounds, 500 metres away (Hansard p 87).

Associate Professor John Middleton, when questioned by the Hon M Parnell regarding the possibility that upwelling events could take place, agreed that there may be "certain sorts of wind events under certain conditions" but there was insufficient data for this region for modelling to predict whether this could occur (Hansard p 92).

Dr Kirsten Benkendorff, Senior Lecturer, School of Biological Sciences at Flinders University, spoke to the Committee about some of the research she has been conducting in Gulf St Vincent focused on the potential impacts a brine stream may have on local species around the Port Stanvac area (Hansard p 35). Those impacts included the effects of increased salinity, low oxygen, alkalinity changes, habitat changes, antifouling and antiscaling chemicals, and the stresses that all of these factors can have on the many life stages of the local biota.

The comment has been made a number of times that although there have been a number of studies conducted overseas on the impacts from brine discharges, all have only been short term and none conducted in the same type of environmental conditions that exist in both gulfs. However, several have shown that the seagrass *Posidonia* has been impacted within a 500 metre radius from outlets in the Mediterranean. There are a number of *Posidonia* species within both gulfs, though not the same species that was monitored at these particular Mediterranean sites.

Dr Benkendorff has conducted salinity tolerance studies on the local southern calamari species; *Sepioteuthis australis*, similar to the work conducted by the University of Adelaide on the Giant Australian Cuttlefish, and has found very similar results. This species, like the cuttlefish, breeds once and then dies, although the species does not lay its eggs only in one area, so that the risk of losing the entire population is not high.

Fifteen of the submissions received were concerned with the impacts emanating from the inlet pipes. With the volumes of water required, approximately 580 ML on a daily basis, concerns were expressed regarding the “significant number of eggs, larvae and phytoplankton that will be removed from the region, the impacts this could have on the species that breed in this area and the possible ongoing food chain effects.

A study monitoring the brine discharge of a desalination plant at Alicante in Spain, found that “significant increases of salinity at the bottom were observed several kilometres away from the discharge point”, in both deep areas (20m) and the more shallow (16m) areas (Fernandez-Torquemada et al 2005). It was also found that echinoderms had disappeared from the seagrass meadow in front of the desalination plant. This was attributed to the fact that these organisms are not able to regulate their osmotic pressure and are therefore only able to tolerate a narrow range of salinities. This is also a concern for the eggs of the Giant Australian Cuttlefish attached under rock surfaces within 500 metres of the “mixing zone”.

Lattemann & Hoepner (2008) state that “most organisms can adapt to minor deviations from optimal salinity and temperature conditions and might even tolerate extreme situations temporarily, but not a continuous exposure to unfavourable conditions”. Accordingly, “the constant discharge of reject streams with high salinity and temperature levels can be fatal for marine life and can cause a lasting change in species composition and abundance in the vicinity of the discharge site”.

Most larval species are sensitive to changes in salinity. In particular, sea urchin larvae as echinoderms are generally less tolerant to salinity changes than other taxonomic groups. The cuttlefish breeding area is also home to a large population of sea urchins that are thought to keep the reef free from algae. If this population were reduced, the habitat may change due to recolonisation of algae and the cuttlefish would have fewer places for eggs to be deposited.

Einav *et al* (2002) discuss the “continuous damage to the biota within the plume’s vicinity” and advise “it is therefore desirable to place the point of brine discharge far away from the beach and from rocky areas which are rich in organisms”.

Lattemann & Hoepner (2008) state that “oceanographic conditions will determine the residence time of residual pollutants and the time of exposure of marine life to these pollutants”, reiterating that site selection “can keep the impacts of the desalination plant on the environment at a minimum”.

Summary

The paucity of information on the direct effects of the brine concentrate on marine ecosystems requires monitoring and further research based on site conditions to assess the potential impacts that this may have on local species and their habitats. The area selected for brine outlet is over the sandy sea floor which supports a range of invertebrates. Within close range of the “mixing zone” lies the only known breeding area of the Giant Australian Cuttlefish, a “globally unique species”, the eggs of which rely on a steady saline state for their development.

Following further discussion with Dr Kaempf regarding “dodge tides” and the possibility of upwelling events, the Committee has concerns that the discharge pipe is not far enough away from the cuttlefish breeding ground for it to be confident that there will be no effects from an upwelling event in the future.

Associate Professor John Middleton stated that “dodge tidal” conditions “are quite predictable” but that the oceanographic data that is currently unavailable is necessary for modelling to accurately depict what may occur under these conditions. He stated that “data is the key” as “data is reality” (Hansard p 96). Recommendations he has provided to both SA Water and BHP Billiton include the placement of live telemetry oceanographic observing systems near the brine outfall sites of both plants in order that natural variability can be determined and “a suitable management response can be undertaken in the event that brine levels exceed ‘environmentally safe’ levels”.

It is therefore vital that monitoring of the desalination discharge is ongoing as the cumulative long term effects of the brine on the receiving environment is not known.

The effect of impingement and entrainment require baseline ecological assessment and careful monitoring. The impact on plankton (including larvae and fish eggs) from being compressed against the screens should be monitored, as well as how much plankton actually enters the plant. This can have implications for the ongoing fecundity of local populations that use the area for breeding. Data should be collected with regard to breeding seasons of prawns, blue crabs and fish species that use the area.

Recommendations:

9. The Committee recommends that further ongoing localised salinity and current profile data be collected by BHP Billiton at Port Bonython over the following 12 month period and applied to the hydrodynamic model used to predict brine stream dispersion for the current EIS.
10. The Committee recommends that if a desalination plant is constructed at Point Lowly, then the Government should require BHP Billiton to construct and operate the plant in such a way that the discharge of waste brine and chemicals to the marine environment can be suspended if necessary during periods of “dodge tides” or at other times when water or weather conditions may give rise to increased risk to the marine environment.
11. The Committee recommends that the Government work with South Australian universities, using the baseline data already collected, to continue to monitor local reef areas and seagrass beds within the area. Utilising the before and after desalination data for comparison, this should include a trigger point for the operation to stop if impacts are detected on local populations at these sites. This is particularly important from May to September during the breeding season of the Giant Australian Cuttlefish.
13. The Committee recommends that BHP Billiton adopt the advice from Associate Professor John Middleton to install a live telemetry ocean observing system near the brine outfall site and also near the cuttlefish habitat to enable adequate response actions in the event that brine levels in this area exceed environmentally safe levels.

13. The Committee recommends that the Government should include Point Lowly, Stony Point, Black Point, False Bay and Fitzgerald Bay as regular salinity data collection sites at depths from three to ten metres (the main cuttlefish egg laying reef depth), and that data also be collected from the eastern side of the gulf from Port Germein and Port Davis for comparison.
14. The Committee recommends that BHP Billiton contribute to an annual Giant Australian Cuttlefish monitoring program to provide an ongoing annual assessment of the fecundity of the local population, in partnership with the University of Adelaide and/or SARDI Aquatic Sciences.
15. The Committee recommends that BHP Billiton develop a strategy to minimise the amount of eggs, larvae and plankton that will be trapped on the intake screens or taken into the plant.

4.4 The potential impact on commercial and recreational fishing sectors

Ms Karen Hollamby, Executive Officer, Spencer Gulf and West Coast Prawn Fishermen's Association, travelled from Port Lincoln to present to the Committee concerns regarding the potential impact of the brine plume on the breeding grounds for the Western King Prawn *Melicertus latisulcatus*. More than 20 years of data clearly indicate that the main recruitment grounds for this species lie in the area between Middle Bank and the west coast, from Point Lowly southwards half way to Cowell (Carrick & Ostendorf 2007). If the brine layer settles to the seafloor with little mixing, and moves southwards, as predicted, it will be travelling across the main breeding ground of a species that lives on the seafloor. If this occurs, there will be a region of low oxygen and high salinity, possibly containing cleaning chemicals, which has been shown in studies overseas to impact on the prawn species. This could then have implications for the economy of the region, as Ms Hollamby informed the Committee that this industry contributed \$42 million to the region in the 2006-07 year (EconSearch 2008) (Hansard p 28).

The upper Spencer Gulf is the most intensively used region by recreational fishermen in Spencer Gulf; their expenditure was estimated at \$A23 million in 2000 (Henry & Lyle 2003). The main species targeted by these fishermen use the upper Spencer Gulf as breeding and nursery areas.

A number of submissions discussed the value of the breeding area of the Giant Australian Cuttlefish in tourist dollars, stating that film crews from around the world visited the area to film the phenomenon and that thousands of divers from around the state, interstate, and around the world came to dive the area and experience this annual event. These tourists inject annually a large amount of money into the region when they visit. As discussed previously, a submission from the Scuba Divers Federation of South Australia voiced "grave concerns in relation to the detrimental effect the heavy low oxygen desalination brine may have on the seabed and marine life" and the possible impact on the cuttlefish.

Mr Richard Yeeles, representing BHP Billiton, stated to the Committee that “based on the work undertaken so far, the desalination plant can be designed and constructed so that it would not have any adverse impact on the general marine environment, cuttlefish, commercial fisheries and aquaculture and recreational fisheries” (Hansard p 70).

The AMLR NRM Board in their submission noted the close association between seagrasses and fisheries production and highlighted the importance of preserving seagrass meadows from impacts that may occur from the brine discharge, suggesting the nominal value of seagrasses in this area is around \$7.5 million.

Dr. Kirsten Benkendorff informed the Committee that she had researched related commercial and recreational species overseas and found that salinities above 38 ppt had increased mortality and compromised immunity to disease in abalone, clams, prawns and lobsters. Her own work in Gulf St Vincent illustrated high impacts to increased salinity in local southern calamari (Hansard p 36).

A number of submissions listed concerns regarding the large quantities of water required by both plants and the impacts to the species with life stages living within the water column that will be trapped by/on the intake screens for both plants. The Conservation Council of South Australia summation stated that the intake water will contain “significant quantities of plankton, much of which is the eggs and larvae of a wide variety of marine organisms,” and that “if there is a significant reduction in plankton biomass, it will have effects that will ripple throughout food webs within both gulfs, both in terms of a reduction of recruitment into populations (from reduced egg/larvae numbers) and a reduction of populations from a potential reduction in a vital food source”. It was thought that this could have substantial economic impacts, as well as ecological ones that may be unforeseen until it is too late.

While the majority of the various chemicals used will be detained in the backwash water and disposed of on land, some will still be contained in the waste stream. Most of these will be diluted and undetectable; however it is important to consider cumulative impact. For instance, quite large amounts of ferric chloride will be used, and iron has been shown to be a major limiting trace element for many species of phytoplankton. Sediments in the region already contain levels of lead, iron, copper, cadmium and zinc due to the dispersal of heavy metal pollution from the Port Pirie and Whyalla industrial regions. As the iron in ferric chloride is bio-available, it will be important to monitor for phytoplankton blooms.

Summary

The Committee concludes that the impact on local populations from the removal of eggs, larvae and plankton taken into the plant with the intake water is largely unknown. It is therefore prudent to obtain some data in order to assess any impact on the fecundity of these species. Data should be collected with regard to the breeding season of species such as prawns, blue crabs and scale fish that use the area as a breeding ground.

The Committee has serious concerns surrounding the impact of the salinity of the brine stream on cuttlefish eggs, prawn and fish eggs and larvae.

Recommendations:

16. The Committee recommends that the Government and BHP Billiton collect data from the intake screens of the species being caught on the screens and the larvae and eggs of local species that are actually taken into the plant with the intake water.
17. The Committee recommends that the Government and BHP Billiton regularly monitor at the discharge site for phytoplankton blooms.

4.5 The potential impact of contamination leachate from the location

Brine from the proposed desalination plant will be disposed of directly into the sea. Backwash wastes will have the water removed and the sludge disposed in land fill. Storage during dewatering, disposal of the dewatering product water and transport of the remaining sludge will require secure containment to prevent risk of contamination from leachate.

Summary

The Committee recognises that the disposal of waste as dewatered landfill is a positive environmental outcome and concludes that the majority of chemicals used in the process for the plant at Port Bonython will not enter the marine environment.

Recommendation:

18. The Committee recommends that the Government ensures secure containment of sludge during de-watering and during transport to land fill.

4.6 Any other matter

The Committee has addressed the Terms of Reference of this inquiry but a large number of submissions were concerned with the related issues of stormwater harvesting, the substantial increase in greenhouse gases the plant would produce, and the increase in the size of the carbon footprint that would follow.

The issue of stormwater harvesting was addressed in the interim report released in December 2008 as it pertained to the Adelaide metropolitan area.

The issues of **greenhouse gases and carbon footprint** were raised by 15 of the submissions. Most recognise the fact that desalination is a highly energy intensive option and have concerns that both these plants will make a significant contribution to the state's carbon footprint, making South Australia's Strategic Plan targets in relation to greenhouse gas emissions much harder to achieve.

Mr Richard Yeeles, on behalf of BHP Billiton, has said that the energy demand for the plant will be 35 megawatts (Hansard p 73), but an earlier figure posted on the Arup website has suggested the energy demand would be approximately 30 megawatts for every 125 ML of freshwater processed, suggesting the figure may be closer to 60 megawatts per day.

None of the submissions were totally opposed to either desalination plant but most, including the people providing evidence, suggested that both sites were inappropriate due to their lack of circulation and the risk to the species that lived there. A number of submissions suggested that Elliston and other sites on the west coast would provide more efficient mixing conditions for the Port Bonython plant, if it were proven that a desalination plant was required to provide Olympic Dam with potable water.

Diverting the brine to local salt ponds for harvesting of salt was another option put forward in several of the submissions but it has been suggested by both BHP Billiton and SA Water that current salt processors would not be able to handle the quantity of water that would be supplied.

A large number of the submissions stated that desalination should only be used as a last resort. This was supported by Dr Kirsten Benkendorff during her presentation. She recommended that a “precautionary approach” should be taken towards the development of desalination plants in either gulf and further research be conducted to determine the flushing ability of each region (Hansard p 37).

Dickie (2007) suggests that desalination plants should only be constructed when they are proven to be “the best and least damaging method of augmenting water supply, after a process which is open, exhaustive, and fully transparent and in which all alternatives, especially demand side and pollution control measures, are properly considered and fairly costed in their environmental, economic and social impacts”.

Summary

Desalination plants need to comply with state and national greenhouse targets and need to be designed as climate neutral, obtaining 100 per cent of their energy needs from renewable energy.

Recommendation:

19. The Committee recommends that the Government and BHP Billiton work within the energy guidelines of South Australia’s Strategic Plan and source all energy for the desalination plant from renewable energy sources, including acquiring renewable energy certificates.

The Committee recommended in the interim report that the Government prepare a comprehensive water security strategy for Adelaide. It should incorporate all water supply and demand options in response to the many submissions received during this inquiry that requested consideration of stormwater capture and reuse as an “alternative water source”.

A response from the office of the Minister for Water Security has informed the Committee that the Government of South Australia is “currently in the process of developing a statewide water security plan with a 2050 horizon”. The statement made no mention of stormwater capture and reuse and the Committee believes that this is a vital and relatively urgent component of any water security plan for this dry state. The Committee notes that more recent policy announcements encompass stormwater capture and reuse.

The Committee concludes that there needs to be a balanced multiple approach to guarantee a sustainable water supply where all options are carefully considered and applied where practicable.

Environmental Impact Statement (EIS)

It is evident from the EIS that environmental considerations have certainly been a part of the focus during the design of the proposed desalination plant. Although the final design is yet to be determined, the modelling design that has been applied is deemed by the Committee to be adequate. However, the Committee feels that insufficient local modelling data has been used for the Committee to have confidence that the model adequately reflects reality in order to guide this process.

The current model estimates a flushing time of 12 months for Spencer Gulf and assumes that the majority of the brine will be dispersed within gulf waters and eventually flushed southwards, leaving very little increase in salinity. However, a number of studies portray different results, including the recent one by Kaempf, Brokensha & Bolton (2008) that employed the hydrodynamic model (COHRENS) to predict the fate of desalination brine in both gulfs. By applying a salinity gradient twice that of the ambient seawater, they found that flushing times for Spencer Gulf were much slower due to the sheltered nature and associated slow flushing, and would likely be in excess of two years.

Following review of the EIS released by BHP Billiton on May 1 2009, the Committee invited Dr Kaempf to discuss any concerns he may have regarding his confidence in the modelling used to predict the brine dispersal in Spencer Gulf. Dr Kaempf explained that he considered the model was lacking some parameters of input data, leaving him with a low level of confidence in the results (Hansard p 84). Dr Kaempf continues to regard the site currently proposed as “the worst choice”, particularly in terms of location and flushing.

Associate Professor John Middleton, oceanographer from SARDI Aquatic Sciences, was invited to provide the Committee with advice following his review of current EIS. He feels confident that the modelling was “of a very good technical standard”, but that “the amount of data used to validate the brine concentrations and ocean currents is inadequate”.

The Committee questions whether enough consideration has been given by BHP Billiton to moving the desalination plant to a more appropriate site further southwards or elsewhere on the South Australian west coast to allow for increased flushing/dispersion ability of the brine stream. This would also provide less risk to both the Giant Australian Cuttlefish and the Western King Prawn.

It is accepted that there will be considerable disturbance to the marine environment during construction but the EIS has outlined strategies to address these issues with the use of management plans and close monitoring to ensure disturbance is minimised as practicably as possible. The construction is scheduled to take place outside of the cuttlefish breeding period so as to minimise impacts on that population.

A number of concerns addressed in the EIS, included the issues numbered below, followed by comment from the Committee:

5.1 *Entrainment of marine biota:*

- Entrainment of phytoplankton, zooplankton and fish larvae drawn into the plant.

5.2 *Entrapment of marine biota:*

- Entrapment of larger organisms against intake.

Comment: Entrapment and entrainment strategies have been provided and an intake velocity of 0.2 ms^{-1} has been proposed for the project to alleviate this issue. This should certainly mitigate entrapment but does not provide any strategies for the prevention of entrainment of eggs, larvae and plankton. This will need to be closely monitored to ascertain what impact the intake water may have on the fecundity of resident populations.

5.3 *Salinity:*

- Elevated salinity concentrations (40 to 60 per cent) of brine discharge may harm organisms unable to tolerate fluctuations or increases in salinity;
- Elevated salinity levels may deter mobile species from remaining in the area;
- Potential for dense plume to spread across seabed.

Comment: Near field diffuser modelling at a dilution of 80:1 within 100 metres of diffuser ports is proposed to adequately disperse the brine stream. The Committee has concerns that the diffusion outlets begin too close to shore, risking impacting cuttlefish eggs, and consider these should be concentrated further away in deeper water. The dispersion qualities of this system will certainly require a stringent monitoring regime during fortnightly periods of “dodge tides”.

There are no long term monitoring studies of the environmental impacts of desalination plants and, although a number of short term studies exist, none of these has involved the siting of a desalination plant in an inverse estuary with an estimated turn over time in excess of twelve months. As recognised in the EIS, Spencer Gulf is already under duress from a number of anthropogenic influences. This would now appear to be an appropriate opportunity to consider cumulative impacts on the gulf, noting the effect the brine stream would have on its own, as well as the cumulative effects, particularly in the future, all of these inputs (including the brine) may exert on the marine ecosystems of the gulf.

Both the Giant Australian Cuttlefish and the Western King Prawn stand to be impacted by any increases in salinity that would result from ineffective dispersion of the brine plume.

5.4 Temperature:

- Temperature differences may influence the dispersion and mixing characteristics of the discharge;
- Increased temperature may change oxygen saturation levels and availability in the water column.

Comment: According to the EIS, the small temperature difference between the brine stream and surrounding waters is expected to be around one degree and would have very little effect.

5.5 Elements:

- Elevated concentrations of nutrients may increase algal growth in the vicinity of the discharge;
- Elevated concentrations of heavy metals may be toxic to marine biota in the vicinity of the discharge;

Comment: Increased levels of heavy metals already in the water column are expected to be removed during the flocculation process and disposed of on land. It is assumed that chlorine dosing within the plant should manage nutrient increases. Any cleaning of organic material build up will require prior approval from the EPA and management strategies to minimise impacts on the nearby marine environment.

5.6 Dissolved Oxygen:

- Inadequate mixing could cause dense saline plume to form over the seabed and lead to localised reduction in benthic oxygen;
- Low concentrations of dechlorination agent (acting as oxygen scavenger) may be released intermittently.

Comment: There is the potential, during “dodge tide” conditions, when the brine may form a salt layer on the seafloor. This salt layer will remain low in oxygen until such time as the brine layer is dispersed, impacting on any benthic organisms in the vicinity. Monitoring will be required to ascertain what impacts, if any, may occur, particularly as this region is recognised as a nursery area for the Western King Prawn.

5.7 Chemicals from pre-treatment:

- Elevated concentrations of chloride and sulphate may be released;
- Low pH of discharge may result in decalcification of organisms;
- Discharge of iron may encourage algal growth in vicinity of discharge;
- Unreacted chlorine could be released from the intake or outfall with adverse effects on organisms.

Comment: The EIS states that the chemicals used for pre-treatment should remain with the suspended solids for disposal with the solids.

5.8 Chemicals for flushing:

- Residue flushing chemicals may be discharged in brine.

Comment: These are expected to adequately dilute through the diffuser system according to the modelling undertaken during the EIS.

5.9 Chemicals for preserving membranes:

- Chemical residues from preservation of RO membranes may be discharged.

Comment: Chemicals used in the preservation of membranes are expected to be neutralised on site prior to disposal offsite.

Marine pest management and mitigation strategies appear to be adequate

Summary

Spencer Gulf is a sheltered, inverse estuary already considerably impacted by industrial, stormwater, and waste water discharges. Taking into account the evidence provided by the witnesses who appeared before the Committee, and following further discussion with Flinders University modeller, Dr Kaempf, and Associate Professor John Middleton, oceanographer from SARDI Aquatic Sciences, the Committee has concerns regarding the siting of this large desalination plant in upper Spencer Gulf where, according to currently available data, the dispersion of brine during the fortnightly event of “dodge tides” is thought to be limited, thus putting at risk the only known breeding population of the Giant Australian Cuttlefish.

The Committee believes that further investigations are required into alternative siting of the desalination plant and that this process requires a regional engagement strategy with an emphasis on local, regional, company and Government collaboration.

None of the submissions was totally opposed to either desalination plant but most, including the witnesses providing evidence, suggested that plants sited within an inverse estuary were inappropriate due to their lack of circulation and the risk that this served for the species that lived there. A number of submissions suggested that the west coast around Elliston as an alternative site that would provide more efficient mixing conditions for the proposed Spencer Gulf plant.

A large number of the submissions stated that the option of desalination should only be used as a last resort. This was supported by Dr Kirsten Benkendorff during her presentation to the Committee and in her recommendation that a “precautionary approach “ should be taken towards the development of desalination plants in either gulf and further research undertaken to determine the flushing ability of each region (Hansard p 37).

The Committee accepts the adequacy of the model used to determine the dispersion of the brine stream but is concerned that not enough data has been applied to the model to be confident that the model accurately reflects the future dispersion of such vast quantities of brine in upper Spencer Gulf.

The Committee considers further collection of “live” oceanographic data over the next 12 months is vital in order to obtain a clearer understanding of the dispersive qualities of this region over time. “Live” data would enable an appropriate management response of the plant during events that may be environmentally damaging.

The Committee also has concerns that the siting of the diffuser outlets in the diffuser pipe should be placed out in deeper water, further away from the cuttlefish breeding area, thereby moving the risk of upwelling events impacting on the eggs.

Diverting the brine to local salt ponds for harvesting of salt was another option proposed in several of the submissions due to concerns of the impact on the marine environment, particularly during periods of restricted flow, such as “dodge tides”, but it has been suggested by both BHP Billiton and SA Water that current salt processors would not be able to handle the quantity of water that would be supplied.

The Committee feels that discharge of waste brine and chemicals to the marine environment should be suspended during periods of “dodge tides” or at other times when water or weather conditions may give rise to increased risk to the marine environment.

The supply of water from the Port Bonython desalination plant of 80 ML potable water per day to towns in upper Spencer Gulf and Eyre Peninsula was discussed with representatives from BHP Billiton, Mr Yeeles and Mr Winter-Dewhirst. It was explained that “processing grade” water could be made available to SA Water which would then require further treatment to “meet Australian drinking water quality guidelines 2004”.

Most desalination research has targeted the improvement of desalination technical performance. Little is known about the cumulative environmental effects of large scale desalination, particularly with respect to the cumulative impacts of the intake of feedwater on marine life and the behaviour and effects of concentrated brine discharge in a shallow inverse estuary with limited water exchange with the open ocean.

Complicating our lack of knowledge here in South Australia are the site specific conditions of building a large scale desalination plant in an inverse estuary where the lack of adequate circulation could amplify impacts on marine ecosystems. Spencer Gulf contains the largest area of seagrass meadows and mangrove forests in South Australia, all of which provide vast fish nursery areas and important bird habitat for the gulf. Much of the seagrass meadows consist of *Posidonia*, a species already shown overseas to be impacted by changes in salinity. With much of the gulf’s seagrass beds already under stress from industrial, storm and wastewater inputs, a long term commitment to monitoring the seagrass beds adjacent to the brine discharge area will be vital to their survival. Since the net movement of water along the coast is northward in summer and in winter the reverse occurs, it will be particularly important to monitor during and following the fortnightly periods of “dodge tide”, when the lack of efficient circulatory movement may provide conditions for the brine to form a layer on the seafloor, impacting on the habitats and species that live there.

Sabine Lattemann stated, "I believe that desalination can be a beneficial technology if used in a sustainable and environmental compatible way. To this end, it is necessary that all relevant issues, including the seawater intake, the concentrate and chemical discharge, the emission of air pollutants and energy demand, are addressed in a detailed EIA in order to investigate and minimise negative impacts, and to find a suitable project site where impacts can be kept at a minimum. Furthermore, I believe that desalination activity needs to become an integrated part of regional and national water management plans in order to identify the best water supply option under environmental, socio-economic, energy and human health criteria".

It will be necessary to design a long term monitoring program for Port Bonython with appropriate monitoring sites in the upper reaches of Spencer Gulf and on the eastern side of the Gulf due to the unpredictability in the spatial distribution and magnitude of the brine plume and the possible accumulative effect on the gulf's salinity in the long term. An ongoing monitoring program should be carefully designed to distinguish human impacts from natural temporal variability and other cumulative impacts, such as global climate change, by selecting replicate sites with similar habitat both within and without the "zone of ecological effect".

Ultimately, increased levels of salinity will impact on almost all of the biota that inhabit Spencer Gulf waters. The question remains, however:

Is the modelling adequate and will adequate dispersion of the brine stream occur during "dodge tide" events when these species are at their greatest risk?

The Committee feels that this question can only be answered through the ongoing long term collection of further data.

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Submissions

No	Organisation	Author	Dated	Tabled
1	-	Shea Cameron	5/9/08	12/9/08
2	-	Jana Bradley	9/9/08	12/9/08
3	Windesal Ltd	Barrie Harrop	23/8/08	12/9/08
4	-	Graham Brookman	11/9/08	24/9/08
5	-	Fran Southern	- /9/08	24/9/08
6	Scuba Divers Federation of SA Inc.	Hank van der Wijngaart	11/9/08	24/9/08
7	Molluscan Research Group	Dr Kirsten Benkendorff	16/9/08	24/9/08
8	Flinders Research Centre for Coastal & Catchment Environments	John Goslino	19/9/08	24/9/08
9	-	Sam Taylor	20/9/08	24/9/08
10	City of Onkaparinga	Mayor Lorraine Rosenberg	19/9/08	24/9/08
11	-	Jarred Osborne	29/9/08	8/10/08
12	Mid South Coast Ward Councilors	City of Onkaparinga	29/9/08	8/10/08
13	-	Anna Shepherd	26/9/08	8/10/08
14	-	Lynda Yates	26/09/08	8/10/08
15	Enersalt Pty Ltd	Rob Paterson	29/9/08	8/10/08
16	Greenlime	Graham Dixon	1/10/08	8/10/08
17	-	Colin Campbell	2/10/08	8/10/08
18	-	Robert Lloyd	2/10/08	8/10/08
19	-	Robert Campbell	2/10/08	8/10/08
20	-	Laraine Lerc	3/10/08	8/10/08
21	Axial Filter Systems	Brad Evans	2/10/08	8/10/08
22	Lincoln Marine Science Centre	Dr Toby Bolton	3/10/08	8/10/08
23	Adelaide Mount Lofty Ranges NRM	Tony Flaherty	3/10/08	8/10/08
24	Spencer Gulf & West Coast Prawn Fisherman's Association Inc	Karen Hollamby	29/9/08	8/10/08
25	Cuttlefish Coast Coalition	Greg Curnow	3/10/08	8/10/08
26	-	Robert Burke	5/10/08	8/10/08
27	Friend of Gulf St Vincent	Pat Harbison	7/10/08	8/10/08
28	-	Dianne Turner	7/10/08	8/10/08
29	-	Ian Dyson	7/10/08	8/10/08
30	-	John Lewis	3/10/08	8/10/08
31	Power Core National Pty Ltd	Paul Kaethner and Graham Young	15/10/08	29/10/08
32	-	Renee Grootenboer	16/10/08	29/10/08
33	Conservation Council SA	Jamnes Danenberg	14/10/08	
34	Save Our Gulf Coalition	Peter Laffan & Imelda Rivers	8/11/08	12/11/08
35	Friends of Gulf St Vincent	John Caldicott	3/11/08	12/11/08
36	The Elliston Concept	Tom Cheesman	29/10/08	12/11/08
37	-	Warren Godson	26/11/08	26/11/08

Witnesses

Name	Organisation	Date appearing
Pat Harbison	Friends of Gulf St Vincent	8/10/08
Peter Laffan	Save our Gulf Coalition	8/10/08
Dr. Toby Bolton	Marine Biologist (& Director) Lincoln Marine Science Centre	8/10/08
Bronwyn Gillanders	Associate Professor, Southern Seas Ecology Laboratories, School of Earth and Environmental Sciences, University of Adelaide	8/10/08
Karen Hollamby	Executive Officer, Spencer Gulf and West Coast Prawn Fisherman's Association Inc	8/10/08
Kirsten Benkendorff	Senior Lecturer, School of biological Sciences,, Flinders University	8/10/08
Jochen Kaempf	Oceanographer, School of Chemistry, Physics and Earth Sciences, Flinders University	8/10/08
Peter Dolan	Director of Science and Sustainability, Environment Protection Authority	8/10/08
John Ringham, (Tim Kildea, Tara Hage)	Chief Operating Officer, SA Water	8/10/08
Gregg Curnow	Cuttlefish Coast Coalition	8/10/08
Kym Winter-Dewhirst Richard Yeeles	BHP Billiton	15/10/08
Jochen Kaempf	Oceanographer, School of Chemistry, Physics and Earth Sciences, Flinders University	13/5/09
John Middleton	Associate Professor, Oceanography, SARDI Aquatic Sciences	3/6/09