TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: May and June 2012

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Introduction

This technical memorandum summarizes the results to date for the public health monitoring during 2012 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 with a recent history of summertime blooms in Copco and Iron Gate reservoirs and that is known to produce microcystin. This monitoring also estimates the presence of other potentially-toxigenic 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 include the May 21st, June 12th, and June 25th sampling. Subsequent memoranda will be prepared approximately every two weeks to report the results of continued monitoring.

Methods

PacifiCorp is conducting phytoplankton sampling at 5 sites (Table 1) for laboratory analysis of potentially toxigenic cyanobacteria, notably MSAE, and microcystin at:

- 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 are planned to be taken at shoreline locations in the reservoirs once in May and August; 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.

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. 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 measurable microcystin variants.

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs and the Klamath River during 2012.

Location	Approximate River Mile	Site ID
Copco Reservoir at Mallard Cove	201.5	CRMC
Copco Reservoir at Copco Cove	200.0	CRCC
Iron Gate Reservoir at Camp Creek	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

Sampling results from the five sites for the May 21st and June 12th sampling events show cell counts below the posting guidelines and microcystin levels were either non-detects or less than the posting guidelines (Appendix 1). The most recent sampling, June 25th, also had cell counts and microcystin levels below the posting guidelines (Table 2).

Table 2. Summary of public health monitoring on June 25th, 2012.										
Date	Time	Location	RM	Sample ID	Depth	MSAE[1]	AFA[2]	ANA[3]	Other	Microcystin (ug/l)
6/25/2012	13:25	CRMC	201.5	KR12810	SG	119	0	0	24([7])	ND
6/25/2012	12:45	CRCC	200.0	KR12811	SG	284	0	56	111([7])	0.37
6/25/2012	14:15	IRCC	192.8	KR12812	SG	0	0	0	28([7])	0.16
6/25/2012	14:05	IRJW	192.4	KR12813	SG	117	0	87	0	0.19
6/25/2012	13:50	KRBI	189.7	KR12815	SG	0	0	0	0	ND

[1]MSAE = *Microcystis aeruginosa*
[2]AFA = *Aphanizomenon flos-aquae*
[3]ANA = *Anabaena flos-aqua*
Other = either [5]*Planktothrix* or [6]*Gloeotrichia* or [7]*Oscillatoria sp.* or [8]*Lyngbya sp.*
"0" value indicates non-detect by analytical laboratory

References

SWRCB. 2010. Cyanobacteria in California Recreational Water Bodies: Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification. July 2010. 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 2012 Public Health Samples

Table 3. Summary of 2012 public health monitoring

Date	Time	Location	RM	Sample ID	Depth	MSAE	AFA	ANA	Other	Microcystin (ug/l)
5/21/2012	12:40	CRMC	201.5	KR12800	SG	0	0	26	290([7]) / 329([8])	**
5/21/2012	13:10	CRCC	200.0	KR12801	SG	0	0	0	58([7])	**
5/21/2012	11:30	IRCC	192.8	KR12802	SG	0	0	0	0	ND
5/21/2012	11:50	IRJW	192.4	KR12803	SG	0	0	0	0	ND
6/12/2012	15:00	CRMC	201.5	KR12804	SG	2,832	0	2,124	1,035([7])	0.29
6/12/2012	16:00	CRCC	200.0	KR12805	SG	8,575	0	0	0	0.74
6/12/2012	13:50	IRCC	192.8	KR12806	SG	0	0	0	0	0.3
6/12/2012	14:00	IRJW	192.4	KR12807	SG	0	0	67	0	ND
6/12/2012	14:10	KRBI	189.7	KR12809	SG	0	0	0	0	ND
6/25/2012	13:25	CRMC	201.5	KR12810	SG	119	0	0	24([7])	ND
6/25/2012	12:45	CRCC	200.0	KR12811	SG	284	0	56	111([7])	0.37
6/25/2012	14:15	IRCC	192.8	KR12812	SG	0	0	0	28([7])	0.16
6/25/2012	14:05	IRJW	192.4	KR12813	SG	117	0	87	0	0.19
6/25/2012	13:50	KRBI	189.7	KR12815	SG	0	0	0	0	ND

**Bottles were damaged during shipping and could not be analyzed

Appendix 2

Laboratory Data Sheets June 25th, 2012 Public Health Sampling

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12810
Sample Depth:	
Sample Date:	25-Jun-12
Total Density (#/mL):	8
Total Biovolume (um³/mL):	2,437
Trophic State Index:	8.9

	Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	6	75.0	956	39.2	bluegreen
2	Oscillatoria sp.	2	25.0	1,481	60.8	bluegreen

Microcystis aeruginosa cells/mL = 119

Oscillatoria sp. cells/mL = 24

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF55

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12811
Sample Depth:	
Sample Date:	25-Jun-12
Total Density (#/mL):	33
Total Biovolume (um³/mL):	12,906
Trophic State Index:	19.0

	Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	17	50.0	2,272	17.6	bluegreen
2	Oscillatoria sp.	11	33.3	6,904	53.5	bluegreen
3	Anabaena flos-aquae	6	16.7	3,730	28.9	bluegreen

Oscillatoria sp. cells/mL = 111

Microcystis aeruginosa cells/mL = 284

Anabaena flos-aquae cells/mL = 56

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF56

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12812
Sample Depth:	
Sample Date:	25-Jun-12
Total Density (#/mL):	2
Total Biovolume (um^3/mL):	1,708
Trophic State Index:	7.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Oscillatoria sp.	2	100.0	1,708	100.0	bluegreen

Oscillatoria sp. cells/mL = 28

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF57

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12813
Sample Depth:	
Sample Date:	25-Jun-12
Total Density (#/mL):	15
Total Biovolume (um^3/mL):	6,788
Trophic State Index:	14.8

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	12	80.0	932	13.7	bluegreen
2	Anabaena flos-aquae	3	20.0	5,856	86.3	bluegreen

Microcystis aeruginosa cells/mL = 117

Anabaena flos-aquae cells/mL = 87

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF58

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12815
Sample Depth:	
Sample Date:	25-Jun-12
Total Density (#/mL):	<4
Total Biovolume (um^3/mL):	
Trophic State Index:	

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	No Toxic Algae Present	<4				

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF60