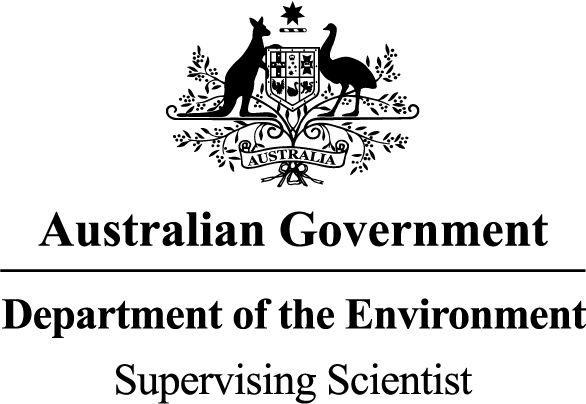
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*internal report*

Ecotoxicological assessment of distillate from the Ranger uranium mine’s brine concentrator plant





Andrew J Harford,  
Melanie A Trenfield and   
Rick A van Dam

November 2014

Release status – unrestricted

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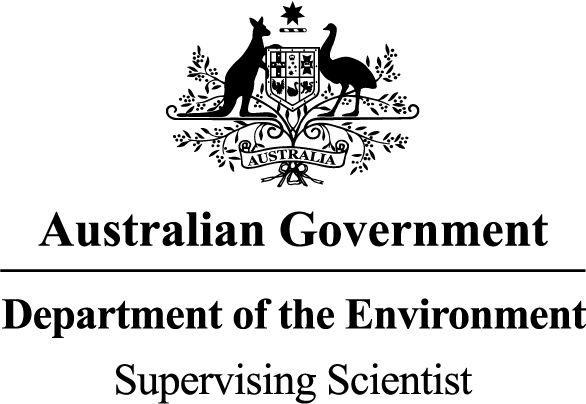
Andrew J Harford, Melanie A Trenfield & Rick A van Dam

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*Authors of this report:*

Dr Andrew Harford – Environmental Research Institute of the Supervising Scientist, GPO Box 461, Darwin NT 0801, Australia

Melanie Trenfield – Environmental Research Institute of the Supervising Scientist, GPO Box 461, Darwin NT 0801, Australia

Dr Rick van Dam – Environmental Research Institute of the Supervising Scientist; GPO Box 461, Darwin NT 0801, Australia

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# Executive summary

The increasing process water inventory at the Ranger uranium mine has become a major operational issue for Energy Resources of Australia Ltd (ERA). Following an assessment of potential technology options, ERA decided that brine concentration was the most viable option to reduce the inventory. The full-scale brine concentrator plant at Ranger was commissioned in September 2013 and the electrical conductivity of the distillate was stabilised in early October 2013. The aims of this study were to assess the toxicity of a distillate sample from the full-scale brine concentrator plant, and to identify the cause/s of any observed effects.

On 7 October 2013, following the stabilisation of distillate water quality, samples of the distillate were collected. Five tropical freshwater species (*Chlorella* sp. (green algae), *Lemna aequinoctialis* (duckweed), *Hydra viridissima* (green hydra), *Moinodaphnia macleayi* (cladoceran)and *Mogurnda mogurnda* (fish)) were exposed to a limited concentration range of the distillate (0, 25, 50 and 100%). Additionally, for all species except *Chlorella* sp., undiluted samples of distillate were amended by adding calcium (Ca), sodium (Na) and potassium (K) at 0.5, 1.0 and 0.4 mg L-1, respectively (termed “100% amended”). Amending these salts of the distillate to concentrations representative of local natural waters aimed to determine if observed effects were due to reduced essential ions.

Chemical analyses from the full-scale plant showed that the distillate sample was a highly-purified water and contained less metals and major ions compared to the sample from the pilot plant. The toxicity of the full-scale-plant distillate was higher than that of the pilot-plant product, which was consistent with the higher purity. Some degree of toxicity was observed for all five species. Addition of Ca, Na and K to the distillate sample resulted in markedly improved performance of the organisms and indicated that a major ion deficiency is the primary cause of effects observed in the distillate. The outcomes of this study have been used to inform regulatory approvals concerning discharge of the distillate to the environment.

# Abbreviations

DO Dissolved Oxygen

EC Electrical Conductivity

ERA Energy Resources of Australia Ltd

GC-MS Gas Chromatograph-Mass Spectrometry

ICP-MS/OES Inductively Coupled Plasma Mass Spectrometry/  
Optical Emission Spectrometry

MCW Magela Creek Water

QC Quality Control

RT-TI Rio Tinto – Technology and Innovation

TSF Tailings Storage Facility

VOCs/sVOCs Volatile/semi-Volatile Organic Compound analysis

# 1 Introduction

The increasing process water inventory at the Ranger uranium mine has become a major operational issue for Energy Resources of Australia Ltd (ERA). Following an assessment of potential technology options, ERA decided that brine concentration was the most viable option to reduce the volume of process water on the mine site. A brine concentrator would produce large volumes of a purified water product (distillate) and a waste stream containing the salts present in the process water (brine concentrate). The distillate will be released (following approval) into the environment via a yet-to-be determined method (at the time of this study being undertaken), while the brine concentrate will be returned to the tailings storage facility (TSF) or, eventually, directly injected into the bottom of Pit 3.

In 2011, Rio Tinto – Technology and Innovation (RT-TI, Bundoora, Victoria) was engaged by ERA to conduct trials on a pilot-scale brine concentrator plant. Two key aims of the RT-TI trial were to (i) demonstrate that the distillate does not pose risks to operator health or the environment, and (ii) provide data to assist with designing water management and disposal systems. To assist with addressing the aquatic environment protection aspect, ***eriss*** undertook a comprehensive toxicity testing program of the pilot plant distillate (Harford et al. 2013). The aims of the toxicity test work were to: (i) detect and quantify any residual toxicity of the pilot distillate and, (ii) in the event that effects were observed, to identify the toxic constituent(s) of the distillate.

Five tropical freshwater species (*Chlorella* sp. (green algae), *Lemna aequinoctialis* (duckweed), *Hydra viridissima* (green hydra), *Moinodaphnia macleayi* (cladoceran)and *Mogurnda mogurnda* (fish)) were exposed to a limited concentration range of the pilot distillate sample (0, 25, 50 and 100%). The distillate was toxic to only *Hydra viridissima* (50-100% effect when exposed to 100% distillate). A series of experiments demonstrated that the effect was not due to residual ammonia (~1 mg L-1 N) or trace organics, and could not definitively identify manganese (Mn; 130 – 230 µg L-1) as the cause. In contrast, the addition of calcium, sodium and potassium (at 0.5, 1.0 and 0.4 mg L-1, respectively) resulted in 100% recovery of *H. viridissima* population growth rate. This indicated that ion deficiency must be considered as a potential stressor in risk/impact assessments of the discharge of purified waste waters, and that such waters may need to be supplemented with the deficient ions to reduce environmental impacts ([Harford et al. 2013](#_ENREF_1)). Further assessment on the likelihood of Mn toxicity indicated that the residual Mn concentrations in the distillate were at levels that could inhibit the growth of *H. viridissima*,but further data were needed to fully assess the risk of Mn in low pH, soft waters (Harford et al. 2014).

The full-scale brine concentrator plant at Ranger was commissioned in September 2013 and the electrical conductivity of the distillate stabilised in early October 2013. The aims of the present study were to assess the toxicity of a distillate from the full-scale brine concentrator plant, and to identify the cause/s of any observed effects.

# 2 Method

## 2.1 Test water

On 7 October 2013, following the stabilisation of distillate water quality, samples of the distillate were collected in glass with Teflon septum lid and plastic containers, including samples for Volatile and semi-Volatile Organic Compound analysis (VOCs and sVOCs measured by Gas Chromatograph-Mass Spectrometry, GC-MS). The samples were transported to the Darwin laboratory and immediately measured for dissolved oxygen, pH and electrical conductivity (EC). The plastic containers were sub-sampled for a full-suite of metals and major ions by ICP-MS/OES (Envirolab, Chatswood, NSW). Additional sub-samples were analysed for alkalinity (APHA2320B), nitrate, phosphate and ammonia (Colourimetric methods, EPA 353.2, EPA 365.1, EPA 350.1).

### 2.2 Test diluent

Natural Magela Creek Water (MCW) was used as the control treatment and for dilution of the distillate samples in all tests, and was obtained from Bowerbird Billabong (latitude 12° 46’ 15’’, longitude 133° 02’ 20’’). This natural water has been extensively characterised and has been used as a diluent in toxicity testing for over 20 years in the ***eriss*** ecotoxicology laboratory. The water was collected in 20 L acid-washed plastic containers and placed in storage at 4 ± 1°C within 1 h of collection. The water was then transported to the laboratory in an air-conditioned vehicle. At the laboratory, it was stored at 4 ± 1°C prior to filtration through 3.0 m pore size (Sartopure PP2 depth filter MidiCaps, Sartorius, Göttingen, Germany) within 3 days of collection. Throughout the testing period, the MCW had a pH of 6.2-6.8 units, an EC of 16-27 S cm-1 and DO of ≥85% saturation.

Diluent water was sub-sampled for physico-chemical analyses. Specifically pH, DO, EC and DOC were measured in-house. Additional sub-samples were analysed at Envirolab for alkalinity (APHA2320B), a limited metal and major ion suite (totals only; Al, Cd, Co, C, Cu, Fe, Mn, Ni, Pb, Se, U, Zn, Ca, Mg, Na, SO4 (analysed as S and converted)), nitrate, phosphate and ammonia (Colourimetric methods, EPA 353.2, EPA 365.1,   
EPA 350.1).

### 2.3 Toxicity tests

Five tropical freshwater species were used to test the toxicity of the distillate, using the standard protocols described in Reithmuller et al. (2003; Table 1). The exposure regimes differed for the five species, thus:

1. *Hydra viridissima* and *M. macleayi*, were exposed to a limited concentration range of the distillate diluted in Magela Creek Water (MCW; 0, 25, 50 and 100%). Additionally, an undiluted sample of distillate was amended by adding Ca, Na and K at 0.5, 1.0 and 0.4 mg L-1, respectively (termed “100% amended”). The concentrations of the added Ca, Na and K are representative of those measured in Magela Creek and were added to determine whether the adverse effects observed in the pilot-plant study could be reversed. Magnesium was not added because the distillate from the pilot-scale plant contained residual Mg that was similar to concentrations measured in the creek, ~0.5 mg L-1 Table 2). This differed from distillate produced by the full-scale plant, which contained Mg <0.1 mg L-1.
2. *Chlorella* sp., *L. aequinoctialis* and *M. mogurnda*, wereall initially exposed to 0 and 100% distillate treatments only. These species were expected to tolerate the distillate based on results from the pilot-plant study. However, toxicity observed in the 100% distillate treatment resulted in repetition of the toxicity tests for *L. aequinoctialis* (using 0, 25, 50 and 100%) and *M. mogurnda* (0, 50 and 100%). Both of the repeated toxicity tests included a 100% amended treatment, as used for the other three test species.

**Table 1** Details of toxicity tests undertaken to assess distillate from the brine concentrator

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test organism** | **Acute/ Chronic** | **Test code** | **Date** | **Treatments tested (% Distillate)** |
| *Chlorella* sp. (unicellular alga) | Chronic | 1356G | 08/10/13 | 0, 100 |
| *Lemna aeqinoctialis* (duckweed) | Chronic Chronic | 1355L 1362L | 08/10/13 14/10/13 | 0, 100 0, 25, 50, 100, 100 (amended)1 |
| *Hydra viridissima* (green hydra) | Chronic | 1352B | 08/10/13 | 0, 25, 50, 100, 100 (amended) |
| *Moinodaphnia macleayi* (cladoceran) | Chronic | 1353D | 10/10/13 | 0, 25, 50, 100, 100 (amended) |
| *Mogurnda mogurnda* (fish) | Acute Acute | 1354E 1364E | 25/10/13 1/11/13 | 0, 100 0, 50, 100, 100 (amended) |

1 Amended: undiluted distillate with addition of 0.5, 1.0 and 0.4 mg L-1 (nominal concentrations) Ca, Na and K, respectively.

## 2.4 Quality control

### 2.4.1 Chemistry

For each test, blanks and procedural blanks (i.e. ultra-pure water that has been exposed to all components of the test system) were also analysed for a limited metal and major ion suite (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, U, Zn, Ca, Mg, Na, SO4 - analysed as S and converted). Chemistry data for the blanks and procedural blanks were initially assessed by searching for analyte concentrations higher than detection limits. There were no instances where contamination in the blanks was greater than 2 g L-1 and above background levels of MCW.

### 2.4.2 General water quality

For each test, data were considered acceptable if: the recorded temperature of the incubator remained within the prescribed limits (see test descriptions, above); the recorded pH was within ± 1 unit of values at test commencement (i.e. Day 0); the EC for each test solution was within 10% (or 5 µS cm-1 for samples with low conductivity) of the values at test commencement; and the DO concentration was greater than 70% throughout the test (see Appendix A for data). The occurrence of any significant water quality changes were investigated and discussed on a case-by-case basis.

### 2.4.3 Control responses

Tests were considered valid if the organisms in the Quality Control (QC) treatment   
(ie those in the MCW control) met the following criteria:

##### Chlorella sp. cell division rate test

* The algal growth rate is within the range 1.4 ± 0.3 doublings day-1; and
* There is <20% variability (i.e. co-efficient of variation, CV <20%) in growth rate.

##### L. aequinoctialis plant growth test

* The average increase in frond number in any flask at test conclusion is at least four times that at test start (i.e. a total of 60 fronds/flask or specific growth   
  rate (k) > 0.4 day-1); and
* There is <20% variability (CV < 20%) in growth rate.

##### M. macleayi 3-brood reproduction test

* 80% or more of the cladocera are alive and female, and have produced three broods at the end of the test period;
* Reproduction in the control averages 30 or more live neonates per female over the test period; and

##### H. viridissima population growth test

* More than 30 healthy hydroids (i.e. specific growth rate specific growth rate (k) > 0.27 day-1) remain in each dish at the end of the test period; and
* There is <20% variability (CV <20%) in growth rate.

##### M. mogurnda larval fish survival test

* The mean mortality or presence of fungus on the fish does not exceed 20%; and
* There is <20% variability (CV <20%) in survival.

# 3 Results and discussion

## 3.1 Quality Control

The quality of the toxicity tests was assessed based on criteria for water quality measurements (Appendix A), chemical analyses of blank and procedural blank samples (Appendix B, Table B3) and control performance (Appendix C). All toxicity tests met the criteria for control performance.

Two tests 1368E and 1355L exhibited a pH shift of over a unit in the new water of the 100% distillate treatment (Appendix A, Tables A7 and A2, respectively). This was not unexpected due to the low buffering capacity of the water. Dissolved oxygen concentrations in all tests were acceptable (> 80% saturation). The EC of the new waters used in all tests did not shift by more than 3 µS cm-1.

Chemical analyses of the diluent, blank and procedural blank samples showed that all tests were free from confounding metal contaminants (Table B3). Hence, all tests reported here were of acceptable quality.

## 3.2 Distillate Chemistry

Chemical analyses from the full-scale plant showed that the distillate sample was a highly-purified water and contained less metals and major ions compared to the sample from the pilot plant (Table 2, Table B1). The EC of the distillate was 3 µS cm-1, all major ions were below detection limits and the ammonia concentration was 0.25 mg L-1. Manganese and uranium (U) concentrations were lower in the distillate from the full-scale plant (7 µg L-1 and 0.05 µg L-1, respectively) compared to that produced by the pilot-scale plant (120-240 µg L-1 and 1.1-1.5 µg L-1, respectively). The only other inorganic elements measured above 0.5 µg L-1 were Al and B, which were 3 and 13 µg L-1, respectively (Table 2). All sVOC and VOCs were below detection limits (Table B2).

**Table 2** Selected measured chemicals in the distillate (the full dataset is reported at Appendix B,   
Table B1).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Analyte** | **Detection limit** | **Pilot-plant  1st sample a** | **Pilot-plant  2nd sample a** | **Full-scale plant** | **Magela Creek Water** |
| pH | 0.1 | 5.8 | 6.7 | 6.1 | 6.1 |
| Electrical conductivity (µS cm-1) | 1 | 17 | 12 | 3 | 16 |
| DOC (mg L-1) | 0.1 | 0.6 | NM b | 0.6 | 2.1 |
| Calcium (mg L-1) | 0.1 | 0.11 | <0.1 | <0.1 | 0.2 |
| Magnesium (mg L-1) | 0.1 | 0.6 | 0.4 | <0.1 | 1.1 |
| Sodium (mg L-1) | 0.1 | <0.1 | <0.1 | <0.1 | 1.3 |
| Potassium (mg L-1) | 0.1 | <0.1 | <0.1 | <0.1 | 0.2 |
| Biocarbonate (mg L-1 CaCO3) | 1 | 7 | 6 | <1 | 5 |
| Ammonia (mg L-1 NH3-N) | 0.005 | 0.7 | 0.8 | 0.3 | N.M. |
| Aluminium (µg L-1) | 0.1 | 18.0 | 23.0 | 3.0 | 6.0 |
| Manganese (µg L-1) | 0.005 | 230 | 130 | 7.0 | 2.0 |
| Boron (µg L-1) | 0.5 | 100.0 | 88.0 | 13.0 | N.M. |
| Uranium (µg L-1) | 0.001 | 1.1 | 1.5 | 0.05 | 0.007 |

a Harford et al. (2013)

b NM: Not measured

## 3.3 Toxicity data

The effects of the distillate on the five freshwater species are shown in Figure 1. The full-scale-plant distillate was higher in toxicity compared to the pilot-plant distillate (Harford et al. 2013), but this was most likely due to the lower concentrations of major ions in the full-scale plant distillate (see below). All species displayed some degree of adverse effects in 100% distillate. *Chlorella* sp. and *M. mogurnda* were the most tolerant species with statistically significant 8% and 17% reductions in growth and survival, respectively. *Moinodaphnia macleayi* and *L. aequinoctialis* were equally sensitive to the 100% distillate with 71% and 73% reductions in reproduction and growth, respectively. However,   
*L. aequinoctialis* showed higher growth rates following the addition of the major ions, returning to levels similar to controls. The reproduction of *M. macleayi* improved with the major ion addition but was still 40% lower than the controls. As observed in the pilot-plant distillate, *H. viridissima*, did not grow in the 100% distillate and all organisms exposed to the water died in 96 h. The addition of the major ions resulted in 82% recovery (Figure 1), compared with100% recovery in the pilot-scale distillate (Harford   
et al. 2013). These results indicate that a major ion deficiency is the primary cause of effects observed in the distillate.



**Figure 1** Toxicity of the full-scale-plant distillate to five local freshwater species. Test treatments represent percent distillate dilutions. See main text for details of the ‘100% amended’ sample. Control responses were (mean ± se); 1.7 ± 0.02 dbl/d for *Chlorella* sp.; 0.32 ± 0.0 cm2/d for *L. aequinoctialis*; 0.31 ± 0.0 for *H. viridissima*; 29.7 ± 1.5 neonates/adult for *M. macleayi*; and 95 ± 10.0% survival for   
*M. mogurnda*.

# 4 Conclusion

The toxicity of the full-scale-plant distillate sample was higher than that of the pilot-plant samples. These results were consistent with the higher purity of the former water. Amending the undiluted distillate sample with Ca, Na and K eliminated or reduced its toxicity. It is possible the remaining effects observed for *H. viridissima* and *M. macleayi* in the amended distillate sample were due to the concentration of Mg not being sufficient for hydra and cladoceran growth and reproduction. The major ion concentrations in the amended waters were similar to those found in MCW with the exception of Mg, which was not added to the treatments because this was not required during the pilot-plant study (Table 2). Nonetheless, the improved performance of the organisms upon addition of Ca, Na and K indicates that a major ion deficiency was the primary cause of effects observed in the distillate. The outcomes of this study have been used to inform regulatory approvals concerning discharge of the distillate to the environment.

# 5 References

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Riethmuller N, Camilleri C, Franklin N, Hogan AC, King A, Koch A, Markich SJ, Turley C & van Dam R 2003. *Ecotoxicological testing protocols for Australian tropical freshwater ecosystems*. Supervising Scientist Report 173, Supervising Scientist, Darwin NT.

# 6 Appendices

## Appendix A Water Quality Parameters

**Table A1 1356G *Chlorella* sp.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment (%)** | **MCW** | | **100%** | |
| **Parameter** | **0h** | **72h** | **0h** | **72h** |
| pH | 6.2 | 6.6 | 6.6 | 6.0 |
| EC (µS cm-1) | 47 | 45 | 34 | 32 |
| DO (%) | 107 | 93 | 101 | 91 |
| Temp (°C) | 24.8 | 19.1 | 22.9 | 19.1 |

**Table A2 1355L *L. aequinoctialis***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment (%)** | **MCW** | | **100%** | |
| **Parameter** | **0h** | **72h** | **0h** | **72h** |
| pH | 6.5 | 7.0 | 5.9 | 4.8 |
| EC (µS cm-1) | 23 | 17 | 16 | 14 |
| DO (%) | 100 | 89 | 103 | 89 |
| Temp (°C) | 23.7 | 22.6 | 23.0 | 22.0 |

**Table A3 1362L *L. aequinoctialis***

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment (%)** | **MCW** | | **25%** | | **50%** | | **100%** | | **100% (amended)** | |
| **Parameter** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** |
| pH | 6.7 | 6.7 | 6.6 | 6.9 | 6.4 | 6.9 | 5.7 | 5.8 | 6.6 | 6.5 |
| EC (µS cm-1) | 27 | 19 | 21 | 15 | 18 | 12 | 11 | 10 | 19 | 11 |
| DO (%) | 106 | 89 | 105 | 91 | 103 | 88 | 104 | 91 | 101 | 91 |
| Temp (°C) | 25.3 | 23.5 | 24.6 | 22.7 | 22.2 | 24.3 | 21.4 | 23.7 | 21.1 | 23.0 |

**Table A4 1352B *H. viridissima***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **(%)** | **MCW** | | **25%** | | **50%** | | **100%** | | **100 % (amended)** | |
| **Parameter** |  | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** |
| Day 0 | pH | 6.5 | 6.5 | 6.5 | 6.8 | 6.4 | 6.6 | 5.7 | 6.0 | 6.1 | 6.3 |
|  | EC (µS cm-1) | 16 | 17 | 13 | 14 | 11 | 11 | 3 | 4 | 11 | 12 |
|  | DO (%) | 98 | 91 | 100 | 93 | 97 | 92 | 96 | 92 | 96 | 90 |
|  | Temp (°C) | 22.9 | 24.6 | 21.7 | 23.8 | 21.2 | 22.8 | 21 | 22 | 20 | 22.1 |
| Day 1 | pH | 6.3 | 6.5 | 6.4 | 6.5 | 6.3 | 6.6 | 5.6 | 6.5 | 6.0 | 6.3 |
|  | EC (µS cm-1) | 16 | 17 | 13 | 17 | 10 | 10 | 6 | 3 | 11 | 12 |
|  | DO (%) | 101 | 91 | 103 | 93 | 102 | 91 | 97 | 91 | 101 | 92 |
|  | Temp (°C) | 21.3 | 23.9 | 21.4 | 23.8 | 21.1 | 23.0 | 21.3 | 22.9 | 21.5 | 22.7 |
| Day 2 | pH | 6.4 | 6.4 | 6.4 | 6.5 | 6.3 | 6.6 | 5.5 | 6.5 | 6.3 | 6.5 |
|  | EC (µS cm-1) | 16 | 18 | 13 | 14 | 10 | 11 | 4 | 3 | 11 | 12 |
|  | DO (%) | 99 | 91 | 104 | 93 | 102 | 92 | 98 | 94 | 101 | 92 |
|  | Temp (°C) | 21.3 | 23.8 | 21.2 | 23.3 | 21.4 | 22.8 | 21.6 | 23 | 21.7 | 22.7 |
| Day 3 | pH | 6.6 | 6.7 | 6.5 | 6.7 | 6.4 | 6.7 | 5.7 | 6.1 | 6.3 | 6.2 |
|  | EC (µS cm-1) | 16 | 17 | 13 | 14 | 10 | 10 | 5 | 3 | 11 | 12 |
|  | DO (%) | 109 | 93 | 107 | 95 | 108 | 93 | 108 | 90 | 109 | 93 |
|  | Temp (°C) | 22.5 | 22.3 | 22.5 | 24.0 | 22.5 | 23.8 | 22.3 | 23.4 | 22.2 | 20.9 |

**Table A5 1353D *M. macleayi***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment (%)** | | **MCW** | | **25%** | | **50%** | | **100%** | | **100% (amended)** | |
| **Parameter** |  | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** |
| Day 0 | pH | 6.5 | 6.8 | 6.5 | 6.7 | 6.3 | 6.6 | 5.6 | 6.6 | 6.3 | 6.6 |
|  | EC (µS cm-1) | 19 | 20 | 17 | 16 | 13 | 13 | 6 | 6 | 14 | 15 |
|  | DO (%) | 108 | 91 | 103 | 92 | 105 | 91 | 109 | 91 | 106 | 89 |
|  | Temp (°C) | 21.8 | 22.0 | 21.8 | 22.2 | 23.8 | 21.9 | 24.6 | 21.7 | 22.8 | 21.3 |
| Day 1 | pH | 6.7 | 6.6 | 6.6 | 6.6 | 6.5 | 6.6 | 5.6 | 6.3 | 6.6 | 6.7 |
|  | EC (µS cm-1) | 20 | 20 | 15 | 16 | 13 | 13 | 7 | 6 | 14 | 15 |
|  | DO (%) | 100 | 91 | 109 | 92 | 101 | 90 | 94 | 88 | 97 | 91 |
|  | Temp (°C) | 23.1 | 22.3 | 23.3 | 22.0 | 22.5 | 22.0 | 21.8 | 22.4 | 21.3 | 21.6 |
| Day 2 | pH | 6.4 | 6.7 | 6.5 | 6.7 | 6.5 | 6.5 | 5.6 | 6.3 | 6.3 | 6.5 |
|  | EC (µS cm-1) | 19 | 20 | 16 | 16 | 13 | 14 | 7 | 7 | 15 | 15 |
|  | DO (%) | 105 | 90 | 97 | 93 | 103 | 93 | 98 | 91 | 102 | 87 |
|  | Temp (°C) | 23.2 | 23.6 | 21.8 | 23.4 | 20.5 | 22.8 | 20.5 | 22.8 | 20.2 | 22.6 |
| Day 3 | pH | 6.5 | 6.8 | 6.5 | 6.8 | 6.4 | 6.7 | 6.0 | 6.5 | 6.5 | 6.6 |
|  | EC (µS cm-1) | 19 | 20 | 16 | 16 | 13 | 14 | 6 | 6 | 15 | 15 |
|  | DO (%) | 102 | 91 | 102 | 91 | 101 | 89 | 102 | 87 | 101 | 88 |
|  | Temp (°C) | 23.0 | 22.0 | 21.6 | 22.0 | 21.1 | 21.8 | 20.9 | 21.3 | 20.9 | 20.9 |
| Day 4 | pH | 6.6 | 6.7 | 6.6 | 6.6 | 6.4 | 6.6 | 6.0 | 6.2 | 6.6 | 6.6 |
|  | EC (µS cm-1) | 19 | 20 | 16 | 17 | 13 | 13 | 7 | 7 | 15 | 14 |
|  | DO (%) | 102 | 89 | 105 | 88 | 106 | 89 | 101 | 85 | 104 | 88 |
|  | Temp (°C) | 20.9 | 22.0 | 22.4 | 21.8 | 21.9 | 21.5 | 21.3 | 21.2 | 23.2 | 20.6 |
| Day 5 | pH | 6.7 | 6.99 | 6.54 | 6.86 | 6.6 | 6.69 | 5.87 | 6.23 | 6.33 | 6.66 |
|  | EC (µS cm-1) | 19 | 20 | 17 | 17 | 12 | 14 | 7 | 7 | 12 | 15 |
|  | DO (%) | 98 | 92 | 109 | 93 | 103 | 90 | 97 | 94 | 103 | 92 |
|  | Temp (°C) | 20.6 | 24.6 | 20.8 | NM | 20.7 | NM | 20.5 | NM | 20.2 | NM |

**Table A6 1354E *M. mogurnda***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **(%)** | **MCW** | | **100%** | |
| **Parameter** |  | **0h** | **72h** | **0h** | **72h** |
| Day 0 | pH | 6.6 | 6.6 | 6.1 | 6.6 |
|  | EC (µS cm-1) | 17 | 20 | 3 | 6 |
|  | DO (%) | 96 | 95 | 101 | 97 |
|  | Temp (°C) | 22.1 | 23.6 | 22.3 | 24.9 |
| Day 1 | pH | 6.3 | 6.8 | 5.6 | 6.3 |
|  | EC (µS cm-1) | 17 | 18 | 4 | 5 |
|  | DO (%) | 103 | 91 | 102 | 92 |
|  | Temp (°C) | 23.9 | 22.2 | 22.8 | 21.9 |
| Day 2 | pH | 6.5 | 6.8 | 5.8 | 6.4 |
|  | EC (µS cm-1) | 17 | 19 | 3 | 5 |
|  | DO (%) | 100 | 91 | 106 | 91 |
|  | Temp (°C) | 22.7 | 21.3 | 22.3 | 20.7 |
| Day 3 | pH | 6.6 | 6.8 | 5.8 | 6.7 |
|  | EC (µS cm-1) | 17 | 20 | 3 | 6 |
|  | DO (%) | 100 | 85 | 109 | 91 |
|  | Temp (°C) | 22.3 | 23.6 | 21.7 | 23.1 |

**Table A7 1368E *M. mogurnda***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **(%)** | **MCW** | | **50%** | | **100%** | | **100% (amended)** | |
| **Parameter** |  | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** | **0h** | **72h** |
| Day 0 | pH | 6.8 | 6.9 | 6.8 | 6.8 | 6.5 | 6.6 | 6.4 | 6.6 |
|  | EC (µS cm-1) | 19 | 20 | 10 | 13 | 4 | 6 | 11 | 14 |
|  | DO (%) | 101 | 95 | 104 | 97 | 105 | 94 | 106 | 92 |
|  | Temp (°C) | 22.7 | 23.6 | 22.1 | 23.2 | 21.7 | 22.8 | 22.1 | 22.4 |
| Day 1 | pH | 6.6 | 6.7 | 6.7 | 6.6 | 5.4 | 6.3 | 5.9 | 6.4 |
|  | EC (µS cm-1) | 17 | 19 | 10 | 12 | 6 | 5 | 11 | 13 |
|  | DO (%) | 104 | 94 | 115 | 91 | 116 | 95 | 115 | 94 |
|  | Temp (°C) | 22.6 | 25 | 22.7 | 25.6 | 22.7 | 25 | 22.4 | 24.8 |
| Day 2 | pH | 6.4 | 6.3 | 6.5 | 6.4 | 5.8 | 6.6 | 6.3 | 6.5 |
|  | EC (µS cm-1) | 17 | 19 | 11 | 12 | 6 | 5 | 12 | 13 |
|  | DO (%) | 108 | 92 | 109 | 93 | 106 | 91 | 110 | 94 |
|  | Temp (°C) | NM | 24.1 | NM | 24.8 | 0 | 25.4 | NM | 26.2 |
| Day 3 | pH | 6.7 | 6.8 | 6.6 | 6.9 | 5.4 | 6.7 | 5.8 | 6.6 |
|  | EC (µS cm-1) | 17 | 22 | 10 | 13 | 5 | 6 | 11 | 13 |
|  | DO (%) | 106 | 94 | 110 | 95 | 109 | 92 | 110 | 91 |
|  | Temp (°C) | 22.7 | 25.6 | 22.5 | 25 | 22.2 | 24.4 | 21.9 | 23.7 |

## Appendix B Chemical analyses

**Table B1 Inorganic analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| Aluminium | µg/L | 0.1 | 3 |
| Cadmium | µg/L | 0.02 | <0.02 |
| Cobalt | µg/L | 0.01 | 0.01 |
| Chromium | µg/L | 0.1 | <0.1 |
| Copper | µg/L | 0.01 | 0.1 |
| Iron | µg/L | 1 | <1 |
| Manganese | µg/L | 0.01 | 7 |
| Nickel | µg/L | 0.01 | <0.01 |
| Lead | µg/L | 0.01 | 0.2 |
| Selenium | µg/L | 0.2 | <0.2 |
| Uranium | µg/L | 0.001 | 0.05 |
| Zinc | µg/L | 0.1 | <0.1 |
| Silver | µg/L | 0.05 | <0.05 |
| Arsenic | µg/L | 0.05 | <0.05 |
| Gold | µg/L | 0.01 | <0.01 |
| Boron | µg/L | 0.5 | 13 |
| Barium | µg/L | 0.02 | 0.06 |
| Beryllium | µg/L | 0.05 | <0.05 |
| Bismuth | µg/L | 0.01 | <0.01 |
| Bromine | µg/L | 1 | <1 |
| Cerium | µg/L | 0.01 | <0.01 |
| Caesium | µg/L | 0.01 | <0.01 |
| Dysprosium | µg/L | 0.01 | <0.01 |
| Erbium | µg/L | 0.01 | <0.01 |
| Europium | µg/L | 0.01 | <0.01 |
| Gallium | µg/L | 0.01 | <0.01 |
| Gadolinium | µg/L | 0.01 | <0.01 |
| Hafnium | µg/L | 0.01 | <0.01 |
| Mercury | µg/L | 0.02 | <0.02 |
| Holmium | µg/L | 0.01 | <0.01 |
| Indium | µg/L | 5 | <5 |
| Lanthanum | µg/L | 0.01 | <0.01 |
| Lithium | µg/L | 0.05 | <0.05 |
| Lutetium | µg/L | 0.01 | <0.01 |
| Molybdenum | µg/L | 0.05 | <0.05 |
| Niobium | µg/L | 0.02 | <0.02 |
| Neodymium | µg/L | 0.01 | <0.01 |
| Osmium | µg/L | 0.1 | <0.1 |
| Palladium | µg/L | 0.05 | <0.05 |

**Table B1 (continued) Inorganic analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| Praseodymium | µg/L | 0.01 | <0.01 |
| Rubidium | µg/L | 0.01 | <0.01 |
| Rhenium | µg/L | 0.01 | <0.01 |
| Antimony | µg/L | 0.05 | <0.05 |
| Scandium | µg/L | 0.5 | <0.5 |
| Samarium | µg/L | 0.01 | <0.01 |
| Tin | µg/L | 0.1 | 0.1 |
| Strontium | µg/L | 0.01 | 0.05 |
| Tantalum | µg/L | 0.05 | <0.05 |
| Terbium | µg/L | 0.01 | <0.01 |
| Tellurium | µg/L | 0.1 | <0.1 |
| Thorium | µg/L | 0.01 | <0.01 |
| Titanium | µg/L | 2 | <2 |
| Thallium | µg/L | 0.01 | <0.01 |
| Thulium | µg/L | 0.01 | <0.01 |
| Vanadium | µg/L | 0.05 | <0.05 |
| Tungsten | µg/L | 0.05 | <0.05 |
| Yttrium | µg/L | 0.01 | 0.02 |
| Ytterbium | µg/L | 0.01 | <0.01 |
| Zirconium | µg/L | 0.05 | <0.05 |
| Sulfur | mg/L | 0.5 | <0.5 |
| Alkalinity as CaCO3 | mg/L | 1.0 | 2.0 |
| Nitrate as N | mg/L | 0.005 | <0.005 |
| Ammonia as N | mg/L | 0.005 | 0.27 |
| Phosphate as P | mg/L | 0.005 | <0.005 |
| Calcium | mg/L | 0.1 | <0.1 |
| Chloride | mg/L | 1 | <1.0 |
| Magnesium | mg/L | 0.1 | <0.1 |
| Sodium | mg/L | 0.1 | <0.1 |
| Potassium | mg/L | 0.1 | <0.1 |

**Table B2 Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| Dichlorodifluoromethane | µg/L | 10 | <10 |
| Chloromethane | µg/L | 10 | <10 |
| Vinyl Chloride | µg/L | 10 | <10 |
| Bromomethane | µg/L | 10 | <10 |
| Chloroethane | µg/L | 10 | <10 |
| Trichlorofluoromethane | µg/L | 10 | <10 |
| 1,1-Dichloroethene | µg/L | 1 | <1 |
| Trans-1,2-dichloroethene | µg/L | 1 | <1 |
| 1,1-dichloroethane | µg/L | 1 | <1 |
| Cis-1,2-dichloroethene | µg/L | 1 | <1 |
| Bromochloromethane | µg/L | 1 | <1 |
| Chloroform | µg/L | 1 | <1 |
| 2,2-dichloropropane | µg/L | 1 | <1 |
| 1,2-dichloroethane | µg/L | 1 | <1 |
| 1,1,1-trichloroethane | µg/L | 1 | <1 |
| 1,1-dichloropropene | µg/L | 1 | <1 |
| Cyclohexane | µg/L | 1 | <1 |
| Carbon tetrachloride | µg/L | 1 | <1 |
| Benzene | µg/L | 1 | <1 |
| Dibromomethane | µg/L | 1 | <1 |
| 1,2-dichloropropane | µg/L | 1 | <1 |
| Trichloroethene | µg/L | 1 | <1 |
| Bromodichloromethane | µg/L | 1 | <1 |
| trans-1,3-dichloropropene | µg/L | 1 | <1 |
| cis-1,3-dichloropropene | µg/L | 1 | <1 |
| 1,1,2-trichloroethane | µg/L | 1 | <1 |
| Toluene | µg/L | 1 | <1 |
| 1,3-dichloropropane | µg/L | 1 | <1 |
| Dibromochloromethane | µg/L | 1 | <1 |
| 1,2-dibromoethane | µg/L | 1 | <1 |
| Tetrachloroethene | µg/L | 1 | <1 |
| 1,1,1,2-tetrachloroethane | µg/L | 1 | <1 |
| Chlorobenzene | µg/L | 1 | <1 |
| Ethylbenzene | µg/L | 1 | <1 |
| Bromoform | µg/L | 1 | <1 |
| m+p-xylene | µg/L | 2 | <2 |
| Styrene | µg/L | 1 | <1 |
| 1,1,2,2-tetrachloroethane | µg/L | 1 | <1 |
| o-xylene | µg/L | 1 | <1 |
| 1,2,3-trichloropropane | µg/L | 1 | <1 |
| Isopropylbenzene | µg/L | 1 | <1 |

**Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| Bromobenzene | µg/L | 1 | <1 |
| n-propyl benzene | µg/L | 1 | <1 |
| 2-chlorotoluene | µg/L | 1 | <1 |
| 4-chlorotoluene | µg/L | 1 | <1 |
| 1,3,5-trimethyl benzene | µg/L | 1 | <1 |
| Tert-butyl benzene | µg/L | 1 | <1 |
| 1,2,4-trimethyl benzene | µg/L | 1 | <1 |
| 1,3-dichlorobenzene | µg/L | 1 | <1 |
| Sec-butyl benzene | µg/L | 1 | <1 |
| 1,4-dichlorobenzene | µg/L | 1 | <1 |
| 4-isopropyl toluene | µg/L | 1 | <1 |
| 1,2-dichlorobenzene | µg/L | 1 | <1 |
| n-butyl benzene | µg/L | 1 | <1 |
| 1,2-dibromo-3-chloropropane | µg/L | 1 | <1 |
| 1,2,4-trichlorobenzene | µg/L | 1 | <1 |
| Hexachlorobutadiene | µg/L | 1 | <1 |
| 1,2,3-trichlorobenzene | µg/L | 1 | <1 |
| Phenol | µg/L | 10 | <10 |
| Bis (2-chloroethyl) ether | µg/L | 10 | <10 |
| 2-Chlorophenol | µg/L | 10 | <10 |
| 1,3-Dichlorobenzene | µg/L | 10 | <10 |
| 1,4-Dichlorobenzene | µg/L | 10 | <10 |
| 2-Methylphenol | µg/L | 10 | <10 |
| 1,2-Dichlorobenzene | µg/L | 10 | <10 |
| bis-(2-Chloroisopropyl) ether | µg/L | 10 | <10 |
| 3/4-Methylphenol | µg/L | 20 | <20 |
| N-nitrosodi-n-propylamine | µg/L | 10 | <10 |
| Hexachloroethane | µg/L | 10 | <10 |
| Nitrobenzene | µg/L | 10 | <10 |
| Isophorone | µg/L | 10 | <10 |
| 2,4-Dimethylphenol | µg/L | 10 | <10 |
| 2-Nitrophenol | µg/L | 10 | <10 |
| bis (2-Chloroethoxy) methane | µg/L | 10 | <10 |
| 2,4-Dichlorophenol | µg/L | 10 | <10 |
| 1,2,4-Trichlorobenzene | µg/L | 10 | <10 |
| Naphthalene | µg/L | 10 | <10 |
| 4-Chloroaniline | µg/L | 10 | <10 |
| Hexachlorobutadiene | µg/L | 10 | <10 |
| 2-Methylnaphthalene | µg/L | 10 | <10 |
| Hexachlorocyclopentadiene | µg/L | 10 | <10 |
| 2,4,6-Trichlorophenol | µg/L | 10 | <10 |

**Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| 2,4,5-Trichlorophenol | µg/L | 10 | <10 |
| 2-Chloronaphthalene | µg/L | 10 | <10 |
| 2-Nitroaniline | µg/L | 10 | <10 |
| Dimethyl phthalate | µg/L | 10 | <10 |
| 2,6-Dinitrotoluene | µg/L | 10 | <10 |
| Acenaphthylene | µg/L | 10 | <10 |
| 3-Nitroaniline | µg/L | 10 | <10 |
| Acenaphthene | µg/L | 10 | <10 |
| 2,4-Dinitrophenol | µg/L | 100 | <100 |
| 4-Nitrophenol | µg/L | 100 | <100 |
| Dibenzofuran | µg/L | 10 | <10 |
| Diethylphthalate | µg/L | 10 | <10 |
| 4-Chlorophenylphenylether | µg/L | 10 | <10 |
| 4-Nitroaniline | µg/L | 10 | <10 |
| Fluorene | µg/L | 10 | <10 |
| 2-methyl-4,6-dinitrophenol | µg/L | 100 | <100 |
| Azobenzene | µg/L | 10 | <10 |
| 4-Bromophenylphenylether | µg/L | 10 | <10 |
| Hexachlorobenzene | µg/L | 10 | <10 |
| Pentachlorophenol | µg/L | 100 | <100 |
| Phenanthrene | µg/L | 10 | <10 |
| Anthracene | µg/L | 10 | <10 |
| Carbazole | µg/L | 10 | <10 |
| Di-n-butylphthalate | µg/L | 10 | <10 |
| Fluoranthene | µg/L | 10 | <10 |
| Pyrene | µg/L | 10 | <10 |
| Butylbenzylphthalate | µg/L | 10 | <10 |
| Bis(2-ethylhexyl) phthalate | µg/L | 10 | <10 |
| Benzo(a)anthracene | µg/L | 10 | <10 |
| Chrysene | µg/L | 10 | <10 |
| Di-n-octylphthalate | µg/L | 10 | <10 |
| Benzo(b)fluoranthene | µg/L | 10 | <10 |
| Benzo(k)fluoranthene | µg/L | 10 | <10 |
| Benzo(a)pyrene | µg/L | 10 | <10 |
| Indeno(1,2,3-c,d)pyrene | µg/L | 10 | <10 |
| Dibenzo(a,h)anthracene | µg/L | 10 | <10 |
| Benzo(g,h,i)perylene | µg/L | 10 | <10 |
| Ethylmethanesulfonate | µg/L | 10 | <10 |
| Aniline | µg/L | 10 | <10 |
| Pentachloroethane | µg/L | 10 | <10 |

**Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| Benzyl alcohol | µg/L | 10 | <10 |
| Acetophenone | µg/L | 10 | <10 |
| N-nitrosomorpholine | µg/L | 10 | <10 |
| N-nitrosopiperidine | µg/L | 10 | <10 |
| 2,6-Dichlorophenol | µg/L | 10 | <10 |
| Hexachloropropene-1 | µg/L | 10 | <10 |
| N-nitroso-n-butylamine | µg/L | 10 | <10 |
| Safrole | µg/L | 10 | <10 |
| 1,2,4,5-Tetrachlorobenzene | µg/L | 10 | <10 |
| Trans-iso-safrole | µg/L | 10 | <10 |
| 1,3-Dinitrobenzene | µg/L | 10 | <10 |
| Pentachlorobenzene | µg/L | 10 | <10 |
| 1-Naphthylamine | µg/L | 10 | <10 |
| 2,3,4,6-Tetrachlorophenol | µg/L | 10 | <10 |
| 2-Naphthylamine | µg/L | 10 | <10 |
| 5-Nitro-o-toluidine | µg/L | 10 | <10 |
| Diphenylamine | µg/L | 10 | <10 |
| Phenacetin | µg/L | 10 | <10 |
| Pentachloronitrobenzene | µg/L | 10 | <10 |
| Dinoseb | µg/L | 10 | <10 |
| Methapyrilene | µg/L | 10 | <10 |
| p-Dimethylaminoazobenzene | µg/L | 10 | <10 |
| 2-Acetylaminofluorene | µg/L | 10 | <10 |
| 7,12-Dimethylbenz(a)anthracene | µg/L | 10 | <10 |
| 3-Methylcholanthrene | µg/L | 10 | <10 |
| a-BHC | µg/L | 10 | <10 |
| b-BHC | µg/L | 10 | <10 |
| g-BHC | µg/L | 10 | <10 |
| d-BHC | µg/L | 10 | <10 |
| Heptachlor | µg/L | 10 | <10 |
| Aldrin | µg/L | 10 | <10 |
| Heptachlor Epoxide | µg/L | 10 | <10 |
| g-Chlordane | µg/L | 10 | <10 |
| a-Chlordane | µg/L | 10 | <10 |
| Endosulfan I | µg/L | 10 | <10 |
| p,p'-DDE | µg/L | 10 | <10 |
| Dieldrin | µg/L | 10 | <10 |
| Endrin | µg/L | 10 | <10 |
| p,p'-DDD | µg/L | 10 | <10 |
| Endosulfan II | µg/L | 10 | <10 |
| Endrin Aldehyde | µg/L | 10 | <10 |

**Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate**

|  |  |  |  |
| --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **Concentration** |
| p,p'-DDT | µg/L | 10 | <10 |
| Endosulfan Sulphate | µg/L | 10 | <10 |

**Table B3 Blank (Blk) and Procedural Blank (Pro Blk) chemistry for the toxicity tests**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analyte** | **Units** | **Detection Limit** | **MCW a** | **1355L  Blk** | **1355L  Pro Blk** | **1356G  Blk** | **1356G  Pro Blk** | **1352B Blk** | **1352B Pro Blk** | **1353D Pro Blk** | **1353D Blk** | **1368E Pro Blk** | **1368E Blk** |
| Aluminium | µg/L | 0.1 | 6 | 2 | 4 | <0.1 | 0.4 | <0.1 | <0.1 | 0.1 | <0.1 | 0.6 | 1 |
| Cadmium | µg/L | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Cobalt | µg/L | 0.01 | 0.03 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Chromium | µg/L | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Copper | µg/L | 0.01 | 0.4 | 0.1 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | <0.01 | <0.01 | 0.04 | 0.1 |
| Iron | µg/L | 1 | 31 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Manganese | µg/L | 0.01 | 2 | 0.03 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.03 |
| Nickel | µg/L | 0.01 | 0.2 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.04 |
| Lead | µg/L | 0.01 | 0.05 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.04 |
| Selenium | µg/L | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Uranium | µg/L | 0.001 | 0.007 | <0.001 | 0.03 | <0.001 | 0.02 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 |
| Zinc | µg/L | 0.1 | 0.5 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.6 |
| Sulphate | mg/L | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |

a Magela Creek Water batch used for the toxicity tests.

## Appendix C Toxicity test raw data and statistical analyses

