Submission to the Olympic Dam Roxby Downs Mine Expansion

Re. Proposed Development of a Desalination Plant at Point Lowly

Prepared by Kirsten Benkendorff*, Ryan Baring and Tom Stewart on Behalf of

The Molluscan Research Laboratory

School of Biological Sciences, Flinders University

GPO Box 2100, Adelaide, S.A., 5001

*Corresponding author Dr Kirsten Benkendorff

Email: kirsten.benkendorff@flinders.edu.au

PH: 08 8201 3959; Fax 08 8201 3015

Introduction

The Molluscan Research Laboratory is a team of 15 research scientists including post doctoral research fellows (PhD, BSc. Hons), post graduate students and research assistants (with B.Sc. Honours) and honours students (B.Sc.) under the supervision of Senior Lecturer Dr Kirsten Benkendorff (PhD. B.Sc., Hons). We have a wide range of expertise in marine biology, including ecotoxicology testing, biodiversity assessment and environmental monitoring. We have prepared this submission as an independent expert opinion and have not been contracted or paid by any community group or industry body. We hope you find this submission as a non-bias statement based on fact and concerns surrounding the scientific uncertainty associated with the potential impacts of the proposed desalination plant at Point Lowly, South Australia.

Inaccessibility of the EIS and implications for public scrutiny

The length of the complete EIS document and the desalination plant section embedded within the larger Olympic Dam development proposal is inappropriate. Desalination plants are listed developments in the Environmental Legislation requiring an EIS as part of the approval process. Therefore it would seem far more appropriate if BHP Billiton had prepared a separate EIS for the desalination proposal in order to enable a transparent assessment process. Given the high ecological importance of the Upper Spencer Gulf, Point Lowly region (as acknowledged in the EIS), it is imperative that there be an option for rejecting the desalination proposal, independent of the Olympic Dam, Roxby Downs Mine expansion, if state environmental standards for water quality and environmental impact can not be adequately met. Although the mine expansion does require a water supply, the environmental issues associated with the mines expansion are completely separate to those involved in a desalination plant with marine discharge. As a result, the EIS is an enormous and intimidating document that is highly complex, with numerous chapters and associated appendices. It is difficult and time consuming to find the relevant information and conclusions that may form the focus of scrutiny by qualified members of the public. Few respected practicing scientists or independent environmental specialists would have the time to navigate this EIS, read the relevant details and provide constructive criticism specifically within their field of expertise.

This submission aims to highlight some scientific concerns associated specifically with the proposed desalination plant at Point Lowly. Although we are also concerned about the threat to seagrass and mangrove habitat associated with the proposed Landing at Port Augusta, as well as the predicted impact of the mine expansion on terrestrial species and communities, time restrictions prevent us from providing a detailed scrutiny of these additional biological components of the BHP Olympic Dam Mine Expansion Project. In this submission we have focused largely on some of the conclusions related to the operation of the proposed desalination plant as outlined in the Executive Summary, as this is the only section of the EIS that will be read by most members of the public. However, we use the information and data provided in Chapter 16 and some of the attached appendices, to highlight limitations and alternative conclusions that would be derived from an appropriate precautionary approach* to a development such as this, which has a very real potential to result in catastrophic irreversible effects on the marine environment. The emphasis indicated by italics in all quotes taken from the EIS has been placed by the authors of this submission.

*** The precautionary principle**

Australia is a signatory to the Rio Declaration stemming from the 1992 International Convention on Biodiversity. Under Principle 15, this international agreement outlines the precautionary approach, which states that:

"*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation*".

The precautionary principle is acknowledged in the National *Environment Protection and Biodiversity Conservation Act, 1999.* It places the burden of proof on the development proponent, in the absence of scientific consensus that severe or irreversible harm will NOT occur to the environment. This requires decision makers to anticipate harm before it occurs and the development proponents must then establish that significant environmental damage is very unlikely. There is clearly scientific uncertainty regarding the long-term cumulative environmental impacts that may result from continual desalination discharge in the Upper Spencer Gulf. The potential for irreversible damage stemming from combined impacts of climate change and the proposed desalination discharge needs to be investigated in more detail and incorporated into specific management and ongoing monitoring plans before negligible impacts on the marine environment can be conclusively demonstrated. Irreversible damage cannot be excluded as a long-term consequence of the proposed development at this stage and therefore a precautionary approach should be taken towards the proposed desalination plant at Point Lowly.

Water quality and associated impacts on marine life

Whilst not stated clearly in the executive summary, the Draft EIS does acknowledge that EPA's water quality standards will be compromised by the proposed desalination plant and ultimately this development will not comply with South Australia's environmental legislation. As the region surrounding Port Bonython is a site of high conservation value (condition 1 ecosystem), measures outlined by the ANZECC/ARMCANZ Guidelines (2000) state that water quality should be assessed for *both* water and sediment physico-chemistry. Despite this, it is evident that only sediment toxicity was considered in detail in the environmental impact assessment and it is not clear as to whether any water quality samples were taken from the water column. An appendix addressing water quality criteria (Appendix 014) contains a brief comparative analysis of desalination plant effluent quality with Spencer Gulf water; however, it appears that samples were only taken at one specific site which is not sufficient to represent the spatial and temporal variability in water quality of the surrounding area (i.e. including the proposed impact zone).

Heavy metals

The large disparity in the range for zinc values falls between 8-58mg/L for the BHP sediment toxicity samples. A recent study by Dupavillion and Gillanders (2009) sampled the surface water at 9 sites within the vicinity of Port Bonython and found that the levels of zinc in the water ranged between 10-20µg/L. ANZECC has outlined a high reliability trigger value of 15µg/L for marine species in reference to Zinc for a 95% protection of species. Not only are the measurements recorded by Dupavillion and Gillanders (2009) either bordering or exceeding the ANZECC reliability trigger value, but this data highlights the extreme differences between sampling efforts and outcomes of sediment and water column surveys. Chapter 16 of the EIS suggests that "most" (but not all) of the metals within the intake water will be removed by the pre-treatment process, but also acknowledges that trace concentrations of metals could be discharged into the return water as a result of corrosion (pg 504). It is highly concerning that there is no quantitative showing current and predicted future concentrations of heavy metals with respect to long-term accumulation based on their relatively inert (long half life).

Another key comprehension issue associated with the sediment toxicity appendix is the ambiguous presentation of toxicity data from the sediment samples. The use of 'less than' and 'greater than' symbols were in place rather than a figure to indicate whether the sample was below or above the trigger value for specific toxicity of individual substances. The use of such symbology, as opposed to the exact concentration means that it is impossible to tell whether the values were bordering the toxicity trigger values therefore leaving uncertainty associated with the potential impacts of brine discharge from the desalination plant (especially if the sediment is disturbed during construction or operation). Given the low tolerance of most marine organisms to heavy metals, only slight increases could have devastating effects on the local ecosystems.

Biocides

Page 504 of the EIS (Chapter 11) identified plans to release chlorine to the feedwater for about 1hr per day (Table 16.7, indicative only), with the chance for "some residual sodium metabisulphite and possibly trace concentration of organic bioproducts of chlorine" being discharged back into the sea. Furthermore, under the dissolved oxygen section, it is suggested that the intake pipes will be "regularly dosed with biocide (chlorine)". However, there is no quantitative data provided for the likely concentrations of these biocides entering the marine environment on a daily basis (Table 16.7 dose chlorine = 8mg/L; sodium metabisulphite = 24mg/L Indicative only) and no modeling has been undertaken to assess how they might accumulate in time and space with continual operation of the desalination plant. Minor amounts of cationic polymer, ferric chloride (Table 16.6) and heavy metals may also be released, as well as 4mg/L continuous release of organophosphate (or other antiscalant) (Table 16.7). Due to the low natural levels of nutrient input in the the Upper Spencer Gulf, organophosphates could have significant impacts on the local algal and seagrass communities. Further experimentation is required to effectively predict the impacts from continually discharging these water pollutants as a result of the desalination plant operation.

Hypersalinity and halotolerance

On Page 44 of the Executive summary under "Dispersion of return water", it is claimed that "locating the return water diffuser seaward of the line shown in Figure 22 *would prevent* adverse impact on the general marine environment, cuttlefish, commercial fisheries and aquaculture". Due to the unpredictable nature of the marine environment and general lack of knowledge about marine species responses, it is simply inappropriate to make such a claim with any certainty. This is especially true in the longer term (>10yrs) in light of likely synergistic impacts with climate change, which has not been considered in the marine studies, including the water modelling of brine dispersal (see subsection below for further discussion on climate change).

Of great concern, the animation in the EIS shows that mixing of the waters within the Upper Gulf near Point Lowly, with oceanic water, occurs for less than 4 months out of every year. Removal of accumulated salt due to natural evaporation processes currently depends on a gravity driven density current that drives the hypersaline water out towards the ocean over the winter period. It is uncertain how this current may be affected by future climate change as haloclines are thermally dependant.

The argument that the predicted long-term salinity increase at Point Lowly is significantly less than that natural depth variation and seasonal variation is misleading and irrelevant. The species that currently live in the Upper Spencer Gulf have adapted to the natural cycles of variation and at least some species appear to be living at their *maximum* halotolerance. An unnatural increase of 0.07g/L *per year* is actually quite substantial and could trigger a cascade of detrimental impacts, beyond which the ecosystem can no longer function productively. The tipping point for salinity change in marine ecosystems close to the limit of halotolerance is simply unknown, but the consequences could be catastrophic, therefore requiring a precautionary approach*.

It is claimed that during a dodge tide “salinity increase would be *no more than* 9% above background levels at 100m from the outfall pipe”. On a biologically relevant scale, 9% is a massive increase in salinity; i.e. this is an increase in salinity from the current range of 40-43 ppt (as stated in the EIS) up to 43.6 – 46.87ppt. These new salinity levels definitely exceed the lethal salinity concentrations of many local species, as indicated in Table 16.8. Ecotoxicological studies revealed detrimental effects were observed at concentrations as low as 1.4% above ambient, with the Giant Cuttlefish and at least two other commercially important species, the Western King Prawn and the Pacific Oyster having tolerance levels below 45ppt salinity (Table 16.8). Additional brine and hypersalinity experiments in our laboratory have revealed low tolerance in a number of additional benthic marine invertebrates that occur in the Point Lowly area, including the Southern Calamary (*Sepioteuthis australis)* (Stewart, 2008), sea squirts (*Pyrua* sp.), brittle stars, blue mussels (Beattie, 2009) and the dogwhelk (*Dicathais orbita*) (unpublished data).

Ecotoxicology studies

These studies were generally quite well done as they incorporated salinity, antiscalant and lower pH. The main limitation (which is typical for most ecotoxicology studies) was the relatively short time frame of the experiments and lack of investigation of sublethal effects. Sublethal effects, such as impacts on metabolic processes and immunity, provide a more conservative prediction of organism susceptibility in short-term experiments because they establish the level of stress and can be used to predict recovery in the face of long term exposure (chronic stress). Pg 44 of the executive summary suggests a “number of conservative measures have been built into the return water modelling and ecotoxicology studies, including” ...”unrealistic continuous exposure to return water (rather than intermittent as would occur in reality”. Whilst this is convenient and typical for ecotoxicology studies, it is not a conservative measure for organism response. When continuously exposed to certain conditions organisms can adapt more easily than when repeatedly, but intermittently, subject to the same stressor. This is particularly true for salinity stress, as organisms require metabolic energy to adjust their osmoregulation to the surrounding environment. The timing, intensity and frequency of exposure will all influence the halotolerance of marine organisms. Furthermore, the species protection trigger values in the EIS are based on only 10 species and it’s not clear how representative these species are for the whole marine community. 167 taxa were identified in the EIS (Pg 490 Chapter 11), but due to the difficulties in comprehensively surveying biodiversity in the marine environment these studies are likely to only represent a small proportion of the local species (i.e. the conspicuous macroflora and fauna only).

In the EIS, salt accumulation from the desalination plant is compared to the salt balance resulting from natural evaporation rates in the Spencer Gulf (e.g. Table 16.12, Pg 519, Chapter 11; Executive Summary pg 44). This appears to be a convincing argument for the insignificance of salt input into the Gulf. However, it is highly misleading and due to the extreme differences in both the processes and the spatial scale, it basically equates to comparing apples with oranges. The salt accumulation from evaporation is calculated from the entire Gulf area and certainly does lead to temporal variations in the salinity of the Upper Spencer Gulf but this occurs as a gradual increase over summer. By comparison, the desalination discharge represents a continuous point source pollution (artificial/anthropogenic input) over and above the natural hypersalinity generated by evaporation in the Upper Spencer Gulf. The predicted salt accumulated is it locally concentrated over a smaller spatial area with a sharper salinity gradient across all seasons. It remains unclear whether this brine plume will disrupt natural cycles, such as migration, feeding and breeding in marine organisms that have adapted to hypersaline conditions across a broader scale in only some months of the year.

Dissolved Oxygen

Dissolved oxygen is stated to be reduced by 1.5mg/L due to increased salinity in the discharge water (pg 504, Chapter 11). However, the likelihood of an anoxic layer forming from the sinking of heavy brine to the seafloor, thus preventing mixing in the water column has not been addressed. This problem has been previously identified in association with desalination brine discharge in the Cockburn Sound WA (Okely et al., 2007). The formation of brine underflows lead to oxygen depletion, especially in calm periods, such as during neap/dodge tides which are known to occur regularly in the Upper Spencer Gulf. This potential problem needs be adequately considered and effectively modeled or experimentally tested with respect to the topography, currents and environmental conditions at the proposed brine discharge outlet off Point Lowly.

Zone of Ecological Impact

On page 44 of the executive summary, the “zone of ecological effect” is described as representing the region surrounding the discharge pipe where the dilution of return water is not within the safe limit for 99 or 100% of the species (= 1:45 or 1:85 dilution respectively). However, the actual size of this predicted “zone of ecological effect” is not actually stated anywhere in the executive summary! In Chapter 16, near field water dispersion models demonstrate that 1:85 dilutions would never be achieved within 100m of the outfall dispersers and 1:45 dilution would only be achieved 30% of the time (Table 16.9). Figure 16.1 indicated that the zone of ecological effect could exceed 400m from either end of the discharge pipe; considering that the discharge diffuser is 200m long, this equates to 1000 m diameter impact zone (500m radius = ~ 78500 m^2). This area is well in excess of the impact zone typically considered acceptable for a desalination plant (e.g. Port Stanvac desalination plant 1:50 dilution zone within a 100m radius). In the conclusions of Chapter 16 (Section 16.6) it is suggested that the 1:85 dilution contour could in fact extend 3.9km to the South West and 2.1km to the North East (Page 543). At present, this zone of ecological impact is predicted from computer models. It is essential that the models are experimentally confirmed, for example by the release of Rotamine dye tracers to examine the actual dispersal from the discharge pipes under the full regime of environmental conditions (incl. Dodge and neap tides, onshore and off shore winds, storms ect).

The *Environment Protection (Water Quality) Policy 2003* outlines the requirements that must be met prior to issuing a licence for discharge into the marine environment. This states that the “mixing zone” (zone of ecological impact) must not have a radius exceeding 100 meters. Consequently, it appears that a desalination plant located at Point Lowly will be in breach of environmental standards for South Australia. Furthermore, the *Environment Protection (Water Quality) Policy* states that “the zone must not be situated within waters that..... have significant value as a spawning or nursery area for aquatic organisms”. As acknowledged in the EIS, the Point Lowly area is an internationally renowned breeding ground for the Giant Cuttlefish protected in an aquatic reserve. Further, the Upper Spencer Gulf serves as a nursery and breeding ground for the Spencer Gulf prawns, which provide a valuable fisheries resource.

Impacts on the Giant Cuttlefish

The Executive summary (pg 44) states that “the return water from the desalination plant *would not* affect the Australian Giant Cuttlefish because the zone of ecological effect and the breeding habitat are well separated vertically and *would never* overlap”. This is a very bold statement to make, because although it is true that brine is heavier than seawater, wind driven currents have been shown to raise bottom water to the surface and drive it up towards the near shore shallow waters. This process has been recently modelled by Dr Jochen Kaempf for Point Lowly in the Upper Spencer Gulf (per. comm.). When considering the effects of deoxygenation and stratification in the Conclusions and Findings (Section 6.7) in Chapter 6 it is stated that “reduced periods of vertical mixing in the vicinity of Point Lowly *are rare* and relatively short due to *good mixing* by strong currents and wind generated waves” (page 543). This appears to directly **contradict** the assertion that vertical separation will prevent high salinity waters reaching the cuttlefish habitat located < 400m from the discharge pipes.

It is also worth noting that the animations of water movements from models of the tide and currents linked to the EIS show that there is no consistent unidirectional tidal flow of the water off Point Lowly over a typical daily cycle. At certain times the water clearly flows from the vicinity of the discharge point towards the coast south of Point Lowly directly overlapping with the Giant Cuttlefish breeding habitat. This, in combination with wind driven currents that could bring the brine to the surface, suggests there in fact **is** potential for overlap between the discharge waters and the Giant Cuttlefish habitat.

International experts, Lattemann & Höpner (2008), clearly state that desalination plant discharge should be avoided in ecosystems or habitats that are “*unique within a region*, *worth protecting on a global scale*, inhabited by *protected... species*, ...or if they play an important role as feeding or *reproductive areas in the region*”. Point Lowly fulfils all of these criteria for conservation importance with respect to the Giant cuttlefish. Due to the high ecological significance of this marine area it is also necessary to account for a potential irreparable damage that could result from an unexpected failure in the dispersers or discharge pipe. Whilst unlikely, the possibility remains that brine could spill into the water column anywhere along the pipe, which passes from the shore to the outlet points 600m offshore, thus crossing the Giant Cuttlefish habitat. Impacts from construction, including siltation from adjacent land-based construction activities must also be avoided.

Impacts on rare species & unique communities

Table 16.10 of the EIS (Chapter 16) combines ecotoxicology testing with oceanographic modelling to produce an overall conclusion regarding the likely effect of the desalination discharge on key marine organisms and communities. Most notable is the predicted “regular effects” on the sponge communities. This sponge community appears to be spatially restricted in the Upper Spencer Gulf, although the spatial extent and proximity to other similar communities is not documented in the EIS. Further studies are required to establish whether these sponge dominated reefs qualify as a marine community of regional significance. Numerous species in temperate subtidal reef communities are typically rare or unknown, including marine taxa such as sponges, bryozoans, ascidians and opisthobranch seaslugs which are known to provide a treasure trove of biomedically useful compounds (e.g. Simmons *et al*., 2005; Blunt *et al*., 2007). Therefore this little studied subtidal reef community off Port Lowly could be particularly valuable to bioprospectors searching for new marine bioresources, especially considering that it appears to exist in a marginal habitat with an above average natural salinity range.

Typically marine invertebrate species receive little attention in EISs because they are not listed as rare or threatened in National or State Environmental legislation. However, this is due to a general lack of knowledge on the rarity of marine invertebrates and a lack of taxonomic specialists focussing on these species in Australia (Hutchings and Ponder 1999). Nevertheless, the precautionary principle* states that the onerous burden of proofs falls on the proponent of the development in cases where there is scientific uncertainty surrounding the significance of environmental impacts. In this case there is a need to demonstrate how wide spread this subtidal reef “sponge” community is in the Upper Gulf St Vincent and whether it possesses and unique species or characteristics that could be lost as a result of the “regular” detrimental effects that are predicted in association with the desalination discharge (Table 16.10).

It is also worth pointing out that the Species list in Appendix 02 is not very professional in its structure. Higher taxa should appear in evolutionary order, with species grouped into families under each Phylum and Class, for easy reference by specialist biologists. Notably, whilst most marine invertebrates in Australia are not listed as rare or endangered, at least one additional molluscan species identified in the species list for the Point Lowly area is a protected species (*Zoila friendii thersite*, the black cowrie, Ponder, 1996).

Other Impacts

Intake pipe

In the executive summary (pg 48) it is stated that the entrainment of planktonic marine organisms and larvae in the intake pipe "would not result in long-term population decrease to the extent that a species would decline". This statement is unsupported by any data in the EIS and is potentially untrue. There is the possibility for rare and restricted range species, including unidentified marine invertebrates, to have very narrow range breeding grounds in the vicinity of the intake pipe (for example the sponge reef community). Therefore, it is necessary to sample the meroplankton communities in the intake area, in comparison to other control locations, over an annual cycle to properly assess the likely impacts from larval entrainment.

Construction impacts and nearshore surveys

Construction impacts for the intake and outlet pipes in the executive summary focus entirely on the Giant Cuttlefish populations (pg 48). It is stated that the construction will be restricted from November to 1st May to avoid potential impacts. However, this neglects to acknowledge that the habitat will still be impacted, along with the rest of the resident intertidal and shallow subtidal communities. Siltation and other forms of habitat disturbance during the construction could have significant impacts, such as smothering and reduced capacity for photosynthesis (primary productivity). Consequently, it is imperative that detailed marine ecological surveys are undertaken in the proposed impact zone, with reference to control sites, in order to establish the regional significance of the area. Replicated baseline surveys of the intertidal and shallow subtidal communities should be undertaken before the construction commences, as well as during and after the development.

The EIS Marine Ecological Surveys currently rely on one previous study of the intertidal reefs undertaken in 1981 (Appendix 02, SEA 1981), which is grey literature and therefore an inaccessible document. This twenty eight year old study is simply insufficient, given the scope and scale of the proposed development and potential impacts.

Risk of bio-invasion

The potential risk of bio-invasion is not addressed in the EIS and more importantly there is no indication of preventative management for potential bio-invasion associated with the desalination plant operation. The United Nations Law of the Sea identifies that:

'*States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto'* (UNCLOS 1982).

Indirect native species loss can occur with the introduction of pollutants (i.e. desalination antiscalants) to the coastal marine environment. Pollutants such as antiscalants can change the coastal water chemistry and act as a precursor for the invasion and colonisation of more tolerant foreign species, which ultimately outcompete native species (Bax *et al*. 2003). For example, recent research identified a higher tolerance to copper in two foreign species of invasive bryozoans, which showed increased growth, decreased mortality and rapid post exposure recovery compared to two native bryozoan species in New South Wales (Piola and Johnston 2009). Furthermore, invasive species are known to tolerate wide fluctuations in a range of physico-chemical parameters including salinity, which can also be a precursor for population blooms (Occhipinti-Ambrogi 2007). Despite the general lack of knowledge of salinity tolerances for invasive species there is some evidence which indicates that invasive species may acclimatise to hypersaline environments. A recent study by Sara *et al*. (2008) found that a salinity increase to 45ppt promotes growth of the invasive mussel *Brachiodontes pharaonis* in the Meditterranena Sea. This highlights the potential risk involved with only the slightest increase in salinity levels from the desalination plant outfall pipe at Point Lowly, which could assist certain invasive species to colonise and persist in the area if introduced.

Combined with the increased traffic of various vessels into the upper reaches of Spencer Gulf associated with the Olympic Dam extension, there is a high risk of foreign species entering the environment from ballast water and biofouling (Hayes and Sliwa 2003). Bio-invasions have already appeared in various coastal regions globally with significant environmental and economical damage as a result. Therefore, any environmental impact statement for coastal construction should acknowledge and address the potential threat of bio-invasion coinciding with any physical change to the marine environment.

Bioaccumulation of Heavy Metals

The upper Spencer Gulf has long been associated with industry with 2 large smelters and a power generation plant being located within the upper regions of Spencer Gulf (Whyalla, Port Pirie and Port Augusta). It is widely recognised that bivalves are susceptible to bioaccumulation. An investigation into the concentration and prevalence of heavy metals in razorfish (*Pinna bicolor*) and sediments was carried out by the EPA in 2004 with the study specifically targeting the northern Spencer Gulf. It was found that the highest concentrations of zinc in the Gulf were detected in the Prohibited zones near Port Pirie and in False Bay, Whyalla. It is evident that the marine environment in the Upper Spencer Gulf is already under pressure from local industry, with elevated levels of zinc detected at sites within the protected zone of False Bay.

Synergistic Impacts from Climate Change

In addition to the increased salinity, increased temperature and a decreased pH are associated with the desalination discharge (e.g. Chapter 16, Table 16.6). These are additional stressors also associated with climate change that must be factored into the long term vulnerability of local marine ecosystems. The waters around Australia have been predicted to warm 1-2ºC by 2070, with greatest warming in Southern and South Eastern Australia (CSIRO Marine and Atmospheric Research, 2006). Furthermore, the absorption of atmospheric CO_2 into the oceans is predicted to decrease pH by 0.4–0.5 units (Calderia and Wickett, 2003; Orr *et al*., 2005). In modelling studies recently undertaken by the CSIRO Marine and Atmospheric Research, the South Australian Gulfs (Spencer and Gulf St Vincent), have been highlighted as particularly vulnerable hotspots for climate change impacts. Extensive research has documented the impacts of ocean warming and acidification on the growth, physiology and calcification processes of marine organisms (e.g. Michaelidis *et al.*, 2005; Reynaud *et al.*, 2003; Pörtner and Langenbuch, 2005), as well as broader scale effects on community composition and stability (Alheit, 2009; Ling, 2008). Consequently, climate change is now considered a major threat to the economic and ecological sustainability of Australian marine fisheries and aquaculture.

It is essential that long-term cumulative impacts associated with any proposed alteration to the current seawater temperature and pH regimes are considered as part of the impact assessment process for all marine developments. Page 504 of the EIS states that, “it is anticipated that ambient seawater would rapidly buffer the return water, resulting in a pH above 7.6 being achieved near the outfall” (based on **continuous** dose of 15mg/L sulphuric acid Table 16.7). No experimental data is provided to support this assertion, especially in light of climate changes effects that may limit the buffering capacity of the Gulf waters due to increased carbon dioxide absorption. Furthermore, a pH of 7.6 is substantially below the current pH of seawater (8.1-8.2) and definitely exceeds the minimum pH tolerance of many marine species (e.g. Riebesell et al. 2000; Cheng and Chen, 2000; Reynaud et al. 2003; Bibby *et al.*, 2008). Synergistic effects of desalination discharge and climate change stressors have not been considered anywhere in the Draft EIS for the Olympic Dam Expansion and is identified by us as a major oversight that could lead to underestimation of the risks associated with the proposed desalination plant.

Alternatives to the Development

Desalination Plant location (Chapter 16 page 522)

Only five alternative sites near Point Lowly and Whyalla, as well as Port Augusta and Ceduna, were considered as alternative locations for the desalination plant. The criteria on which the decision for Point Lowly was based on included “proximity to Olympic Dam, accessibility and constructability of the water supply pipeline, potential effects on sensitive receivers and the likely rate of dispersion of the return water plume”. The ecological significance of the adjoining marine communities was not considered in the assessment of alternative locations. Clearly Port Augusta at the head of the Gulf St Vincent is an inappropriate location due to lack of flushing. The alternative locations surrounding Point Lowly and Whyalla all experience similar condition of restricted flushing for the majority of the year and really can not be considered “alternatives” on an appropriate spatial scale. The reasons for not considering Ceduna as a possible location and not explained in the EIS. Logic and numerous published recommendations in relation to the location of desalination plants warn against 1) regions of limits water exchange with the open ocean and 2) areas of biological significance (e.g. Lattemann & Höpner, 2008). Both of these conditions exist at Point Lowly and as a result alternative locations in more open coastlines should be considered in depth.

Desalination Plant Design and Operation

No alternatives to discharging waste brine into the gulf have been considered in the EIS. Alternatives would include relocating the brine into evaporation pans on land and harvesting the salt product. This would have comparatively negligible environmental effects when compared to the local impacts and large scale risks associated discharge into the Upper Spencer Gulf.

CONCLUSIONS AND RECOMMENDATIONS

Overall we remain concerned about the proposed construction of desalination plant at Point Lowly. We have identified several misleading conclusions in the EIS and inadequacies in the environmental impact assessment studies. Further research is required to alleviate the scientific uncertainty with respect to the potential for long term damaging effects on the marine environment. Ultimately, we recommend **rejection** of this development at Point Lowly. Alternative sites and/or alternatives to brine discharge in the Upper Spencer Gulf should be seriously considered.

If, however, the desalination plant is approved in Upper Spencer Gulf, it is essential that scientifically rigorous monitoring programs are put in place. This involves replicated before, after, control impact studies. The location of control sites needs careful consideration and should include sites of similar habitat across a broad spatial scale. At least three years of data should be collected prior to construction, to account for natural temporal variability. These surveys should then be repeated regularly during construction and throughout the entire period of operation.

We request that the issues raised in this submission be considered in the decision making process and would like a written response to the concerns raised.

References

Alheit, J. 2009. Consequences of regime shifts for marine food webs. *Int. J. Earth Sci. (Geol Rundsch)* 98, 261-268.

ANZEC/ARMCANZ, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality – chapter 7 Monitoring and Assessment, report for Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality) [Accessed 1/8/09]

Bax N., Williamson A., Aguero M., Gonzalez E., Geeves W., 2003, Marine invasive alien species: a threat to global diversity, *Marine Policy* 27: 313-323

Beattie, K., 2009. "Effects of desalination brine on marine invertebrates" Honours Thesis, School of Biological Sciences, Flinders University.

Blunt, J.W., Copp, B.R., Munro, M.H.G., Northcote, P.T. & Prinsep, M.R. (2007) Marine natural products. *Natural Product Reports* **24**, 31-86.

Bibby, R., Widdicombe, S., Parry, H., *et al.* 2008. *Aquat Biol* 2, 67-74.

Caldeira, K., Wickett, M.E., 2003. *Nature* 425, 365.

Cheng W and Chen J-C 2000 *Fish Shellfish Immunol* 10: 387-391

CSIRO Marine and Atmospheric Research, 2006. In: Hobday, A.J., *et al*. (Eds.), Impacts of climate change on Australian marine life. Department of the Environment and Heritage Australian Greenhouse Office, pp. 46

Dupavillon, J.L. and B.M. Gillanders, 2009. Impacts of seawater desalination on the giant Australian cuttlefish Sepia apama in the upper Spencer Gulf, South Australia, *Marine Environmental Research*, 67, 207-218

Environmental Protection Authority, 2004, 'Heavy metal concentrations in razorfish (*Pinna bicolor*) and sediments across the northern Spencer Gulf', report for the Government of South Australia (http://www.epa.sa.gov.au/pdfs/razorfish.pdf) [Accessed 7/8/09]

Hayes K.R., Sliwa C., 2003, Identifying potential marine pests – a deductive approach applied to Australia, *Marine Pollution Bulletin* 46: 91-98.

Hutchings P.A. and Ponder W.F. 1999. Criteria for assessing and conserving threatened invertebrates. A summary of a workshop held in conjunction with the Other 99% Conference. *Transactions of the Royal Zoological Society of New South Wales*. 297–315.

Lattemann S. & T. Höpner, 2008, Environmental impact and impact assessment of seawater desalination, *Desalination* 220: 1–15.

Ling, S.D. (2008) Range expansion of a habitat modifying species leads to a loss of taxonomic diversity: a new and impoverished reef state. *Oecologia* 156:883-894. DOI 10.1007/s00442-008-1043-9

Michaelidis, B., Ouzounis, C., Paleras, A., Pörtner, H.O., 2005. *Mar. Ecol. Prog. Ser.* 293, 109-118.
Occhipinti-Ambrogi A., 2007, Global change and marine communities: Alien species and climate change, *Marine Pollution Bulletin* 55: 342-352.
Okely, P., J.P. Antenucci, J. Imberger and C.L. Marti, 2007: Field investigations into the impact of the Perth Seawater Desalination Plant discharge on Cockburn Sound. Final Report. Centre for Water Research. University of Western Australia, 102 pp.
Orr, J.C., Fabry, V.J., Aumont, O., *et al*. 2005. *Nature* 437, 681-686.
Piola R.F., Johnston E.L., 2009, Comparing differential tolerance of native and non – indigenous marine species to metal pollution using novel assay techniques, Environmental Pollution, In Press.
Pörtner, H.O., Langenbuch, M., 2005. *J. Geophys. Res.* 110, doi:10.1029/2004JC002561.
Reynaud, S., Leclercq, N., Romaine-Lioud, S., *et al*. 2003. *Global Change Biol*. 9, 1660-1668.
Sara G., Romano C., Widdows J., Staff F.J., 2008, Effect of salinity and temperature on feeding physiology and scope for growth of an invasive species (*Brachidontes pharaonis* – MOLLUSCA: BIVALVIA) within the Mediterranean sea, *Journal of Experimental Marine Biology and* Ecology 363: 130-136.
Simmons T, Andrianasolo E, McPhail K, Flatt P, Gerwick W. 2005. Marine natural products as anticancer drugs. *Mol Can Ther* 4:333-342.
Stewart, T. 2008 “Effects of hypersalinity on the benthic egg masses of the Southern Calamary *Sepioteuthis australis*” Honours Thesis, School of Biological Sciences, Flinders University.
Social and Ecological Assessment Pty Ltd 1981, Draft Environmental Impact Statement for Port and Terminal Facilities at Stony Point, South Australia, SEA, report for Santos Limited, Adelaide.
United Nations Convention on the Law of the Sea, 1982, Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea,http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindxAgree.htm [Accessed 30th August 2009].