2008 Assessment of Microcystins in the Des Moines Water Works Source and Finished Waters

Toxic cyanobacteria (blue-green algae) blooms are an emerging issue for the Des Moines Water Works because of increased source water pollution caused by eutrophication. Microcystins are fresh water hepatoxins produced by a number of cyanobacterial genera (*Microcystis, Anabeena, Oscillatoria, Nostoc, Anabaenopsis*, and terrestrial *Hepalosiphon***)**. Microcystin-LR is the primary hepatoxin produced by *Microcystis aeruginosa.* It is speculated that low-level exposure to the microcystin toxin may promote the development of cancer and other chronic gastrointestinal disorders. In response to documented health risks and to protect consumers from adverse effects due to exposure to the microcystin toxin, the World Health Organization (WHO) issued a provisional concentration guideline of 1 microgram per liter microcystin for drinking water. The United States Environmental Protection Agency placed cyanobacteria on its Candidate Contaminant List in 2005.

The development of a quick, inexpensive and highly sensitive Enzyme-Linked ImmunoSorbent Assay, ELISA, made it feasible for the DMWW to effectively investigate the presence/absence of Microcytisn-LR. This development allowed DMWW to efficiently screen environmental waters of concern for public health risks from toxigenic cyanobacteria (microcystin). The following assessments present the findings of the summer 2008 survey of microcystin-LR in the source and treated waters for the DMWW.

Source and Finished waters for both the Fleur and McMullen treatment plants were included in this study. Figure 1 correlates the sample sites at both treatment plants with their abbreviation.

Fleur Treatment Plant

Sample Site	Sample ID
Raccoon River	RR
Des Moines River	DMR
Filter Effluent	FE

McMullen Treatment Plant

Sample Site	Sample ID
McMullen Raw	MR
McMullen Filter Effluent	MFE
Crystal Lake	CL
Maffitt Reservoir	MRES

Figure 1. Sample site identification

Source Water Assessment.
Microcystins were detected in some source water samples up to a concentration of 1.3 ug/L, as shown in Fig. 2. The majority of the raw water samples contained the microcystin toxin at concentrations below the WHO guideline of 1 ug/L. Peak levels of the microcystin toxin appeared in late August and the month of September in the Gallery recharge ponds and RR River (Figure 2). The "East Pond" and "Pond 17" are off-river storage reservoirs used to saturate the soil structure and enhance water yield from the Gallery.

SAMPLE	FLEUR TREATMENT PLANT					McMULLEN TREATMENT PLANT		
DATE	RR	DMR	FE	EAST POND	POND 17	MR	MFE	CL
7/7/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
7/14/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
7/21/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3
7/28/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
8/4/2008	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8/7/2008	0.9	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
8/11/2008	1.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2
8/18/2008	0.4	0.1	<0.1	0.6	0.2	<0.1	<0.1	0.4
8/25/2008	0.3	<0.1	<0.1	0.9	0.4	<0.1	<0.1	0.3
9/2/2008	0.2	<0.1	<0.1	0.4	0.5	<0.1	<0.1	0.2
9/8/2008	<0.1	<0.1	<0.1	0.3	0.3	<0.1	<0.1	0.1
9/15/2008	<0.1	<0.1	<0.1	0.4	0.5	0.1	<0.1	<0.1
9/22/2008	0.1	<0.1	<0.1	0.7	**1.3**	<0.1	<0.1	<0.1
9/29/2008	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1

Figure 2. 2008 Fleur and McMullen Treatment Plant Microcystin Assessment
***Bold exceeds the WHO drinking water guideline for Microcystin**

Comparison of the raw and filter effluent samples suggested that the existing water treatment process at both plants were effective for microcystin removal at the time of the study. Figure 3 is a graphic presentation of the microcystin results for the raw and finished waters of the Fleur plant and figure 4 is a graphic presentation of the microcystin results of the McMullen plant.

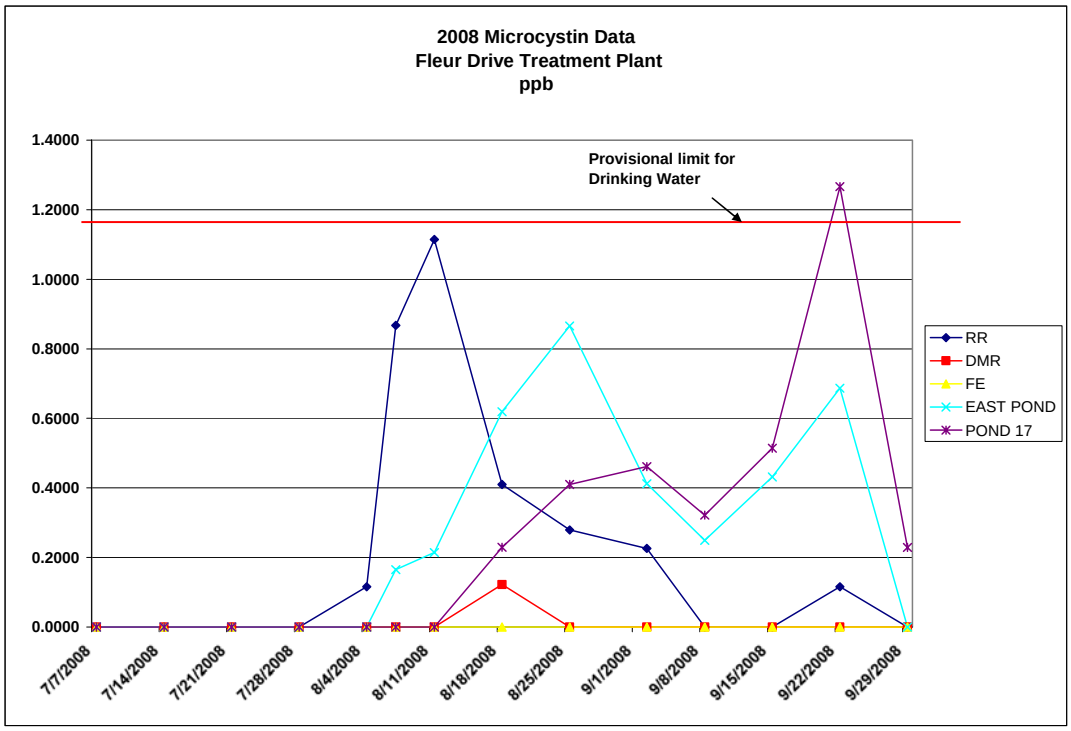

Figure 3. 2008 Microcystin Results Fleur Treatment Plant

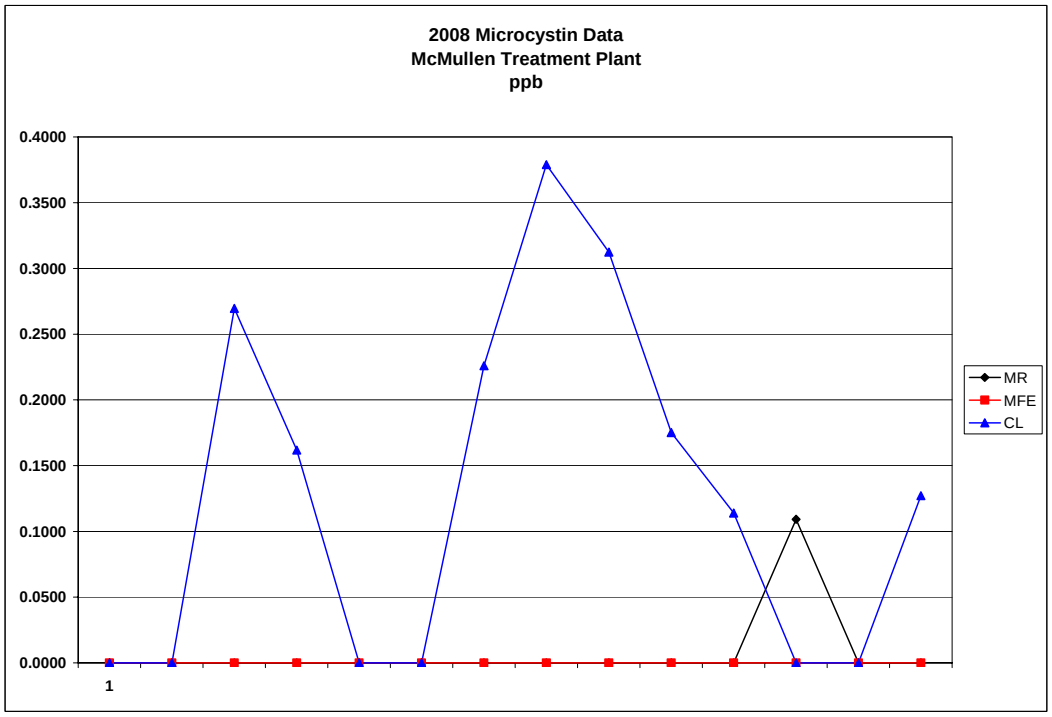

Figure 4. 2008 Microcystin Results McMullen Treatment Plant

Discussion.
The 2008 microcystin assessments demonstrated that ELISA kits are useful as a microcystin screen for environmental water samples. The majority of the raw water samples contained the microcystin toxin at concentrations well below the WHO guideline of 1 ug/L. However, the microcystin toxin was detected in the Raccoon River and Pond 17 at concentrations of 1.1 g/L and 1.3 ug/L respectively. These peak levels appeared in late August and the month of September in the Gallery recharge ponds and RR River. The microcystin toxin was not detected in the finished water at either of the treatment plants indicating complete toxin removal was achieved during the water treatment process.

Source water management, including monitoring of nitrogen and phosphorus fertilizer usage, sewage, wastewater, storm water, and flow rate, should remain essential operating practices of DMWW. Weekly monitoring of source water by ELISA, during the summer months following microscopic cyanobacteria detection, would be a proactive and inexpensive approach to detect microcystins. ELISA would also be a useful tool for the evaluation of the treatment process to ensure safe drinking water for the customers of the Des Moines Water Works.