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Our Ref: RMH: L.N1792.002_SouthLagoonPumping6yrSims_PreliminaryDraft.doc

16 April 2010

Coorong, Lower Lakes, Murray Mouth Project
Level 8 Chesser House
91-97 Grenfell Street
Adelaide SA 5000

Attention: Glynn Ricketts

Dear Glynn

**RE: Updated 6 Year Coorong Model Simulations of Proposed Pumping from the Southern Lagoon**

This letter describes an update of Coorong South Lagoon pumping simulations. This study is an update of investigations previously presented in L.N1792.001_SouthLagoonPumpingSimulations_Final.pdf (L.N.1792.001) which was delivered to the SA MDB NRM Board in December 2009.

The scope of the updated study was discussed in emails between BMT-WBM and DEH on 10/12/09, 12/01/10, 21/1/10 (present proposal), 25/2/10 (proposal accepted), 1/3/10 (receive EC data), 8/3/10 (discuss 100m dredge option), 19/3/10 (discuss high/low UPSE runs), 1/4/10 (send updated proposal), and 8/4/10 (send modelling update).

It should be noted that these results should be considered draft status until the appropriate level of quality assurance has occurred.

**Scope of Works**

The current scope of works includes:

- Generate initial conditions based EC spatial survey data from the 16th December 2009;
- Run base case model for 6 years (1/1/2010 – 1/1/2016) using new initial conditions;
- Then run the 250 ML/day pumping and the 250 ML/day pumping with dredged (~50m) channel models;
- Revise the dredged mesh to 100m width and re-run the dredge scenario;
- Re-run the pumping run with the low UPSE flows (15GL in 2013-2016 instead of 60GL).

Given that it is possible that the predictions of salinity will be strongly linked to the applied boundary conditions a further proposed scope of works includes checking the model calibration against the observed 2009 boundary conditions and data sets, improving the calibration if necessary and re-running the simulations using the 2009 boundary conditions to determine the sensitivity of the predictions to the selected boundary conditions.

**Model Setup and Calibration**

The model setup and calibration is as previously described in L.N1792.001. However, the following assumption and minor changes to the model have been made:

- The bathymetry of the mouth has been updated based on SA Water hydrosurvey collected on the 12th August, 2009.
- Initial conditions for the model are based on EC spatial survey data collected on the 16th December 2009 by DWLBC. Approximate water levels (based on DWLBC data on 16/12/2009) that were used as the initial conditions for 1st January 2010 are: North Lagoon WL set to +0.05mAHD, Hells Gate Area WL set to 0.0mAHD, and South Lagoon WL set to -0.1mAHD.
- Pumping is assumed to start on 1/1/2011 and run for three years at 250 ML/day until the 1/1/2014.
- Dredging is assumed to be instantaneous and occurs on the 1/1/2012. The dredging provides a channel of a maximum bed level of -0.8mAHD through the Hells Gate region between the North and South Lagoon. Meshes with a 50m wide channel and a 100m wide channel have been developed.
- The required annual inflow series for 2010 – 2016 for Morella (assuming UPSE connection in 2013) is: 15, 10, 10, 60, 60, 60 GL/year. This was applied by scaling the average daily flow series (created by averaging daily flow values from 2001 – 2008) up to the required annual discharge. A typical salinity value (based on recorded data) of 8 ppt (~13,300 µS/cm) was applied to the inflow.
- For the scenario investigating if the UPSE scheme is not diverted in the South Lagoon, a flow time series of 15, 10, 10, 15, 15, 15 GL/year (2010 – 2016) for Morella inflow was used.
- A lower (default) wind stress co-efficient of 1.0 instead of 1.8 has been used based on experience gained during the Virtual Weir Investigations. This results in a more conservative prediction of salinity and a more realistic prediction of water level changes in the Southern Lagoon as described in the results section of this letter (see Figures 5 and 6). During the 2009 model calibration investigations to be undertaken in the 2nd half of this study, a check on the appropriateness of this parameter will be made.

A Summary of Boundary Conditions for 2008 as detailed in L.N1792.001 is provided below:

- Tide Level data recorded and increased by 0.14 m (to bring them in line with the recorded water levels in the Coorong) at Victor Harbour in 2008 (repeated) are applied as a water level boundary at the mouth of the Murray.
- Salinity data as recorded at the three automatic stations closest to the entrance (Beacon 1, Beacon 17 and Barker Knoll) in 2008 is applied at the Murray Mouth.
- The wind record used for the present study was acquired from the gauge at Pelican Point during 2008. Where data was unavailable from this record, data from the wind gauge at Narrung was used to infill the gaps.
- Evaporation and rainfall data was acquired from the SILO database for 2008 over Lake Alexandrina. To best match observed salinity data, evaporation was decreased by 15% during the middle of summer and 30% during the middle of winter.

**Description of Five Scenarios:**

| | Scenario | Description |
|---|---|---|
| 1 | Base Case | Repeat 2008 BC's 1/1/2010 – 1/1/2016 |
| 2 | Pumping | Pumping (250ML/day) for 3 years (1/1/2011 – 1/1/2013) |
| 3 | Pumping & 50m Dredging | Pumping (250ML/day) for 3 years (1/1/2011 – 1/1/2013)<br>Dredge 50m wide (-0.8mAHD) channel between lagoons on 1/1/2012 |
| 4 | Pumping & 100m Dredging | Pumping (250ML/day) for 3 years (1/1/2011 – 1/1/2013)<br>Dredge 100m wide (-0.8mAHD) channel between lagoons on 1/1/2012 |
| 5 | Pumping & low UPSE inflows | Pumping (250ML/day) for 3 years (1/1/2011 – 1/1/2013)<br>Low (15 GL/year) not high (60 GL/year) (1/1/2013 – 1/1/2016) |

**Simulation Results**

Time-series showing predicted salinity in the Southern Lagoon at Policeman's Point is shown in Figure 1. The Figure clearly shows the beneficial impact of pumping on salinity within the South Lagoon, with peak summer salinity reducing from 200 ppt to ~ 150 ppt within a year. By the end of the three year pumping program peak summer salinity is expected to be ~ 100 ppt (April 2014). If pumping is not used, peak summer salinity (at Policemen's Point) within the southern Lagoon could reach 250 ppt by April 2013.

If 60 GL/year of inflow from the UPSE occurs a year later (after cessation of pumping) peak summer salinity is expected to be ~ 115 ppt (April 2015). However, if the UPSE scheme connection does not occur and UPSE inflow are only 15 GL/year peak summer salinity is expected to be ~ 145 ppt (April 2015).

The results show that dredging either a 50m or 100m wide channel to a minimum bed level of -0.8mAHD between the north and south lagoon has minimal impact on salinity within the Southern Lagoon.

Time-series showing predicted salinity in the North Lagoon at Robs Point is shown in Figure 2. The model results show that pumping is able to greatly reduce salinity levels within the North Lagoon. Pumping is able to prevent salinity from exceeding 200 ppt and is able to cause a reduction in peak summer salinity to less than 100 ppt. If pumping from the southern lagoon does not occur peak summer salinity in the North Lagoon at Robs Point could reach 230 ppt by March 2014.

Time-series showing predicted water levels in the Southern Lagoon at Policeman's Point is shown in Figure 3. From the figure we can see that pumping at 250 ML/day results in a reduction in water level of ~0.1m in the South Lagoon. Dredging actually slightly exacerbates the minimum water level which is caused by a strong north westerly wind pushing water out of the South Lagoon in February. Due to low water levels in the North Lagoon over Summer and Autumn, water levels in the South Lagoon do not recover till mid-late March. While dredging does increase the speed at which water level increases during Autumn, it has negligible overall benefit on water levels or salinity.

Time-series showing predicted water levels in the North Lagoon at Robs Point is shown in Figure 4. The model predicts there is insignificant differences in water levels between the five scenarios.

Figure 5 and Figure 6 show the impact of selecting different wind stress co-efficients on South Lagoon salinity and water levels. In previous modelling described in L.N1792.001, the wind stress parameter was increased from 1.0 to 1.8. However, during subsequent model studies for the Virtual Weir Investigation it was found that a value of 1.0 is more appropriate for the Pelican Point wind data set. The model results (Figure 6) show that by using a higher value of wind stress (1.8), water levels during summer fall by an additional -0.1m. This occurs during a single wind event when a strong north easterly blows significant volumes of water from the south lagoon into the north lagoon. The impact on south lagoon salinities is shown in Figure 5 where the use of a higher wind stress parameter is able to reduce salinity in the south lagoon by encouraging mixing between the north and south lagoons. The validity of using the lower wind stress co-efficient will be further checked during model validation for 2009 data sets.

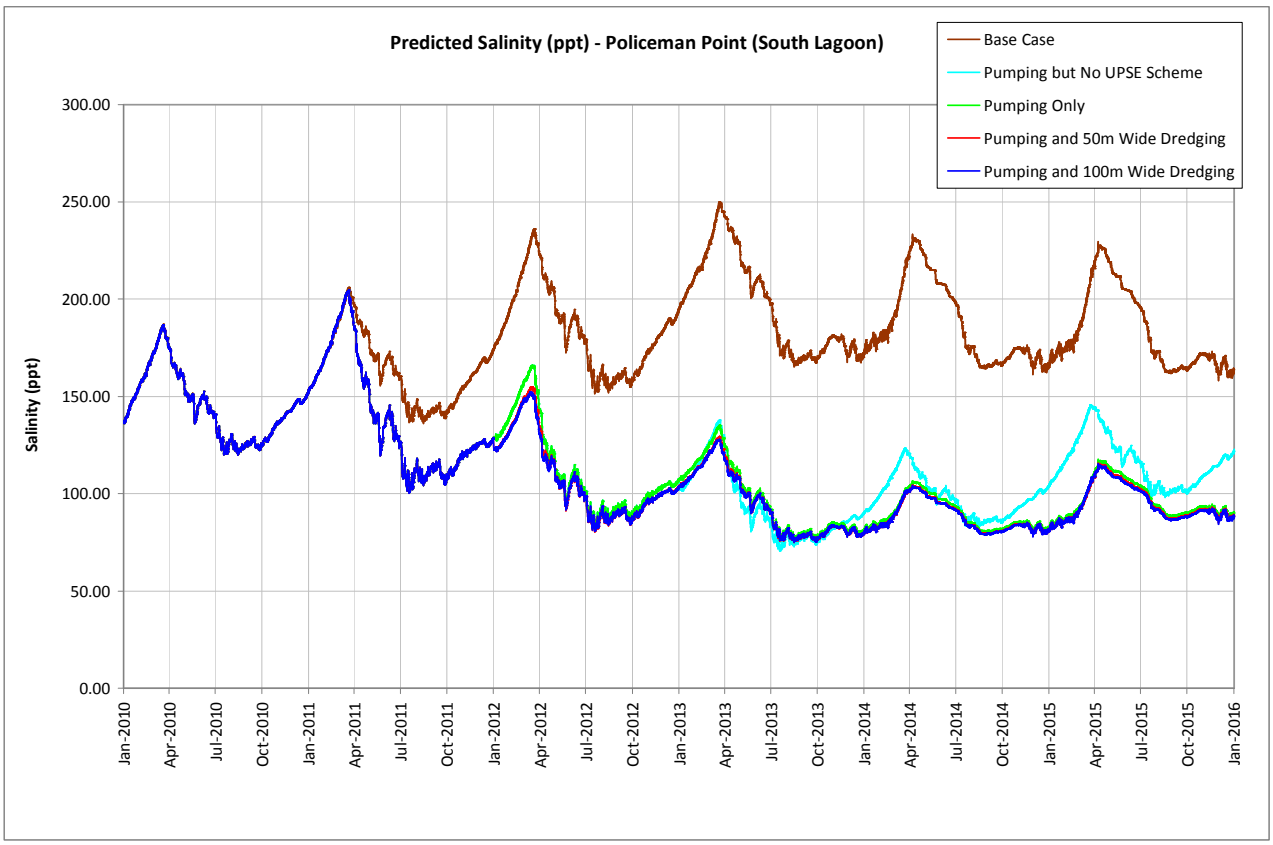


**Figure 1 Simulated Salinities at Policeman's Point (South Lagoon) for "Future" Scenarios**

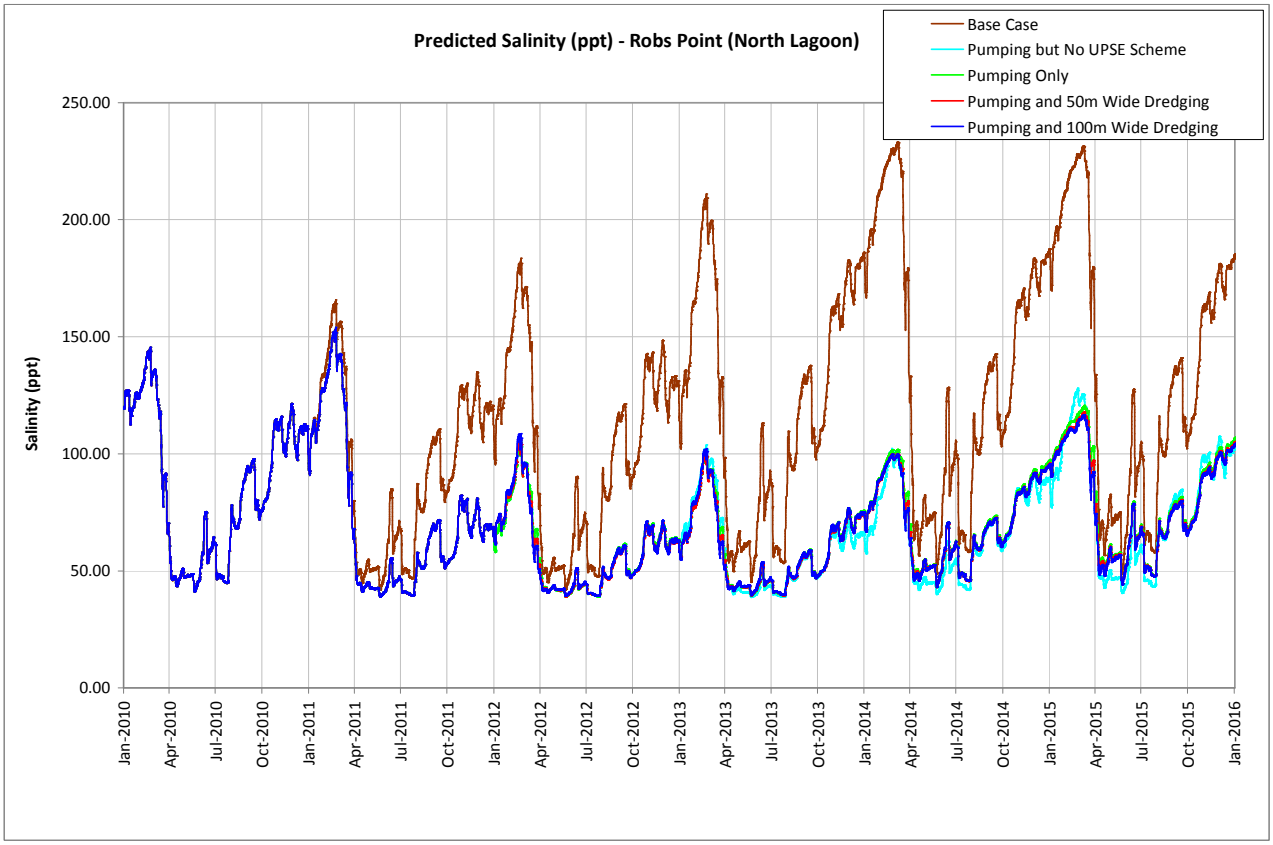


**Figure 2 Simulated Salinities at Robs Point (North Lagoon) for "Future" Scenarios**

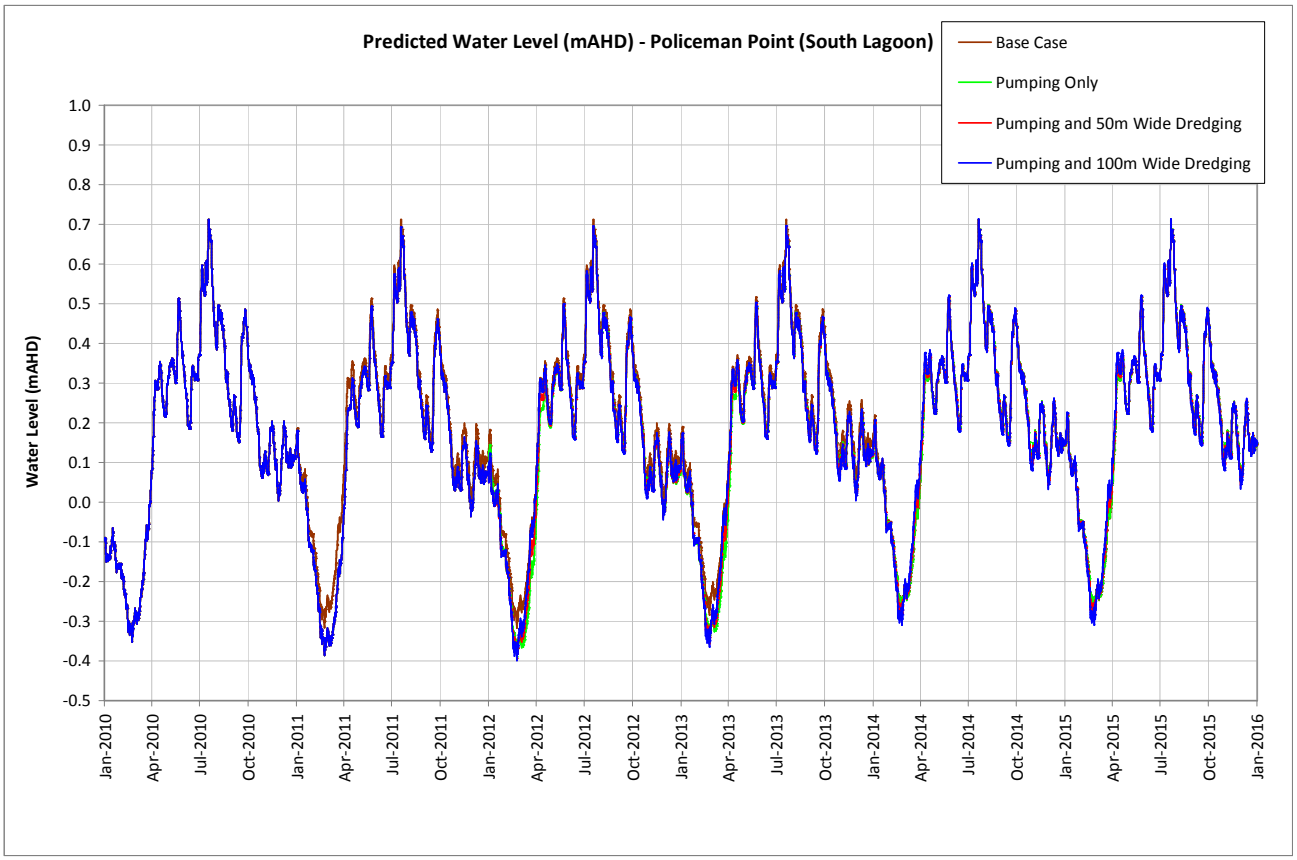


**Figure 3 Simulated Water Levels at Policeman's Point (South Lagoon) for "Future" Scenarios**

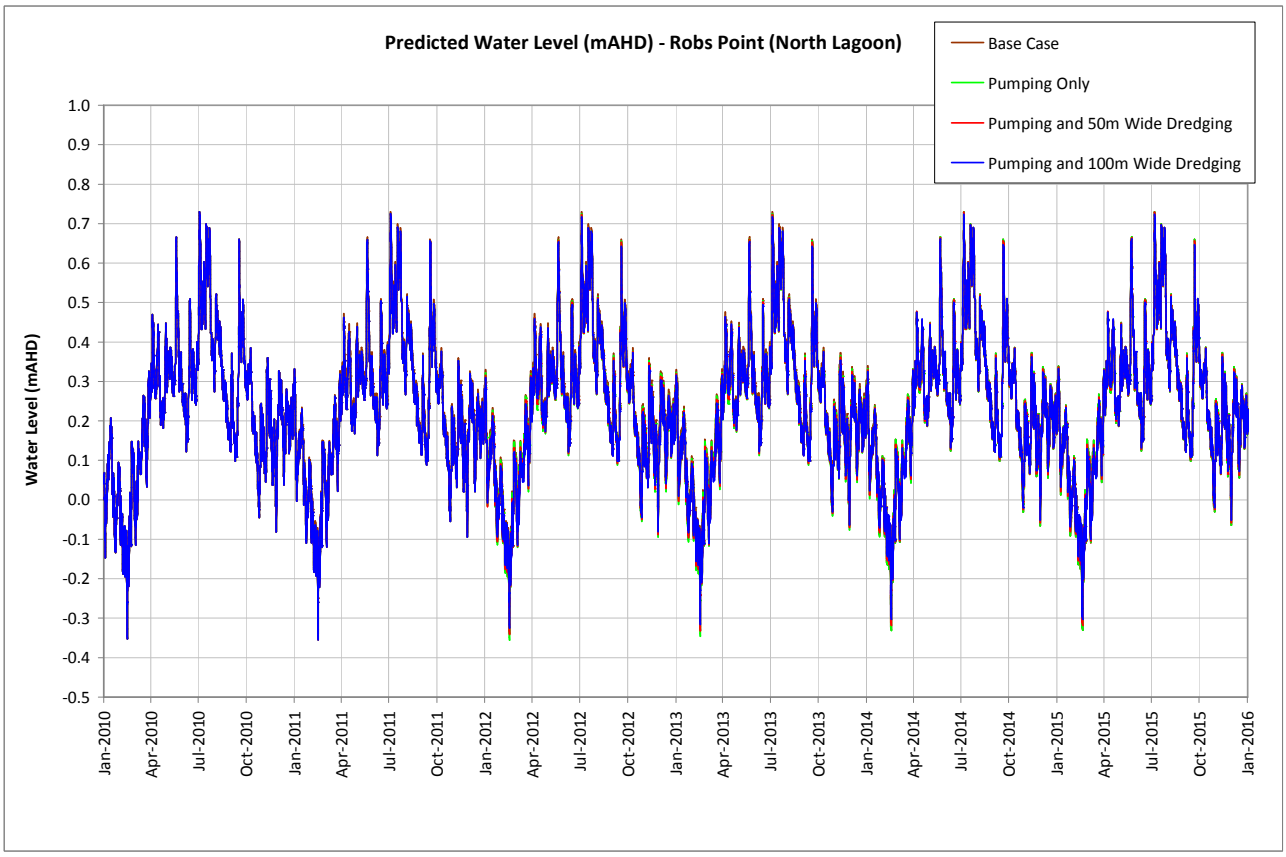


**Figure 4 Simulated Water Levels at Robs Point (North Lagoon) for "Future" Scenarios**

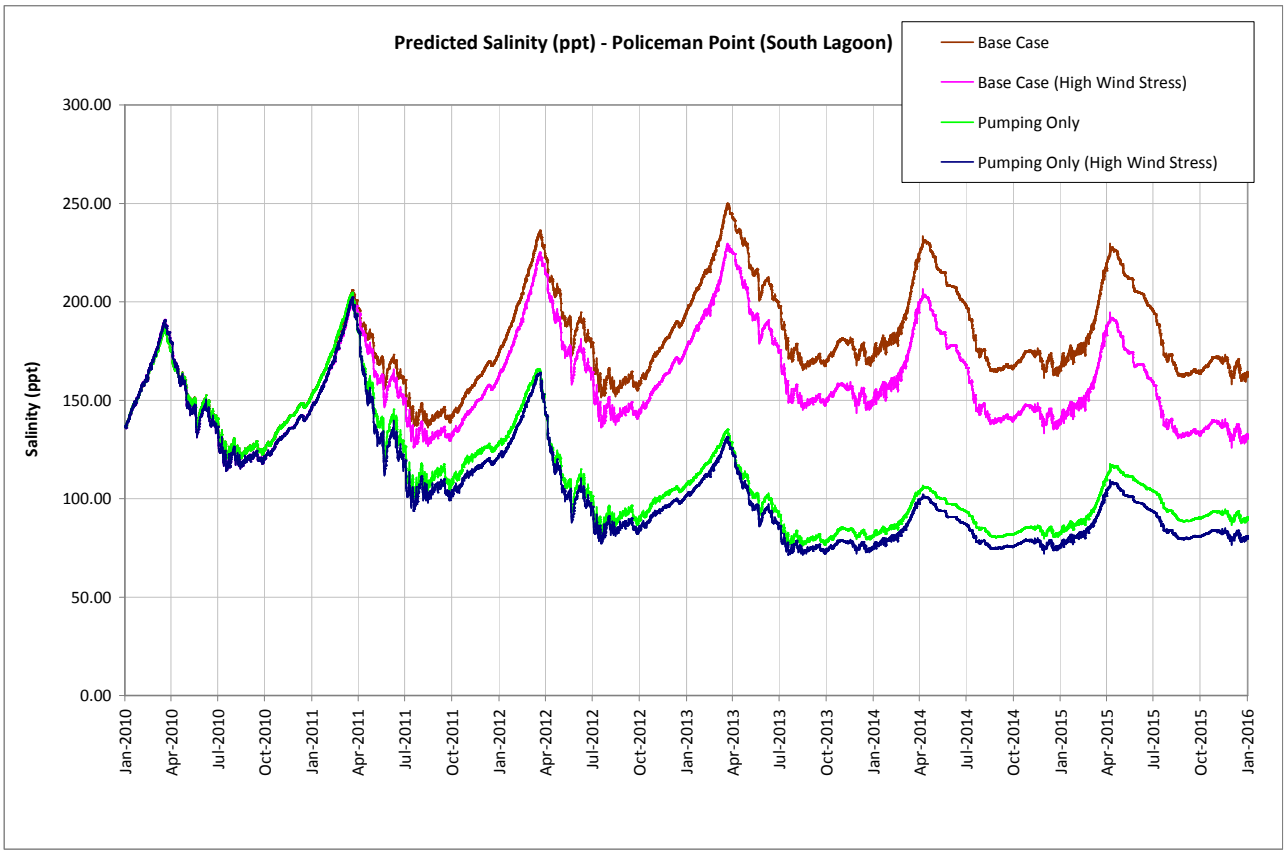


**Figure 5 Simulated Salinities at Policeman's Point (South Lagoon) Comparing Applied Wind Stress**

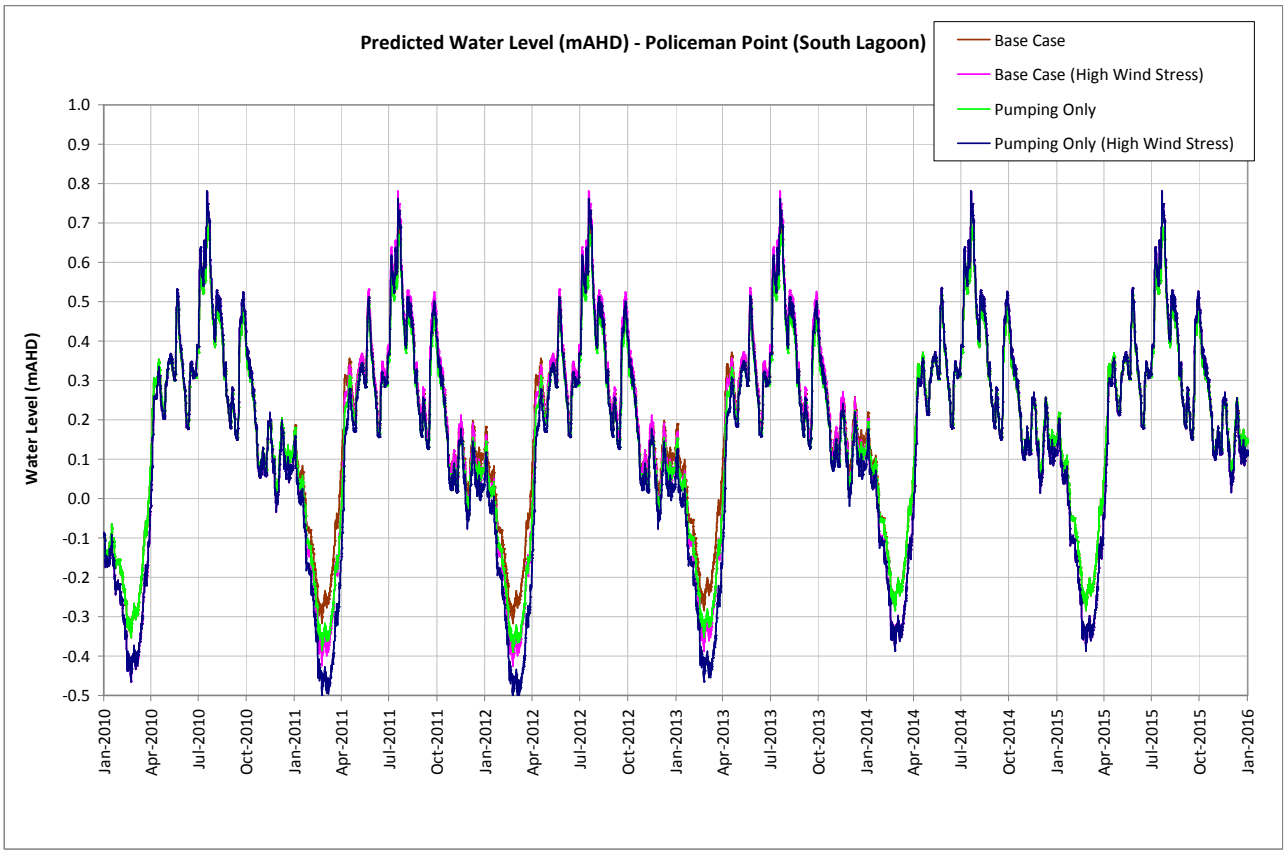


**Figure 6 Simulated Water Level at Policeman's Point (South Lagoon) Comparing Applied Wind Stress**

**Discussion**

This letter provides preliminary draft results of five, six year long simulations (1/1/2010 – 1/1/2016) of water levels and salinities of the Coorong North (Robs Point) and South Lagoons (Policeman's Point). The simulation is based on repeating 2008 conditions and tests four management options including: pumping at 250 ML/day (for three years from 1/1/2011); pumping and dredging a 100m wide x -0.8mAHD channel through Parnka Point; and pumping but not connecting in the UPSE scheme which would limit UPSE inflow from 2013 to 15 GL/year.

The results show:

- Pumping has definite benefit by removing salt from south lagoon.
- Increased UPSE flow aids dilution (especially in summer), though acts to push salt into the north lagoon and also reduces the effectiveness of pumping regime.
- Dredging to -0.8mAHD seems to have minimal impact on south lagoon salinities. This is because of low summer water levels in both north and south lagoon. Dredging only encourages slight mixing but does not cause significant dilution or salt removal. It could be worth testing the sensitivity of dredging to -1.5 mAHD.

The model results are sensitive to the chosen wind stress co-efficient. During the forthcoming 2009 calibration study there will be increased confidence in the selection of this parameters.

We trust that the above details meet the requirements of DEH. Should you require any further information, please contact the undersigned on (02) 4940 8882.

Yours Faithfully
**BMT WBM Pty Ltd**

Rohan Hudson
Senior Engineer