Coastal Habitats
UPL Chemical Spill:
Ver 1.6
31 October 2022

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TABLE OF CONTENTS

Citation – when using information from this report please reference in full as follows:
Forbes, N.T. (2022). UPL Chemical Spill: Pesticide concentrations and Toxicity Results of different treatments applied to PCD water Ver 1.6 MER Specialist Report 9/UPL/21.

UPL Chemical Spill
Pesticide concentrations and Toxicity Results of different treatments applied to PCD water

N.T. Forbes

1 PREFACE

This report is submitted as a stand-alone document focussed on toxicity and interpretation of laboratory analysis of water collected from the PCD. This version of the report only deals with the results of the chemical analysis for metalloid and organic pesticide concentrations and sea urchin toxicity testing for the PCD water pre- and post- the specified treatments in late September and early October 2022.

2 INTRODUCTION

MER sampled water at the PCD on the 22 September for analysis of pre- and post-treatment samples being put through Reverse Osmosis treatment at the DCLM Reverse Osmosis plant in Ballito, Durban and CSIR. Further investigations on the 11 October involved the testing of PCD water pre and post treatment with UV and Ozone at Xylem Watermark in Johannesburg and again toxicity testing at CSIR. Both sets of results are reported here. At the time of sampling approximately 175 mm of rain had fallen since the 8/4/22. Seven sites were sampled (Figure 1-1). They were sent to CSIR for standard Whole Effluent Testing (WET) using sea urchin fertilisation and embryo-larval development testing and to V&M Analytical Toxicological Services Laboratory for metals and pesticide analysis.

3 RESULTS AND DISCUSSION

3.1 Reverse Osmosis (RO) treatment

3.1.1 Organic pesticide concentrations

A total of fifty-five pesticide standards were used to analyse the PCD water sample taken on the 22 September 2022 and of these 16 were present in the pre-RO. Twelve of these were below quantifiable limits but results indicated they were present. Four of these, viz amicarbazone, metalochlor, tebuthiuron and triclopyr were present at varying but quantifiable concentrations (Figure 3-1 and Table 3-1 and certificates attached in Appendix A).

The post-RO analysis showed a significant improvement in chemical composition of the PCD water. Ten organic pesticides were completely removed by the treatment. The remaining six were all reduced by the treatment and showed varying levels of improvement from 66 – 97% (Table 3-1).

3.1.2 Metals

The four metals and metalloid which have been routinely sampled for the UPL project were included in the RO analysis. The post-RO treatment showed improvements (decreases) in all the elemental compounds with arsenic showing the most improvement resulting in concentrations akin to background levels. The same was true for copper and manganese. Zinc levels remained higher than guideline limits post-treatment.

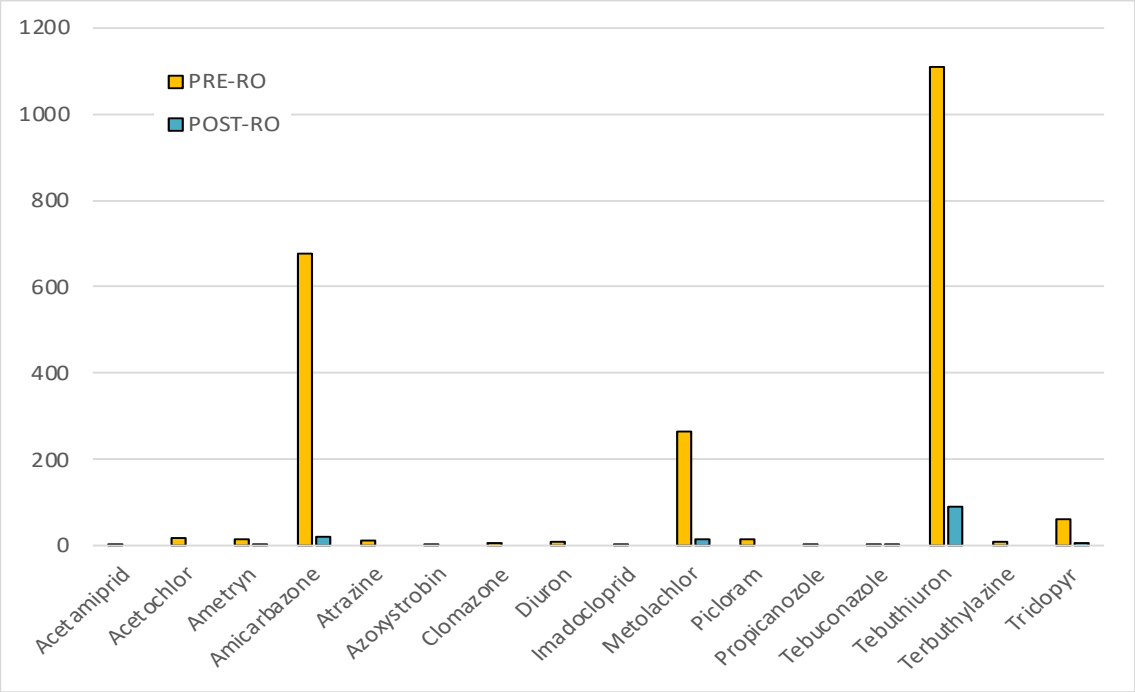

Figure 3-1 Organic pesticide concentrations pre- and post-reverse osmosis treatment.

Table 3-1 Organic pesticide concentrations pre- and post-reverse osmosis treatment with an indication of the percentage improvement in each compound.

Organic pesticide	PRE-RO µg/l	POST-RO µg/l	% improvement
Acetamiprid	2	0	100
Acetochlor	18	0	100
Ametryn	15	2	87
Amicarbazone	676	20	97
Atrazine	11	0	100
Azoxystrobin	2	0	100
Clomazone	5	0	100
Diuron	8	0	100
Imadocloprid	4	0	100
Metolachlor	265	14	95
Picloram	14	0	100
Propicanozole	1	0	100
Tebuconazole	3	1	66
Tebuthiuron	1109	89	92
Terbuthylazine	8	0	100
Triclopyr	60	5	92

Table 3-2 Metal concentrations pre- and post-RO treatment with improvement percentage indicated.

Organic pesticide	PRE-RO µg/l	POST-RO µg/l	% improvement
Arsenic	21.1	1.8	91.5
Copper	8.2	0.8	91
Manganese	24.3	4.3	82
ZInc	86.8	31.5	64

3.1.3 Ecotoxicity

The improvements seen in the concentrations of the organic pesticides with reverse osmosis treatment were reflected in the toxicity results (Table 3-3). Pre-RO treatment the raw undiluted PCD sample was rated Highly Toxic. Post-RO the same water had improved markedly with the fertilization test showing Marginal Toxicity and the chronic and more sensitive development test improving to Moderately Toxic.

Table 3-3 Toxicity results of water collected on the 22 September 2022 using the sea urchin fertilization and embryo development test.

PCD Water Test	**Fertilization (Acute)**		**Embryo-Larval Development (Chronic)**	
Treatment	**Pre-RO**	**Post-RO**	**Pre-RO**	**Post-RO**
Raw	Highly Toxic	Marginally Toxic	Highly Toxic	Moderately Toxic
1:5 Dilution	Marginally Toxic	Slightly Toxic	Marginally Toxic	Slightly Toxic
1:10 Dilution	Slightly Toxic	Not Toxic	Slightly Toxic	Not Toxic
1:20 Dilution	Not Toxic	Not Toxic	Not Toxic	Not Toxic
1:40 Dilution	Not Toxic	Not Toxic	Not Toxic	Not Toxic
1:100 Dilution	Not Toxic	Not Toxic	Not Toxic	Not Toxic
1:200 Dilution	Not Toxic	Not Toxic	Not Toxic	Not Toxic
1:400 Dilution	Not Toxic	Not Toxic	Not Toxic	Not Toxic

3.2 UV and Ozone Treatment.

The sample of PCD water taken on the 11 October was sent for treatment with a UV and ozone technique (details unavailable but can be sourced from Xylem Watermark. Samples were taken from the PCD directly, from the flowbin filled with PCD water and also from the flowbin by Xylem prior to treatment. A post-UV/O3 sampling was then taken after treatment.

3.2.1 Organic pesticide concentrations

The organic pesticides showed an interesting result with an increase in many of the pesticides pre-treatment which is attributed to the agitation of the sample during transport. The sediment load in the water was fairly high and it postulated that chemicals were liberated during transport. The treatment appeared very effective at removing the pesticides with only low levels of amicarbazone and tebuthiuron remaining in the sample post-treatment.

Table 3-4 Organic pesticide concentrations pre- and post-UV and Ozone treatment with an indication of the percentage improvement in each compound.

	PRE-UV/O3 PCD	**PRE-UV/O3 FLOWBIN**	**PRE-UV/O3 FLOWBIN JHB**	**POST-UV/O3**
Acetochlor	26	32	3	0
Ametryn	70	63	17	0
Amicarbazone	1 610	2 155	4 287	18
Atrazine	3	0	0	0
Azoxystrobin	4	3	3	0
Clomazone	8	8	2	0
Diuron	13	8	0	0
Imadocloprid	6	5	4	0
Metolachlor	375	402	748	0
Picloram	31	47	51	0
Propicanozole	3	2	3	0
TCPY	146	120	0	0
Tebuconazole	5	8	3	0
Tebuthiuron	4 045	3 973	11 160	45
Terbuthylazine	3	4	0	0
Thiamethoxam	3	3	3	0
Thiamethoxam	10	0	0	0

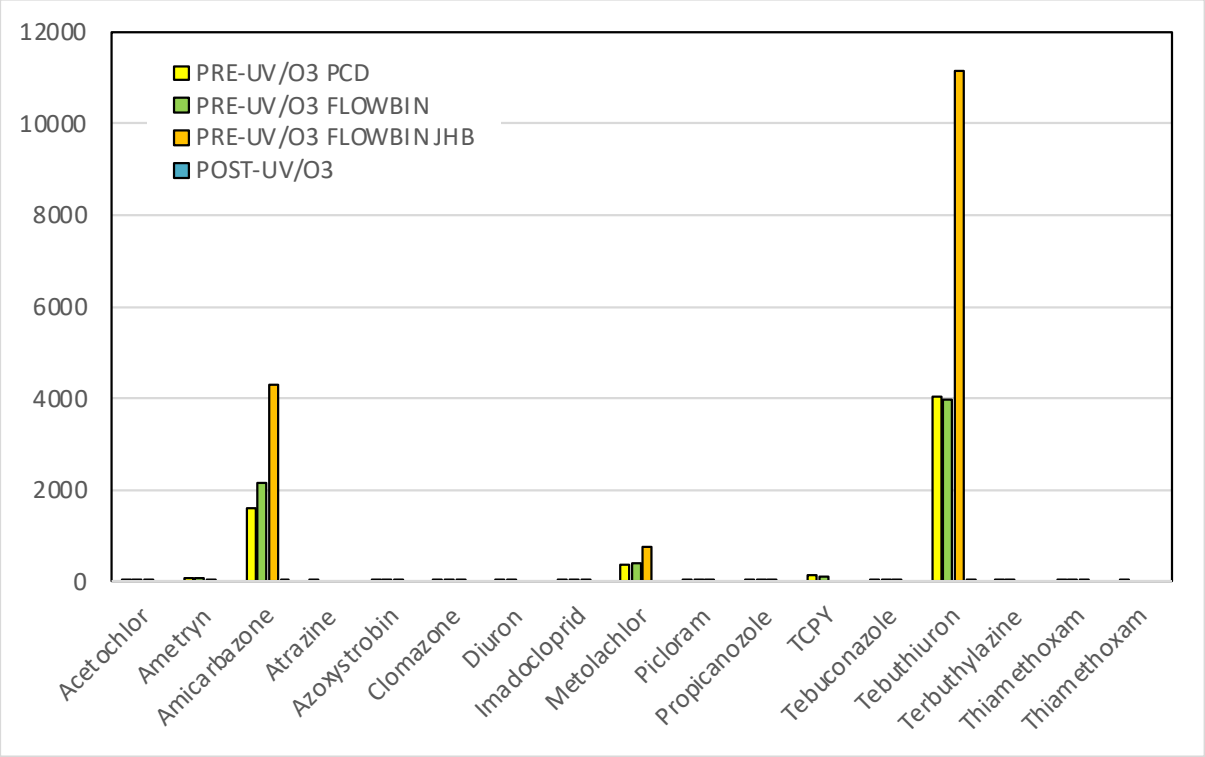

Figure 3-2 Organic pesticide concentrations pre- and post-UV/ozone treatment

3.2.2 Metalloids and Metals

The metalloids and metals in the pre-tests showed an increasing trend for manganese and zinc (Table 3-5). Again, this was attributed to the agitation of the water in the flowbin *en route* to Johannesburg resulting in the liberation of manganese and zinc.

Table 3-5 Organic pesticide concentrations pre- and post- pre- and post-UV and Ozone treatment with an indication of the percentage improvement in each compound.

	PRE-UV/O3 PCD	**PRE-UV/O3 FLOWBIN**	**PRE-UV/O3 FLOWBIN JHB**	**POST-UV/O3**
Arsenic	49	50.7	44.5	49.6
Copper	10.4	9.7	8.2	13.0
Manganese	21.1	10.4	54.5	49.0
Zinc	37.5	13.0	170.9	210.7

3.2.1 Ecotoxicity

The toxicity results showed an improvement post-treatment with the PCD water going from Moderately Toxic to Slightly Toxic (one category above not toxic).

Table 3-5 Ecotoxicity results of pre- and post-UV/O3 treatment

Treatment Dilution	PRE-UV/O3 PCD	PRE-UV/O3 FLOWBIN	PRE-UV/O3 FLOWBIN JHB	POST-UV/O3
Raw	**Moderately toxic**	**Moderately toxic**	**Marginally toxic**	**Slightly toxic**
1:5 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:10 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:20 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:40 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:100 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:200 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**
1:400 Dilution	**Not Toxic**	**Not Toxic**	**Not Toxic**	**Not Toxic**

4 CONCLUSIONS AND RECOMMENDATIONS

Variations in the concentrations of pesticides occurred in the PCD between the 22 September and 11 October with an increase in metals and organic pesticides concentration. This is assumed to be a result of stormwater flushing from the platform into the PCD via outlet 1. In particular a doubling of arsenic and many of the pesticides occurred.

The two treatments both produced positive results in terms of reducing concentrations of organic pesticides improving water quality by reducing toxicity. Only the RO treatment removed metals. Neither of the treatments completely removed the organic pesticides with tebuthiuron being the most persistent and some toxicity remaining for the raw undiluted water.