

## TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: June 6<sup>th</sup> and June 22<sup>nd</sup>, 2011

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## Introduction

This technical memorandum summarizes the latest results of public health monitoring during 2011 for cyanobacteria species and the associated toxin microcystin in Copco and Iron Gate reservoirs in PacifiCorp's Klamath Hydroelectric Project (Project) and at one monitoring station in the Klamath River below Iron Gate Dam. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), a cyanobacterium that is known to produce microcystin, with a recent history of summertime blooms in Copco and Iron Gate reservoirs. This monitoring also estimates the presence of other potentially-toxicogenic cyanobacteria, including *Anabaena* spp. and *Planktothrix* (*Oscillatoria*) spp. This monitoring is being conducted pursuant to Interim Measure 15, Water Quality Monitoring Activities, contained in the Klamath Hydroelectric Settlement Agreement (KHSA) executed between the United States Department of Interior, the states of California and Oregon, PacifiCorp, and other parties.

The results addressed in this memorandum are specifically for samples collected on June 6<sup>th</sup> and 22<sup>nd</sup>, 2011. Subsequent memoranda will be prepared approximately every two weeks to report the results of continued monitoring.

## Methods

PacifiCorp is conducting phytoplankton sampling for laboratory analysis of potentially toxicogenic cyanobacteria, notably MSAE, and microcystin at four sites in Copco and Iron Gate reservoirs and one site below Iron Gate Dam (listed in Table 1), including:

- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir).
- One Klamath River site below Iron Gate Dam near the hatchery bridge.

Samples will be taken at the shoreline locations in the reservoirs once in May and twice per month in June, July, October, and November. Samples for the river site below Iron Gate Dam are scheduled to be collected twice per month in June, July and October and weekly in August and September but may change due to river conditions. Sampling in the river would increase when the potential for blooms exists.

Phytoplankton samples from the river sites are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (<http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring>). Additional samples at open water sites in Copco and Iron Gate reservoirs, including a grab sample at 0.5 m depth and an integrated sample over 8 m depth, will be collected as part of the baseline water quality monitoring.

Samples for potentially toxic phytoplankton are preserved in Lugol's solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The laboratory analysis of phytoplankton speciation and abundance is performed on prepared microscope slides of filtered samples using phase contrast microscopy. Species are counted as algal units of cell, filament, or colony depending on the natural growth form of the species. Algal forms are identified to species or otherwise to the lowest practicable taxonomic level. Biovolumes are estimated by multiplying the cell counts by the average geometric dimensions of the cells for a given phytoplankton taxon. Results for cyanobacteria species are reported as individual cells per milliliter.

Samples for determination of microcystin toxin are placed in a cooler on ice and shipped to the EPA Region 9 Laboratory in Richmond, California. The samples are analyzed using the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method based on the EnviroLogix QuantiPlate Kit for Microcystins. The quantitation limit is 0.18 µg/L or parts per billion (ppb). This test method does not distinguish between the specific microcystin congeners, but detects their presence to differing degrees. That is, ELISA test results yield one value as the sum of all measurable microcystin variants.

<b>Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs during 2011.</b>		
<b>Location</b>	<b>Approximate River Mile</b>	<b>Site ID</b>
Copco Reservoir at Mallard Cove ramp	201.5	CRMC
Copco Reservoir at Copco Cove ramp	200.0	CRCC
Iron Gate Reservoir at Camp Creek ramp	192.8	IRCC
Iron Gate Reservoir at John Williams campground	192.4	IRJW
Klamath River below Iron Gate dam near hatchery bridge	189.7	KRBI

## Results

### Samples of June 6 and 22, 2011

Five samples and four samples were collected for public health purposes on June 6, 2011 and June 22, 2011 respectively, from shoreline stations in Copco and Iron Gate reservoirs and the Klamath River below Iron Gate dam. Aliquots were sent to the EPA Region 9 laboratory for analysis for Microcystin via ELISA, to Aquatic Analysts for cyanobacteria species identification and enumeration, and held for potential subsequent analysis for microcystin and anatoxin-a via LCMS.

The results of cyanobacteria species identification and enumeration are summarized in Table 2a/b. The June 6 sampling event detected the presence of one potentially toxigenic species (*Anabaena*) at one location. The June 22 results detected the presence of potentially toxigenic species at all locations except IRJW; however, the cell counts were still low.

The results of microcystin analysis are summarized in Table 3a/b. There was no detection of microcystin for the June 6 results, and for the June 22 results, 2 sites had reported concentrations below the quantitation limit and should be considered estimated values.

**Table 2a.** Summary of cyanobacteria public health monitoring on June 6, 2011.

Date	Sample	Location	Species	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	Cells/mL
06/06/11	KR11806	CRMC	Anabaena flos-aquae	9,623	144
06/06/11	KR11807	CRCC	None		
06/06/11	KR11808	IRCC	None		
06/06/11	KR11809	IRJW	None		
06/06/11	KR11812	KRBI	None		

**Table 2b.** Summary of cyanobacteria public health monitoring on June 22, 2011.

Date	Sample	Location	Species	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	Cells/mL
06/22/11	KR11813	CRMC	Aphanizomenon flos-aquae	49,869	792
06/22/11	KR11813	CRMC	Microcystis aeruginosa	1,277	160
06/22/11	KR11814	CRCC	Anabaena flos-aquae	378,226	5,645
06/22/11	KR11814	CRCC	Aphanizomenon flos-aquae	201,984	3,206
06/22/11	KR11815	IRCC	Aphanizomenon flos-aquae	23,588	374
06/22/11	KR11815	IRCC	Anabaena sp.	2,572	38
06/22/11	KR11815	IRCC	Anabaena flos-aquae	1,267	19
06/22/11	KR11815	IRCC	Microcystis aeruginosa	1,210	151
06/22/11	KR11816	IRJW	None		

**Table 3a.** Summary of microcystin public health monitoring on June 6, 2011.

Date	Sample	Location	Result	Units
06/06/11	KR11806	CRMC	ND	$\mu\text{g/L}$
06/06/11	KR11807	CRCC	ND	$\mu\text{g/L}$
06/06/11	KR11808	IRCC	ND	$\mu\text{g/L}$
06/06/11	KR11809	IRCJW	ND	$\mu\text{g/L}$
06/06/11	KR11812	KRBI	ND	$\mu\text{g/L}$

**Table 3b.** Summary of microcystin public health monitoring on June 22, 2011.

Date	Sample	Location	Result	Units
06/22/11	KR11813	CRMC	0.16	$\mu\text{g/L}$
06/22/11	KR11814	CRCC	0.16	$\mu\text{g/L}$
06/22/11	KR11815	IRCC	ND	$\mu\text{g/L}$
06/22/11	KR11816	IRJW	ND	$\mu\text{g/L}$

## References

SWRCB. 2007. Cyanobacteria in California Recreational Water Bodies: Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification. June 2007. Document provided as part of Blue-green Algae Work Group of State Water Resources Control Board (SWRCB) and Office of Environmental Health and Hazard Assessment (OEHHA).

## Appendix 1

### Cumulative Species data for 2011 Public Health Samples.

Date	Sample	Location	Species	Biovolume, µm <sup>3</sup> /mL	Cells/mL
05/24/11	KR11800	CRMC	NA	0	0
05/24/11	KR11801	CRCC	NA	0	0
05/24/11	KR11802	IRCC	NA	0	0
05/24/11	KR11803	IRJW	NA	0	0
05/24/11	KR11804	CRCC	NA	0	0
06/06/11	KR11806	CRMC	<i>Anabaena flos-aquae</i>	9,623	144
06/06/11	KR11807	CRCC	None		
06/06/11	KR11808	IRCC	None		
06/06/11	KR11809	IRJW	None		
06/06/11	KR11812	KRBI	None		
06/22/11	KR11813	CRMC	<i>Aphanizomenon flos-aquae</i>	49,869	792
06/22/11	KR11813	CRMC	<i>Microcystis aeruginosa</i>	1,277	160
06/22/11	KR11814	CRCC	<i>Anabaena flos-aquae</i>	378,226	5,645
06/22/11	KR11814	CRCC	<i>Aphanizomenon flos-aquae</i>	201,984	3,206
06/22/11	KR11815	IRCC	<i>Aphanizomenon flos-aquae</i>	23,588	374
06/22/11	KR11815	IRCC	<i>Anabaena sp.</i>	2,572	38
06/22/11	KR11815	IRCC	<i>Anabaena flos-aquae</i>	1,267	19
06/22/11	KR11815	IRCC	<i>Microcystis aeruginosa</i>	1,210	151
06/22/11	KR11816	IRJW	None		



Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11807			
Sample Depth:					
Sample Date:		6-Jun-11			
Total Density (#/mL):		<3			
Total Biovolume (um <sup>3</sup> /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<3				
NOTE: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM56			

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11808			
Sample Depth:					
Sample Date:		6-Jun-11			
Total Density (#/mL):		<122			
Total Biovolume (um <sup>3</sup> /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<122				
Note: This sample contained a huge amount of Spirogyra... could not get lower detection limit.					
NOTE: Toxic Algae Only					
Aquatic Analysts			Sample ID: PM57		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11809			
Sample Depth:					
Sample Date:		6-Jun-11			
Total Density (#/mL):		<5			
Total Biovolume (um <sup>3</sup> /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<5				
NOTE: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM58			

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11812			
Sample Depth:					
Sample Date:		6-Jun-11			
Total Density (#/mL):		<2			
Total Biovolume (um <sup>3</sup> /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<2				
NOTE: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM60			

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11813			
Sample Depth:					
Sample Date:		22-Jun-11			
Total Density (#/mL):		51			
Total Biovolume (um <sup>3</sup> /mL):		51,145			
Trophic State Index:		28.5			
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	49	96.9	49,869	97.5	bluegreen
2 Microcystis aeruginosa	2	3.1	1,277	2.5	bluegreen
Aphanizomenon flos-aquae cells/mL =		792			
Microcystis aeruginosa cells/mL =		160			
Note: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM75			

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11814			
Sample Depth:					
Sample Date:		22-Jun-11			
Total Density (#/mL):		322			
Total Biovolume (um <sup>3</sup> /mL):		580,210			
Trophic State Index:		45.9			
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	176	54.8	378,226	65.2	bluegreen
2 Aphanizomenon flos-aquae	146	45.2	201,984	34.8	bluegreen
Anabaena flos-aquae cells/mL =		5,645			
Aphanizomenon flos-aquae cells/mL =		3,206			
Note: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM76			



Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11816			
Sample Depth:					
Sample Date:		22-Jun-11			
Total Density (#/mL):		<3			
Total Biovolume (um <sup>3</sup> /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um <sup>3</sup> /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<3				
Note: Toxic Algae Only					
Aquatic Analysts		Sample ID: PM78			