SOUTHERN PORTS AUTHORITY
Port of Esperance

SOUTHERN PORTS AUTHORITY
PORT OF ESPERANCE

ANNUAL MARINE SEDIMENT MONITORING REPORT 2014/15

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SOUTHERN PORTS AUTHORITY
Port of Esperance

CONTENTS

Page No.

SOUTHERN PORTS AUTHORITY
Port of Esperance

FIGURES

TABLES

1 SUMMARY

The Annual Sediment Report has been produced in accordance with the Southern Ports Authority Port of Esperance (PoE) Operating Licence (L5099/1974/14) (herein the licence) and discusses results from annual sampling of marine sediments at 19 sites in Esperance Harbour. The current version of the Licence L5099/1974/14 issued on 19th February 2015 requires undertaking annual sediment monitoring between 1st June to 31st July each year according to a comprehensive sampling methodology. The first survey implementing the sampling design was conducted in 2010, and subsequent annual surveys have built on this baseline information. PoE requested an alteration to the 2014/15 sediment monitoring dates for the 2014/15 monitoring year due to dredging works undertaken at PoE in July-August 2014. Completion of the sediment sampling after dredging allowed PoE to determine the spatial changes to contamination characterised in surveys conducted between 2010 and 2013. PoE obtained authorisation from DER to undertake sediment monitoring in October 2014 following the completion of maintenance dredging works in August 2014.

The July-August 2014 dredging works caused increases in levels of contamination in the top 10cm of sediment in the berth pockets in the October 2014 survey, but this increase did not cause a statistically significant increase in concentrations of nickel and lead in the inner harbour compared to any of the previous surveys. Furthermore, concentrations of both contaminants remain two to three fold below levels recorded in 2010, and all bioavailable concentrations of metals, including nickel and lead, did not present significant risks of toxicity to marine biota (below ISQG criteria). No triggers for contingency actions were activated with the exception of reporting an increase from one to two sites exceeding ISQG-High values for TBT to DER via this report. Further actions maybe discussed with DER, but the 2008 ban on TBT applications and entry of IMO-registered only vessels will ensure the eventual decline of TBT exposures to marine biota.

Risks of re-contamination of inner harbour sediments with historical lead and nickel residues in stormwater drains were reduced in October 2013 by the removal of contaminated solids from stormwater drains, prior to the commencement of maintenance dredging works.

Maintenance dredging for removal of the remaining contaminated sediments at the berth pockets (disposal to land) is targeted for completion before the next marine sediment survey is scheduled in 2016.

2 INTRODUCTION

The Port of Esperance (PoE) was required by licence L5099/1974/14 to sample the top 10cm of harbour sediments from 19 locations on an annual basis during June/July within the licence year from 1st October 2014 to 30th September 2015. Due to maintenance dredging conducted in the inner harbour (Berth Pockets and turning circle) and outer harbour (harbour channel) which was completed in August 2014, PoE requested early sampling of marine sediments to capture any changes in marine sediment immediately after dredging. Sampling for the 2014/15 monitoring year was undertaken on the 27th and 28th October 2014 in accordance with authority provided by DER via email on 22th July 2014 to approve the timing of sediment sampling to occur following the completion of harbour dredging works. Sediment sampling during June/July will resume in the 2015/16 licence reporting period. A brief history of harbour sediment contamination and monitoring is provided below as background information.

Historical bulk handling of lead carbonate and nickel concentrate operations at PoE have led to lead and nickel contamination in the marine sediments within the berth pockets. PoE ceased handling and export of bulk lead carbonate in 2007, with all bulk handling of nickel exports ceasing in June 2012. PoE now exports nickel in a fully containerised handling system.

Ministerial Statement 681 (2005) required marine sediment monitoring for tri-butyl tin (TBT) and nickel between 2002 and 2006. Following commencement of bulk lead exports, lead monitoring began in 2005. In March 2006 Condition M8.5 of the Ministerial Statement was closed and monitoring temporarily ceased. In 2007, DER (formerly Department of Environment Conservation) found high lead and nickel levels near a stormwater discharge pipe at Berth 1 (close to existing Site A10a shown in Figure 2). As a result of this, Oceanica were contracted by PoE to develop a Sampling Analysis Program (SAP) to assess the ecological risks of the lead and nickel contamination within the harbour waters at the Port.

Between 2007 and 2010 Oceanica undertook an extensive survey and investigation of the toxicity of surficial sediments (Oceanica, 2010). This included testing for total and bioavailable metals in marine sediments and early life stage testing of three different marine species and an acute mortality test using a burrowing crustacean (Amphipod) in whole sediments. The early life stage testing was selected since these stages represent the most sensitive stages of an organism's life cycle. The testing was conducted in elutriate waters of contaminated sediments and deformities in larval development of scallops and rock oysters and the changes in growth rates of algae were

assessed. These studies by Oceanica found that despite the high levels of contamination, neither lead nor nickel within the sediments had significant toxicity to marine biota in any of these tests (Oceanica, 2010).

PoE annually monitors sediments and report levels of contaminants in marine sediments under the current DER Licence (5099/1974/14). Conditions 3.1.1, 3.8.3 and 5.2.1 specify the requirements and reference the Comprehensive Sediment Monitoring and Reporting Plan (CSMRP) (Oceanica, 2009a). Contaminants analysed include nickel and lead at all 19 sites, plus arsenic, cadmium, chromium, copper, zinc, manganese and sulphur at nine sites (Sites A5-A13). Organotins and Total Organic Carbon were analysed for sites in the berth pockets (Sites A8, A9 and A10). Particle size is required to be analysed once every three years and was undertaken in conjunction with the previous year 2013/14 monitoring and was therefore not required for the 2014/15 monitoring year. The ANZECC-ARMCANZ (2000) sediment quality criteria were adopted to form triggers for management actions (refer to Section 3 of the CSMRP, Oceanica, 2009a).

Maintenance dredging works were conducted at the Port in July and August 2014, but the removal and disposal of contaminated sediments in the Berth pockets was incomplete due to the poor manoeuvrability of the dredge leaving high spots along the fender line of each berth. The partial removal of contaminated sediments close to the berth pockets may lead to this survey showing higher concentrations of contaminants than before the dredging works. The risk of increasing contamination in the top 10cm is indicated by the results of deeper (to 1.5m) core sampling conducted in the Berth pockets in August 2012. This survey of deeper sediments was conducted as part of the Environment Impact Assessment required to secure dredging approvals (Oceanica, 2013). The 2012 survey demonstrated that concentrations of nickel and lead were two to three fold lower in the upper layer (0-0.5m) compared to the 0.5-1.0m layer of cores, although concentrations of TBT remained higher in the 0-0.5m layer. The difference in trends between the TBT and metals is likely due to lead and nickel emissions being reduced after 2008 and metal elements not breaking down. TBT is an organometallic (complex molecule) and breaks down according to a typical half-life of one to two years in marine sediments (Dowson *et al*., 1996). Hence TBT contamination is more in the surface sediments due to it being likely that ships still cause TBT contamination as historical layers of this paint on their hulls flake off as they rub against the berth fender. We can expect a gradual decline in TBT in sediments following the 2008 ban of application on IMO registered vessels accepted by the Port. Given these patterns of contamination, and the dredging contractor not dredging to the full design depths, reductions in

contaminant concentrations may not occur despite the most of the contaminated material being removed and disposed on land.

3 OBJECTIVES

The objectives of the 2014/15 annual marine sediment monitoring were to:

1. Assess the effect of the July-August 2014 maintenance dredging on the spatial distribution of contaminated material;

2. Assess sediment quality of the inner harbour against the triggers for management action described in the CSMRP (Oceanica, 2009a). The triggers are as follows:

    a. If bioavailable metal concentrations exceed the ISQG-Low or ISQG-High values at a site where no previous exceedance has taken place;

    b. If more than one out of three sites exceeds the Tributyltin ISQG-High values; and

    c. If the mean nickel or mean lead concentration of the 15 inner harbour sites shows a statistically significant increase (from t-test results) since 2008 (revised to 2010 as 2008 monitoring was confounded by variable depth samples);

    If these triggers are exceeded, contingency management actions include investigation and conducting actions to reduce risk.

3. Submit the Annual Marine Sediment Monitoring Report to DER before 19th December 2015 as required by the licence.

4 METHODOLOGY

4.1 Sampling Works

The 2014/15 annual marine sediment monitoring was conducted on the 27th and 28th October 2014. Samples were collected from 19 monitoring locations (sample locations have been grouped as per the CSMRP (Oceanica, 2009a)):

1. 11 monitoring locations within and around the berth pockets (A8, A9, A10b and A14 - A21);

2. Five monitoring locations within the turning basin and channel (A11, A12, A13, A22 and A23); and

3. Three outer harbour monitoring locations (A5, A6 and A7).

Professional divers previously contracted by Oceanica and PoE were appointed (consistent with AS/NZS 4122) to collect 330 sediment cores (including QA/QC samples) in October 2014. Three replicate samples were taken within five metres of each other at the 19 sites. Each replicate consists of a homogenate of five 0-10cm cores taken from each corner and in the centre of a 1m^2 quadrat (as shown on Figure 1). The locations of the 19 marine sediment sampling sites are provided on Figure 2.

Figure 1: Five cores within 1 m^2 quadrat to make one replicate sample.

Source: CSMRP (Oceanica 2009a)

In 2011 and 2012, sample Site A10 was sampled twice, with triplicate samples taken from the landward side (south side) of the metal sheet piling (A10a) and from the ocean side (northern side) of the metal sheet piling (A10b) located beneath Berth 1. Sample results at Site A10 between 2007 and 2008 indicated there may be a difference in results depending upon which side of the metal sheet piling the samples were taken. The 2011 results indicated the landward side retains historical sediments, as the sheet piling creates a barrier, while the ocean side undergoes regular flushing due to ocean currents and ships propeller wash. Samples were taken again in 2012 to provide further support for these differences observed in 2011. Subsequent surveys in 2013 and 2014 omitted site A10a as it is not representative of the inner harbour with samples only being collected from the ocean side of the sheet piling only (A10b).

The polycarbonate corers used for the 2014 sediment sampling had an internal diameter ~100 mm in line with dimensions recommended in Section 2.2.4 of the CSMRP (Oceanica, 2009a). The corer dimensions recommended in CSMRP (Oceanica 2009a) are different to those specified in Australian Standard (AS 5667.12:1999 (Annex C)), which requires an internal diameter of 66mm and an outer diameter of 70mm. DER have clarified that the dimensions of the polycarbonate corers used are acceptable as described in CSMRP (Oceanica, 2009a).

Further details regarding sampling methodology are provided in Section 2.2.4 of the CSMRP (Oceanica, 2009a). Details of sampling sites are provided below in Table 1, while sample locations are shown on Figure 2. Due to operational constraints including inclement weather and the rockiness of the harbour bed, location may deviate slightly from the below coordinates.

Table 1: Details of Sampling Sites

Site Name	Latitude	Longitude	Site Location Description
Outer Harbour Sites			
A5	33.51.870	121.54.590	~ 350m NNE from tip of northern break wall
A6	33.51.730	121.54.327	~600m NNW from tip of northern break wall
A7	33.51.426	121.54.192	~1,100m from tip of northern break wall
Inner Harbour Sites			
Berth Pockets			
A8	33.52.179	121.54.193	Berth 3
A9	33.52.328	121.54.022	Berth 2
A10b	33.52.250	121.54.860	Berth 1
A14	33.52.303	121.54.967	Western end of Berth 2
A15	33.52.270	121.54.916	Eastern end of Berth 1
A16	33.52.233	121.53.835	Western end of Berth 1
A17	33.52.297	121.53.101	~100m W of the Tugboat wharf
A18	33.52.291	121.54.031	~80m N of Berth 2
A19	33.52.243	121.53.928	~80m N of eastern end of Berth 1
A20	33.52.218	121.53.839	~80m N of western end of Berth 1
A21	33.52.181	121.53.794	~150m NW of western end of Berth 1
Channel and Turning Circle			
A11	33.51.968	121.54.307	~ 200m WNW from tip of northern break wall
A12	33.52.137	121.54.132	~ 150m W of Berth 3
A13	33.52.024	121.54.927	~500m NW of Berth 3
A22	33.52.265	121.53.125	~120m NW of the Tugboat wharf
A23	33.52.079	121.54.245	~ 100m N of northern end of Berth 3
Note: approximate (~) site locations were determined from sample locations provided on Figure 2.			

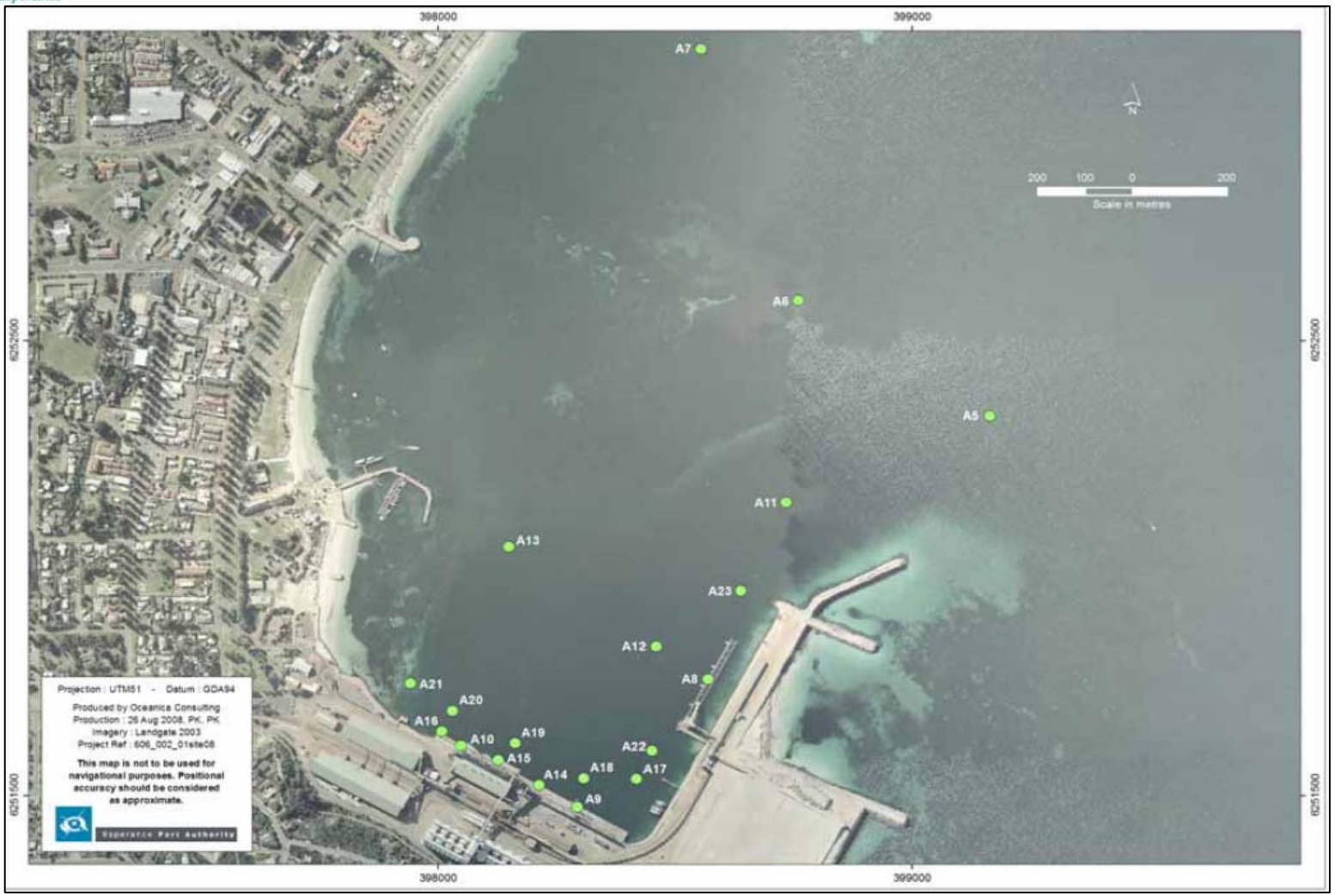

Figure 2: Marine Sediment Sampling Sites at Esperance Ports Sea and Land

4.2 Laboratory Analyses

In accordance with condition 9(b) of the Licence, all samples were submitted to National Association of Testing Authorities (NATA) accredited laboratories for analysis. The same laboratories have been used for all analytes since 2007. All sediment samples collected were analysed for the list of analytes required in Table 2 of the Licence and is outlined in Table 2 below with the exception of particle size distribution which is analysed trienially. Laboratory Certificates of Analysis have been provided in Appendix B.

Table 2: Laboratory Analysis required and Frequency of Analysis

Sampling Sites	Annual Analysis		Analysis Every 3 years	
	Analytes	**Replicates to be analysed**	**Analytes**	**Replicates to be analysed**
All 19 Sites	Lead and nickel	All three replicates	Particle size distribution	One replicate per site
Sites A5 to A13	Arsenic, cadmium Chromium, copper zinc, manganese sulphur	All three replicates	-	-
Sites A8, A9 and A10 (the three berth pocket sites)	Total Organic Carbon (TOC) Organotins (TBT, DBT, MBT)	One replicate per site	-	-

Note: Table sourced from CSMPR (Oceanica 2009a) and Licence L5099/1974-14
Note: Metals analysed were analysed for totals (strong acid extraction) and bioavailable (dilute acid extraction)

NATA accredited analytical laboratories Marine and Freshwater Research Laboratory (MAFRL) and National Measurement Institute (NMI) were commissioned for sediment sample analysis, consistent with the laboratories utilised by Oceanica. All samples were frozen prior to transport and transported on ice at 4°C and couriered overnight to Perth in appropriate containers provided by each laboratory. NATA accredited laboratories undertook analysis of sediment samples for analytes required by condition 9(a) of the Licence as follows:

- NMI was used to analyse TOC and organotins (TBT, DBT, MBT);
- MAFRL were used to analyse for a suite of metal (arsenic, cadmium, chromium, copper, manganese, nickel, lead and zinc) and sulphur analysis;
- Duplicate (split replicate) samples from three sites (A6, A7 and A8) were sent to NMI to provide quality assurance, to ensure reliable metal results were obtained. This is

based on AS 4482.1 - 2005 for soil sampling that suggests one split sample per batch of 20 samples be sent to a secondary laboratory; and

- Particle size distribution is analysed at CSIRO every three years in accordance with the licence, and was not required in this 2014/15 survey.

4.3 Quality Assurance/Quality Control

Field QA/QC was undertaken and three split replicate samples were collected and sent to NMI for analysis. MAFRL and NMI undertook the required laboratory QA/QC. More detailed information regarding QA/QC methods are provided in Appendix C.

4.3.1 Statistical design and analyses

The required data analyses of laboratory results include:

1. Determine median triplicate concentrations at each site to assess compliance with sediment quality criteria (ANZECC-ARMCANZ, 2000);

2. Assess levels of organotins (TBT, DBT and MBT), normalised to 1% TOC content (as per National Assessment Guidelines for Dredging, (Commonwealth of Australia, 2009) in the sediments of the three berth pockets (Berths 1, 2, and 3) and compare to the number of sites exceeding the ANZECC-ARMCANZ (2000) guidelines in 2008.

3. Calculate the mean lead and nickel concentrations for each triplicate sample in 2013 for the 15 inner harbour sites and determine whether values are significantly different to those of 2012, 2011 and 2010 using a standard t-test (two tailed). The software package Statistica (Version 10, 2011) was used to conduct the t-tests. All data was Log10 transformed to normalise the data distribution that was inspected using a histogram. For comparison of the 2013 data to other years, the Levene's test for equal variances indicated the assumption of equal variances is valid. All data passed the Levene's test for equal variances with Levene's p value > 0.05.

5 RESULTS AND DISCUSSION

Results of the 2014/15 annual marine sediment monitoring event are presented and discussed herein, including field sampling and observations, laboratory analytical results and their assessment against the relevant guidelines and changes from the baseline established in 2010 and to the previous survey in 2013, 2012 and 2011.

5.1 Field Sample Observations

Samples were collected from all 19 monitoring sites during the 2014/15 monitoring event, however there were several sites where the total 10cm core of sediment was difficult to obtain. Sites A5, A7 and A12 were within a rocky limestone area, resulting in some of the samples at these sites containing a substantial amount of shell fragments and making it difficult for divers to collect the full 10cm sample depth. A summary of the sample descriptions for samples collected at each site are provided in Table 3. PoE will endeavour to relocate these sites in future according to the recommendations in Section 7.2.

Table 3: Sample Field Observation Descriptions

Site Name	Sample Description
Outer Harbour Sites	
A5	Pale brown shells and seagrass fragments – very difficult to get a sample
A6	Pale brown/yellow sand, odourless, some shells and seagrass fragments
A7	Light brown, odourless, moderate shells and shell fragments
Inner Harbour Sites	
Berth pocket sites	
A8	Dark grey sand, H_2S odour, some seagrass fragments[1]
A9	Pale grey/dark grey sand, H_2S odour, minor shells and seagrass fragments[1]
A10b	Pale grey/grey sand, H_2S odour, no foreign objects
A14	Pale grey sand, slight H_2S odour, no foreign objects present
A15	Pale grey sand, no foreign objects
A16	Pale grey/yellow sand, odourless, Minor shell fragments
A17	Dark grey sand, organic/hydrocarbon odour, minor surface algae
A18	Pale grey sand, organic odour, some small urchins present in one replicate
A19	Pale grey sand, odourless, minor shells present
A20	Pale grey sand, no foreign objects
A21	Pale grey/light brown sand, odourless, some shells. Razor clams collected
Channel and Turning Circle	
A11	Pale grey sand, odourless, shells and shell fragments, some rocks
A12	Light brown sand, odourless, shells and shell fragments present – rocky limestone
A13	Pale grey sand, no foreign objects
A22	Pale grey sand, odourless, some shells and shell fragments
A23	Grey sand, slight H_2S odour, some seagrass fragments

Note [1]: hammer oysters found at these sites

5.2 Particle Size Distribution

Triennial particle size distribution analysis was undertaken in the 2013/14 monitoring year, therefore is not required again until the 2015/16 monitoring year.

5.3 Comparison of Results to Sediment Quality Guidelines

Median values for total and bioavailable levels of each metal were determined from the triplicate results for each site and compared to the results from 2013 sampling and the Australian and New Zealand Interim Sediment Quality Guidelines (ISQG) ISQG-Low and ISQG-High criteria (ANZECC-ARMCANZ, 2000) (refer to Tables 4 and 5). A full set of laboratory results are attached in Appendix B.

5.3.1 Outer Harbour Sites

Median analytical results for total metals (strong acid extraction) and bioavailable metals (dilute acid extraction) for the three outer harbour sites (A5, A6 and A7) were below the ISQG-Low values for each analyte tested, with results consistent with the 2013 annual sediment monitoring results.

5.3.2 Inner Harbour Sites

For total metals, the largest changes in concentrations of metals were observed in sites located in the Berth pockets ((A8, A9, A10b, A14, A15, A16, A17 and A18). Overall, the average concentration of total nickel in the top 10cm of cores from these berth pocket sites nearly doubled between the 2013 survey (41.7 mg/Kg) and the October 2014 post-dredging survey (78.9 mg/Kg). Concentrations of total nickel at these eight Berth pocket sites all exceeded the ISQG-Low for total nickel, with another two sites outside the Berth pockets also exceeding the ISQG-Low (refer to Table 4). Ten sites with total nickel exceeding the ISQG-Low represent an increase from eight sites in 2013/14. Four sites in the Berth pockets (A8, A9, A14 and A17) were also above the ISQG-High values in 2014/15, an increase from one site (A10b) exceeding ISQG-High in 2013/14. Increases in concentrations of total lead and total copper were also observed across the Berth pocket sites following the 2014 dredging works.

Three sites had concentrations of total nickel that exceeded the ISQG-Low or High values recorded for the first time in the sediment surveys. Since these results are not bioavailable concentrations, they do not trigger any contingency actions.

- Site A8 – Total nickel was equal to ISQG-High value of 52 mg/kg. This site exceeded ISQG-Low for total nickel in 2010 and 2012;
- Site A17 – Total nickel (62 mg/kg) exceeded the ISQG-High value. This site exceeded ISQG-Low for total nickel in 2010 and 2011; and
- Site A18 – Total nickel (31 mg/kg) exceeded the ISQG-Low value.

For all metals, all median (n=3) bioavailable concentrations were below the ISQG-Low and High values for each sampling location in 2014 (refer to Table 5). Therefore, nickel is unlikely to be having a significant effect on marine biota and immediate reporting contingencies have not been triggered.

SOUTHERN PORTS AUTHORITY
Port of Esperance

Table 4: Total Metal (strong acid extraction) Median (n = 3) Results for 0-10cm Cores for 2014

	Arsenic		Cadmium		Chromium		Copper		Manganese		Nickel		Lead		Sulphur		Zinc	
Reporting Limit	*<2*		*<0.1*		*<0.2*		*<0.2*		*<0.05*		*<0.7*		*<1*		*<10*		*<0.5*	
	ISQG Low = 20		ISQG Low = 1.5		ISQG Low = 80		ISQG Low = 65		ISQG Low = NA		ISQG Low = 21		ISQG Low = 50		ISQG Low = NA		ISQG Low = 200	
	ISQG High = 70		ISQG High = 10		ISQG High = 370		ISQG High = 270		ISQG High = NA		ISQG High = 52		ISQG High = 220		ISQG High = NA		ISQG High = 410	
	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
Site	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results
A5	3	3	<0.1	<0.1	4.4	3.1	1	1.2	6.9	7	2.2	2	<1	<1	750	1000	2.6	2.3
A6	3	2	<0.1	<0.1	7.6	6.9	0.2	0.8	9.1	8.6	**0.7	**0.7	**1	<1	1100	1100	1.9	1.1
A7	4	3	<0.1	**0.1	4.6	4.9	0.6	1	6.3	6.4	<0.7	1	**1	<1	1200	1100	2.7	1.3
A8	3	3	**0.1	**0.1	8.1	8.7	7.6	29	9.4	11	20	**52**	7	18	1600	2500	13	23
A9	3	6	0.1	0.2	8.2	9.7	9.1	35	8	9.8	**37**	**220**	17	8	1400	3700	13	59
A10b	4	*3	*0.1	0.1	8.6	7.5	23	6.8	10	7.5	**140**	**40**	45	25	1700	1600	28	9.2
A11	<2	<	<0.1	<0.1	4.6	4.6	0.9	1.4	6.2	6.6	2.3	3.4	2	2	770	950	1.9	2.2
A12	2	*2	<0.1	<0.1	5.6	4.1	1.6	1.2	6.7	6	5	3.2	3	*1	1000	1000	5	1.5
A13	5	3	0.1	0.1	9.1	8.1	11	5.3	9.8	9	**28**	12	7	4	1900	1500	21	10
A14	-	-	-	-	-	-	-	-	-	-	**28**	**110**	9	**60**	-	-	-	-
A15	-	-	-	-	-	-	-	-	-	-	**21**	**38**	7	11	-	-	-	-
A16	-	-	-	-	-	-	-	-	-	-	**34**	**27**	13	5	-	-	-	-
A17	-	-	-	-	-	-	-	-	-	-	12	**62**	6	22	-	-	-	-
A18	-	-	-	-	-	-	-	-	-	-	5.7	**31**	4	13	-	-	-	-
A19	-	-	-	-	-	-	-	-	-	-	3.6	12	2	5	-	-	-	-
A20	-	-	-	-	-	-	-	-	-	-	16	**28**	5	10	-	-	-	-
A21	-	-	-	-	-	-	-	-	-	-	**32**	15	11	7	-	-	-	-
A22	-	-	-	-	-	-	-	-	-	-	1.7	8.9	1	4	-	-	-	-
A23	-	-	-	-	-	-	-	-	-	-	**33**	**24**	11	8	-	-	-	-
Bold	indicates median values that exceed the ISQG-Low guideline																	
Grey highlight	indicates median values that exceed the ISQG-High guideline																	

SOUTHERN PORTS AUTHORITY
Port of Esperance

Table 5: Bioavailable Metals (dilute acid extraction) Median (n = 3) Results for 0-10cm Cores for 2014

	Arsenic		Cadmium		Chromium		Copper		Manganese		Nickel		Lead		Sulphur		Zinc	
Reporting Limit	*<2*		*<0.1*		*<0.2*		*<0.2*		*<0.05*		*<0.7*		*<1*		*<10*		*<0.5*	
	ISQG Low = 20		ISQG Low = 1.5		ISQG Low = 80		ISQG Low = 65		ISQG Low = NA		ISQG Low = 21		ISQG Low = 50		ISQG Low = NA		ISQG Low = 200	
	ISQG High = 70		ISQG High = 10		ISQG High = 370		ISQG High = 270		ISQG High = NA		ISQG High = 52		ISQG High = 220		ISQG High = NA		ISQG High = 410	
	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
Site	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results	2013 results	2014 results
A5	2	3	<0.1	<0.1	2.7	2.2	0.5	0.5	2.9	4.1	<0.7	<0.7	<1	<1	670	810	1.1	1.1
A6	3	2	<0.1	**0.1	6.8	6.3	<0.2	0.3	7.2	7	<0.7	<0.7	<1	<1	1100	1100	0.6	*0.5
A7	3	3	<0.1	**0.1	3	4.2	0.3	0.3	3.3	4.6	<0.7	<0.7	<1	<1	970	1100	1.1	0.8
A8	**2	3	<0.1	0.2	5.5	6.5	3.6	6.9	6	7.4	2.3	3.5	7	18	1200	1400	5.6	10
A9	**2	**2	<0.1	0.3	6.4	7	2.8	4.1	4.9	5.4	3	12	13	6	1000	1200	5.5	12
A10b	2	<2	*0.1	0.1	6.2	6.2	4.3	2.5	4.9	5.2	9.2	3.6	44	24	1100	1200	16	21
A11	<2	<2	<0.1	<0.1	2.7	3.1	0.4	0.6	3.3	5	<0.7	<0.7	*2	2	590	780	0.9	1
A12	<2	<2	<0.1	<0.1	3.5	2.3	0.7	0.5	3.7	2.9	*0.7	0.8	3	*1	720	670	1.6	0.8
A13	3	3	0.1	0.1	6.6	6.8	2.7	1.9	6.4	6.3	2.9	1.6	7	**4	1400	1300	8.1	5
A14	-	-	-	-	-	-	-	-	-	-	4	4.8	8	49	-	-	-	-
A15	-	-	-	-	-	-	-	-	-	-	2.8	4.7	6	11	-	-	-	-
A16	-	-	-	-	-	-	-	-	-	-	2.6	5	13	5	-	-	-	-
A17	-	-	-	-	-	-	-	-	-	-	1.4	3.7	5	21	-	-	-	-
A18	-	-	-	-	-	-	-	-	-	-	**0.7	3.2	3	13	-	-	-	-
A19	-	-	-	-	-	-	-	-	-	-	<0.7	1.4	2	5	-	-	-	-
A20	-	-	-	-	-	-	-	-	-	-	1.3	2.2	5	10	-	-	-	-
A21	-	-	-	-	-	-	-	-	-	-	2.5	1.4	10	7	-	-	-	-
A22	-	-	-	-	-	-	-	-	-	-	<0.7	1	<1	4	-	-	-	-
A23	-	-	-	-	-	-	-	-	-	-	2.9	2	10	8	-	-	-	-

Bold indicates median values that exceed the ISQG-Low guideline

Grey highlight indicates median values that exceed the ISQG-High guideline

NA = not available.

Organotins

The results from the three berth pockets samples showed two sites had concentrations of TBT (standardised to 1% Total Organic Carbon (TOC) and dry weight) above the ISQG-High value (80 µg/kg) (refer to Table 6). TBT concentrations of 103.3µg/kg and 1687.5µg/kg were recorded at sites A8 and A10b, respectively. Both of these sites are likely to be located on high spots remaining close to the fender lines of Berths 1 and 3. The increase in TBT concentrations is likely to be due to a combination of sediment disturbance from the 2014 dredging and the patchy spatial distribution due to the association of TBT with antifouling paint flakes (Negri & Marshall, 2009). The number of sites exceeding the ISQG-High value since 2008 increased from one to two sites which triggers the following management actions (Oceanica, 2009a):

1. DER (previously DEC) to be informed via annual reporting;
2. Esperance Port Authority to only accept IMO registered vessels that are compliant with MARPOL;
3. AQIS to conduct random checks on vessels;
4. PoE (previously Esperance Port Sea and Land) to do checks on suspect vessels; and
5. Need for further action to be discussed with DER.

Table 6: Organotins Results 2014 - standardized to 1 % TOC

Site	Monobutyltin		Dibutyltin		Tributyltin	
	µg/kg/1%TOC ISQG Low = NA ISQG High = NA		µg/kg/1%TOC ISQG Low = NA ISQG High = NA		µg/kg/1%TOC *ISQG Low = 9 *ISQG High = 80	
	2008 results	2014 results	2008 results	2014 results	2008 results	2014 results
A8	<LOR	0.66	20.2	21.0	**1181.8**	**103.3**
A9	<LOR	<LOR	5.2	4.7	**14.1**	**21.0**
A10b	<LOR**	1.0	3.9**	32.0	**10.4****	**1687.5**

*ISQG low and high trigger values in ug/Sn/kg^2 (National Assessment Guidelines for Dredging, 2009 – as suggested in CSMRP, 2009).
** 2008 results were for site A10a but are now compared to A10b as this site (oceanside of sheet piling) provides more representative data
Bold - indicated median value that exceed the ISQG-Low guideline
Grey highlight - indicates median value that exceeds the ISQG-High guideline

The breakdown of TBT in sediments has a half-life of 360 to 775 days in surficial sediments (Dowson *et al*, 1996), however the rate of breakdown is dependent on sediment characteristics and temperatures. The MARPOL legislation on the use of TBT anti-fouling

paint required commercial ships to cease application of TBT paints in September 2008. PoE only accepts vessels that are IMO registered and compliant with the MARPOL convention. Therefore, a gradual decline in TBT in sediments is expected, but the continued levels of TBT in sediments support the likelihood that ships still arrive at the Port with historical undercoats of TBT applied to their hulls.

5.4 Quality Assurance/Quality Control Results

Details of the laboratory and field QA/QC results are provided in Appendix C. Some of the field QA/QC showed % Relative Standard Deviation above 50% however, the results are still considered reliable, given that all sites had all triplicate results below the ISQG-Low value for the relevant analyte. The Relative Percentage Difference (RPD) comparing primary environmental samples sent to MAFRL to split samples sent to NMI laboratory showed variable compliance with the ±30 - 50% RPD range (AS4482.1, 2005). Split samples in 2014 were collected from three replicate samples at three sampling locations. Considering the variability between triplicate samples, RPDs outside the 30-50% RPD range should not affect the overall validity of the data for the purpose of the 2014 annual sediment monitoring.

5.5 Time Series Analysis

A t-test was conducted to detect any change in nickel and lead concentrations across the 15 inner harbour sites between the 2014 results, and previous surveys in 2013 2012, 2011 and 2010. As stated in the 2013 report, comparisons to results from 2007 and 2008 were confounded by the variable depths sampled in the earlier surveys.

Average values of nickel concentrations are shown in Tables 7 (nickel) and 8 (lead) for the 15 inner harbor sites between 2010 and 2014. Results of the t-tests are presented in Tables 9, 10 and 11. Raw and log10 transformed data was assessed for normal distribution using a histogram in Statistica. Subsequently, Log10 transformed was selected to conduct t-tests. A statistically significant difference was based on a p-value of less than 0.05 (<0.05). The raw output from Statistica is provided in Appendix A.

Table 7: Average Values (n = 3) for Total Nickel for T-tests

Sampling Site	Ni 2014	Ni 2013	Ni 2012	Ni 2011	Ni 2010

	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
A8	60.00	20.7	26.3	28.3	32.0
A9	386.7	37.0	34.7	107.0	623.3
A10b	41.3	160.0	160.0	86.3	543.3
A12	3.1	4.7	4.0	7.1	3.1
A13	11.7	31.7	21.7	27.0	32.7
A14	40.3	29.0	13.7	46.3	58.0
A15	40.3	22.7	9.2	16.3	45.7
A16	37.7	36.0	41.3	28.0	112.7
A17	57.3	12.0	11.7	24.3	34.3
A18	32.3	6.3	3.2	13.7	10.3
A19	10.7	4.1	8.9	15.3	6.0
A20	29.3	16.0	17	32.3	38.3
A21	13.7	31.7	29.7	32.7	44.7
A22	8.1	1.4	22.7	2.4	2.6
A23	23.3	33.0	36.3	32.7	39.7
Total Mean	***53.06***	***29.74***	***29.36***	***33.31***	***108.45***

Note: Data in this table was not normally distributed. All data was Log10 transformed to provide a normally distributed data set prior to undertaking t-test

Table 8: Average Values (n = 3) for Total Lead for T-tests

Sampling Site	Pb 2014	Pb 2013	Pb 2012	Pb 2011	Pb 2010
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
A8	20.00	7.00	10.33	10.67	18.67
A9	14.33	17.00	20.33	39.33	210.00
A10b	26.00	47.00	65.67	58.67	326.67
A12	1.00	2.67	4.33	2.67	3.33
A13	4.33	7.67	8.67	8.67	10.00
A14	57.00	10.00	8.33	21.33	27.67
A15	20.67	7.00	7.00	7.33	21.33
A16	5.00	13.00	20.33	9.67	38.67
A17	20.33	5.67	6.67	11.00	16.33
A18	17.67	4.00	4.00	5.33	5.33
A19	4.33	2.00	6.67	11.67	3.00
A20	10.33	5.33	8.00	11.33	13.00
A21	6.67	11.67	12.00	14.33	18.33
A22	4.33	1.00	3.00	1.67	2.33
A23	8.33	11.00	13.00	12.00	15.00
Total Mean	***14.69***	***10.13***	***13.22***	***15.04***	***48.64***

Note: Data in this table was not normally distributed. All data was Log10 transformed to provide a normally distributed data set prior to undertaking t-test

5.5.1 T-test Inner Harbour Nickel Results

1. *Analyses of the 2014 data against the 2013, 2012, 2011 and 2010 data for all 15 inner harbour sites*

T-tests were conducted for average concentrations of nickel in the top 10cm of sediment for all 15 inner harbour sites in 2010, 2011, 2012, 2013 and 2014. T-test results comparing 2014 total nickel results against the previous year's results are provided below in Table 10. T-test results show that there was no significant difference ($p>0.05$) when comparing 2014 to 2013, 2012, 2011 and 2010 data.

Table 9: T-Test Results for all Inner Harbour Sites for Total Nickel

	t value	p value	df
Nickel 2014 vs. 2013	1.291	0.207435	28
Nickel 2014 vs. 2012	1.506	0.143209	28
Nickel 2014 vs. 2011	0.480	0.634920	28
Nickel 2014 vs. 2010	-0.448	0.657737	28
Note: All data was Log10 transformed to provide normal distribution of data			

Concentrations of total nickel were two to three fold higher in 2010 than in the subsequent four surveys between 2011 and 2014 (refer to table 7). In the four surveys between 2011 and 2014, the concentrations measured in 2014 were higher than the three surveys between 2011 and 2013, but these differences were not significant (refer to Table 9). Although patterns in total nickel are indicative of exposure, exposures of nickel to marine biota are measured via bioavailable concentrations. All bioavailable concentrations were below ISQG-Low values and so are unlikely to present significant risks of toxicity.

5.5.2 T-test Inner Harbour Lead Results

The results for the t-test conducted for lead data (Table 11) for all 15 inner harbour sites are provided below in Table 11. There was no significant difference ($p<0.05$) for total lead concentrations in the top 10cm of sediment sampled at 15 inner harbour sites when comparing 2014 results to those of 2013, 2011 and 2010 however there was a significant difference in lead concentrations when comparing 2014 results to those in 2012. Concentrations of total lead were three fold higher in 2010 than in subsequent four surveys between 2011 and 2014 (refer to table 8). In the four surveys between 2011 and 2014, there is no clear pattern or any further decline in concentrations of lead in the inner harbour. Although patterns in total lead are indicative of exposure, exposures of lead to marine biota are measured via bioavailable concentrations. All bioavailable concentrations were below ISQG-Low values and so are unlikely to present significant risks of toxicity.

Table 10: T-Test Results for all Inner Harbour Sites for Total Lead

	t value	p value	df
Nickel 2014 vs. 2013	0.921	0.365195	28
Nickel 2014 vs. 2012	0.047	0.963172	28
Nickel 2014 vs. 2011	-0.295	0.770292	28
Nickel 2014 vs. 2010	-1.334	0.193116	28

Note:
All data was Log10 transformed prior to undertaking t-test to provide normal distribution of data

6 CONCLUSION

Despite the July-August 2014 dredging works causing increases in levels of nickel and lead contamination in the top 10cm of sediment in the berth pockets in the October 2014 survey, this increase was not statistically significant compared to any of the previous surveys. Furthermore, concentrations of both contaminants remain two to three fold below levels recorded in 2010 and bioavailable concentrations of metals did not present significant risks of toxicity to marine biota. No triggers for contingency actions were activated with the exception of reporting an increase from one to two sites exceeding ISQG-High values for TBT to DER via this report. Further actions maybe discussed with DER, but the 2008 ban on TBT applications and entry of IMO-registered only vessels will ensure the eventual decline of TBT exposures to marine biota.

7 RISK MANAGEMENT AND RECOMMENDATIONS

7.1 Actions taken since 2013 Annual Sediment Monitoring

1. Cleaning procedures on the multi-user Berth 2 have been upgraded and continue to be reviewed for additional improvements. These improvements aim to reduce the potential for nickel (containerised export), bulk sulphur and bulk fertiliser contaminated water from entering the harbour;

2. Cleaning of stormwater infrastructure was finalised in October 2013 These cleaning works and additional survey works will allow the infrastructure and land surfaces to be to be mapped into sub-catchments towards help improved management of contaminants in storm water.

3. Maintenance dredging works were completed in August 2014 which removed a proportion of contaminated sediments from berth pockets and the inner harbour but also caused a redistribution of contaminated material.

7.2 Further actions to be taken

1. Aim to complete maintenance dredging that removes the remaining contaminated sediments at the berth pockets (disposal to land) before the next marine sediment survey is scheduled in 2016;

2. Reduce potential for future nickel contamination of the marine sediments by continuing to receive nickel products within sealed containers to reduce the potential for nickel entering the marine environment; and

3. All sites that were difficult to sample to 10cm depth will be moved and the new locations will be recorded. These movements include sites:

    a. A7 which will be moved to the first visible area that does not have dense seagrass growth and has clear sand patches, or seaward until the depth increases above 10m.

    b. Divers will attempt to sample sites A12 and A22. The depth sounder will be utilised to show when the bottom becomes less dense. The divers will enter the water at this point to conduct sampling.

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9 APPENDICES

9.1 Appendix A - T-test Results from Statistica

T-Tests comparing Data for all 15 inner harbour sites

Note: For all tests, T-test for independent samples. Variables were treated as independent samples. All data was Log10 transformed to provide normally distributed data sets

Test 1: Levene's T-test for mean total Nickel results comparing 2014 and 2013 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2013	1.472170	1.253449	1.290492	28	0.207435	15	15	0.464102	0.464216	1.000494	0.999276	0.062248	28	0.804799

Test 2: Levene's T-test for mean total Nickel results comparing 2014 and 2012 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2012	1.472170	1.215395	1.506224	28	0.143209	15	15	0.464102	0.469620	1.023922	0.965348	0.017192	28	0.896618

Test 3: Levene's T-test for mean total Nickel results comparing 2014 and 2011 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2011	1.472170	1.398505	0.480052	28	0.634920	15	15	0.464102	0.371249	1.562776	0.413826	0.643934	28	0.429048

Test 4: Levene's T-test for mean total Nickel results comparing 2014 and 2010 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2010	1.472170	1.564238	-0.447809	28	0.657737	15	15	0.464102	0.647035	1.943700	0.226054	0.475731	28	0.496040

Test 5: Levene's T-test for mean total Lead results comparing 2014 and 2013 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Pb 2014 vs. Pb 2013	1.028928	0.911780	0.920460	28	0.365195	15	15	0.360262	0.336423	1.146745	0.801396	0.228724	28	0.636185

Test 6: Levene's T-test for mean total Lead results comparing 2014 and 2012 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Pb 2014 vs. Pb 2012	1.028928	1.023289	0.046588	28	0.963172	15	15	0.360262	0.300021	1.441895	0.502406	0.798325	28	0.379210

Test 7: Levene's T-test for mean total Lead results comparing 2014 and 2011 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Pb 2014 vs. Pb 2011	1.028928	1.066817	-0.294838	28	0.770292	15	15	0.360262	0.343401	1.100609	0.860184	0.413238	28	0.525560

Test 8: Levene's T-test for mean total Lead results comparing 2014 and 2010 data for 15 inner harbour sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Pb 2014 vs. Pb 2010	1.028928	1.260267	-1.33350	28	0.193116	15	15	0.360262	0.567146	2.478294	0.100793	0.840514	28	0.367079

T-Tests comparing data for sites which exceeded ISQG-Low in 2010

Test 9: Levene's T-test for mean total Nickel results comparing 2014 and 2013 for 10 Inner Harbour Sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2013	1.591708	1.465029	0.776922	18	0.447295	10	10	0.389930	0.337367	1.335883	0.673172	0.108762	18	0.745365

Test 10: Levene's T-test for mean total Nickel results comparing 2014 and 2012 for 10 Inner Harbour Sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2012	1.591708	1.450797	0.873794	18	0.393739	10	10	0.389930	0.328652	1.407669	0.618690	0.056865	18	0.814215

Test 11: Levene's T-test for mean total Nickel results comparing 2014 and 2011 for 10 Inner Harbour Sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2011	1.591708	1.550355	0.284933	18	0.778948	10	10	0.389930	0.242052	2.595103	0.171636	0.679152	18	0.420665

Test 12: Levene's T-test for mean total Nickel results comparing 2014 and 2010 for 10 Inner Harbour Sites

	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
Ni 2014 vs. Ni 2010	1.591708	1.864161	-1.36837	18	0.188035	10	10	0.389930	0.494363	1.607382	0.490615	1.239746	18	0.280168

9.2 Appendix B – Laboratory Reports

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Research Laboratory
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Accreditation Number: 10603
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Murdoch UNIVERSITY

SEDIMENT DATA

Contact: Catherine Field
Customer: Southern Ports Authority
Address: Crn Bower Ave and The Esplanade, Esperance, WA 6450

Date of Issue: 04/12/2014
Date Received: 30/10/2014
Our Reference: SPA14-1
Your Reference: ENV13-285

METHOD SAMPLE CODE	Sampling Date	ICP002 Total Ext As mg/kg	ICP002 Total Ext Cd mg/kg	ICP002 Total Ext Cr mg/kg	ICP002 Total Ext Cu mg/kg	ICP002 Total Ext Mn mg/kg	ICP002 Total Ext Ni mg/kg	ICP002 Total Ext Pb mg/kg	ICP002 Total Ext S mg/kg	ICP002 Total Ext Zn mg/kg
Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111801	14111801	14111801	14111801	14111801	14111801	14111801-2701	14111801	14111801
A5-1	28/10/2014	3	<0.1	3.0	1.1	8.6	2.0	<1	1200	2.3
A5-2	28/10/2014	3	<0.1	3.1	1.2	7.0	1.6	<1	890	1.9
A5-3	28/10/2014	3	<0.1	3.4	10	6.2	2.5	<1	1000	3.8
A6-1	28/10/2014	2	<0.1	6.9	0.9	8.8	<0.7	<1	1200	1.1
A6-2	28/10/2014	3	<0.1	6.7	0.8	8.0	0.8	<1	1100	1.5
A6-3	28/10/2014	2	0.1	6.9	0.6	8.6	<0.7	<1	1100	1.0
A7-1	27/10/2014	3	<0.1	4.3	1.3	6.5	0.9	<1	1100	1.3
A7-2	27/10/2014	3	0.1	5.1	1.0	6.4	1.3	<1	1400	1.5
A7-3	27/10/2014	3	<0.1	4.9	0.8	6.3	1.0	<1	1100	1.3
A8-1	27/10/2014	6	0.2	11	29	13	100	18	3600	42
A8-2	27/10/2014	3	0.2	8.0	67	10	28	10	2100	23
A8-3	27/10/2014	3	0.2	8.7	19	11	52	32	2500	18
A9-1	27/10/2014	4	0.2	8.1	15	7.1	200	8	2200	15
A9-2	27/10/2014	9	0.6	10	110	14	740	28	4900	180
A9-3	27/10/2014	6	0.3	9.7	35	9.8	220	7	3700	59
A10b-1	27/10/2014	3	0.2	8.0	38	8.4	47	28	1700	60
A10b-2	27/10/2014	3	0.1	6.9	6.8	6.8	40	25	1400	9.2
A10b-3	27/10/2014	<2	0.1	7.5	6.0	7.5	37	25	1600	7.7
A11-1	28/10/2014	<2	<0.1	4.6	1.5	6.6	3.4	2	1000	4.3
A11-2	28/10/2014	<2	<0.1	4.2	1.0	6.1	2.6	1	820	1.8
A11-3	28/10/2014	<2	<0.1	4.8	1.4	6.6	3.7	2	950	2.2
A12-1	27/10/2014	2	<0.1	4.6	1.2	7.6	3.2	1	1000	1.9

Signatory: Jamie Woodward
Date: 04/12/2014

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Marine and Freshwater
Research Laboratory
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Murdoch UNIVERSITY

SEDIMENT DATA

Contact: Catherine Field
Customer: Southern Ports Authority
Address: Crn Bower Ave and The Esplanade, Esperance, WA 6450

Date of Issue: 04/12/2014
Date Received: 30/10/2014
Our Reference: SPA14-1
Your Reference: ENV13-285

METHOD SAMPLE CODE	Sampling Date	ICP002 Total Ext As mg/kg	ICP002 Total Ext Cd mg/kg	ICP002 Total Ext Cr mg/kg	ICP002 Total Ext Cu mg/kg	ICP002 Total Ext Mn mg/kg	ICP002 Total Ext Ni mg/kg	ICP002 Total Ext Pb mg/kg	ICP002 Total Ext S mg/kg	ICP002 Total Ext Zn mg/kg
Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111801	14111801	14111801	14111801	14111801	14111801	14111801-2701	14111801	14111801
A12-2	27/10/2014	<2	<0.1	3.3	1.6	4.2	2.5	<1	920	1.5
A12-3	27/10/2014	3	<0.1	4.1	1.1	6.0	3.5	1	1300	1.5
A13-1	28/10/2014	3	0.1	8.1	5.0	8.8	11	4	1500	10
A13-2	28/10/2014	3	0.1	8.3	5.3	9.2	12	5	1500	8.9
A13-3	28/10/2014	3	0.1	8.1	6.1	9.0	12	4	1500	10
A14-1	27/10/2014						110	60		
A14-2	27/10/2014						90	62		
A14-3	27/10/2014						120	49		
A15-1	27/10/2014						45	46		
A15-2	27/10/2014						38	5		
A15-3	27/10/2014						38	11		
A16-1	27/10/2014						27	5		
A16-2	27/10/2014						60	5		
A16-3	27/10/2014						26	5		
A17-1	28/10/2014						48	16		
A17-2	28/10/2014						62	23		
A17-3	28/10/2014						62	22		
A18-1	28/10/2014						38	31		
A18-2	28/10/2014						28	13		
A18-3	28/10/2014						31	9		
A19-1	28/10/2014						12	5		
A19-2	28/10/2014						12	5		

Signatory: Jamie Woodward
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Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111801	14111801	14111801	14111801	14111801	14111801	14111801-2701	14111801	14111801
A19-3	28/10/2014						8.1	3		
A20-1	27/10/2014						26	10		
A20-2	27/10/2014						28	10		
A20-3	27/10/2014						34	11		
A21-1	27/10/2014						15	8		
A21-2	27/10/2014						11	5		
A21-3	27/10/2014						15	7		
A22-1	28/10/2014						8.9	4		
A22-2	28/10/2014						5.4	3		
A22-3	28/10/2014						10	6		
A23-1	27/10/2014						28	10		
A23-2	27/10/2014						18	7		
A23-3	27/10/2014						24	8		
QA/QC DATA	Criteria									
SRM RECOVERY 1	80%-120%	114%	92%	105%	104%	106%	105%	103%	117%	106%
SRM RECOVERY 2	80%-120%	112%	86%	99%	107%	100%	99%	96%	109%	97%
SRM RECOVERY 3	80%-120%	111%	88%	104%	104%	104%	102%	103%	114%	101%
SRM RECOVERY 4	80%-120%	110%	94%	105%	105%	107%	106%	104%	118%	106%
SRM RECOVERY 5	80%-120%	111%	92%	106%	106%	107%	105%	104%	118%	105%

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Reporting Limit		**<2**	**<0.1**	**<0.2**	**<0.2**	**<0.05**	**<0.7**	**<1**	**<10**	**<0.5**
File		**14111801**	**14111801**	**14111801**	**14111801**	**14111801**	**14111801**	**14111801-2701**	**14111801**	**14111801**
QA/QC DATA	**Criteria**									
Duplicate 1	<20% difference	Low Conc	Low Conc	2%	2%	0%	Low Conc	Low Conc	0%	10%
Duplicate 2	<20% difference	Low Conc	Low Conc	1%	2%	5%	Low Conc	Low Conc	3%	5%
Duplicate 3	<20% difference	2%	1%	3%	3%	3%	1%	2%	4%	3%
Duplicate 4	<20% difference	Low Conc	Low Conc	0%	4%	3%	1%	Low Conc	1%	6%
Duplicate 5	<20% difference	Low Conc	Low Conc	7%	3%	15%	6%	Low Conc	5%	1%
Duplicate 6	<20% difference	Low Conc	Low Conc	1%	1%	2%	9%	1%	2%	1%
Duplicate 7	<20% difference						9%	4%		
Duplicate 8	<20% difference						1%	2%		
Duplicate 9	<20% difference						6%	3%		
Duplicate 10	<20% difference						1%	3%		
Duplicate 11	<20% difference						8%	4%		
Duplicate 12	<20% difference						1%	4%		
BLANK 1	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 2	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 3	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 4	<Reporting Limit	<2	<0.1	<0.2	<0.2	0.23	<0.7	<1	<10	<0.5
CRM RECOVERY 1	80%-120%	105%	101%	96%	100%	96%	99%	97%	103%	89%
CRM RECOVERY 2	80%-120%	98%	101%	98%	104%	98%	100%	99%	103%	90%

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Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111701	14111701	14111701	14111701	14111701	14111701	14111701-2501	14111701	14111701
A5-1	28/10/2014	3	<0.1	2.2	0.5	5.7	<0.7	<1	850	1.2
A5-2	28/10/2014	3	<0.1	2.1	0.5	4.1	<0.7	<1	710	1.1
A5-3	28/10/2014	3	<0.1	2.2	0.5	4.0	<0.7	<1	810	1.0
A6-1	28/10/2014	2	<0.1	6.3	0.2	7.0	<0.7	<1	1100	<0.5
A6-2	28/10/2014	3	<0.1	6.2	0.3	6.3	<0.7	<1	1100	0.7
A6-3	28/10/2014	2	<0.1	6.3	0.3	7.3	<0.7	<1	1100	0.5
A7-1	27/10/2014	3	<0.1	3.8	0.3	4.4	<0.7	<1	1100	0.7
A7-2	27/10/2014	3	0.1	4.3	0.3	4.9	<0.7	<1	1300	1.1
A7-3	27/10/2014	3	<0.1	4.2	0.3	4.6	<0.7	<1	1100	0.8
A8-1	27/10/2014	3	0.1	6.5	6.9	7.6	5.2	18	1500	9.7
A8-2	27/10/2014	2	<0.1	5.3	8.2	6.2	2.5	10	1300	18
A8-3	27/10/2014	3	<0.1	6.5	6.7	7.4	3.5	32	1400	10
A9-1	27/10/2014	2	0.2	7.0	2.4	4.9	12	6	1100	6.0
A9-2	27/10/2014	<2	0.3	8.4	9.6	6.8	20	17	1200	28
A9-3	27/10/2014	<2	0.1	6.9	4.1	5.4	7.6	3	1200	12
A10b-1	27/10/2014	<2	0.1	6.5	2.5	5.3	2.9	28	1200	75
A10b-2	27/10/2014	<2	0.1	6.2	2.5	5.2	3.8	23	1200	21
A10b-3	27/10/2014	<2	0.1	6.1	1.8	4.9	3.6	24	1200	5.4
A11-1	28/10/2014	<2	<0.1	3.0	0.7	5.0	<0.7	2	800	1.3
A11-2	28/10/2014	<2	<0.1	3.1	0.5	4.0	<0.7	<1	720	0.9
A11-3	28/10/2014	<2	<0.1	3.1	0.6	5.1	<0.7	2	780	1.0
A12-1	27/10/2014	<2	<0.1	2.8	0.6	3.8	<0.7	1	780	0.8

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SEDIMENT DATA

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Date of Issue: 04/12/2014
Date Received: 30/10/2014
Our Reference: SPA14-1
Your Reference: ENV13-285

METHOD SAMPLE CODE	Sampling Date	ICP002 Dilute Acid As mg/kg	ICP002 Dilute Acid Cd mg/kg	ICP002 Dilute Acid Cr mg/kg	ICP002 Dilute Acid Cu mg/kg	ICP002 Dilute Acid Mn mg/kg	ICP002 Dilute Acid Ni mg/kg	ICP002 Dilute Acid Pb mg/kg	ICP002 Dilute Acid S mg/kg	ICP002 Dilute Acid Zn mg/kg
Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111701	14111701	14111701	14111701	14111701	14111701	14111701-2501	14111701	14111701
A12-2	27/10/2014	<2	<0.1	2.1	0.4	1.9	0.8	<1	630	0.6
A12-3	27/10/2014	<2	<0.1	2.3	0.5	2.9	0.9	<1	670	0.8
A13-1	28/10/2014	3	0.1	7.1	1.9	6.4	1.6	4	1300	4.9
A13-2	28/10/2014	2	0.1	6.8	2.1	6.3	1.9	5	1300	5.0
A13-3	28/10/2014	3	<0.1	6.3	1.9	5.8	1.4	4	1200	8.0
A14-1	27/10/2014						5.5	49		
A14-2	27/10/2014						4.8	58		
A14-3	27/10/2014						4.6	41		
A15-1	27/10/2014						4.7	44		
A15-2	27/10/2014						4.9	4		
A15-3	27/10/2014						4.3	11		
A16-1	27/10/2014						4.7	5		
A16-2	27/10/2014						7.0	4		
A16-3	27/10/2014						5.0	6		
A17-1	28/10/2014						2.8	15		
A17-2	28/10/2014						3.7	21		
A17-3	28/10/2014						3.8	22		
A18-1	28/10/2014						4.1	30		
A18-2	28/10/2014						2.2	13		
A18-3	28/10/2014						3.2	4		
A19-1	28/10/2014						1.8	5		
A19-2	28/10/2014						1.4	5		

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Reporting Limit		<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
File		14111701	14111701	14111701	14111701	14111701	14111701	14111701-2501	14111701	14111701
A19-3	28/10/2014						1.0	3		
A20-1	27/10/2014						2.2	10		
A20-2	27/10/2014						1.9	10		
A20-3	27/10/2014						2.5	11		
A21-1	27/10/2014						1.4	8		
A21-2	27/10/2014						1.1	5		
A21-3	27/10/2014						1.5	7		
A22-1	28/10/2014						0.9	4		
A22-2	28/10/2014						1.0	2		
A22-3	28/10/2014						1.3	6		
A23-1	27/10/2014						3.2	10		
A23-2	27/10/2014						1.9	7		
A23-3	27/10/2014						2.0	8		
QA/QC DATA	Criteria									
SRM RECOVERY 1	80%-120%	107%	98%	103%	101%	99%	93%	105%	113%	104%
SRM RECOVERY 2	80%-120%	103%	96%	101%	99%	99%	91%	103%	110%	102%
SRM RECOVERY 3	80%-120%	104%	94%	99%	99%	99%	91%	104%	110%	101%
SRM RECOVERY 4	80%-120%	109%	97%	103%	102%	101%	93%	107%	114%	103%
SRM RECOVERY 5	80%-120%	104%	93%	99%	97%	97%	92%	102%	108%	100%

Signatory: Jamie Woodward
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Reporting Limit		**<2**	**<0.1**	**<0.2**	**<0.2**	**<0.05**	**<0.7**	**<1**	**<10**	**<0.5**
File		**14111701**	**14111701**	**14111701**	**14111701**	**14111701**	**14111701**	**14111701-2501**	**14111701**	**14111701**
QA/QC DATA	**Criteria**									
Duplicate 1	<20% difference	Low Conc	Low Conc	10%	Low Conc	4%	Low Conc	Low Conc	5%	Low Conc
Duplicate 2	<20% difference	Low Conc	Low Conc	3%	7%	2%	12%	12%	4%	17%
Duplicate 3	<20% difference	Low Conc	Low Conc	1%	1%	1%	1%	6%	1%	0%
Duplicate 4	<20% difference	Low Conc	Low Conc	1%	3%	10%	Low Conc	Low Conc	2%	Low Conc
Duplicate 5	<20% difference	Low Conc	Low Conc	2%	1%	2%	6%	2%	2%	1%
Duplicate 6	<20% difference	Low Conc	Low Conc	1%	6%	3%	2%	3%	5%	13%
Duplicate 7	<20% difference						0%	1%		
Duplicate 8	<20% difference						6%	6%		
Duplicate 9	<20% difference						Low Conc	6%		
Duplicate 10	<20% difference						Low Conc	2%		
Duplicate 11	<20% difference						4%	6%		
Duplicate 12	<20% difference						0%	2%		
BLANK 1	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 2	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 3	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
BLANK 4	<Reporting Limit	<2	<0.1	<0.2	<0.2	<0.05	<0.7	<1	<10	<0.5
CRM RECOVERY 1	80%-120%	104%	103%	108%	111%	111%	103%	100%	116%	105%
CRM RECOVERY 2	80%-120%	100%	99%	101%	108%	105%	97%	98%	113%	100%

Signatory: Jamie Woodward
Date: 04/12/2014

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Australian Government

National Measurement Institute

REPORT OF ANALYSIS

Report No. RN1044350

Client	: SOUTHERN PORTS AUTHORITY	Job No.	: SOUT97_W/141030
	CORNER BOWER AVENUE & THE ESPLANADE	Quote No.	: QT-02002
	ESPERANCE WA 6450	Order No.	:
		Date Sampled	: 27-OCT-2014
		Date Received	: 30-OCT-2014
Attention	CAROLINE AYLOTT	Sampled By	: CLIENT
Project Name :			
Your Client Services Manager	: DAVID LYNCH	Phone	: (08) 9368 8420

Lab Reg No.	Sample Ref	Sample Description
W14/018831	A8-1	MARINE SEDIMENT 27/10/14
W14/018832	A9-1	MARINE SEDIMENT 27/10/14
W14/018833	A10b-1	MARINE SEDIMENT 27/10/14

Lab Reg No.		W14/018831	W14/018832	W14/018833		
Sample Reference	Units	A8-1	A9-1	A10b-1		Method
Organotins						
Monobutyltin as Sn	ng/g	0.66	< 0.5	1.0		NR_35
Dibutyltin as Sn	ng/g	21	4.7	32		NR_35
Tributyltin as Sn	ng/g	62	4.4	270		NR_35
Surrogate: Tripropyltin	%REC	100	115	121		NR_35
Dates						
Date extracted		4-NOV-2014	4-NOV-2014	4-NOV-2014		
Date analysed		4-NOV-2014	4-NOV-2014	4-NOV-2014		

Danny Slee, Section Manager
Organics - NSW
Accreditation No. 198

14-NOV-2014

Lab Reg No.		W14/018831	W14/018832	W14/018833		
Sample Reference	Units	A8-1	A9-1	A10b-1		Method
Trace Elements						
Total Solids	%	67.6	73.5	71.8		NT2_49

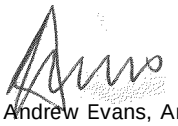
Andrew Evans, Analyst
Inorganics - NSW
Accreditation No. 198

14-NOV-2014

REPORT OF ANALYSIS

Report No. RN1044350

Lab Reg No.		W14/018831	W14/018832	W14/018833		
Sample Reference	Units	A8-1	A9-1	A10b-1		Method
Miscellaneous						
Carbon - Total Organic	mg/kg	6000	2100	1600		NW_S15



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14-NOV-2014

Unless notified to the contrary, the above samples will be disposed of one month from the reporting date.

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Results relate only to the sample(s) tested.

This Report supersedes reports: RN1043863 RN1043969 RN1044107

9.3 Appendix C – QA/QC Information and Results

Field QA/QC Methods

The following field quality assurance/quality control (QA/QC) steps were taken during sampling which included:

- Laboratory provided sample jars were used for sampling;
- White plastic sample spatulas and bucket were used for homogenisation of samples, to prevent contamination from trace metals which may be present in coloured plastic;
- The sample spatula and bucket were washed thoroughly with sea water after each replicate sample to minimise cross contamination between samples;
- All polycarbonate sample corers and lids were thoroughly washed with sea water after each sample site to avoid cross contamination between sample sites;
- Frozen samples were transported on ice to NATA accredited laboratories (NMI and MAFRL) in hard eskies;
- Split duplicate samples were collected from 3 monitoring sites (A7, A8 and A9) and sent to NMI, as a reference laboratory, to ensure results were reliably comparable to primary laboratory results for the same samples; and
- Relative Standard Deviation % (RSD) for each sample site was calculated.

Laboratory QA/QC Methods

MAFRL and NMI carried out the required QA/QC as part of their digestions and analysis methods, which include blanks, duplicates, spikes and standard reference material. MAFRL and NMI QA/QC results have been provided in Appendix B. Reported results from MAFRL and NMI laboratories were all within the acceptable percentage recovery ranges.

QA/QC Results
Lab QA/QC

The relative standard deviations (RSD) of the triplicates for total metals were calculated for all sites using the following equation:

$$\text{Relative Standard Deviation (RSD \%)} = \frac{\text{(standard deviation of triplicate)} \times 100}{\text{(average of triplicate)}}$$

The acceptable RSD for triplicates is 50%. This calculation is based on the National Ocean Disposal Guidelines for Dredged Material (Environment Australia, 2002).

RSD results for total metals and sulphur are provided in Table A9-1. Calculated RSDs were below 50% for all metals and sulphur results with the following exceptions:

- Site A5 recorded an RSD of 125% for copper;
- Site A6 recorded an RSD of 52% for nickel;
- Site A8 recorded an RSD of 66% (copper), 61% (nickel) and 45% (lead);
- Site A9 recorded an RSD of 50% (cadmium), 94% (copper), 79 % (nickel), 83% (lead) and 101% (zinc);
- Site A10b recorded an RSD of 108% (copper) and 116% (zinc);
- Site A15 recorded an RSD of 107% for lead;
- Site A16 recorded an RSD of 51% for nickel; and
- Site A18 recorded an RSD of 66% for lead.

The above mentioned RSDs greater than 50% account for 15 out of the total 101 calculated RSD's for total metals. The three sites with RSD above 50% all had three triplicates below the ISQG-Low values whose lower values may result in a lower precision in laboratory measurement.

Table A9-1 Total Metal Results Relative Standard Deviation (RSD %)

	Arsenic	Cadmium	Chromium	Copper	Manganese	Nickel	Lead	Sulphur	Zinc
Reporting Limit	*<2*	*<0.1*	*<0.2*	*<0.2*	*<0.05*	*<0.7*	*<1*	*<10*	*<0.5*
Site									
A5	0	<LOR	7	**125**	17	22	<LOR	15	38
A6	25	<LOR	2	20	5	****52**	<LOR	5	22
A7	0	**43	9	24	2	20	<LOR	14	8
A8	43	43	**17	**66**	13	**61**	**56**	28	46
A9	40	**50**	11	**94**	34	**79**	**83**	38	**101**
A10b	*49	0	7	**108**	11	12	7	10	**116**
A11	<LOR	<LOR	7	20	4	18	35	10	49
A12	*50	<LOR	16	20	29	17	*35	19	14
A13	0	*35	1	10	2	5	13	0	7
A14	-	-	-	-	-	14	12	-	-
A15	-	-	-	-	-	10	**107**	-	-
A16	-	-	-	-	-	**51**	0	-	-
A17	-	-	-	-	-	14	19	-	-
A18	-	-	-	-	-	16	**66**	-	-
A19	-	-	-	-	-	21	27	-	-
A20	-	-	-	-	-	0	6	-	-
A21	-	-	-	-	-	17	23	-	-
A22	-	-	-	-	-	30	35	-	-
A23	-	-	-	-	-	22	18	-	-

Bold: RSD % above 50
<LOD: all triplicates for that site were <LOD
* one triplicate result <LOD (was given value of LOD/2)
** two triplicate results <LOD (were given values of LOD/2)
Based on Oceanica, 2008 and reference (Environment Australia, 2002)

Each site that was sampled for organotins and TOC were single samples, and as a result, field QA/QC is not applicable.

Field QA/QC

Three split duplicate samples were collected at sampling sites A6, A7 and A8 and sent to the secondary laboratory (NMI) for analysis. The Relative Percentage Difference (RPD) was calculated, based on the Australian Standard (AS 4482.1, 2005). RPD results for total and bioavailable metals are provided below in Tables A9-2 and A9-3 respectively. Total metals results showed variable compliance with the ±30-50% RPD range. Total copper results from A6 and A7 and chromium, manganese, nickel and sulphur from A8 showed RPD's above 50%. With the exception of nickel in A8 values were an order of magnitude below the ISQG-Low therefore these results should not have significantly impacted on the validity of the data. AS4482.1 (2005) states that the variability of samples should be considered when evaluating RPD results. High variability between triplicate samples has been illustrated in section 5.3.2 and 5.4 due to the variable nature of sediment sampling, therefore it is determined that RPDs outside the 30-50% RPD range should not affect the overall validity of the data for the purpose of the annual sediment monitoring.

Table A9-2: RPD results for total metals

	Arsenic	Cadmium	Chromium	Copper	Manganese	Nickel	Lead	Sulphur	Zinc
Reporting Limit	*<2*	*<0.1*	*<0.2*	*<0.2*	*<0.05*	*<0.7*	*<1*	*<10*	*<0.5*
	ISQG Low = 20	ISQG Low = 1.5	ISQG Low = 80	ISQG Low = 65	ISQG Low = NA	ISQG Low = 21	ISQG Low = 50	ISQG Low = NA	ISQG Low = 200
	ISQG High = 70	ISQG High = 10	ISQG High = 370	ISQG High = 270	ISQG High = NA	ISQG High = 52	ISQG High = 220	ISQG High = NA	ISQG High = 410
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Site									
A6 (MAFRL)	2	<0.1	6.9	0.8	8.6	0.7	1	1100	1.1
A6 (NMI)	2.3	<LOR	6	0.3	6.5	0.7	0.8	1300	0.9
RPD	13.95	<LOR	13.95	**90.91**	27.81	0.00	22.22	16.67	20.00
A7 (MAFRL_	3	**0.1	4.9	1	6.4	1	1	1100	1.3
A7 (NMI)	2.3	<LOR	3.4	0.3	4	1	0.9	1300	1.1
RPD	26.42	<LOR	36.14	**107.69**	46.15	0.00	10.53	16.67	16.67
A8 (MAFRL)	3	0.1	8.7	29	11	52	18	2500	23
A8 (NMI)	1.8	0.1	5.1	21	6	29	13	1300	23
RPD	**50.00**	0.00	**52.17**	32.00	**58.82**	**56.79**	32.26	**63.16**	0.00

Table A9-3: RPD results for bioavailable metals

	Arsenic	Cadmium	Chromium	Copper	Manganese	Nickel	Lead	Sulphur	Zinc
Reporting Limit	*<2*	*<0.1*	*<0.2*	*<0.2*	*<0.05*	*<0.7*	*<1*	*<10*	*<0.5*
	ISQG Low = 20	ISQG Low = 1.5	ISQG Low = 80	ISQG Low = 65	ISQG Low = NA	ISQG Low = 21	ISQG Low = 50	ISQG Low = NA	ISQG Low = 200
	ISQG High = 70	ISQG High = 10	ISQG High = 370	ISQG High = 270	ISQG High = NA	ISQG High = 52	ISQG High = 220	ISQG High = NA	ISQG High = 410
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Site									
A6 (MAFRL)	2	**0.1	6.3	0.3	7	0.7	<1	1100	0.5
A6 (NMI)	0.87	<LOR	6.2	0.51	6	1.8	<LOR	1120	0.53
RPD	***78.75***	*<LOR*	*1.60*	***51.85***	*15.38*	***88.00***	*<LOR*	*1.80*	*5.83*
A7 (MAFRL_	3	**0.1	4.2	0.3	4.6	0.7	1	1100	0.8
A7 (NMI)	0.67	<LOR	4.7	0.51	4.1	2.4	0.57	1140	1.1
RPD	**126.98**	<LOR	11.24	**51.85**	11.49	**109.68**	**54.78**	3.57	31.58
A8 (MAFRL)	3	0.2	6.5	6.9	7.4	3.5	18	1400	10
A8 (NMI)	0.5	<LOR	6.6	5.4	6.9	5.5	19	1370	9.9
RPD	**142.86**	<LOR	1.53	24.39	6.99	44.44	5.41	2.17	1.01