APPENDIX D
OUTER HARBOUR RECLAMATION SEDIMENT SAMPLING AND TESTING

PORT KEMBLA
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PORT KEMBLA OUTER HARBOUR
RECLAMATION AREA
SEDIMENT SAMPLING & TESTING

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1 INTRODUCTION

Sampling and analysis of sediment from Port Kembla Outer Harbour was undertaken during August 2005 as part of an Environmental Assessment (EA) to assess the potential impacts of spoil disposal within a proposed reclamation area. The sampling and analysis was undertaken in accordance with a sampling and analysis plan (SAP) prepared by Patterson Britton (August 2005).

This report details the outcomes of the sampling and analysis program.

2 METHODOLOGY

2.1 GENERAL

Sampling was undertaken at 12 sampling locations (see **Figure 2.1**). At eight sampling locations, a grab sampler was used to collect surface samples. At the remaining four sampling locations, vibrocores were retrieved as part of a geotechnical investigation along the alignment of proposed slag containment bunds. A surface sample (0 to 500 mm) was recovered from each vibrocore.

2.2 GRAB SAMPLES

The grab sampling was undertaken by Daniel Fitzhenry, an accredited specialist hydrographer from Land & Marine Pty Ltd on 10 August 2005. Collection of the sediment samples was undertaken using a stainless steel Van Veen grab sampler deployed from the boat. The grab sampler was lowered to the harbour bed at each sampling location where the jaws of the grab were triggered to close, penetrating the sediment.

Sample processing took place on the boat immediately following recovery of the grab sample. From each sample retrieved by the grab sampler at each location, a 500 ml sub-sample was taken for chemical analysis. The sub-samples were transferred to appropriate sampling jars using a stainless steel spoon. The lid of each sample container was tightly screwed on to avoid loss of sample and the jar labelled with a unique identification number. To avoid cross contamination, after the lid was secured, the outside of each sample container was washed with harbour water.

All sampling equipment was decontaminated between each sampling event. Decontamination procedures included rinsing equipment in harbour water to remove visible sediment, followed by a Decon 90 rinse.

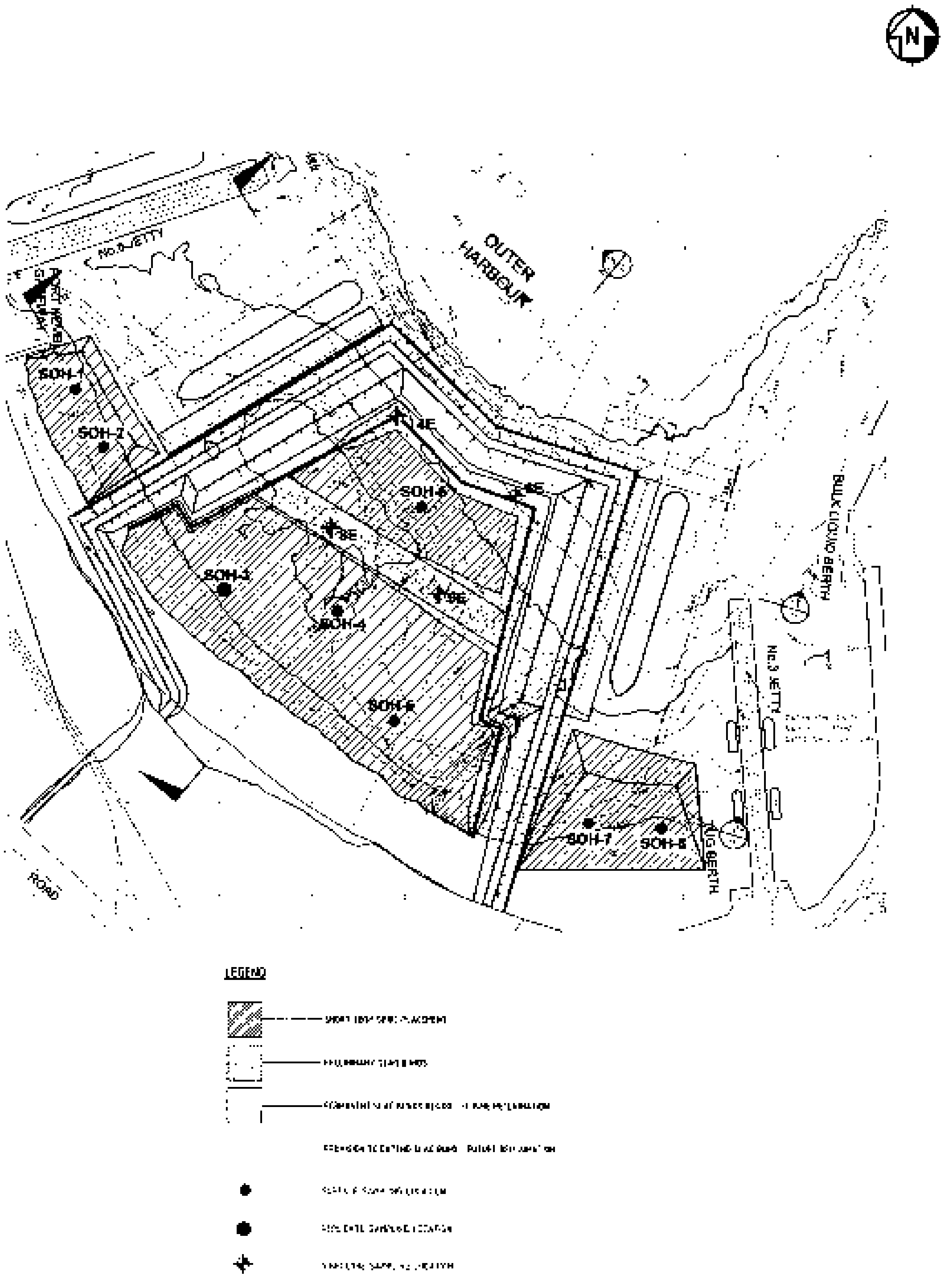
A field log was completed during sampling noting the time, date, water depth and coordinate location. The characteristics of the sediment recovered in each grab were also noted in the field log book i.e. colour, odour and texture.

2.3 VIBROCORE SAMPLES

The vibrocoring was also undertaken by Land & Marine Pty Ltd. The four vibrocores were cut at 500 mm from the surface. These tubes were sealed and immediately placed in the freezer. The cores were couriered to Patterson Britton for splitting and sub sampling.

The vibrocores were split longitudinally using a circular saw. One half of the core was logged, photographed and wrapped in plastic for storage. The remaining half of each core was sub sampled for contamination testing. A 500 ml composite sample from 0 to 500 mm down the core was retrieved from each vibrocore.

FIGURE 2.1



SOURCE: Base drawing Maunsell

SEDIMENT SAMPLING LOCATIONS

J4827_07/FIG4_5_OuterHarbourSediment.jpg

2.4 REPLICATE SAMPLES

Replicate samples were collected from one location. At all other sample locations only one sample was retrieved. At sample location SOH-3 (refer **Figure 2.1**) replicate samples were retrieved (3 separate grab samples at the one location). The replicate samples were collected to give an indication of the variability in the chemical properties of the sediment at a sample location.

2.5 SAMPLE HANDLING

The grap samples for chemical analysis were packed in ice in an esky immediately after sampling to maintain the temperature below 4°C. The vibrocore tubes were immediately placed in the freezer. The grab samples and the vibrocore tubes were transported in an esky in ice to Patterson Britton before all the samples were transported in an esky in ice to the appropriate NATA registered analytical laboratory. All samples were transported under Patterson Britton chain of custody procedures (refer **Attachment A**).

3 ANALYTICAL WORK

Sediment samples collected for chemical analysis were forwarded to the laboratory on 15 August 2005. Advanced Analytical Australia laboratory undertook the analysis. In all, a total of 15 samples (*12 locations, 2 replicates and a blank*) were analysed. Chemical testing of each sediment sample included:

- moisture content;
- total organic carbon (TOC);
- a suite of metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn, Mn, Co, V, Se);
- total petroleum hydrocarbons (TPH);
- organochlorine pesticides (OC pesticides);
- benzene, toluene, ethylbenzene and xylenes (BTEX);
- polychlorinated biphenyls (PCBs);
- organotins; and
- polycyclic aromatic hydrocarbons (PAHs)

4 FINDINGS OF THE INVESTIGATION

4.1 GENERAL

The full laboratory results of the chemical analysis of the sediment samples are included in **Appendix B**. A discussion of the results is provided below.

4.2 FIELD AND LABORATORY QUALITY ASSURANCE

One field triplicate (*3 samples at the same location*) was analysed to determine the variability of the sediments chemical characteristics. The relative standard deviation (*RSD*) of the triplicate for the majority of contaminants was calculated to be less than +/-50% (*refer* **Attachment B**). The RSD of the triplicate for Total PAHs and some of the individual PAH constituents was greater than +/-50%.

National Ocean Disposal Guidelines for Dredged Material (DEH, 2002) recommends that field triplicates should agree within an RSD of +/- 50% although the guidelines note they may not always do so where the sediments are very inhomogeneous or greatly differing in grain size.

A trip blank was shipped and tested with the samples. The results for the blank sample were below the Practical Quantitation Limit (*PQL*) for all contaminants except for some metals (As, Cr, Cu, Mn, Ni and Pb), which was at a trace level not unexpected for the washed river sand used as the blank sample.

The field quality assurance was therefore considered satisfactory.

Laboratory quality assurance consisted of the analysis of blank, spike, and duplicate samples. The results of this quality assurance can be found in **Appendix A**. The laboratory quality assurance was considered acceptable with almost all laboratory duplicates within a relative percent difference (*RPD*) of +/- 35% as recommended in the *National Ocean Disposal Guidelines for Dredged Material* (*DEH, 2002*).

4.3 COMPARISON OF SEDIMENT QUALITY DATA WITH SEDIMENT QUALITY GUIDELINES

The chemical analysis results have been compared to the sediment quality guidelines provided in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)* (*refer* **Table 4.1**). The ANZECC sediment quality guidelines provide low and high interim sediment quality guideline (*ISQG*) values, allowing definition of three levels of contamination. There is a low probability that there would be toxic effects on benthic biota if contamination levels fall below the ISQG Low guideline value and there is a high probability that there will be toxic effects if contamination levels lie above the ISQG High guideline value. Contamination levels falling between ISQG Low and ISQG High have an intermediate probability of effects.

The results show that the 95% UCL[1] of the mean for the majority of the contaminants are above ISQG Low. The 95% UCL of the mean for copper, lead mercury, silver, zinc and naphthalene are above ISQG High.

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[1] The upper confidence limit is the upper bound estimate of the mean contaminant concentration of a sampling area. For example, if the 95% UCL is stated, it implies that there is a 95% probability that the mean contaminant concentration within the sampling area will not exceed the value determined by this method.

Table 4.1 Comparison of chemical analysis results to ANZECC guidelines

Contaminant	Units	Sample ID												mean	standard deviation	95% UCL	ISQG LOW	ISQG HIGH
		SOH-1	SOH-2	SOH-3	SOH-4	SOH-5	SOH-6	SOH-7	SOH-8	4E	6E	8E	9E					
Moisture Content	%	22.9	25.0	19.0	46.2	43.0	50.5	42.9	49.0	43.5	32.7	20.6	37.1	30.5	13.9	35.36	--	--
Metals & Metalloids																		
Antimony	mg/kg	0.40	0.70	0.50	<0.1	0.70	2.0	3.3	3.3	2.2	0.90	0.20	<0.1	0.97	1.06	1.4	2	25
Arsenic	mg/kg	15	20	27	12	20	79	95	140	40	29	4.1	11	36	37	52	20	70
Cadmium	mg/kg	0.20	0.20	0.1	2.5	0.70	1.8	4.6	6.5	1.1	1.3	0.60	3.6	1.4	1.9	6.0	1.5	10
Chromium	mg/kg	19	22	21	130	88	140	74	120	95	63	35	220	66	60	91	80	370
Copper	mg/kg	260	310	55	130	260	1400	4000	4100	450	290	27	95	898	1203	49800	65	270
Lead	mg/kg	70	73	76	110	150	560	800	1500	600	170	29	150	265	365	2958	50	220
Mercury	mg/kg	0.090	0.070	0.060	0.52	0.26	1.8	0.23	3.8	1.1	0.70	0.11	2.5	0.68	1.07	4.0	0.15	1
Nickel	mg/kg	4.9	6.6	7.9	27	18	42	37	65	20	15	8.1	23	18	17	25	21	52
Silver	mg/kg	0.1	0.1	<0.1	0.40	0.50	3.6	3.2	14	1.2	0.80	0.1	0.50	1.78	3.76	13.16	1	3.7
Zinc	mg/kg	220	280	380	760	620	1600	1500	2400	1400	550	220	1500	757	669	1040	200	410
Manganese	mg/kg	110	170	110	990	420	500	290	350	450	200	580	610	315	255	422		–
Cobalt	mg/kg	2.9	4.3	2.6	13	9.9	13	14	18	13	12	4.9	13	7.8	5.6	10	--	–
Vanadium	mg/kg	28	38	26	140	84	110	77	100	91	72	130	67	63	41	81	–	–
Selenium	mg/kg	1.0	2.6	1.3	5.4	4.7	13	31	35	6.5	3.9	16	6.7	6.9	10.4	22	–	–
Total Recoverable Hydrocarbons																		
TRH C6 – C9	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	<10	–	–
TRH C10 – C14	mg/kg	<10	<10	<10	55	22	21	15	88	27	<10	11	98	24	30	52	–	–
TRH C15 – C28	mg/kg	<50	<50	<50	880	330	470	510	890	990	170	190	1200	357	402	532		–
TRH C29 – C36	mg/kg	<50	<50	<50	540	200	390	370	460	<50	130	150	900	243	263	358	–	–
Organochlorine Pesticides																		
Individual OC Pesticides	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.001	–	
BTEX																		
Benzene	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	0.11	0.03	0.12		–
Toluene	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	0.20	0.12	0.05	0.14	–	–
Ethyl benzene	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		–	below detection	–	–
m+p xylenes	mg/kg	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	–	--	below detection		–
o-xylene	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	–	--	below detection	–	--
Total BTEX	mg/kg	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	-	–	below detection	–	–
Polychlorinated Biphenyls																		
Individual PCBs	mg/kg	<0.0005	<0.0005	<0.0005	<0.025	<0.025	<0.0006	<0.0006	<0.0006	<0.0005	<0.0005	<0.0005	<0.025	--	–	below detection	2x10⁻⁵ - 0.0022	0.001 - 0.046
Total PCBs	mg/kg	<0.0005	<0.0005	<0.0005	<0.025	<0.025	<0.0006	<0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.025	–	--	below detection	0.025	–

Contaminant	Units	Sample ID																
		SOH-1	SOH-2	SOH-3	SOH-4	SOH-5	SOH-6	SOH-7	SOH-8	4E	6E	8E	9E	mean	standard deviation	95% UCL	ISQG LOW	ISQG HIGH
Organotins[1]																		
Monobutyltin	µgSn/kg	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	--	–	below detection	--	–
Dibutyltin	µgSn/kg	13.7	11.0	23.0	12	5.0	4.1	5.9	5.9	0.1	0.1	5.9	1.8	7.29	6.84	10.52	--	–
Tributyltin	µgSn/kg	27.4	40.0	15.0	29	10.0	5.9	10.6	15.9	0.1	0.1	12.2	4.1	12.20	11.18	17.40	5	70
Polycyclic Aromatic Hydrocarbons[1]																		
Naphthalene	mg/kg	1.59	0.67	0.19	[illegible]	[illegible]	1.3	1.00	0.59	1.44	0.79	3.78	6.16	1.29	1.63	2.78	0.16	2.1
1-Methylnaphthalene	mg/kg	0.09	0.05	nd	0.12	0.15	0.06	0.05	0.03	0.07	0.04	0.14	0.17	0.08	0.05	0.10	–	..
2-Methylnaphthalene	mg/kg	0.19	0.10	0.04	0.32	0.40	0.15	0.12	0.07	0.15	0.08	0.37	0.50	0.19	0.15	0.26	–	–
Acenaphthylene	mg/kg	0.35	0.15	0.04	0.55	0.60	0.19	0.15	0.08	0.26	0.12	0.67	0.82	0.30	0.26	0.42	0.044	0.64
Acenaphthene	mg/kg	0.05	0.04	nd	0.11	0.13	0.04	0.03	0.02	0.04	0.02	0.13	0.14	0.05	0.05	0.09	0.016	0.50
Fluorene	mg/kg	0.20	0.09	nd	0.39	0.34	0.10	0.07	0.05	0.12	0.06	0.40	0.39	0.19	0.15	0.25	0.019	0.54
Phenanthrene	mg/kg	1.15	0.47	0.10	1.89	1.85	0.74	0.49	0.31	0.78	0.35	2.35	2.00	0.94	0.77	1.30	0.24	1.5
Anthracene	mg/kg	0.36	0.15	0.04	0.76	0.65	0.24	0.15	0.10	0.36	0.11	0.97	0.69	0.34	0.30	0.48	0.085	1.1
Fluoranthene	mg/kg	1.30	0.80	0.11	2.18	1.50	0.78	0.48	0.38	0.92	0.46	3.37	1.97	1.06	0.93	1.50	0.6	5.1
Pyrene	mg/kg	1.11	0.53	0.11	2.47	1.50	0.67	0.37	0.34	0.94	0.39	2.55	2.15	0.99	0.85	1.38	0.665	2.6
Benzo(a)anthracene	mg/kg	0.63	0.31	0.05	1.26	1.33	0.41	0.19	0.15	0.28	0.17	1.33	0.89	0.52	0.47	0.74	0.261	1.6
Chrysene	mg/kg	0.59	0.29	0.05	1.45	1.50	0.40	0.22	0.18	0.39	0.17	1.63	0.94	0.59	0.56	0.85	0.384	2.8
Benzo(b)&(k)fluoranthene	mg/kg	1.30	0.73	0.13	2.99	2.60	0.74	0.46	0.34	0.61	3.37	2.96	1.94	1.14	1.02	1.52	–	--
Benzo(a)pyrene	mg/kg	0.59	0.32	0.07	1.84	1.70	0.44	0.27	0.19	0.36	0.18	1.64	1.28	0.68	0.67	0.99	0.430	1.6
Indeno(1,2,3-cd)pyrene	mg/kg	0.18	0.11	nd	1.00	0.95	0.22	0.14	0.08	0.12	0.11	0.79	0.65	0.34	0.36	0.52	–	..
Dibenz(a,h)anthracene	mg/kg	0.06	0.03	nd	0.26	0.26	0.06	0.04	0.02	0.03	0.03	0.21	0.15	0.10	0.10	0.15	0.063	0.26
Benzo(g,h,i)perylene	mg/kg	0.19	0.11	nd	1.11	1.10	0.25	0.16	0.00	0.13	0.13	0.82	0.70	0.39	0.41	0.59		–
Coronene	mg/kg	nd	nd	nd	0.87	0.55	0.13	nd	nd	0.06	0.06	0.30	0.50	0.36	0.30	0.58	–	–
Benzo(e)pyrene	mg/kg	0.44	0.28	0.06	1.34	1.20	0.34	0.19	0.15	0.26	0.13	1.35	0.94	0.50	0.49	0.73	–	--
Total PAHs	mg/kg	10.37	5.23	0.95	24.74	22.50	7.41	4.59	3.13	7.22	3.79	25.51	22.94	10.33	9.24	14.58	4	45

Notes

1. normalised to 1 % TOC
2. ☐ > ISQG Low
3. ☐ > ISQG High

5 REFERENCES

ANZECC & ARMCANZ (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australian and New Zealand