



Port of Melbourne Corporation

Algal Blooms – Quarterly Report

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Date:	Wednesday 30 th April 2008
Subject:	Algal Blooms - Quarterly report
File ref:	Algal Bloom Quarterly Report #1.doc

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Revision history

Date	Version	Name	Reason

Approval history

Date	Name and title
30/04/08	Jeff Bazelmans - General Manager Environment

Contents

1	Executive summary	5
2	Introduction	6
	2.1 Objectives	7
3	Methods	7
	3.1 Data collection	7
	3.2 Data analysis	8
4	Results and discussion	10
	4.1 Sampling	10
	4.2 General	10
	4.3 Comparison with SEPP	11
	4.4 Comparison with EWMA control limits	12
	4.5 Comparison with EWMAST control limits	12
	4.5.1 Assessment of results outside of expected variability	17
	4.6 Species composition and enumeration of algal blooms	18
5	Conclusions and recommendations	18
6	References	20

1 Executive summary

The Baywide monitoring programs commenced in late 2007 and this report represents the first quarterly report under the Algal Bloom Monitoring Program. This report covers the period November 2007 to February 2008.

Samples were collected monthly under the Water Quality Monitoring Program at various sites around the Bay and analysed for chlorophyll a and phaeophytin concentrations. A number of sites were not sampled in December 2007 and samples were collected for phytoplankton identification and enumeration only for a single month (February 2008) for the period. In addition, chlorophyll a concentrations from continuous loggers were collected at three sites from December 2007 to February 2008 under the Nutrient Cycling Monitoring Program.

The results of monthly samples indicated that chlorophyll a concentrations were generally $< 1 \mu\text{g/L}$ for the period November 2007 to January 2008, with the exception of sites in Hobsons Bay and the Yarra River, which were higher. With the limited amount of data collected to date, meaningful spatial and temporal trends could not be determined and comparison with SEPP is not meaningful at this stage.

Data from continuous *in situ* loggers was transformed into EWMAST control charts by Emphron Pty Ltd. and compared to control limits. Although chlorophyll a concentrations from Hobsons Bay and Central sites were within control limits, phytoplankton biomass exceeded control limits at Long Reef from early December to late January. This exceedence of control limits was further assessed, and was not considered significant to Bay ecology.

2 Introduction

Phytoplankton are microscopic free floating organisms that inhabit the water column to fresh marine and hypersaline waters. Although strictly speaking there are minor components of phytoplankton that may be heterotrophic, they are typically photosynthetic and form the basis of the food chain in marine ecosystems.

There is a wide variety of phytoplankton species within Port Phillip Bay. The phytoplankton communities of the Bay are typically dominated by diatoms, with dinoflagellates, prasinophytes, prymnesiophytes and cryptophytes also common components. Potentially toxic species of diatoms and dinoflagellates have been recorded in the past at a number of locations, in low numbers and occasionally in bloom proportions.

Phytoplankton population dynamics are a function of changes in biomass, species composition and spatial distribution. The major abiotic environmental factors that regulate phytoplankton population dynamics include: light, nutrient concentrations and temperature and it is these same factors that can lead to increases in phytoplankton biomass and algal blooms.

Phytoplankton accounts for a significant proportion of primary production in Port Phillip Bay and algal blooms have long been a natural component of Bay ecology. However, human activities can result in an increased incidence and duration of algal blooms and this can have an effect on Bay ecology and human health. Specifically, sustained increases in phytoplankton production could result in negative impacts to nutrient cycling and denitrification in the Bay. In addition, increased incidence of toxic algal blooms can affect marine organisms through the food chain as well as economic and human health impacts via accumulation in shellfish.

The Channel Deepening Project has the potential to affect algal populations in a number of ways. However the risk assessment (URS, 2007) did not identify increased incidence of algal blooms as a pathway by which the CDP could significantly impact assets, beneficial uses and values. However, PoMC has committed to augmenting existing monitoring programs to help inform ongoing environmental management during the CDP. Specifically, PoMC will augment the Baywide Water Quality and Nutrient Cycling programs to collect information on phytoplankton abundance and community composition in Port Phillip Bay.

PoMC, as part of the Baywide monitoring report, reviews the results of the Baywide Monitoring Program quarterly. This review is for the period November 2007 – February 2008 inclusive and is the first algal bloom quarterly report under this program.

2.1 Objectives

The key objective of this program is:

- To detect changes in the occurrence of algal blooms outside expected variability.

In addition, where a bloom of a potentially toxic species is identified, this will be referred to the Department of Sustainability and Environment (DSE) for management.

3 Methods

Data to inform this project was collected via the Baywide Water Quality and Nutrient Cycling monitoring programs. In addition to these routine sampling programs, the algal bloom program is designed to be flexible and any observations of reports from the public or agency staff of a visible algal bloom in the Bay would instigate additional sampling. However, no such observations of reports were made during the period November 2007 and February 2008.

A detailed description of sampling methodology is contained in the relevant detailed design documents (Nutrient Cycling Detailed Design CDP_ENV_MD_019 and Water Quality Detailed Design CDP_ENV_MD_023). Provided below is a summary of the methods relevant to the algal bloom program.

3.1 Data collection

Phytoplankton was monitored using two indicators:

- a biomass indicator (chlorophyll *a*); and
- identification and enumeration of phytoplankton taxa.

The Baywide Water Quality monitoring program was designed to collect samples at monthly intervals at 11 sites from around the Bay (Figure 1).

Parameters of direct relevance to the algal bloom program are:

- In-situ profiles of chlorophyll *a* concentration by fluorescence (Limit of Reporting 0.1 µg/L);
- Surface water (top 1m) samples collected for laboratory analysis of chlorophyll *a* and phaeophytin concentrations (Limit of Reporting 0.2 µg/L); and
- Phytoplankton tows (10 m) and integrated grab for laboratory identification and enumeration of phytoplankton (to species level for potentially toxic taxa and to broad groups for other taxa).

In addition, results from other parameters collected (e.g. dissolved oxygen and nutrient concentrations) may be used in interpreting phytoplankton biomass and community composition results.

The Baywide Nutrient Cycling monitoring program collects continuous chlorophyll a concentration data (as fluorescence) from four sites around the Bay (Figure 1). Loggers are located in surface waters (3 m) and bottom waters (10 -18 m). Divers collect this data every two months.

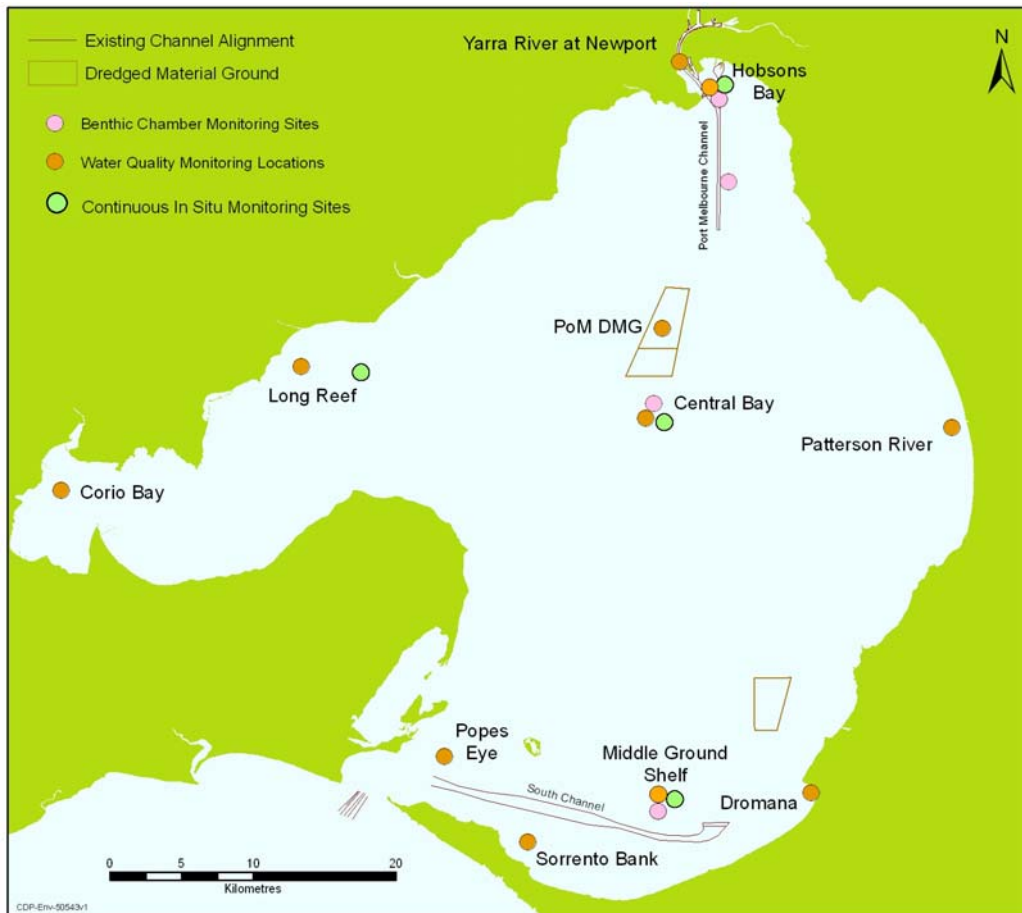


Figure 1 Sampling sites for Water Quality and Nutrient Cycling monitoring programs

3.2 Data analysis

Chlorophyll a data was plotted over time and assessed against:

- The SEPP objective (Table 1); and
- Control limits based on deviation from historical chlorophyll a concentrations (Table 2 and Table 3).

The latter of these is achieved by comparing the results of two control charts against control limits derived by Emphron (2007):

- Chlorophyll a data from monthly sampling is transformed into EWMA control charts; and
- Chlorophyll a data from the continuous *in situ* loggers is transformed into EWMA control charts.

These have been designed to detect both long-term shifts in baseline phytoplankton biomass as well as short term spikes in concentrations as a result of algal blooms.

Table 1: SEPP Waters of Victoria or ANZECC Objectives for Chlorophyll a

Site name	Annual Median	Annual 90 th percentile
Yarra River – Newport Power Station	2.5	4.0
Hobsons Bay	2.5	4.0
Central Bay	1.0	2.0
Port of Melbourne DMG (b)	1.0	2.0
Corio Bay	1.5	2.5
Long Reef	2.5	4.0
Patterson River	1.0	2.0
Dromana	1.0	2.0
Middle Ground Shelf	1.0	2.0
Sorrento Bank	1.0	2.0
Popes Eye	1.0	2.0

Table 2: Control limits for monthly EWMA chlorophyll a concentrations.

Site name	Control limits
Yarra River – Newport Power Station	2.0 µg / L
Hobsons Bay	3.9 µg / L
Central Bay	1.1 µg / L
Port of Melbourne DMG (b)	1.0 µg / L
Corio Bay	1.4 µg / L
Long Reef	6.8 µg / L
Patterson River	2.2 µg / L
Dromana	1.6 µg / L
Middle Ground Shelf	0.8 µg / L
Sorrento Bank	0.8 µg / L
Popes Eye	0.8 µg / L

Table 3: Control limits for continuous EWMAST chlorophyll a concentrations.

Site name	Daily average
Hobsons Bay (surface and bottom)	4.4 µg / L
Central Bay (surface and bottom)	1.3 µg / L
Long Reef (surface)	1.7 µg / L
Middle Ground Shelf	1.3 µg / L

In addition, data from the phytoplankton identification and enumeration are compared against the minimum warning levels used in the Victorian Shellfish Quality Assurance Program (VSQAP; DPI, 2004) for potentially harmful species.

4 Results and discussion

4.1 Sampling

Collection of samples under the Baywide Water Quality monitoring program was not consistent over the four month period (November 2007 – February 2008). Sampling was undertaken as follows:

- November – total of 11 sites (7 sites on 1/11/2007; 3 sites on 9/11/2007; and 1 on the 12/11/2007);
- December – total of 7 sites (4 sites on 29/11/2007; and 3 sites on 13/12/2007); and
- January – total of 11 sites (1 site on 11/1/2008; 4 sites on 22/1/2008; and 6 sites on 23/1/2008).
- February – total of 11 sites (1 site on 13/2/08; 2 sites on 21/2/08; 3 sites on 25/2/08 and 5 sites on 27/2/08)

Although samples were collected and analysed for chlorophyll a and phaeophytin concentrations, samples for phytoplankton identification and enumeration were only collected once, in February 2008.

Continuous chlorophyll a concentrations were recorded as part of the Nutrient Cycling monitoring program at 3 sites for the period 3 December 2007–5 February 2008. No data was collected from Middle Ground Shelf during this period.

4.2 General

The *in situ* chlorophyll a results ranged from low concentrations near the limit of detection to short-term peaks at around 2µg/L at Hobsons Bay and >6µg/L at Long Reef and Hobsons Bay. Consistent with historical trends, concentrations at

Hobsons Bay and Long Reef are higher than those recorded in other areas of the Bay due to their proximity to nutrient inputs from the Yarra River and Western Treatment Plant. Summary statistics are presented in Table 4.

Table 4: Summary of results from in situ loggers from December 2007 – February 2008.

Site name	Period Minimum	Period Median	Period 90 th percentile	Period Maximum
Hobsons Bay (surface)	0.5	0.5	2.7	4.0
Hobsons Bay (bottom)	0.4	2.1	3.2	6.4
Central Bay (surface)	0.1	0.6	0.9	1.5
Central Bay (bottom)	0.3	0.7	1.1	1.8
Long Reef (surface)	0.4	1.5	2.9	5.7
Long Reef (bottom)	0.3	1.3	2.7	6.8

Results from the monthly laboratory analyses ranged from a minimum of 0.16 µg/L at the PoM DMG in November to a maximum of 6.9 µg/L at Yarra Newport in December 2007 (Table 5). In general, most chlorophyll a concentrations were < 1 µg/L at most sites over the four month period, with the exception of the sites located in the Yarra River, Hobsons Bay and Long Reef. With only 3 to 4 data points at each site there was insufficient data to determine meaningful statistics or trends at this stage.

Table 5: Summary of results from monthly samples.

Site name	November 2007 (early)	November 2007 (late)	December 2007	January 2008	February 2008
Patterson river	0.49	-	-	0.57	0.74
Central	0.22	-	-	0.76	0.99
Dromana	0.39	0.45	-	0.93	0.9
PoMC DMG	0.16	-	-	0.87	1.13
Middle Ground Shelf	0.28	0.4	-	0.71	1.7
Popes eye	0.51	0.47	-	0.44	0.9
Sorrento bank	0.41	0.53	-	0.49	0.77
Corio Bay	0.67	-	0.98	0.96	1.07
Long reef	5.6	-	-	0.96	0.41
Hobsons Bay	1	-	3.2	1.03	2.25
Yarra Newport	2.29	-	6.9	5.15	2.3

4.3 Comparison with SEPP

SEPP objectives for chlorophyll a are based on annual median and 90th percentile values. As a consequence, a meaningful comparison cannot be made with only four months data.

4.4 Comparison with EWMA control limits

Comparison of monthly chlorophyll a data with EWMA control limits requires that raw data be integrated into an EWMA control chart. However, data received were in a raw data format only and no historical data provided to formulate an EWMA control chart. As such, no comparison with EWMA control limits could be made. This comparison will be conducted in future reports.

4.5 Comparison with EWMAST control limits

Chlorophyll a concentrations from continuous *in situ* logger data was integrated into EWMAST control charts by Emphron Pty Ltd (Figure 2 to Figure 7).

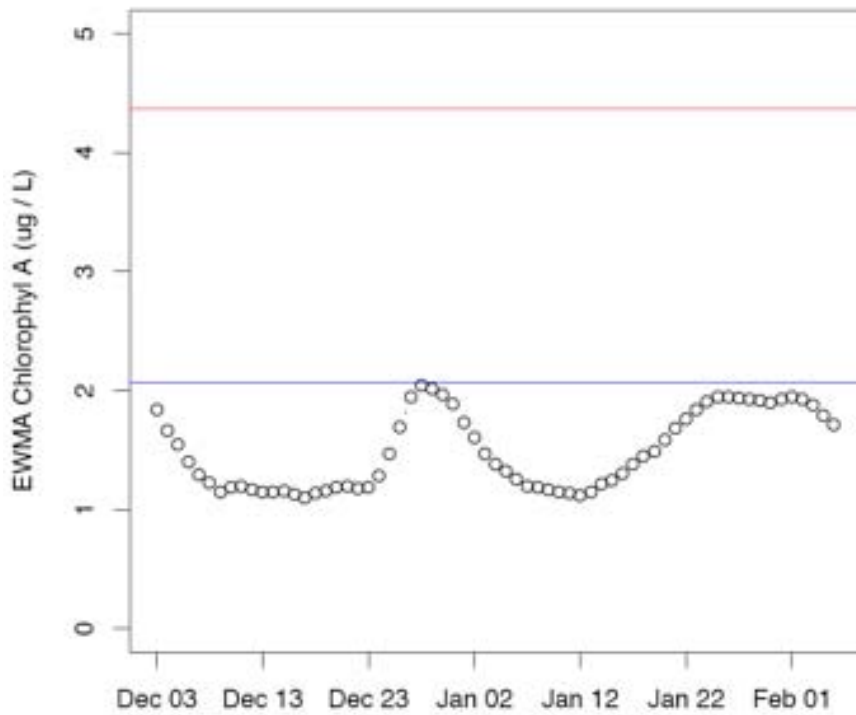


Figure 2 EWMAST Chlorophyll a (ug/L) from Hobsons Bay (surface) December 3 2007 to February 5 2008. Red lines indicate control limits

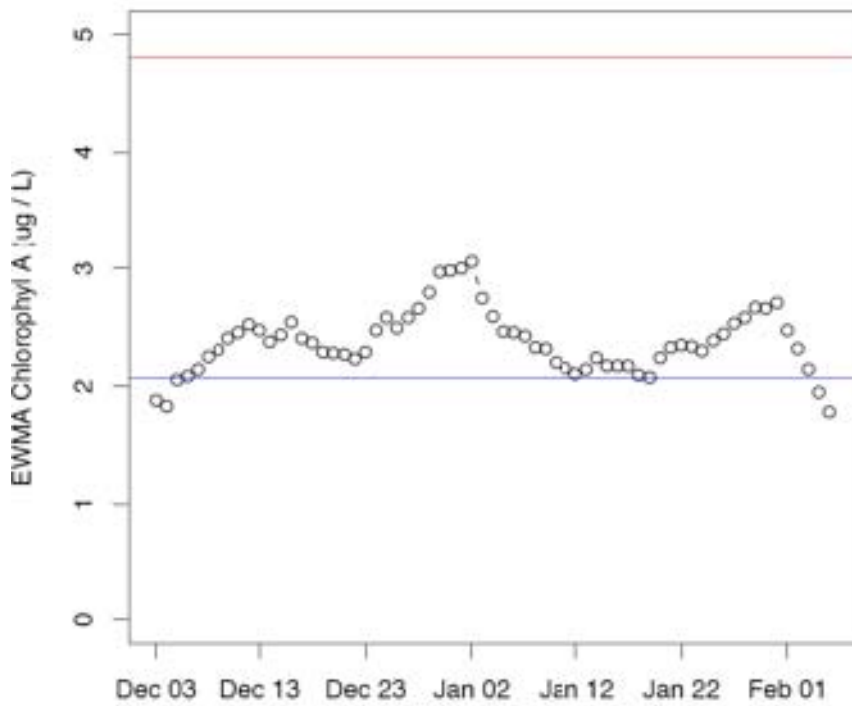


Figure 3 EWMAST Chlorophyll a (ug/L) from Hobsons Bay (bottom) December 3 2007 to February 5 2008. Red lines indicate control limits

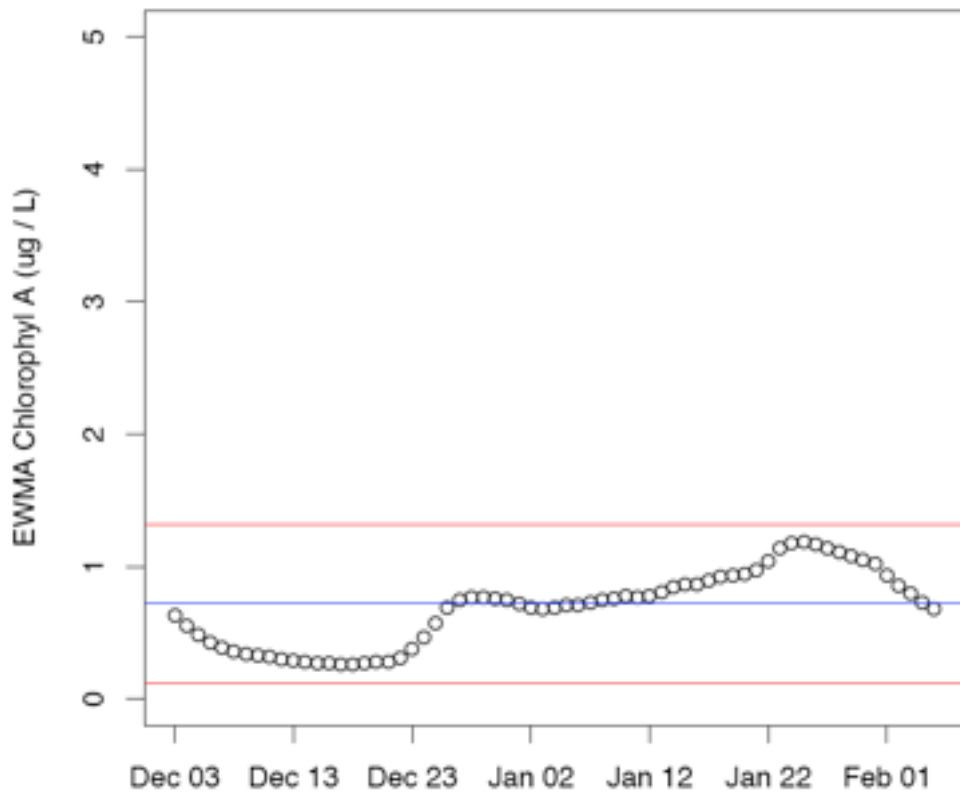


Figure 4 EWMAST Chlorophyll a (ug/L) from Central Bay (surface) December 3 2007 to February 5 2008. Red lines indicate control limits

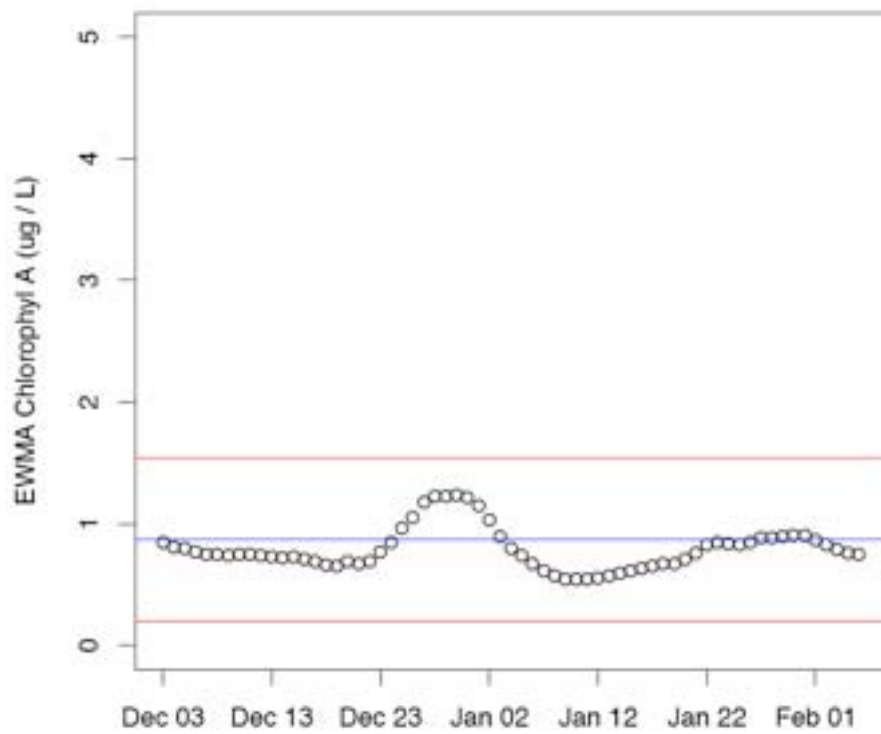


Figure 5 EWMAST Chlorophyll a (ug/L) from Central Bay (bottom) December 3 2007 to February 5 2008. Red lines indicate control limits

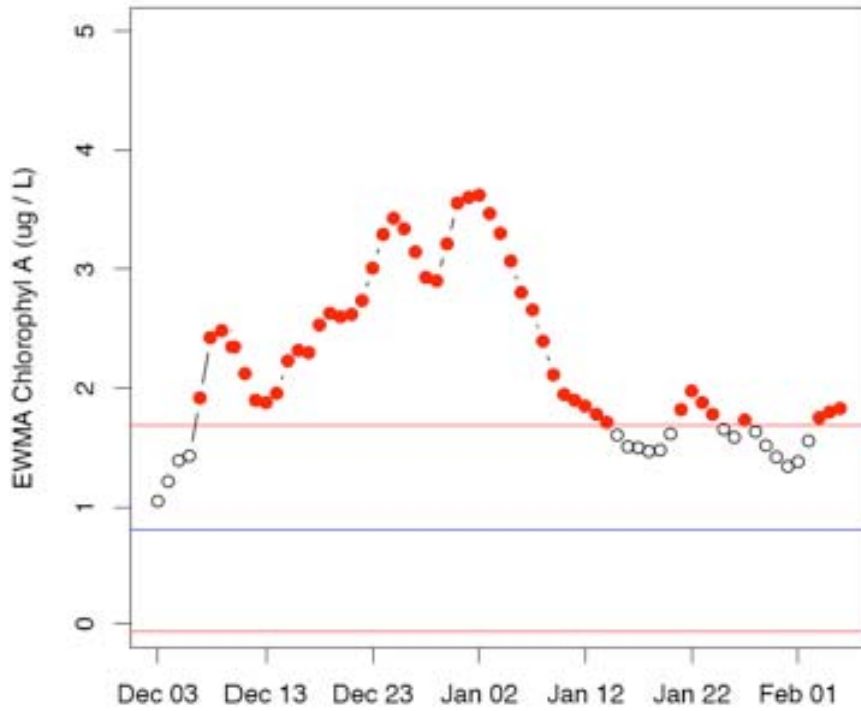


Figure 6 EWMAST Chlorophyll a (ug/L) from Long Reef (surface) December 3 2007 to February 5 2008. Red lines indicate control limits

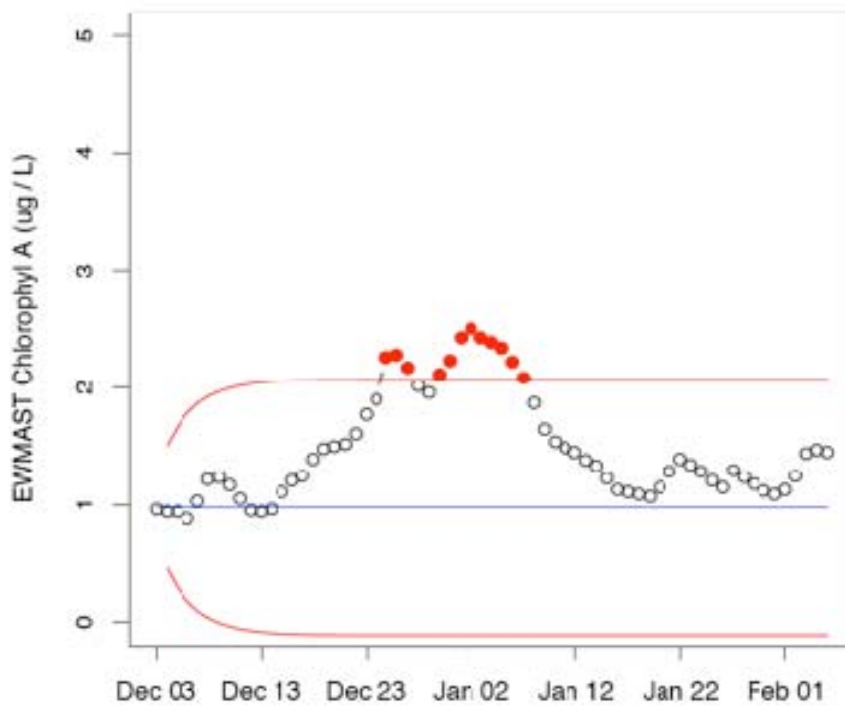


Figure 7 EWMAST Chlorophyll a (ug/L) from Long Reef (bottom) December 3 2007 to February 5 2008. Red lines are preliminary control limits.

Comparison with EWMASST control limits indicated that phytoplankton biomass at Hobsons Bay and Central Bay was within natural variability. However, chlorophyll a concentrations at Long Reef were above control limits for much of the period (particularly in surface waters).¹

A brief examination of the raw chlorophyll a data from this sampling period (Figure 8) and a comparison against historical concentrations from this site since 2002 (Figure 9) indicates that phytoplankton biomass at this site is influenced by transitory peaks in both datasets. However, the December 2007 – February 2008 period was characterised not only by peaks, but a baseline shift in chlorophyll a concentrations above 1 µg/L.

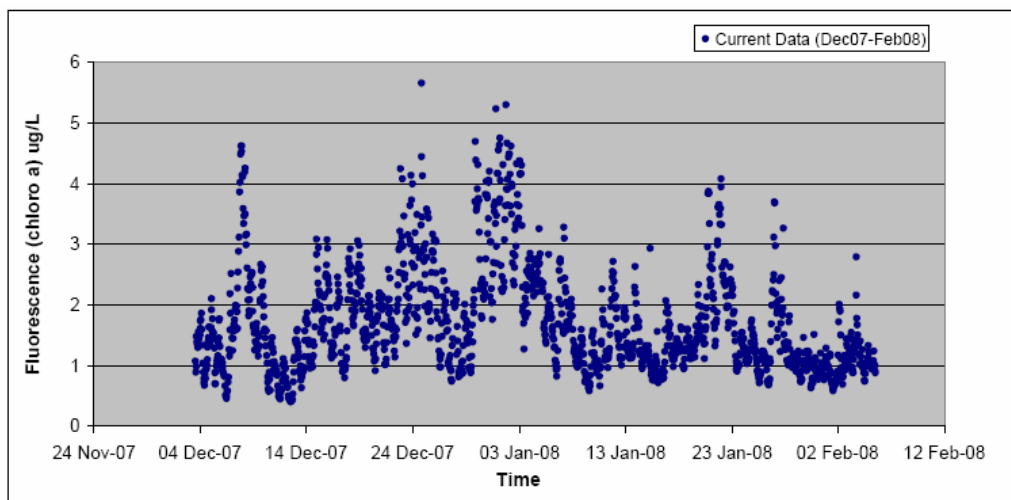


Figure 8 Chlorophyll a (µg/L) concentrations from Long Reef (surface) December 3 2007 to February 5 2008)

¹ Note that there is no EWMASST limit for Long Reef bottom logger published in the Detailed Design. The limit presented in Figure 7 is a preliminary derivation for indicative purposes only. This discussion focuses on the results from the shallow logger, for which a limit has been published.

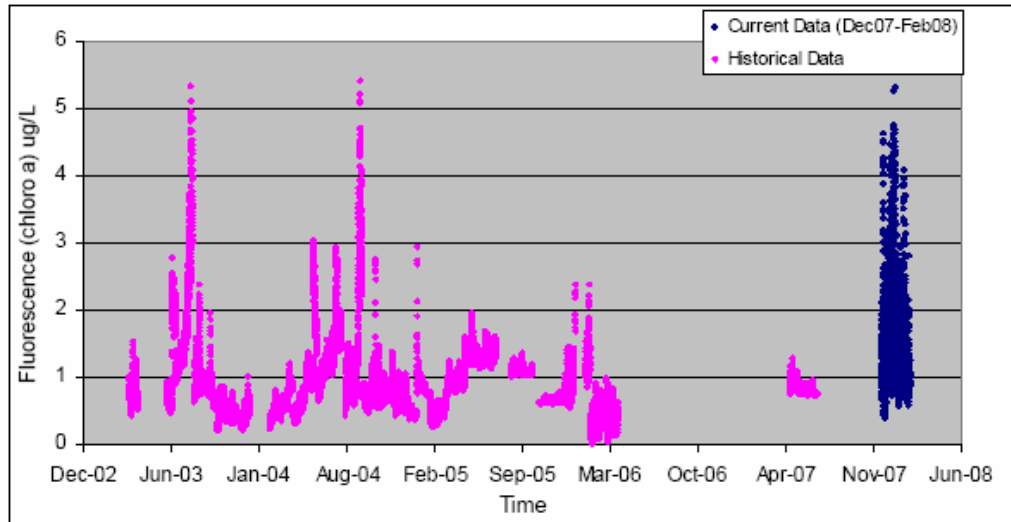


Figure 9 Historical Chlorophyll a ($\mu\text{g/L}$) concentrations from Long Reef (surface) since 2002 plus concentrations from the current period

4.5.1 Assessment of results outside of expected variability

The *in situ* logger results from Long Reef are considered to be outside expected variability as:

- They are in exceedence of EWMASST control limits, and therefore outside of natural variability; and
- They are outside of the predicted effects of the CDP, as there was no dredging during the period of December 2007 to January 2008 and no dredging in the north of the Bay during February.

As per the Decision Framework for Management (see Detailed Design), this initiates a further assessment to determine the significance of these results to the environment. This assessment drew on multiple lines of evidence.

The first of these relates to the accuracy of the results. Fisheries Research Branch (DPI) is responsible of the QAQC of data. Its review of both field and laboratory QAQC has not identified any concerns with the accuracy of this data. Therefore, the data is to be considered valid and not erroneous.

The second consideration is a comparison of the results (actual, rather than EWMASST) with relevant guideline values. SEPP guidelines (Table 1) have been set based on historical data and an assessment of ecological risk to Bay health. Therefore they provide some context for the current results. Although SEPP is based on an annual median and 90th percentile, it is worthwhile considering these descriptive statistics for the three month period December 2007 to February 2008 (Table 4).

The median chlorophyll a concentrations for the period December 2007 to February 2008 from Long Reef was 1.5 $\mu\text{g/L}$ (surface) and 1.3 $\mu\text{g/L}$ (bottom). This is below the SEPP guideline of 2.5 $\mu\text{g/L}$. Similarly the 90th percentiles of 2.9 $\mu\text{g/L}$ (surface) and 2.7 $\mu\text{g/L}$ (bottom) are below the SEPP guideline of 4 $\mu\text{g/L}$. This

suggests that these results do not represent a significant ecological risk to Bay health.

A third consideration is the historical context of exceedences. As discussed above (Figure 9), the range of concentrations recorded during this period was within that historically recorded at this site.

A fourth consideration is spatial and temporal extent of the exceedences. Although the chlorophyll a concentrations were above control limits for a significant proportion of the monitoring period, the exceedence was limited to a single site. There was no evidence of chlorophyll a concentrations outside of expectations from the other *in situ* logger positions, or from the EPA Water Quality Monitoring Program for this period.

The assessment concluded that the results considered outside of expected variability are not of significance to the longer-term health of the Bay. This data is important in improving our understanding of background variability in phytoplankton biomass and algal blooms.

Further risk-based investigation of these results is not required at this time.

4.6 Species composition and enumeration of algal blooms

Data was only collected for phytoplankton identification and enumeration one single occasion in February 2008. Total numbers ranged from 220,000 cells per litre at Sorrento Bank to 1.4 million cells per litre at Patterson River. The phytoplankton community was dominated by diatoms at all sites with *Chaetoceros spp.* the most abundant taxon. Dinoflagellates also comprised a significant proportion of the phytoplankton community at all sites. One potentially toxic species (*Pseudo-nitzschia*) was recorded (at all sites except Central Bay), but in numbers well below the VSQAP warning levels.

5 Conclusions and recommendations

This represents the initial quarterly report for the Algal Bloom program. As such it is difficult to draw any definitive conclusions from this small dataset. However, the following conclusions are made:

- Improve the consistency of sampling under the Water Quality Program, to be conducted in accordance with the Detailed Design for this program.
- Regarding the results at Long Reef outside of expected variability:
 - These results are not of significance to the longer-term health of the Bay, and do not require further risk-based investigation.
 - In accordance with the EMP, PoMC notified Department of Sustainability.

- Given that the range of concentrations did not significantly differ from the historical range, and since they were within SEPP guidelines, the EWMAST control limits would benefit from reassessment to determine their accuracy and appropriateness.

6 References

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- Hale, J. (2006) Supplementary Environment Effects Statement, Head Technical Report Nutrient Cycling – Appendix 1 Phytoplankton Blooms.
- Longmore A (2008) Baywide Nutrient Cycling (Denitrification) Monitoring Program – Progress Report No. 1 (Dec. 2007 – Feb. 2008). Fisheries Victoria, March 2008. Department of Primary Industries, Queenscliff, Victoria, Australia.