THE UNIVERSITY OF
NEW SOUTH WALES

WATER RESEARCH
LABORATORY
School of Civil and
Environmental Engineering

22nd August 2008

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**CAPE TOWN SOUTH AFRICA**

By email: JaneE@pdna.co.za
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Dear Sirs,

**SALDANHA EIA REVERSE OSMOSIS DESALINATION PLANT**
**REVIEW OF MODELLING COMPONENT OF MARINE STUDIES**

Associate Prof Ron Cox and Mr Brett Miller have undertaken a review of the following documents as provided by PDNA.

- 2b_deadp_specialist_review_guideline_june05.pdf
- 36447042G_RO Plant_Comments and Responses Table_May08.pdf
- 36447042G_RO Plant_Final BA Main Report_May08.pdf
- Marine Specialist Study - EIA_DesalinationPlant_SaldanhaBay_AddendumtoFinalReport_20080515.pdf
- Marine Specialist Study - EIA_DesalinationPlant_SaldanhaBay_AppendixC_ModelResults_20080515.pdf
- Marine Specialist Study - EIA_DesalinationPlant_SaldanhaBay_FinalReport_20070515.pdf

In summary, while there are some concerns raised in the following review, on an international scale, this is a 3.6 ML/day plant which is rather small. Any reviewer either technical or public should be impressed by the level of attention paid to this small desalination plant. Typical plants being considered in Australia for which the reviewers have undertaken related studies have ranged from 30 ML/day to 500 ML/day.

The experience, reputation and capabilities of the CSIR modelling team are internationally recognised. The reviewers are also specifically aware of the extensive experience of the CSIR team in previous modelling of water quality and assessment of environmental impacts within Saldanha Bay.

## Intakes

*Beach Wells*

It is agreed that having the intake as a beach well is most environmentally acceptable. It will:

- Reduce the level of marine ecology intake
- Most likely to reduce the amount of pre-treatment required.



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PNDA and CSIR have advised that design of beach intake wells has been undertaken and the issue of the long term sustainability of beach wells regarding clogging of the sandy soils has been considered. The Water Research Laboratory has not reviewed this work as it was outside of the scope of assessing marine studies.

Without reviewing the groundwater components, particular emphasis should be placed on lowering the fresh groundwater under the beach and inland by the extractions through beach wells. As a further comment, lateral wells projecting seaward have been considered in Australia to reduce the possible impact on groundwater under the land. Lateral wells may be a lower impact and cheaper option than up to 10 vertical beach wells.

*Direct Pipeline Intakes*

It is understood from the reviewed reports and subsequent communications that a direct pipeline intake is not the preferred option. As stated above, it is agreed that the beach wells are most environmentally acceptable. The following review comments are provided for thoroughness and should be addressed if pipeline intakes were to be re-considered.

There are no model results presented as to quantifying the zone of capture (entrainment zone) of seawater and hence entrainment of marine biota. Assessment of the longer term capture of fish larvae, etc as a percentage of total fish larvae with Saldahna Bay (Big + Small) appears not to have been undertaken. The specific biota of entrainment concern would need to be identified.

Velocity at the direct pipeline intakes were discussed as being maintained less than 0.15m/s – this being considered as a speed at which most fish can swim and avoid being drawn into the intake. In all of the Australian investigations this velocity criteria has been set at < 0.10m/s.

**Discharge Impacts**

The considered dilution criteria of greater than 50 times for salinity is commensurate with other investigations.

The treatment of coagulants in the brine discharge has been considered and reports conclude that some removal of sludge and coagulants may be required rather than discharge. Ferric Hydroxide has been discussed as a discharge constituent but WRL highlights further specific concerns related to discharging ferric hydroxide into the ocean environment. Physically the ferric hydroxide particulate can aggregate to form larger flocculate material. The aggregation process can lead to the particles settling on the bed into a large ferric hydroxide elastic network. This commonly occurs in estuarine environments and can result in severe environmental degradation including the smothering of aquatic life, a decrease in dissolved oxygen, the release of heavy metals and the reduction of light penetration. Resuspended material can also be transported significant distances from the pollution source during high energy events. This can result in sensitive receivers being impacted. In addition to the physical

impacts, there are also chemically related concerns regarding ferric hydroxides. In the ocean environment iron is a limiting micro-nutrient for many algal species. As such, discharging ferric hydroxides into the photic zone (as is commonly done in brine outfalls) has the potential to increase algal blooms. Similarly, iron hydroxide flocculate has a high scavenging potential and it is well documented that ferric hydroxides particulate can be associated with increased nutrient and other unwanted biological constituents.

Specific issues with ferric hydroxide may result in a greater need to separate coagulants and sludges and not discharge.

Other biocides and de-scalants are listed but the particular chemicals will not be known until such time as a plant and operator have been selected. The Australian experience is that dilutions of >50 are generally adequate for ensuring no acute nor chronic toxicity impact. Specific eco-toxicology investigations must be undertaken for the particular chemicals and the local ecology as recommended in the monitoring activities.

In the commissioning of larger desalination plants, it is common for a pilot plant to be operated for a period of six to twelve months. This allows the plant operators to gain specific experience with local intake water conditions and hence determine the specific process chemicals to be used before the main plant is constructed. Ecotoxicology studies are generally undertaken while the pilot plant is operational. However, these pilot plants are of similar size to the Saldahna desalination plant being considered. As such, the reviewers agree that ecotoxicology studies should be undertaken once the Saldana plant is operational.

Various impacts of de-oxygenation have been presented in the discussion. However, one not listed but potentially of concern is the introduction of additional stratification and hence de-oxygenation of the benthic layer. This was of specific concern in the shallow Cockburn Sound waters for the Perth Desalination Plant. The potential for this impact is higher in periods of sustained low wind when mixing is restricted. It is also problematic when deep holes (natural or dredged) are present close to the release location. Maximising near field mixing to ensure minimum density differences should allow for vertical mixing to be achieved. Brief desktop calculations (such as the Richardson number mixing criteria) assessing the wind, currents and waves energy available to destratify various density differences at various depths could be undertaken to determine whether target dilutions of 50 minimise this concern.

**Near Field Mixing**

It is understood that detailed design of a near field diffuser was not available at the time of marine modelling. Only 4.4ML/day of brine is being discharged which will only require a single port diffuser. While the following is not provided as design advice, a diffuser with a single 110mm nozzle angled at 60 degrees from the horizontal should achieve greater than 50 times dilution within 10m from the diffuser. However, to achieve such optimal mixing, a minimum water depth of 8 m will be required.

Discharges at Sites 1 and 2 have been modelled as simple released into the water column which is likely to be the case in such shallow water. However discharges at Site 3 have also been modelled as a simple release into the water column. In the water depths at Site 3, near field dilutions of greater than 50 can be achieved. As such, the modelled impact at Site 3 is conservative and the predicted advantages in discharging at Site 3 are understated.

A conceptual design of the discharge nozzle could usefully be incorporated in the environmental assessment to ensure that the dilutions being considered can be achieved.

**Presented Zones of Impact**

As noted in the introduction, CSIR have extensive experience in modelling of the Saldanha Bay system. The application of Delft3D-WAVE and Delft3D-FLOW presented in Appendix B of the "Marine Impact Assessment Specialist Study" is thorough, professional and of international standard.

The grid refinements introduced to the existing Saldanha Bay models to more accurately resolve any possible impacts of the relatively small desalination plant discharges into such a large water body are suitable. Grid sizes in the vicinity of the discharge sites being 20 to 25mm and the adoption of 10 vertical sigma layers (with lower 2 layers being 2% and 5 % of water depth) provide good resolution of the far field dispersion and dilution processes.

The model calibration for waves is extensive and being based on many years of past work in the Saldanha region provides confidence to the application of the model.

The water quality/circulation model calibration is equally extensive, however due to the higher complexity and higher number of forcing parameters not as good as the wave model calibration. The offshore boundary condition assumptions are well argued and recognised as critical to the model performance.

Overall the model system for application to the assessment of the desalination plant impact is well conceived and suitably calibrated and applied to allow reliable discrimination of possible impacts between various discharge site options.

The reviewers can agree with the CSIR statement "*In general, it may be concluded that the model can reliably simulate the overall tidal, wind-driven, wave-driven circulation and water column mixing processes. Differences between the modelled and measured data, in general, may be ascribed to penetration into the bay of large–scale circulation features over the adjacent shelf and further offshore (i.e. features generated outside the model domain), as well as localised effects such as spatial variation of winds over the bay and rip currents not accounted for in the model forcing……In summary, the overall accuracy of the model is considered satisfactory for the purpose of simulating the transport and fate of the brine discharge plumes*."

It is noted that the purpose of the study is to discriminate relative impacts between different intake and discharge options for the proposed desalination plant. The constituents selected for impact assessment cover the range of potential impacts (salinity, thermal, biocide, dilution).

The selection of environmental conditions is considered appropriate:-

- a two month late summer period when the bay is most stratified resulting in relatively quiescent bottom waters and limited vertical mixing;
- a two month winter period when the water column is well-mixed resulting in more active vertical mixing and typically stronger bottom flows; and
- a "worst case" one month simulation comprising a both calm and stratified period (typically April to June in Saldanha Bay) that is representative of the calmest period in 15 years or more in Saldanha Bay.

**Potential Impacts**

The methodology although remaining based on qualitative assessment of various aspects is thorough and well structured. The adopted levels of impact significance ranging from Low to Very High are sound. The consequence rating score system for extent, intensity and duration is also sound. The inclusion of probability with consequence in determining the significance of impact results in an overall impact assessment that although subjective and qualitatively based is relatively quantitative for the major impacts (salinity, temperature and biocides). The reviewers consider the assessments to be reasonable.

**Public Review Comments**

The public review comments regarding marine impact are all relevant and have been each well addressed in the response. However, it is noted that the public did not directly raise any of the questions / concerns raised by ourselves above.

Attached to this review is the table of "Review Checklist for Specialist Input".

Yours faithfully,

**B M Miller**
Manager
Water Research Laboratory

**R J Cox**
A/Professor
School of Civil and Environmental Engineering

**REVIEW CHECKLIST FOR SPECIALIST INPUT (FROM KEATIMILWE AND ASHTON (2005)**
**Completed by Mr Brett Miller and Assoc. Professor Ron Cox**
**Provided as a supplementary document to WRL Letter Report of 22nd August 2008.**

| REVIEW AREA | REVIEWER'S COMMENT | ADEQUATE | INADEQUATE |
|---|---|---|---|
| **Review Field 1 : Overall Quality Assurance** | | | |
| **A. Ethics** | | | |
| A.1 Does the specialist/s have the necessary qualifications, expertise and experience, to provide input to the EIA process? | | X | |
| A.2 Is there any evidence of unethical behaviour? e.g. bias or inappropriate emphasis, unwarranted assumptions, emotive, irrational or unsubstantiated statements, vested or conflict of interest? | No. | X | |
| A.3 Has the specialist confirmed the validity of the information included in the integrated report? | | X | |
| A.4 Are the specialist's Terms of Reference adequate and appropriate to the proposed development? | | X | |
| **B. Adequacy of Information** | | | |
| B.1 Is information sufficient for decision-making purposes in terms of the level of detail and reliability of findings? | | X | |
| B.2 Have impacts been assessed and communicated in terms of the extent to which they support or conflict with the desired future state/vision of the area and sustainable development objectives (as described in relevant policies, plans and legislation)? | | X | |
| B.3 Has the specialist met all the requirements of the Terms of Reference for the specialist input? | | X | |
| B.4 Where appropriate, has traditional or indigenous knowledge been included as information in the input? | Reviewers unable to comment. | | |

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|---|---|---|---|
| B.5 Are there any uncertainties, or low levels of confidence in the assessment or evaluation? Are these uncertainties and confidence levels clearly stated? | The basis of all predictions are presented and can be assessed. | X | |
| B.6 Are the assumptions in the approach and method, assessment, evaluation and management options sound? Do any undermine the credibility of findings? | | X | |
| **C. Clarity of Report** | | | |
| C.1 Is there a clear, non-technical summary? | | X | |
| C.2 Are the sources of information clear and explicit? | | X | |
| C.3 Are opinions or statements justified and adequately motivated? | | X | |
| C.4 Are conclusions derived from findings of study logically consistent? | | X | |
| C.5 Is a summary impact assessment table included, using the defined impact assessment and significance rating criteria to evaluate different alternatives both with and without management actions? | A table is included with sufficient information provided to justify selected option. | X | |
| C.6 Are consequences of the predicted impacts made explicit? | | X | |
| C.7 Is a statement of impact significance provided for each issue, specifying whether thresholds of significance have been exceeded or not, and whether or not the impact presents a potential fatal flaw? | Uncertainties of discharge constituents and possible ecotoxic impacts have been identified and contingencies presented. | X | |
| C.8 Is there a clear indication of whether impacts are irreversible or result in an irreplaceable loss to the ecosystem and/or society? | | X | |
| C.9 Are key risks and uncertainties that may influence the impact assessment findings clearly specified? | See C7 comment | X | |

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|---|---|---|---|
| C.10 Is the degree of confidence in the impact assessment prediction clearly specified? | | X | |
| C.11 Is a summary of key management actions that fundamentally affect impact significance provided? | Management actions for detection of adverse impacts have been included. | X | |
| **D. Consideration of alternatives** | | | |
| D.1 Has adequate consideration been given to the identification of reasonable alternatives?<br>• For projects proposed on public land and/or for the public good, have fundamental development alternatives been considered which would meet the stated need and purpose for the project; e.g. the nature and location of the proposed project?<br>• For all projects, both public and private, are incremental alternatives considered; e.g. the siting, process, design, scale, timing, funding and production system alternatives, as and where appropriate? | Reviewers only assessed marine impact. | | |
| D.2 Have alternatives been addressed at a scale and level of detail that enables adequate comparison with the proposed project? | | X | |
| D.3 Has the specialist identified the alternative that is the best practicable environmental option (BPEO) from the perspective of their specialist domain? | The reviewers agree that the selected option will have the least environmental impact | X | |
| **E. Description of the project and the affected environment** | | | |
| E.1 Has the purpose and need for the proposed project been clearly stated? | | X | |

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|---|---|---|---|
| E.2 Is there adequate description of the proposed project and alternatives to identify and assess possible direct, indirect and cumulative impacts (e.g. location, siting, routing, scheduling, activities, inputs and outputs, labour, buildings and structures, infrastructure and operating scenarios)? | | X | |
| E.3 Is there adequate description of the key characteristics of the affected socio-economic and biophysical environment (as relevant to the specialist domain) including baseline conditions, sensitive receptors or resources, uses/users, anticipated trends and pressures, and future scenarios? | Reviewers only assessed marine impacts | X | |
| E.4 Are off-site as well as on-site characteristics adequately described to provide the broader context within which the development is proposed, where it is clear that impacts of the proposed project would extend beyond the immediate site? | Reviews only assessed marine impacts | | |
| E.5 Are clear and accurate maps, plans and possibly photographs, of the project and affected environment provided? | | X | |
| **F. Description of legislation, policies and plans** | | | |
| F.1 Is the legal context described and are legal requirements, including those arising from international agreements, clearly considered? | No comment | | |
| F.2 Is the policy and planning context of the proposal described, and clearly considered (taking into consideration international, national, provincial and local policies and plans)? | No comment | | |

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|---|---|---|---|
| F.3 Have accepted standards been identified and clearly taken into consideration (e.g. WHO standards, DWAF water quality standards, etc.)? | No comment | | |
| F.4 Have opportunities for the proposed project to support or contribute to the implementation of policy, plans or programmes been identified? | No comment | | |
| F.5 Have inconsistencies, potential areas of conflict and or likely non-compliance between the proposed project and the legal, policy and planning context been clearly identified and the implications described? | No comment | | |
| **G. Identification of key issues** | | | |
| G.1 Has the identification of potential issues through scoping been adequate? If not, has the specialist identified additional key issues? | | X | |
| G.2 Within the specialist's area of expertise, have key I&APs had input to scoping where the proposed project could have a direct and/or potentially significant effect on their particular or mandated area of responsibility or interest? | Reviewers are aware and have been provided with public review comments | X | |
| G.3 Where scoping has missed key stakeholders, and/or where additional stakeholder involvement is clearly needed to refine, or better define issues or impacts, has the specialist made adequate provision for such involvement? | Reviewers are aware and have been provided with public review comments | X | |
| **H. Prediction and assessment of impacts** | | | |
| H.1 Are the time and space boundaries of the study appropriate and adequately motivated? | | X | |
| H.2 Have plausible environmental and operating scenarios been considered in the assessment? | | X | |

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|---|---|---|---|
| H.3 Has a recognised approach and methodology been used by the specialist and has this been clearly motivated? | | X | |
| H.4 Have linkages to other specialist inputs been identified and taken into account where relevant? | | X | |
| H.5 Are clear, sufficient and explicit criteria used to assess impacts of different alternatives? | | X | |
| H.6 Have the issues raised and alternatives suggested by I&APs during scoping, and in comment on draft documents, been addressed satisfactorily? | Yes | X | |
| H.7 Is there adequate attention to indirect or cumulative effects on significant or sensitive resources? Where potentially significant cumulative effects are possible, but cannot be addressed at the EIA level, has the need for higher order studies been clearly stated? | The studies have adequately demonstrated that cumulative impacts are highly unlikely. | X | |
| H.8 Have explicit and sufficient criteria been used to evaluate significance of impacts of alternatives, taking into account the planned mitigation and management? | | X | |
| H.9 Are there systematic, explicit and rational links from identification of key issues, through assessment to evaluation of significance? | | X | |
| H.10 Are the beneficiaries, and those who stand to lose from the proposed development, clearly identified? | Reviewers only assessed marine impacts | | |
| H.11 For trans-boundary projects, have the approach and methodology been agreed to by all countries? | Reviewers only assessed marine impacts | | |

| **I. Recommendations for management and monitoring** | | | |
|---|---|---|---|
| I.1 Has the management of the potential positive and negative impacts been systematically and adequately addressed (i.e. has the specialist considered measures for the avoidance, mitigation, restoration, rehabilitation or compensation of negative impacts in a hierarchical fashion; and have measures for enhancing positive impacts been considered)? | No comment | | |
| I.2 Has the precautionary principle been applied to the recommendations for management and monitoring measures where there is uncertainty or high risk associated with impacts? | | X | |
| I.3 Are recommended management actions practical, viable and in line with best practice? Are these clearly described and motivated? | | X | |
| I.4 Have potential knock-on impacts of management actions been considered by the other specialist/s and the EIA practitioner? | No comment | | |
| I.5 Does the recommended monitoring program(es) include: the specific questions to be asked by monitoring; the frequency, season and timing for monitoring; responsibility for monitoring, analysis and implementation of responsive management actions;<br>targets and indicators for monitoring; significance thresholds; and auditing and reporting requirements? | | X | |
| I.6 Is the proposed monitoring program(es) practical, viable and in line with best practice? Has it been clearly described and motivated? | | X | |