DRAFT MEMORANDUM

To: Port of Seattle project files

April 5, 2000

From: Doug Henderson / Linda Logan

556-2912-001 (61)

Subject: Range-Finding Water-effect ratio results Round 2.

This memorandum summarizes results of range-finding toxicity tests conducted as part of the water-effect ratio (WER) study for copper in streams receiving STIA stormwater. The purpose of these range-finding WERs is to determine if the final WERs would be robust enough to warrant the expense of conducting definitive studies. Although range-finding WERs were conducted in February 1999, these tests were conducted on simulated receiving water samples that were mixtures of outfall SDS3 stormwater and instream receiving water. Mixture ratios of these two samples were prepared in the laboratory by combining measured volumes of stormwater and upstream receiving water in proportions estimated to occur in the receiving water (based on hydrographs generated using HSPF). In the event that mixing zones cannot be granted for the creeks, it was agreed that two additional types of range-finding WERs be conducted, one without any mixing with stormwater (i.e., receiving water only) and the other one after complete mix, below outfall discharges.

Sampling

Samples were collected at five pre-determined locations during a qualifying storm event on the morning of 15 April 2000. This storm event started at Xh on 15 April and ended at Xh on 15 April 2000. The dry antecedent period preceding this storm was at least 24 hours. Approximately X inches of rain fell at STIA during this x-hour storm.

Taylor Associates collected flow-weighted composite samples for X hours during the storm event from each of the five sampling sites (Miller Creek Upstream, Miller Creek Detention Facility, Northwest Ponds Outlet, Northwest Ponds Inlet, and Des Moines Creek Weir). ISCO samplers automatically composite samples based on flow.

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Quality assurance and quality control elements were followed according to the Port's Procedure Manual for Stormwater Monitoring (POS, 1999).

The samples were delivered to Parametrix's toxicology laboratory with completed chain-of-custody forms in sufficient time to meet the applicable holding times. The synthetic laboratory water was prepared according to U.S. EPA (1993).

Analysis

The procedure for determining a WER involves using an indicator species to evaluate and quantify the toxicity and bioavailability of a compound in a particular site water compared to that in "clean" laboratory water. To accomplish this, the chemical of concern (in this case, copper) is spiked into both the clean laboratory water and site water at known concentrations. A median lethal concentration (LC50) is then determined for each water, and the two are compared to generate a WER:

$$\frac{\text{LC50 Site Water}}{\text{LC50 Laboratory Water}} = \text{WER}$$

The WER is then applied to the generic water quality standard to derive a site-specific standard:

$$\text{WER} * \text{Generic WQS} = \text{Site-specific WQS}$$

For example, if the water quality standard for a chemical is 3 µg/L, and a WER of 3 is derived for a particular site, the resulting site-specific water quality standard would be 9 µg/L.

Nominal copper test concentrations were prepared using a 500 mg/L copper stock solution made from copper sulfate pentahydrate ($CuSO_4 \cdot 5H_20$) (CAS#7758-99-8). Since these were preliminary tests, concentrations were not measured; thus the WERs were calculated using nominal test concentrations. However, the stock solution was analyzed by Battelle and verified to be 500.0 mg/L copper.

The toxicity tests were conducted according to *Short-term Methods for Estimating the Acute Toxicity of Effluents and Receiving Waters to Freshwater Organisms and Marine Organisms*. EPA/600/4-90/027F, August 1993. A summary of test conditions for the *D. magna* toxicity tests is presented in Table 1.

Table 1. Summary of test conditions for the acute *Daphnia magna* toxicity tests.

Job Name: Port of Seattle

Job Number: 556-2912-001 (61)
Date: 15-17 April 2000

Test Protocol:	*Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (Fourth Edition), EPA/600/4-90/027F, August 1993.
Test Material:	Copper-spiked site waters Copper-spiked synthetic laboratory water
Test Organisms/age:	*Daphnia magna*; ≤24 hrs old
Source:	In-house culture
Number/Test Chamber:	5
Volume/Test Chamber:	20 mL
Nominal Test Concentrations:	Site water: 0, 12.5, 25, 50, 100, 150, and 200 µg/L copper Synthetic laboratory water: 0, 5, 10, 20, 40, and 80 µg/L copper
Replicates:	Four
Test Duration:	48 hours
Control:	Unspiked synthetic laboratory water Unspiked site water
Test Chambers:	30 mL polystyrene cups
Lighting:	Fluorescent bulbs (50-100 foot candles)
Photoperiod:	16 hours light; 8 hours dark
Aeration:	None
Feeding:	None
Temperature:	25 ± 1°C
Chemical Data:	Dissolved oxygen, temperature, and pH at test initiation and every 24 hours; specific conductivity at test initiation and termination; hardness, alkalinity, ammonia, and residual chlorine at test initiation for 100% site water sample; hardness and alkalinity for laboratory and site water
Effect Measured:	Mortality
Test Acceptability:	Control mortality ≤10%

Results

Results of the range-finding water-effect ratio tests are presented in Table 2. Reference toxicant results were within acceptable ranges. All raw data sheets and statistical analyses are located in the project files at Parametrix.

Table 2. Summary of *Dapnnia magna* range-finding water-effect ratio for POS.

Test Water	Hardness (mg/L)	Cu LC50 (µg/L)		Normalized[1] LC50 (µg/L)		WER
NPIN DMU Cu-Spiked Northwest Ponds Inlet Site Water	60	10	143.6	8	120.93	64	28.43387
(complete mix) NPOUT DMO Cu-Spiked Northwest Ponds Outlet Site Water (west branch)	90	4.3	132	3.3	75.87	96	17.83784
(complete mix) MCDF Cu-Spiked Miller Creek Detention Facility Site Water	92	4.4	168.8	4.7	95.03	95	22.34329
MCUP Cu-Spiked Miller Creek Upstream Site Water	46	5.6	111.6	4.0	120.72	64	28.38372
(complete mix) DMWEIR Cu-Spiked Des Moines Creek Weir Site Water (includes influence of East branch)	65	5.8	136.6	5.6	106.68	73	25.08299
Cu-Spiked Laboratory Water	90	5.0	7.4		4.25		n/a
Reference Toxicant (LC50) =				Acceptable			

WER = Calculated water effect ratio
n/a = not applicable
[1] LC50 adjusted to a hardness of 50 mg/L

In summary, given the results of WERs estimated based on nominal concentrations (17.8 – 28.4), we recommend pursuing a definitive WER and application of a site-specific water quality standard for copper.

REFERENCES

Parametrix, Inc. 1999. Water-effect ratio screening study at Seattle-Tacoma International Airport: Toxicity evaluation of site water. Prepared for the Port of Seattle, February 1999.

U.S. EPA. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. EPA/600/4-90/027F, August 1993. U.S. Environmental Protection Agency, Cincinnati, Ohio.

POS. 1999. Procedure Manual for Stormwater Monitoring. Port of Seattle, April 1999.