Supplementary Statement to Channel Deepening Panel Inquiry

Dr. David R. Fox

Background

I have been asked by the Port of Melbourne Corporation (PoMC) to provide additional information in relation to statistical modeling work I undertook on behalf of PoMC in relation to the proposed Channel Deepening Project (CDP). Specifically, I have been asked to respond to the following request from the Inquiry Panel:

"The PoMC provided the Expert Witness Statement of Dr David Fox. Please provide a short explanation of the manner in which the statistical approach proposed in this statement has been applied to the monitoring programs proposed in the revised EMP."

It is also my understanding that both the Inquiry and the IEG have requested an explicit analysis of the likelihood of exceedance of environmental limits. My responses to each of these are detailed in subsequent sections of this statement.

Scope

As presented in the Expert Witness Statement (June 2007), I have provided statistical advice to PoMC on a range of matters pertaining to the design of turbidity monitoring programs; analysis of data generated from these programs; and presentation of results. The advice to PoMC from late last year up to the time of the panel hearing has been in response to a series of specific questions and/or issues put to me by PoMC. Since that time my services have been retained by PoMC to assist with the implementation of statistical procedures identified in my various reports. Matters previously investigated include:

- Suggested analysis of raw data received from turbidity buoys;
- Identification of Response Levels and a method for determining exceedence of the response levels and environmental limits;
- Statistical aspects of turbidity monitoring program design in the southern regions of the Bay (sample size and spatial dependency issues);
- Investigations into the relationship between TSS, NTU, and light attenuation and the identification of appropriate statistical models. In particular, a robust approach for the conversion of Total Suspended Solids (TSS) into Nephelometric Turbidity Units (NTU);
- Identification of a turbidity threshold (NTU) which will ensure maintenance of an independently established minimum light criterion necessary for the protection of seagrass at site 2006.

In assisting in the design of a turbidity monitoring program, I was asked to consider:

- The level of protection afforded to the most vulnerable assets;
- A monitoring program design that is robust and yet statistically defensible;
- Timeliness of data collection, analysis, and reporting with particular reference to:
    - Practicality (in terms of cost and time to implement and operate) of monitoring program design;
    - Treatment/analysis of data in a scientifically defensible and transparent manner;
    - Ease of data collection and analysis (with automated systems where possible).

I have reviewed Revision B of the PoMC's draft Environmental Management Plan and note that my suggested time-based control charting procedures to ensure (i) compliance with the environmental limit of 25NTU; and (ii) maintenance of the minimum light requirement for seagrasses using a limit of 15NTU have been adopted. These suggestions were based on a detailed analysis of both the background and predicted incremental (CDP-generated) turbidity at site 2006 in the southern region of the Bay as this apparently represents one of the most vulnerable sites. I note that Annexure 8 is a recent addition to the EMP, although I have had no specific involvement in the development of a Bay-wide monitoring program.

Implementation: Environmental limits, response levels, and seagrass protection

As stated in the revised EMP "the turbidity environmental limit relates to the increased suspended sediments resulting from dredging and dredged material placement". I provided advice on setting an environmental limit as part of my expert witness statement. Subsequent to this statement, I have undertaken further analysis of the relationship between NTU and light attenuation (Kd) for sediments in the south of the Bay. I have presented this analysis and been involved in consultations with Mr Scott Chidgey of Consulting Environmental Engineers and the Environment Protection Authority.

Consequently, I am satisfied, based on the information supplied to me (and listed in section 1.2 of my expert witness statement) and the additional analyses I have conducted, that the NTU thresholds I have identified for seagrass (as set out in Revision B of the draft EMP) are adequate to deliver 15% of surface irradiance at 3m depth for a minimum of 50% of time during a two week period for well-mixed sediments of the southern Bay region.

Turbidity Monitoring

It is important to be clear that the objective of the CDP monitoring program is to provide informed and timely environmental assessments: it is not about testing research hypotheses.

The monitoring program that I proposed in my report "Statistical Aspects of Turbidity Monitoring – Control Charting" (attached to my expert witness statement) is underpinned by the following considerations:

- Suitability (fit-for-purpose);
- Robustness (insensitivity to moderate perturbations to assumed conditions:
- Timeliness (information on both operational and environmental conditions and performance is provided at frequencies commensurate with the timescales of environmental and management responses)

The report describes key aspects of establishing a monitoring program which can assess performance against an environmental limit by tracking fluctuations on appropriate spatial and temporal scales.

Key points from this paper have been expressed in the Turbidity Monitoring Program section (Annexure 5) of Revision B of the draft EMP, including:

- Identification of environmental limits on exponentially weighted moving average (EWMA) control charts. The exception is the 2 week moving average for the one component of the seagrass limit which is appropriately expressed as a simple moving average.
- Description of the response levels. These are operational parameters, designed to provide an 'early-warning' of potentially adverse conditions. Response Level 1 is intended to trigger heightened surveillance and/or further investigation while the exceedence of Response Level 2 would result in pro-active intervention to ensure the environmental limit is not exceeded.

Likelihood of exceeding an environmental limit

The following brief analysis for site 2006 is offered in response to the questioning of the rate of exceedence of the environmental limit for turbidity. Figure 1 is indicative of the type of plot generated by the EWMA process. Importantly, this chart is derived from *actual background* turbidity at Cameron's Bight between February 2005 and July 2007 – there is no contribution from dredging. During this period the EWMA statistic exceeded 25NTU 4.3% of the time. If the modelled TSS is converted to NTU (using procedures established in the report "An Examination of Regression Options for TSS and NTU" (Environmetrics Australia 2007) and this incremental NTU is added to the background, the EWMA statistic is expected to exceed 25 approximately 6.6% of the time. The *actual* exceedence rate during dredging operations cannot be predicted since background turbidity for these days cannot itself be predicted in advance. However, the provision of response levels as discussed above is designed to mitigate against any unanticipated exceedences.

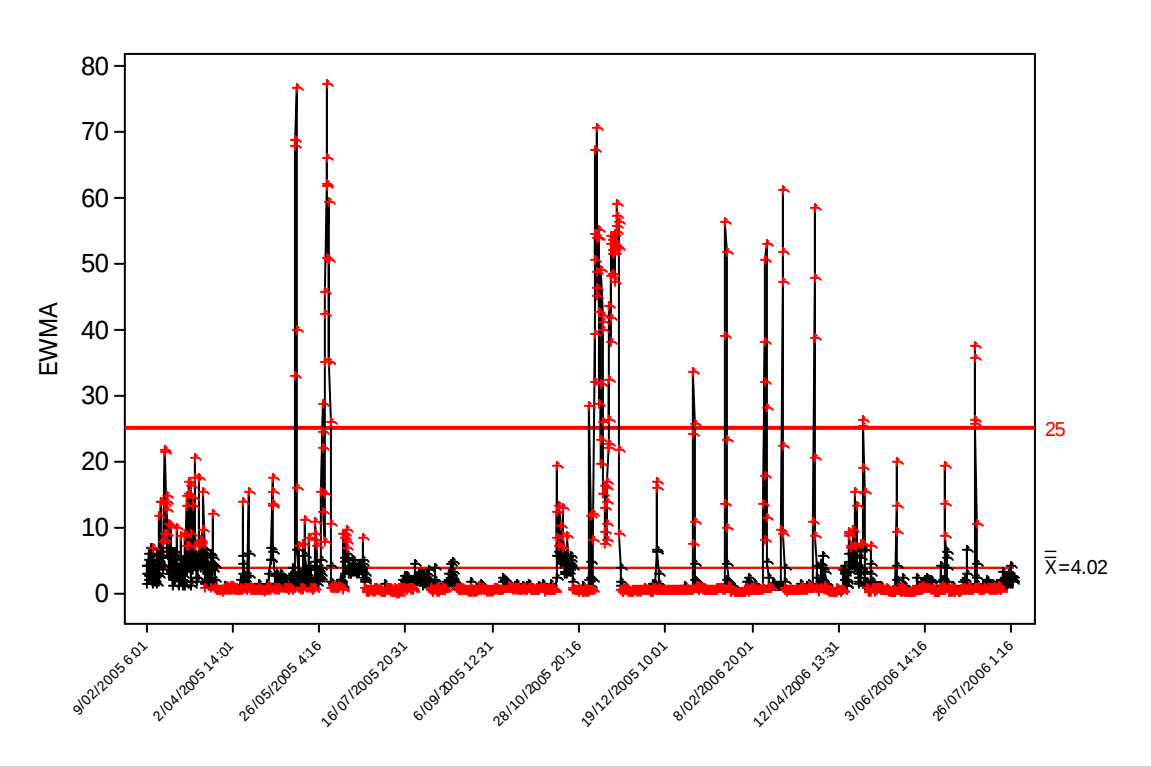

Figure 1. 6-hourly EWMA for *background* turbidity at site 2601. Input data are 15-minute NTU readings. λ=0.6

Conclusion

In summary, I believe the statistical approach proposed in my witness statement has been appropriately incorporated in the turbidity monitoring program proposed in Revision B of the draft EMP. Work is continuing on detailed operational aspects of instrument deployments including sampling frequency, modes of operation, back-up systems, and data processing. Although important, these considerations involve a level of detail not appropriate for a high-level EMP. It is expected that all relevant instrument sampling parameters, data processing algorithms, QA-QC processes and statistical treatment of the NTU data will be fully documented and will be commensurate with the high-level EMP objectives.

Dr. David R. Fox

20 July 2007.