TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: September 22nd and 28th, 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-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 are specifically for samples collected on September 22nd and 28th, 2011. Also included are the results from the ELISA analysis for samples previously collected. 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 toxigenic 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 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. 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.

Table 1. **Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs and the Klamath River during 2011.**

Location	Approximate River Mile	Site ID
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

One sample was collected for public health purposes on both September 22nd and 28th, 2011, from 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 via LCMS.

The results of cyanobacteria species identification and enumeration are summarized in Table 2.

The Klamath River below Iron Gate dam was posted with public health advisories on September 2nd, 2011since the levels o MSAE were present above California's posting guidelines (40,000 cell/mL) (SWRCB 2010). Although the cell count of MSAE was below the posting guidelines on September 22, it was above the guidelines on September 28.

The results from the microcystin analysis for samples collected on September 7 and 15, 2011 are summarized in Table 3. Both samples are below the posting guidelines of 8 ug/l.

The results from previous public health sampling showed that cell counts at both coves in Copco reservoir and at the John Williams campground at Iron Gate reservoir exceed California's posting guidelines

(SWRCB 2010). The reservoirs were posted with public health advisory signs on August 17th, 2011. Since the reservoirs have been posted, public health sampling at the reservoir locations has been discontinued until the blooms have visibly diminished and data are need for de-posting purposes. Public health sampling continues in the Klamath River below Iron Gate dam.

Table 2. Summary of cyanobacteria public health monitoring on September 22nd and 28th, 2011.

Date	Sample	Location	Species	Biovolume (μm^3/mL)	Cells/mL
09/22/11	KR11850	KRBI	*Microcystis aeruginosa*	244,395	30,549
09/22/11	KR11850	KRBI	*Aphanizomenon flos-aquae*	89,725	1,424
09/22/11	KR11850	KRBI	*Anabaena* sp.	4,035	59
09/28/11	KR11851	KRBI	*Microcystis aeruginosa*	441,054	55,132
09/28/11	KR11851	KRBI	*Aphanizomenon flos-aquae*	92,404	1,467
09/28/11	KR11851	KRBI	*Anabaena* sp.	38,402	565

The results of microcystin analysis for samples collected on September 22 and 28 are not available and will be added to subsequent memos once they have been received.

Table 3. Summary of microcystin public health monitoring on September7 and 15th.r7.

Date	Sample	Location	Result	Units
09/07/11	KR11848	KRBI	5.8	µg/L
09/15/11	KR11849	KRBI	4.7	µg/L

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 2011 Public Health Samples

Date	Sample	Location	Species	Biovolume, $\mu m^3/mL$	Cells/mL
05/24/11	KR11800	CRMC	None	0	0
05/24/11	KR11801	CRCC	None	0	0
05/24/11	KR11802	IRCC	None	0	0
05/24/11	KR11803	IRJW	None	0	0
05/24/11	KR11804	CRCC	None	0	0
06/06/11	KR11806	CRMC	*Anabaena flos-aquae*	9,623	144
06/06/11	KR11807	CRCC	None	0	0
06/06/11	KR11808	IRCC	None	0	0
06/06/11	KR11809	IRJW	None	0	0
06/06/11	KR11812	KRBI	None	0	0
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	0	0
07/05/11	KR11820	CRMC	None	0	0
07/05/11	KR11821	CRCC	None	0	0
07/05/11	KR11822	IRCC	*Oscillatoria sp.*	1,268	20
07/05/11	KR11823	IRJW	*Aphanizomenon flos-aquae*	2,208	35
07/05/11	KR11823	IRJW	*Anabaena flos-aquae*	7,044	105
07/05/11	KR11824	KRBI	*Aphanizomenon flos-aquae*	13,708	218
07/18/11	KR11827	CRMC	*Anabaena flos-aquae*	131,944	1,969
07/18/11	KR11828	CRCC	*Anabaena flos-aquae*	3,082,134	46,002
07/18/11	KR11828	CRCC	*Aphanizomenon flos-aquae*	623,338	9,894
07/18/11	KR11829	IRCC	*Anabaena flos-aquae*	506,274	7,556
07/18/11	KR11829	IRCC	*Aphanizomenon flos-aquae*	18,170	288
07/18/11	KR11829	IRCC	*Anabaena sp.*	2,451	36
07/18/11	KR11829	IRCC	*Microcystis aeruginosa*	8,652	1,082
07/18/11	KR11830	IRJW	*Aphanizomenon flos-aquae*	1,186,477	8,762
07/18/11	KR11830	IRJW	*Anabaena flos-aquae*	587,073	18,833
07/18/11	KR11830	IRJW	*Anabaena sp.*	20,221	297
07/18/11	KR11833	KRBI	*Aphanizomenon flos-aquae*	6,899	110
07/18/11	KR11833	KRBI	*Anabaena flos-aquae*	3,252	49
07/18/11	KR11833	KRBI	*Microcystis aeruginosa*	498	62
08/08/11	KR11834	CRMC	*Microcystis aeruginosa*	772,802	96,600
08/08/11	KR11834	CRMC	*Aphanizomenon flos-aquae*	94,014	1,492
08/08/11	KR11834	CRMC	*Anabaena flos-aquae*	27,773	415
08/08/11	KR11835	CRCC	*Microcystis aeruginosa*	67,717,650	8,464,706
08/08/11	KR11835	CRCC	*Aphanizomenon flos-aquae*	6,712,571	106,549
08/08/11	KR11835	CRCC	*Anabaena flos-aquae*	16,694,893	249,178

Date	Sample	Location	Species	Biovolume, µm^3/mL	Cells/mL
08/08/11	KR11836	IRCC	*Microcystis aeruginosa*	180,818	22,602
08/08/11	KR11836	IRCC	*Anabaena flos-aquae*	1,242,838	18,550
08/08/11	KR11836	IRCC	*Aphanizomenon flos-aquae*	98,828	1,569
08/08/11	KR11837	IRJW	*Microcystis aeruginosa*	4,510,000	563,750
08/08/11	KR11837	IRJW	*Aphanizomenon flos-aquae*	2,927,400	46,467
08/08/11	KR11837	IRJW	*Anabaena flos-aquae*	457,833	6,833
08/08/11	KR11840	KRBI	*Aphanizomenon flos-aquae*	43,396	689
08/08/11	KR11840	KRBI	*Anabaena flos-aquae*	7,082	106
08/22/11	KR11841	CRMC	*Microcystis aeruginosa*	4,007,067	500,883
08/22/11	KR11841	CRMC	*Aphanizomenon flos-aquae*	129,150	2,050
08/22/11	KR11842	CRCC	*Microcystis aeruginosa*	39,425,446	4,928,181
08/22/11	KR11842	CRCC	*Aphanizomenon flos-aquae*	1,300,595	20,644
08/22/11	KR11843	IRCC	*Microcystis aeruginosa*	169,355	21,169
08/22/11	KR11843	IRCC	*Aphanizomenon flos-aquae*	54,120	859
08/22/11	KR11844	IRJW	*Aphanizomenon flos-aquae*	121,783,997	1,933,079
08/22/11	KR11844	IRJW	*Gloeotrichia echinulata*	10,071,593	148,112
08/22/11	KR11847	KRBI	*Microcystis aeruginosa*	114,649	14,331
08/22/11	KR11847	KRBI	*Aphanizomenon flos-aquae*	79,756	1,266
08/22/11	KR11847	KRBI	*Anabaena flos-aquae*	3,313	49
09/07/11	KR11848	KRBI	*Microcystis aeruginosa*	401,058	50,132
09/07/11	KR11848	KRBI	*Aphanizomenon flos-aquae*	837,436	13,293
09/15/11	KR11849	KRBI	*Microcystis aeruginosa*	195,433	24,429
09/15/11	KR11849	KRBI	*Aphanizomenon flos-aquae*	295,969	4,698
09/22/11	KR11850	KRBI	*Microcystis aeruginosa*	244,395	30,549
09/22/11	KR11850	KRBI	*Aphanizomenon flos-aquae*	89,725	1,424
09/22/11	KR11850	KRBI	*Anabaena* sp.	4,035	59
09/28/11	KR11851	KRBI	*Microcystis aeruginosa*	441,054	55,132
09/28/11	KR11851	KRBI	*Aphanizomenon flos-aquae*	92,404	1,467
09/28/11	KR11851	KRBI	*Anabaena* sp.	38,402	565

Appendix 2

Laboratory Data Sheets for September 22nd and 28th, 2011 Public Health Samples

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 11850
Sample Depth:	
Sample Date:	22-Sep-11
Total Density (#/mL):	2,878
Total Biovolume (um^3/mL):	338,155
Trophic State Index:	42.0

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	2,777	96.5	244,395	72.3	bluegreen
2	Aphanizomenon flos-aquae	95	3.3	89,725	26.5	bluegreen
3	Anabaena sp.	6	0.2	4,035	1.2	bluegreen

Microcystis aeruginosa cells/mL = 30,549

Aphanizomenon flos-aquae cells/mL = 1,424

Anabaena sp. cells/mL = 59

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** PN46

Phytoplankton Sample Analysis

Sample:	Klamath Basin
Sample Site:	KR 11851
Sample Depth:	
Sample Date:	24-Sep-11
Total Density (#/mL):	5,145
Total Biovolume (um^3/mL):	571,860
Trophic State Index:	45.8

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	5,012	97.4	441,054	77.1	bluegreen
2	Aphanizomenon flos-aquae	86	1.7	92,404	16.2	bluegreen
3	Anabaena sp.	47	0.9	38,402	6.7	bluegreen

Microcystis aeruginosa cells/mL = 55,132

Aphanizomenon flos-aquae cells/mL = 1,467

Anabaena sp. cells/mL = 565

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** PN47

Note: 24-Sep-11 is the incorrect sample date. Changes were made in Table 2 and Appendix 1 to reflect the correct date.