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PORT OF BRISBANE PTY LTD

Water Quality Monitoring Program: Quarterly Report December 2012

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21 December 2012

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PROJECT 301001-01598 - WATER QUALITY MONITORING PROGRAM: QUARTERLY REPORT DECEMBER 2012

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
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1 INTRODUCTION

The Port of Brisbane Pty Ltd (PBPL) has contracted WorleyParsons to undertake a water quality monitoring program for the Port of Brisbane. The objective of this water quality monitoring program is to enhance PBPL's understanding of the quality (and variation in quality) of the receiving waters surrounding the Port of Brisbane, hereto referred to as the Port. The water quality monitoring program will build upon previous monitoring programs by providing more comprehensive and appropriate spatial coverage, sampling frequency and a range of analytes for the receiving waters adjacent to the Port.

The water quality program is being conducted quarterly per annum. This report presents the first quarterly results and details sampling and analysis undertaken between 13 -14 November 2012. The purpose of this report is to provide an overview of the key results, investigate trends if applicable, and highlight if any water quality guideline values were exceeded.

2 METHODOLOGY

2.1 Water column profiling

The PBPL water quality sampling design comprises a total of twelve sampling sites provided by PBPL and shown in Figure 1. Sampling occurred on the ebb flood tide as PBPL is concerned with diffuse point source impact (stormwater water and land runoff) from Port operations into the receiving environment. A hand-held multi-parameter water quality probe (Hydrolab MiniSonde 5) measuring temperature, pH, turbidity, electrical conductivity and dissolved oxygen was used for physico-chemical analysis. The probe was lowered through the water column to pre-determined depths to provide an understanding of the vertical variability of physico-chemical properties of the water column. Data was collected at three depths (0.5, 1.5 and 3.0 m) at each site and was stored into the water quality probe data logger unit. At each depth range three to five measurements were taken. Data was downloaded upon return to office and all data was collated in an excel database for processing. Statistical analyses were performed using Excel (Microsoft) and Statistica (Statsoft).

Table 1 presents the list of physico-chemical parameters measured and their representative units of reporting. The water quality probe was calibrated in the laboratory (Thermofisher) to industry standards prior to being used in the field.

Table 1: *In situ* physicochemical parameters measured for the DPCT water quality monitoring program.

Parameter		Units of reporting
In-situ physico-chemical	Temperature	0.01 °C
	pH	0.01
	Turbidity (NTU)	0.1 NTU
	Electrical Conductivity (EC)	0.01 µS/cm or mS/cm
	Dissolved Oxygen (DO)	0.1%, 0.1mg/L

LEGEND

EHMP WATER QUALITY SAMPLING SITES

PBC WATER QUALITY SAMPLING SITES

SITE	EASTING	NORTHING
1	514333.8	6967598.3
2	515105.2	6970388.9
3	517628.6	6974265.7
4	518335.3	6975398.4
5	519992.5	6974455.6
6	519365.7	6972629.0
7	516473.0	6969854.4
8	518754.7	6968230.2
9	522872.0	6974873.0
10	522028.0	6976971.0
11	516381.2	6972396.7
12	515932.2	6969267.0

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PREPARED by Adam Jamison

Date 03/07/2012

PORT OF BRISBANE

WATER QUALITY MONITORING LOCATIONS

JULY 2012

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2.2 Surface water sampling: chemical analyses

Surface water samples were collected using a 2L van-Dorn Beta Water Sampler (grab sampler). Water samples were collected at ~0.5 m below the surface at each site and placed into sample bottles/jars supplied by Advanced Analytical Australia (AAA). Dissolved metals were filtered in the field prior to analysis using individual 20 mL sterile syringes and a 0.45 µm Sartorius filter. Sample bottles were clearly labelled with site code, sampler, date and time of sampling, with all standard quality control measures taken to avoid cross-contamination between samples.

All samples were placed on ice in an esky until hand delivered to AAA (Brisbane) at the end of each sampling day. A chain of custody (COC) form was completed and accompanied all samples.

2.3 Laboratory analysis

The key parameters that were analysed for the water quality monitoring program and their respective Practical Quantitation Limits (PQLs) are presented in Table 2. Laboratory analysis included appropriate Quality Assurance and Quality Control (QA/QC) protocols to ensure the highest quality of data and confidence in the results. All PQLs were selected to ensure results could be compared against relevant guidelines where applicable.

2.4 Comparisons with guidelines

The guideline values chosen for this study are based upon previous water quality programs undertaken for PBPL (ALS Water Resources Group, 2010) that have characterised the nature of the receiving environment as “slightly to moderately disturbed” marine waters. This classification comes from the ANZECC (2000) guidelines which states that moderately disturbed ecosystems are “ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity”. Based upon this classification, the data were assessed against the relevant water quality guidelines and they include:

- the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000a) guidelines for ‘slightly to moderately’ disturbed ecosystems at the 95% species protection levels.
- the Queensland Department of Environment and Heritage Protection’s (DEHP) Queensland Water Quality Guidelines (QWQG) for south east Queensland region enclosed coastal water type and sub-region –western bays (DERM 2009).

Table 2 Analytical parameters for the baseline water quality sampling program.

Analytical parameter		Practical Quantitation Limits (PQLs)
Nutrients	Nitrite as N (NO_2), Nitrate as N (NO_3), Total Phosphorus	0.01 to 0.02 mg/L
	Ammonia as N, Total Kjeldahl Nitrogen as N (TKN), Total Nitrogen	0.1 mg/L
Dissolved Metals (Ultra-trace)	Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Lead (Pb), Zinc (Zn)	0.1 µg/L to 20 µg/L
Total Metals (Ultra-trace)	Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Lead (Pb), Zinc (Zn)	0.1 µg/L to 20 µg/L
Total Petroleum Hydrocarbons/ Recoverable Hydrocarbons	C6-C9	25 µg/L
	C10-C14	50 µg/L
	C15-C28	100 µg/L
	C29-C36	100 µg/L
Polycyclic Aromatic Hydrocarbons	Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo (b&k) fluoranthene, Benzo(a)pyrene, Indeno (1,2,3-cd) pyrene, Dibenza (a,h) anthracene, Benzo(g,h,i) perylene	1 µg/L
Organtin (Ultra-trace)	Tributyltin (Ultra-trace)	0.001µg/L
OC Pesticides	Organochlorine Pesticides	0.03 µg/L
	Endrin aldehyde, Methoxychlor	0.1 µg/L
OP Pesticides	Organophosphorus Pesticides	2 to 0.015 µg/L

3 RESULTS

3.1 Water column profiling

Figure 2 through Figure 6 present the mean (± SE) for each of the physico-chemical parameters (turbidity, DO, pH, EC and temperature) measured at 3 depths (0.5m, 1.5 m and 3 m) at each of the 12 PBPL sampling sites. Note that PBPL 7 and 8 had only two depths recorded. The main findings from the results are outlined below.

Turbidity

- Turbidity readings were similar at all sites, showing increasing turbidity with increasing depth. (Figure 2)
- PBPL sampling sites on the eastern side of the Port had lower turbidity readings.
- Turbidity readings for PBPL sampling sites 1, 2, 3, 4, 7, 11 and 12 were all above QWQG "Western Bays" high value of 6 NTU.

Turbidity readings for PBPL sampling sites 5, 6, 8 (surface only), 9 and 10 for each depth, were between the QWQG "Western Bays" high value of 6 NTU and low value of 1 NTU.

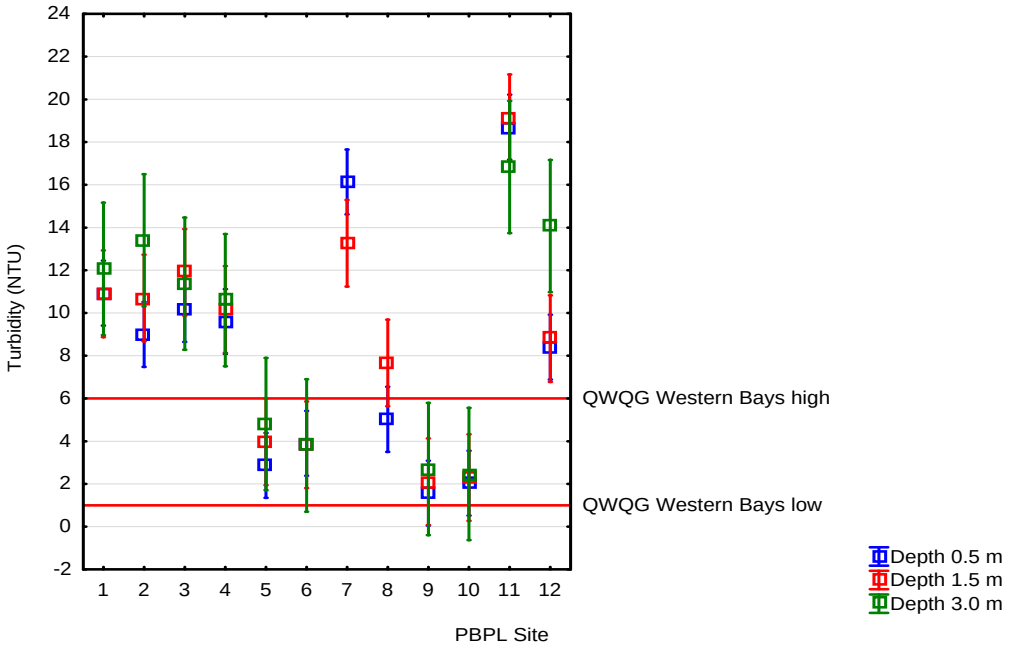

Figure 2 Mean (± SE) turbidity at each PBPL sampling sites at each depth (0.5, 1.5, 3.0m).

Dissolved Oxygen (DO) (% saturation)

- Dissolved oxygen readings (% saturation) were similar at all sites, showing decreasing DO with increasing depth (Figure 3).
- DO readings (% saturation) for PBPL sampling sites 3, (middle and bottom),4 (surface only), 6, 8 and 12 for each depth fell between the QWQG "Western Bays" high value of 105 % sat and QWQG "Western Bays" low value of 95 %sat.
- DO readings (% saturation) for PBPL sampling sites 1, 2 3 (surface only), 4 (middle and bottom) 7, 9, 10 and 11 for each depth fell below the QWQG "Western Bays" low value of 95 %sat.

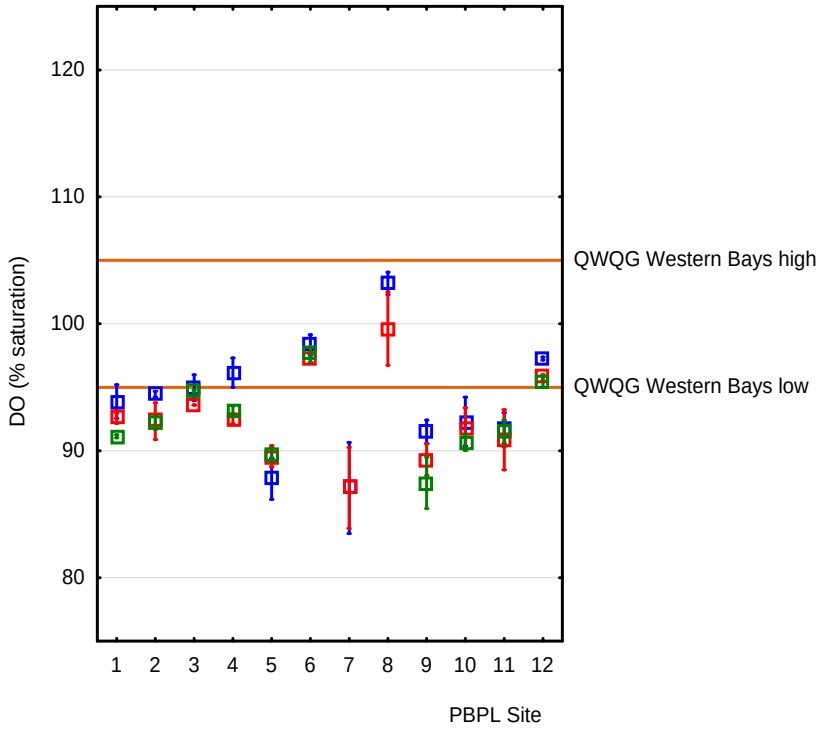

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Figure 3 Mean (+ SE) dissolved oxygen (% saturation) at each PBPL sampling sites at each depth (0.5, 1.5, 3.0m).

pH

- pH showed a consistent pattern at most sites demonstrating little variability with depth. There was one exception at PBPL10 which had a lower pH reading at the surface than at depth (Figure 4).
- All pH readings fell between the QWQG "Western Bays" high value of 8.4 and QWQG "Western Bays" low value of 8.1.

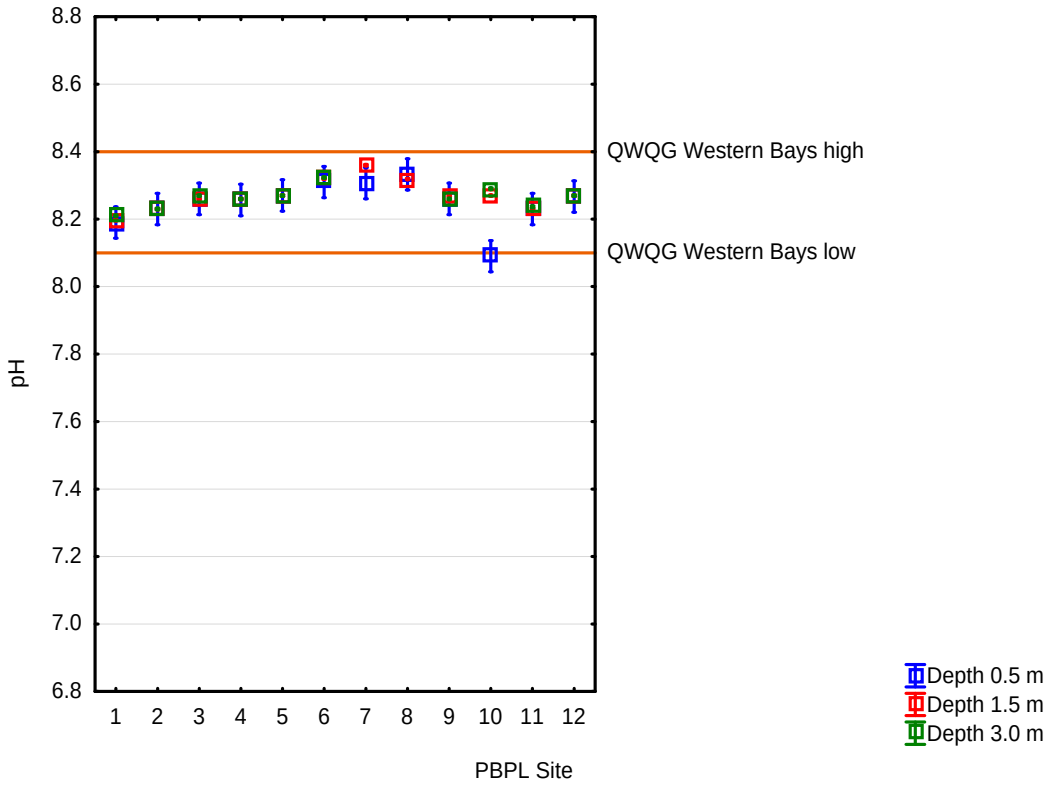

Figure 4 Mean (± SE) pH at each PBPL sampling sites at each depth (0.5, 1.5, 3.0m).

Electrical conductivity

- Electrical conductivity readings were similar at all sites, showing increasing EC with increasing depth, indicating freshwater on surface (Figure 5).
- There is no guideline value for comparison.

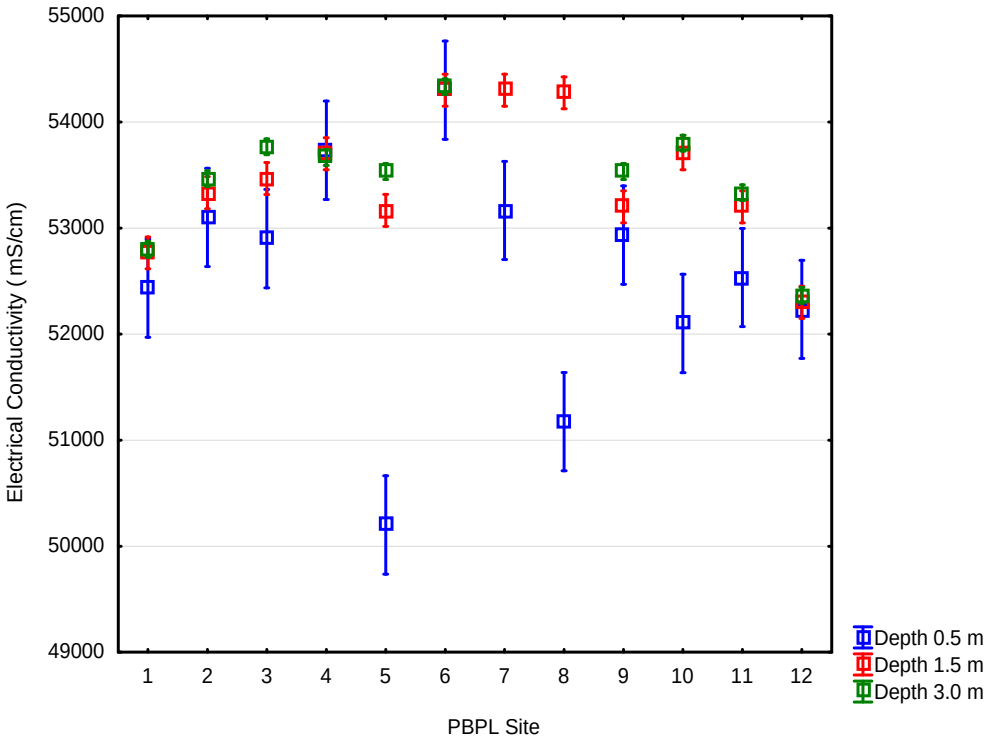

Figure 5 Mean (± SE) EC at each PBPL sampling sites at each depth (0.5, 1.5, 3.0m).

Temperature

- Temperature showed a consistent pattern at most sites with temperatures decreasing as depth increased. (Figure 6).
- There is no guideline value for comparison.

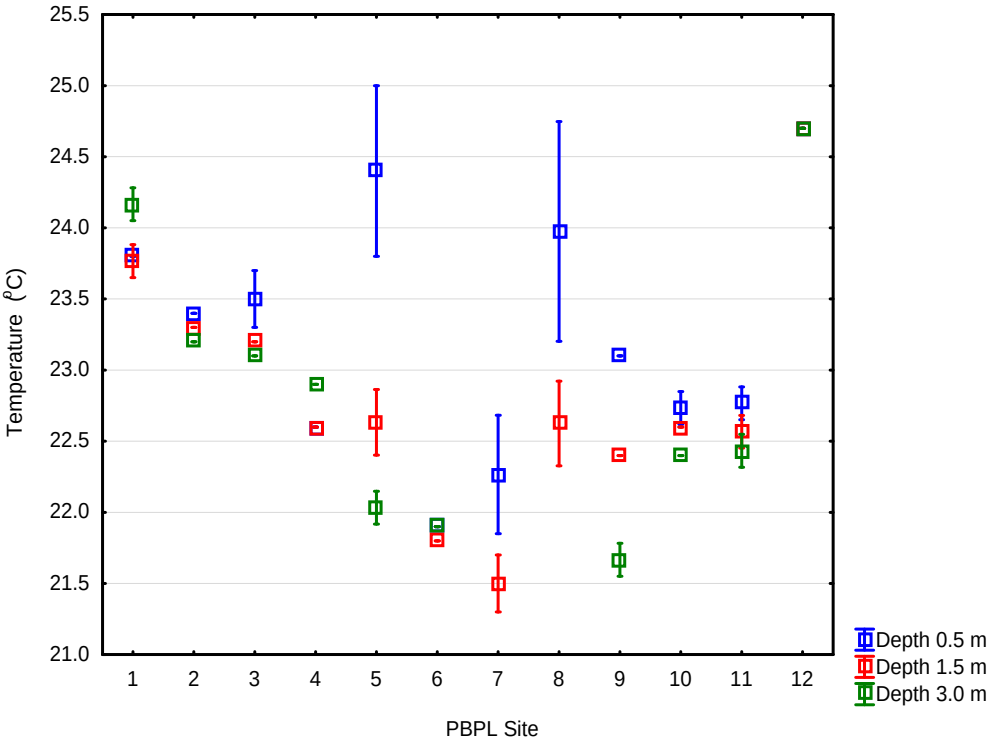

Figure 6 Mean (± SE) Temperature at each PBPL sampling sites at each depth (0.5, 1.5, 3.0m).

3.2 Surface water chemistry

The results for total and dissolved metals/metalloids that were detected during this first sampling event are presented in **Table 3** and Table 4.

Total metals

- Total metals; Ar, Cd, Cr, Co, Pb, Hg and Ni were all below their respective PQLs at all 12 sampling sites for this first round of sampling.

- Total metals; Al, Cu, Fe, Mn and Zn, were detected at all 12 sampling sites at the following concentrations:
    - Al ranged from 0.06 to 0.59 mg/L
    - Cu ranged from 1.5 to 6.1 µg/L
    - Fe ranged from 0.11 to 0.49 mg/L
    - Mn ranged from < 5 to 21 µg/L
    - Zn ranged from 9.4 to 14 µg/L
- Selenium (Se) was detected at only one site, PBPL5 at a concentration of 6.1 mg/L.
- There is no guideline value for comparison.

Dissolved metals

- Dissolved metals; Al, Ar, Cd, Cr, Co, Fe, Pb, Mn, and Ni were all below their respective PQLs at all 12 sampling sites for this first round of sampling.
- Cu was detected all 12 sampling sites and ranged from 1.5 to 6.1 µg /L. All values exceeded the ANZECC/ARMCANZ 95% species protection level of 1.3 µg/L.
- Zn was detected at 9 of the 12 sampling sites and ranged from <5 to 13 µg /L. All samples were below the ANZECC/ARMCANZ 95% species protection value of 15 µg/L.

Total suspended solids (TSS)

The results for total suspended solids and nutrients that were detected during this first sampling event are presented in **Table 5**.

- Total suspended solids ranged from < 2 mg/L at sites PBPL 9 & 10 to a high of 26 mg/L at PBPL 6.
- Only one sample (PBPL 6 at 26 mg/L) during this first sampling event exceeded the QWQG (enclosed-coastal) guideline value of 15 mg/L.

Nutrients

- Total nitrogen was detected above the PQL of 0.1 mg/L at all 12 PBPL sampling sites. Eleven of the twelve PBPL sites had total nitrogen values that were above the QWQG “Western Bays” guideline value 0.2 mg/L.
- Total ammonia measured as N was detected above PQL in samples from PBPL sites 1, 2, 3, 4, 11 and 12. All values were above the QWQG “Western Bays” guideline value of 0.005 mg/L.
- Nitrate was below the PQL of 0.01 mg/L in all samples. Nitrite was detected at two sites, PBPL 1 and PBPL12 but there is no guideline value under QWQG “Western Bays” for comparison.
- Total phosphorus was detected in samples from PBPL 5, 6, 7, 8, 9 and 10. All values exceeded the QWQG “Western Bays” guideline of 0.03 mg/L.

Organics

- All samples analysed for BTEX were below their respective PQLs
- All samples analysed for TPH were below their respective PQLs.

- All samples analysed for PAHs were below their respective PQLs.
- All samples analysed for OC/OP pesticides were below their respective PQLs.

Quality Assurance/Quality Control

- All blanks analysed for each class of constituents' had no contamination. All analytes were below their respective PQLs.
- All surrogate recoveries for all samples were within their allowable range (10-140%).
- All duplicate results had relative percentage differences that compiled with the following:
  - If < 10 times PQL- no limits
  - If > 10 times PQL – 0% to 50%.
- All matrix spike results fell within the following:
  - For trace elements (50-150%);
  - Organic (50-150%) and
  - BTEX and TPH/PAH (10-140%).

Table 3 Summary of results for total metals/metalloids for PBPL Field Trip #1 (November 13-14 2012).

Analyte Description	Units	PQL	PBPL 1	PBPL 1	PBPL 2	PBPL 3	PBPL 4	PBPL 5	PBPL 5	PBPL 6	PBPL 7	PBPL 8	PBPL 9	PBPL 10	PBPL 11	PBPL 12
			14/11/12	14/11/12	14/11/12	14/11/12	14/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	14/11/12	14/11/12
Aluminium - Total	mg/L	0.05	0.48	0.47	0.45	0.59	0.41	0.13	0.12	0.14	0.42	0.26	0.1	0.07	0.81	0.46
Arsenic - Total	µg/L	5	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Cadmium - Total	µg/L	0.7	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Chromium - Total	µg/L	2	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Cobalt - Total	µg/L	1	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Copper - Total	µg/L	1	4.1	4.8	5.3	5.6	5.7	1.5	2.4	2.6	3.5	3.8	3.3	2.5	5.6	6.1
Iron - Total	mg/L	0.05	0.49	0.49	0.39	0.52	0.35	0.11	0.11	0.12	0.35	0.22	0.08	0.06	0.67	0.38
Lead - Total	µg/L	1	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Mercury - Total	mg/L	1E-04	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Manganese - Total	µg/L	5	17	16	16	18	15	10	10	7.1	17	9	6.4	<5	21	15
Nickel - Total	µg/L	3	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Selenium - Total	µg/L	5	<	<	<	<	<	6.1	<	<	<	<	<	<	<	<
Zinc - Total	µg/L	5	14	13	11	11	11	10	10	9.6	11	9.8	9.4	11	13	11

Table 4 Summary of results for dissolved metals/metalloids for PBPL Field Trip #1 (November 13-14 2012).

Analyte Description	Units	PQL	PBPL 1	PBPL 1	PBPL 2	PBPL 3	PBPL 4	PBPL 5	PBPL 5	PBPL 6	PBPL 7	PBPL 8	PBPL 9	PBPL 10	PBPL 11	PBPL 12
Date sampled			14/11/12	14/11/12	14/11/12	14/11/12	14/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	14/11/12	14/11/12
Aluminium - Dissolved	µg/L	20	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Arsenic - Dissolved	µg/L	5	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Cadmium - Dissolved	µg/L	0.7	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Chromium - Dissolved	µg/L	2	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Cobalt - Dissolved	µg/L	1	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Copper - Dissolved	µg/L	1	3.3	3.3	3.2	2.9	2.9	2.6	2.6	3.4	3.6	3.5	3.1	3	3.1	3.4
Iron - Dissolved	µg/L	20	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Lead - Dissolved	µg/L	1	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Manganese - Dissolved	µg/L	5	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Mercury - Dissolved	mg/L	1E-04	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Nickel - Dissolved	µg/L	3	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Selenium - Dissolved	µg/L	5	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Zinc - Dissolved	µg/L	5	12	11	13	<5	<5	11	10	11	<5	9.8	11	11	12	11

Table 5 Summary of results for total suspended solids and nutrients for PBPL Field Trip #1 (November 13-14 2012).

Analyte Description	Units	PQL	PBPL 1	PBPL 2	PBPL 3	PBPL 4	PBPL 5	PBPL 5	PBPL 6	PBPL 7	PBPL 8	PBPL 9	PBPL 10	PBPL 11	PBPL 12
Date Sampled			14/11/12	14/11/12	14/11/12	14/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	13/11/12	14/11/12	14/11/12
Total Kjeldahl Nitrogen	mg/L	0.1	0.17	0.12	0.097	0.09	0.2		0.1	0.3	0.2	0.2	0.2	0.14	0.13
Total Nitrogen	mg/L	0.1	0.2	0.3	0.2	0.3	0.2		0.1	0.3	0.2	0.2	0.2	0.3	0.3
Total Ammonia as N	mg/L	0.1	0.3	0.3	0.2	0.3	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	0.3	0.3
Nitrate as N	mg/L	0.01	<0.1	<0.1	<0.1	<0.1	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1
Nitrite as N	mg/L	0.01	0.06	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
Phosphorus - Total	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	0.09	0.08	0.07	0.095	0.08	0.07	0.06	<0.01	<0.01
Total Suspended Solids	mg/L	2	8	8	9	8	2		26	10	3	<2	<2	12	5

4 SUMMARY

The physico-chemical parameters measured during this study are indicators for water quality health and are routinely monitored in environmental monitoring programs such as the Mackay Whitsunday Healthy Waterways Program and Reef to Paddock (Carroll et al. 2012). The aim of depth profiling is to identify differences in physico-chemical conditions through the water column. Physico-chemical conditions may differ near the surface compared to mid-water or near the sea bed, and this may be due to the mixing and wave action toward the surface and/or currents/waves acting at the seabed. As this is the first sampling event, there is little inference that can be made from the physico-chemical data but as more data are collected under this water quality program, statistical relationship will be investigated.

Similar to the physico-chemical results, there is little inference that can be made about the surface water chemistry after this first sampling event. The surface water chemistry highlighted detection of dissolved Copper and Zinc and total nitrogen, ammonia, total phosphorus. Surface water samples collected from all twelve PBPL sites demonstrated no detectable concentration of BTEX, TPH, PAHs or OC/OP. As OC/OP pesticide were required to be assessed annually, they will not be included in the next sampling event scheduled for February 2013.

5 REFERENCES

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Department of Environmental Resource Management (2009). Queensland Water Quality Guidelines, Version 3. ISBN 978-0-9806986-0-2.