TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: July 24th, 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 all the available data for the 2012 public health sampling up to and including the July 24th sampling event. 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, collected 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, June 12th, and June 25th 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 July 11th sampling had cell counts at Copco Reservoir at Copco Cove and microcystin levels at Iron Gate Reservoir (John Williams campground) (Table 3) above the posting guidelines. Both of these reservoirs are currently posted with health advisory guidelines. However, the cell counts at Iron Gate reservoir continue to remain below posting guidelines (40,000 cells/mL of MSAE) and the microcystin levels at this reservoir were below the posting guidelines (8 ug/l) the following week (Appendix 1). Results from the July 24 sampling event are not yet available. Cell counts at Copco Cove in Copco Reservoir continue to be above the posting guidelines.

Table 2. Summary of public health monitoring on July 24th, 2012.

Date	Time	Location	RM	Sample ID	Depth	MSAE	AFA	ANA	Other	Microcystin (ug/l)
7/24/2012	11:00	CRMC	201.5	KR12826	SG	1,973,811	0	11,504	0	*
7/24/2012	12:35	CRCC	200.0	KR12827	SG	9,616,424	0	156,930	0	*
7/24/2012	12:00	IRCC	192.8	KR12828	SG	8,016	0	0	847([7])	*
7/24/2012	11:45	IRJW	192.4	KR12829	SG	6,497	43	107	64([7])	*
7/24/2012	11:30	KRBI	189.7	KR12831	SG	322	107	43	0	*

* Results were not available upon release of this memo and will be release with the subsequent memo

[1]MSAE = *Microcystis aeruginosa* (cells/mL)
[2]AFA = *Aphanizomenon flos-aquae* (cells/mL)
[3]ANA = *Anabaena flos-aquae* (cells/mL)
Other = either [5]*Planktothrix (Oscillatoria) sp.* or [6]*Gloeotrichia echinulata* or [7]*Anabaena sp.* or [8]*Lyngbya sp.* (cells/mL)
"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 cyanobacteria public health monitoring (2012).

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([5]) / 329([8])	**
5/21/2012	13:10	CRCC	200.0	KR12801	SG	0	0	0	58([5])	**
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([5])	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([5])	ND
6/25/2012	12:45	CRCC	200.0	KR12811	SG	284	0	56	111([5])	0.37
6/25/2012	14:15	IRCC	192.8	KR12812	SG	0	0	0	28([5])	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
7/11/2012	11:50	CRMC	201.5	KR12816	SG	2,019	0	2,042	0	5.9
7/11/2012	12:30	CRCC	200.0	KR12817	SG	694,479	0	1,173,209	0	460
7/11/2012	14:00	IRCC	192.8	KR12818	SG	821	0	1,195	112([7])	0.86
7/11/2012	14:15	IRJW	192.4	KR12819	SG	26,670	0	3,196	499([7])	9.8
7/11/2012	14:30	KRBI	189.7	KR12821	SG	0	0	0	0	0.17
7/17/2012	18:15	CRMC	201.5	KR12822	SG	7,362	0	0	0	1.6
7/17/2012	18:45	CRCC	200.0	KR12823	SG	9,095	167	543	0	2.7
7/17/2012	19:15	IRCC	192.8	KR12824	SG	259	0	0	35([7])	0.32
7/17/2012	19:30	IRJW	192.4	KR12825	SG	0	893	3,046	7,527([6])	0.32
7/24/2012	11:00	CRMC	201.5	KR12826	SG	1,973,811	0	11,504	0	*
7/24/2012	12:35	CRCC	200.0	KR12827	SG	9,616,424	0	156,930	0	*
7/24/2012	12:00	IRCC	192.8	KR12828	SG	8,016	0	0	847([7])	*
7/24/2012	11:45	IRJW	192.4	KR12829	SG	6,497	43	107	64([7])	*
7/24/2012	11:30	KRBI	189.7	KR12831	SG	322	107	43	0	*

* Results were not available upon release of this memo and will be release with the subsequent memo
**Bottles were damaged during shipping and could not be analyzed

Appendix 2

Laboratory Data Sheets July 24th, 2012 Public Health Sampling

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12826
Sample Depth:	
Sample Date:	24-Jul-12
Total Density (#/mL):	94,514
Total Biovolume (um^3/mL):	16,561,243
Trophic State Index:	70.1

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	93,991	99.4	15,790,490	95.3	bluegreen
2	Anabaena flos-aquae	523	0.6	770,752	4.7	bluegreen

Microcystis aeruginosa cells/mL = 1,973,811

Anabaena flos-aquae cells/mL = 11,504

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF79

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12827
Sample Depth:	
Sample Date:	24-Jul-12
Total Density (#/mL):	305,576
Total Biovolume (um^3/mL):	87,445,679
Trophic State Index:	82.1

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	300,513	98.3	76,931,396	88.0	bluegreen
2	Anabaena flos-aquae	5,062	1.7	10,514,283	12.0	bluegreen

Microcystis aeruginosa cells/mL = 9,616,424

Anabaena flos-aquae cells/mL = 156,930

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF80

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12828
Sample Depth:	
Sample Date:	24-Jul-12
Total Density (#/mL):	855
Total Biovolume (um^3/mL):	121,719
Trophic State Index:	34.7

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	802	93.8	64,126	52.7	bluegreen
2	Anabaena sp.	53	6.2	57,592	47.3	bluegreen

Microcystis aeruginosa cells/mL =	8,016
Anabaena sp. cells/mL =	847

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF81

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 12829
Sample Depth:	
Sample Date:	24-Jul-12
Total Density (#/mL):	671
Total Biovolume (um^3/mL):	66,254
Trophic State Index:	30.4

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	650	96.8	51,972	78.4	bluegreen
2	Anabaena flos-aquae	11	1.6	7,195	10.9	bluegreen
3	Aphanizomenon flos-aquae	5	0.8	2,706	4.1	bluegreen
4	Anabaena sp.	5	0.8	4,381	6.6	bluegreen

Microcystis aeruginosa cells/mL =	6,497
Anabaena flos-aquae cells/mL =	107
Aphanizomenon flos-aquae cells/mL =	43
Anabaena sp. cells/mL =	64

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF82

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 12830
Sample Depth:
Sample Date: 24-Jul-12

Total Density (#/mL): 925
Total Biovolume (um^3/mL): 130,568
Trophic State Index: 35.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	889	96.1	71,144	54.5	bluegreen
2	Aphanizomenon flos-aquae	32	3.4	54,025	41.4	bluegreen
3	Anabaena sp.	4	0.4	5,399	4.1	bluegreen

Microcystis aeruginosa cells/mL = 8,893

Aphanizomenon flos-aquae cells/mL = 858

Anabaena sp. cells/mL = 79

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF83

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 12831
Sample Depth:
Sample Date: 24-Jul-12

Total Density (#/mL): 43
Total Biovolume (um^3/mL): 12,220
Trophic State Index: 18.6

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	32	75.0	2,577	21.1	bluegreen
2	Anabaena flos-aquae	5	12.5	2,878	23.6	bluegreen
3	Aphanizomenon flos-aquae	5	12.5	6,765	55.4	bluegreen

Microcystis aeruginosa cells/mL = 322

Anabaena flos-aquae cells/mL = 43

Aphanizomenon flos-aquae cells/mL = 107

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** QF84