TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: July 19, 2010

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Introduction

This technical memorandum summarizes the latest results of monitoring during 2010 for cyanobacteria species and the associated toxin microcystin in Copco and Iron Gate reservoirs in PacifiCorp's Klamath Hydroelectric Project (Project) and in 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 July 19, 2010. Subsequent memoranda such as this will be prepared 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 six sites in Copco and Iron Gate reservoirs and one site below Iron Gate Dam as 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.
- Two open-water reservoir sites in the lower ends of Iron Gate and Copco reservoirs (near the log booms). These sites are part of the basic water quality monitoring that is being performed under the 2010 KHSA Measure 15 water quality monitoring plan. The plan is available on the Regional Board's website.[1]

Samples will be taken at the shoreline locations in the reservoirs twice per month in June through October. Samples for the river site below Iron Gate Dam will be collected twice per month in June, July and October and weekly in August and September. Sampling will occur at the two open-water monitoring sites once per month in April through December.

[1] http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/klamath_river/

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. This SOP is an appendix to the 2010 KHSA Measure 15 water quality monitoring plan. Additional samples at open-water sites in Copco and Iron Gate reservoirs, including a grab sample at 0.5 m depth and an additional sample integrated 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 taxa. 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 0.16 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. Samples are also sent to the California Department of Fish and Game laboratory in Rancho Cordova, California for analysis for microcystin congeners and other toxins by liquid chromatography and mass spectrometry (LC/MS).

Table 1. Sites of Cyanobacteria and Microcystin Public Health Monitoring in Copco and Iron Gate reservoirs during 2010.

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 Williams campground	192.4	IRJW
Klamath River below Iron Gate dam near hatchery bridge	189.7	KRBI

Results

Samples of July 19, 2010

Five samples and one replicate, plus one blank for microcystin, were collected for public health purposes on July 19, 2010 from shoreline stations in Copco and Iron Gate reservoirs and the Klamath River below Iron Gate dam. Aliquots were sent to Aquatic Analysts for cyanobacteria species identification and enumeration, to the EPA Region 9 laboratory for analysis for microcystin by ELISA methodology, and to the California Fish and Game laboratory for microcystin analysis by LC/MS.

The results of cyanobacteria species identification and enumeration are summarized in Table 2. Five cyanobacteria species capable of producing potentially harmful toxins were observed in the samples collected on July 19. *Aphanizomenon flos-aquae* was observed at every location sampled. *Anabaena flos-aquae* was observed at every location except below Iron Gate dam. *Microcystis aeruginos*a was observed at both shoreline locations in Copco reservoir and at Camp Creek in Iron Gate reservoir. No species at any location exceeded 40,000 cells/mL. *Anabaena flos-aquae* exceeded 20,000 cells/mL at Camp Creek in Iron Gate reservoir.

Results from microcystin analyses for samples collected on July 19 are not yet available. Results for ELISA analysis of microcystin analysis through July 6 are provided in Appendix 1. In samples collected May 27 and June 7 and analyzed by LC/MS for nine congeners of microcystin, anatoxin a, domoic acid, and okadaic acid all results have been below the method reporting limit.

Table 2. Summary of cyanobacteria public health monitoring on July 19, 2010.

Date	Sample	Location	Species	Biovolume, $\mu m^3/mL$	Cells/mL
07/19/10	KR 10151	KRBI	*Aphanizomenon flos-aquae*	3,748	59
07/19/10	KR 10152	IRCC	*Anabaena flos-aquae*	1,498,364	22,364
			Microcystis aeruginosa	35,285	4,411
			Aphanizomenon flos-aquae	11,741	186
07/19/10	KR 10153	IRJW	*Aphanizomenon flos-aquae*	47,626	756
			Anabaena flos-aquae	31,656	472
			Anabaena sp.	10,077	148
07/19/10	KR 10154	CRMC	*Microcystis aeruginosa*	18,080	2,260
			Anabaena flos-aquae	33,800	504
			Aphanizomenon flos-aquae	5,085	81
			Oscillatoria sp.	2,502	40
07/19/10	KR 10155	CRCC	*Anabaena flos-aquae*	91,080	1,359
			Aphanizomenon flos-aquae	57,431	912
			Microcystis aeruginosa	1,279	160
07/19/10	KR10156	KRBI (dup)	*No toxic algae present*		

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 2010 Public Health Samples.

Date	Sample	Location	Species	Biovolume, $\mu m^3/mL$	Cells/mL	Microcystin, µg/L (ELISA)
05/27/10	KR10070	KRBI	*NA*	0	0	
05/27/10	KR10072	CRMC	*NA*	0	0	
05/27/10	KR10073	CRCC	*Anabaena flos-aquae*	8,324	124	
05/27/10	KR10074	IRJW	*NA*	0	0	
05/27/10	KR10075	IRCC	*NA*	0	0	
06/07/10	KR10076	KRBI	*NA*	0	0	0.26
06/07/10	KR10078	CRMC	*NA*	0	0	0.25
06/07/10	KR10079	CRCC	*Anabaena flos-aquae*	4,700	70	0.47
06/07/10	KR10080	IRJW	*NA*	0	0	ND
06/07/10	KR10081	IRCC	*NA*	0	0	ND
06/21/10	KR10112	KRBI	*Anabaena flos-aquae*	13,021	164	
06/21/10	KR10110	CRMC	*Anabaena flos-aquae*	3,672,205	54,809	0.44
06/21/10	KR10109	CRCC	*Anabaena flos-aquae*	7,408,676	110,582	0.46
06/21/10	KR10107	IRJW	*Anabaena flos-aquae*	343,999	5,134	0.16
			Anabaena sp.	35,906	643	
			Anabaena planctonica	117,661	528	
06/21/10	KR10108	IRCC	*Anabaena flos-aquae*	97,509	1,455	0.21
			Anabaena planktonica	28,535	156	
07/06/10	KR10117	KRBI	*Anabaena flos-aquae*	230,529	3,441	ND
			Aphanizomenon flos-aquae	108,049	1,715	
			Microcystis aeruginosa	2,117	256	
			Anabaena planctonica	9,687	53	
07/06/10	KR10118	IRJW	*Anabaena flos-aquae*	498,696	7,443	ND
			Anabaena planctonica	136,085	744	
07/06/10	KR10119	IRCC	*Anabaena flos-aquae*	643,510	9,605	ND
			Aphanizomenon flos-aquae	19,731	313	
			Anabaena sp.	16,565	244	
07/06/10	KR10120	CRCC	*Anabaena flos-aquae*	76,049	568	ND
			Aphanizomenon flos-aquae	35,755	1,135	
07/06/10	KR10121	CRMC	*Oscillatoria sp.*	23,644	381	ND
			Aphanizomenon flos-aquae	3,482	55	
			Anabaena flos-aquae	7,406	111	
07/06/10	KR10123	KRBI (blank)	*NA*	NA	NA	ND
07/06/10	KR10123	KRBI (dup)	*Anabaena flos-aquae*	166,633	2,487	ND
			Aphanizomenon flos-aquae	74,370	1,180	
			Microcystis aeruginosa	1,816	227	
07/19/10	KR 10151	KRBI	*Aphanizomenon flos-aquae*	3,748	59	
07/19/10	KR 10152	IRCC	*Anabaena flos-aquae*	1,498,364	22,364	
			Microcystis aeruginosa	35,285	4,411	
			Aphanizomenon flos-aquae	11,741	186	
07/19/10	KR 10153	IRJW	*Aphanizomenon flos-aquae*	47,626	756	
			Anabaena flos-aquae	31,656	472	

			Anabaena sp.	10,077	148	
07/19/10	KR 10154	CRMC	*Microcystis aeruginosa*	18,080	2,260	
			Anabaena flos-aquae	33,800	504	
			Aphanizomenon flos-aquae	5,085	81	
			Oscillatoria sp.	2,502	40	
07/19/10	KR 10155	CRCC	*Anabaena flos-aquae*	91,080	1,359	
			Aphanizomenon flos-aquae	57,431	912	
			Microcystis aeruginosa	1,279	160	
07/19/10	KR10156	KRBI (dup)	*No toxic algae present*			

Appendix 2

Laboratory Data Sheets for July 19, 2010 Public Health Samples.

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10151
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): 5
Total Biovolume (um^3/mL): 3,748
Trophic State Index: 11.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	5	100.0	3,748	100.0	bluegreen

Aphanizomenon flos-aquae cells/mL = 59

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** NP92

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10152
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): 1,075
Total Biovolume (um^3/mL): 1,545,389
Trophic State Index: 53.0

Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
Anabaena flos-aquae	621	57.8	1,498,364	97.0	bluegreen
Microcystis aeruginosa	441	41.0	35,285	2.3	bluegreen
Aphanizomenon flos-aquae	12	1.2	11,741	0.8	bluegreen

Microcystis aeruginosa cells/mL = 4,411

Anabaena flos-aquae cells/mL = 22,364

Aphanizomenon flos-aquae cells/mL = 186

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** NP93

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10153
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): 77
Total Biovolume (um^3/mL): 89,358
Trophic State Index: 32.5

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	47	61.1	47,626	53.3	bluegreen
2	Anabaena flos-aquae	24	30.6	31,656	35.4	bluegreen
3	Anabaena sp.	6	8.3	10,077	11.3	bluegreen

Aphanizomenon flos-aquae cells/mL = 756

Anabaena sp. cells/mL = 148

Anabaena flos-aquae cells/mL = 472

Note: Toxic Algae Only

Aquatic Analysts

Sample ID: NP94

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10154
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): 256
Total Biovolume (um^3/mL): 59,467
Trophic State Index: 29.6

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Microcystis aeruginosa	226	88.2	18,080	30.4	bluegreen
2	Anabaena flos-aquae	20	7.9	33,800	56.8	bluegreen
3	Aphanizomenon flos-aquae	8	3.1	5,085	8.6	bluegreen
4	Oscillatoria sp.	2	0.8	2,502	4.2	bluegreen

Microcystis aeruginosa cells/mL = 2,260

Anabaena flos-aquae cells/mL = 504

Aphanizomenon flos-aquae cells/mL = 81

Oscillatoria sp. cells/mL = 40

Note: Toxic Algae Only

Aquatic Analysts

Sample ID: NP95

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10155
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): 118
Total Biovolume (um^3/mL): 149,790
Trophic State Index: 36.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Anabaena flos-aquae	54	45.9	91,080	60.8	bluegreen
2	Aphanizomenon flos-aquae	48	40.5	57,431	38.3	bluegreen
3	Microcystis aeruginosa	16	13.5	1,279	0.9	bluegreen

Anabaena flos-aquae cells/mL = 1,359

Aphanizomenon flos-aquae cells/mL = 912

Microcystis aeruginosa cells/mL = 160

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** NP96

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KR 10156
Sample Depth:
Sample Date: 19-Jul-10

Total Density (#/mL): <2
Total Biovolume (um^3/mL):
Trophic State Index:

Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
No Toxic Algae Present	<2				

Note: Toxic Algae Only

Aquatic Analysts **Sample ID:** NP97