

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: June 20th, 2013

Prepared for: Tim Hemstreet (PacifiCorp)
Linda Prendergast (PacifiCorp)

Prepared by: Sam Mackey

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Introduction

This technical memorandum summarizes the results for the public health monitoring conducted June 20th, 2013 for cyanobacteria species and the associated toxin, microcystin, in Copco and Iron Gate reservoirs within PacifiCorp's Klamath Hydroelectric Project (Project) and at one monitoring station in the Klamath River below Iron Gate Dam. The public health 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, but also estimates the presence of other potentially-toxic cyanobacteria, including *Anabaena* spp., *Planktothrix (Oscillatoria)* spp. and others. The 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 data summarized in this memorandum also include results the previous 2013 public health sampling events (see Appendix 1).

Methods

PacifiCorp is conducting phytoplankton sampling at 5 sites (Table 1) for laboratory analysis of potentially toxic 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 twice per month in June, July, August, September, October, and November. Samples to be collected from the river site below Iron Gate Dam are scheduled to be collected according to the discretion of the sampling entity (PacifiCorp) based on 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 2013.		
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

Laboratory data sheets for the June 20th public health sampling are provided in Appendix 2. A summary of these result sheets is contained within Table 2.

Because the cell counts for *Anabaena* were above the California posting guidelines¹ for Copco Reservoir during the previous public health sampling (see Appendix 1), public access areas in this reservoir were posted with public health advisory signs on June 18, 2013. The June 20th sampling had cell counts of *Anabaena*, MSAE, and microcystin above the posting guidelines in both reservoirs. Health advisories were posted at public access areas at Iron Gate reservoir on June 27, 2013. Phytoplankton data collected at the Klamath River below Iron Gate dam (KRBI) on June 20th as part of baseline sampling, indicate that cell counts are way below posting guidelines and these results are also included in Appendix 2.

¹ The California State Water Resources Control Board provides guidelines for posting advisories in recreation water (SWRCB 2010). SWRCB recommends posting advisories in recreation waters under three circumstances: (1) if "scum is present associated with toxigenic species"; (2) if scum is not present, but the density of *Microcystis* or *Planktothrix* is 40,000 cells/ml or greater; and (3) if scum is not present, but the density of all potentially toxigenic BGA is 100,000 cells/ml or greater.

Table 2. Summary of public health monitoring (June 20th, 2013).

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(6), (7), (8), (9), or (10)}	Microcystin (µg/L)
6/20/2013	16:30	CRMC	201.5	KR13811	SG	802,969	4,205	475,179	0	240
6/20/2013	15:45	CRCC	200.0	KR13812	SG	13,903	303	454	0	2.1
6/20/2013	13:05	IRCC	192.8	KR13813	SG	3,679	0	300,667	0	2.6
6/20/2013	12:45	IRJW	192.4	KR13814	SG	61,419	2,967	665,967	14,539	24
6/20/2013	15:45	CRCC _{dup}	201.5	KR13815	SG	3,794	0	3,502	0	2.0

¹MSAE = *Microcystis aeruginosa* (cells/mL)

²AFA = *Aphanizomenon flos-aquae* (cells/mL)

³ANA = *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) or ⁹*Anabaena circinalis* (cells/mL) or ¹⁰*Anabaena planctonica* (cells/mL)

“0” value indicates non-detect by analytical laboratory

“*” value indicates results were not available upon the date this memo was submitted and will be included in subsequent memos as availability allows

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 Cyanobacteria Species data for 2013 Public Health Samples

Table 3. Summary of public health monitoring: 2013

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(6), (7), (8), (9), or (10)}	Microcystin (µg/L)
5/20/2013	9:40	CRMC	201.5	KR13800	SG	0	0	0	0	ND
5/20/2013	11:15	CRCC	200.0	KR13801	SG	0	0	90	0	ND
5/20/2013	10:45	IRCC	192.8	KR13802	SG	0	0	0	0	ND
5/20/2013	10:30	IRJW	192.4	KR13803	SG	0	0	0	0	ND
5/20/2013	11:20	CRCC _{dup}	201.5	KR13804	SG	0	0	0	0	ND
6/06/2013	14:15	CRMC	201.5	KR13805	SG	9,429	0	379,340	0	10
6/06/2013	16:00	CRCC	200.0	KR13806	SG	12,403	0	88,088	0	2.4
6/06/2013	15:30	IRCC	192.8	KR13807	SG	839	0	5,264	0	0.22
6/06/2013	15:15	IRJW	192.4	KR13808	SG	23	0	615	0	0
6/06/2013	15:20	IRJW _{dup}	201.5	KR13809	SG	18	0	483	0	0.15
6/20/2013	16:30	CRMC	201.5	KR13811	SG	802,969	4,205	475,179	0	240
6/20/2013	15:45	CRCC	200.0	KR13812	SG	13,903	303	454	0	2.1
6/20/2013	13:05	IRCC	192.8	KR13813	SG	3,679	0	300,667	0	2.6
6/20/2013	12:45	IRJW	192.4	KR13814	SG	61,419	2,967	665,967	14,539	24
6/20/2013	15:45	CRCC _{dup}	201.5	KR13815	SG	3,794	0	3,502	0	2.0

¹MSAE = *Microcystis aeruginosa* (cells/mL)

²AFA = *Aphanizomenon flos-aquae* (cells/mL)

³ANA = *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) or ⁹*Anabaena circinalis* (cells/mL) or ¹⁰*Anabaena planctonica*

“0” value indicates non-detect by analytical laboratory

“*” value indicates results were not available upon the date this memo was submitted and will be included in subsequent memos as availability allows

Appendix 2

Laboratory Data Sheets June 20th, 2013 Public Health Sampling

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 13811				
Sample Depth:					
Sample Date:	20-Jun-13				
Total Density (#/mL):	19,133				
Total Biovolume (um ³ /mL):	38,525,703				
Trophic State Index:	76.2				
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	11,879	62.1	31,837,026	82.6	bluegreen
2 Microcystis aeruginosa	7,044	36.8	6,423,754	16.7	bluegreen
3 Aphanizomenon flos-aquae	210	1.1	264,923	0.7	bluegreen
Anabaena flos-aquae cells/mL =	475,179				
Microcystis aeruginosa cells/mL =	802,969				
Aphanizomenon flos-aquae cells/mL =	4,205				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: RE52				

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 13812				
Sample Depth:					
Sample Date:	20-Jun-13				
Total Density (#/mL):	585				
Total Biovolume (um ³ /mL):	160,715				
Trophic State Index:	36.7				
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	535	91.4	111,226	69.2	bluegreen
2 Anabaena flos-aquae	30	5.2	30,420	18.9	bluegreen
3 Aphanizomenon flos-aquae	20	3.4	19,069	11.9	bluegreen
Microcystis aeruginosa cells/mL =	13,903				
Anabaena flos-aquae cells/mL =	454				
Aphanizomenon flos-aquae cells/mL =	303				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: RE53				

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13813			
Sample Depth:					
Sample Date:		20-Jun-13			
Total Density (#/mL):		6,155			
Total Biovolume (um ³ /mL):		20,174,097			
Trophic State Index:		71.5			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	6,013	97.7	20,144,667	99.9	bluegreen
2 Microcystis aeruginosa	141	2.3	29,430	0.1	bluegreen
Anabaena flos-aquae cells/mL =		300,667			
Microcystis aeruginosa cells/mL =		3,679			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE54		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13814			
Sample Depth:					
Sample Date:		20-Jun-13			
Total Density (#/mL):		14,193			
Total Biovolume (um ³ /mL):		47,958,658			
Trophic State Index:		77.8			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	9,940	70.0	44,619,774	93.0	bluegreen
2 Microcystis aeruginosa	3,412	24.0	491,353	1.0	bluegreen
3 Anabaena planctonica	692	4.9	2,660,603	5.5	bluegreen
4 Aphanizomenon flos-aquae	148	1.0	186,928	0.4	bluegreen
Anabaena flos-aquae cells/mL =		665,967			
Microcystis aeruginosa cells/mL =		61,419			
Anabaena planctonica cells/mL =		14,539			
Aphanizomenon flos-aquae cells/mL =		2,967			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE55		

Phytoplankton Sample Analysis						
	Sample:	Klamath Basin				
	Sample Site:	KR 13815				
	Sample Depth:					
	Sample Date:	20-Jun-13				
	Total Density (#/mL):	491				
	Total Biovolume (um ³ /mL):	264,976				
	Trophic State Index:	40.3				
		Density	Density	Biovolume	Biovolume	
	Species	#/mL	Percent	um ³ /mL	Percent	
					Group	
	-----				-----	
	1 Microcystis aeruginosa	345	70.3	30,350	11.5	bluegreen
	2 Anabaena flos-aquae	146	29.7	234,626	88.5	bluegreen
	Anabaena flos-aquae cells/mL =	3,502				
	Microcystis aeruginosa cells/mL =	3,794				
	Note: Toxic Algae Only					
	Aquatic Analysts			Sample ID: RE56		

**Phytoplankton Sample Analysis-
Baseline Sampling for KRBI**

Klamath
Sample: Basin
Sample Site: KR 13098
Sample Depth:
Sample Date: 20-Jun-13

Total Density (#/mL): 477
Total Biovolume (um³/mL): 295,213
Trophic State Index: 41.1

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
-	-	-	-	-
Anabaena flos-aquae	78	16.3	130,510	44.2
Rhodomonas minuta	69	14.4	1,375	0.5
Cryptomonas erosa	32	6.7	16,683	5.7
Microcystis aeruginosa	32	6.7	2,567	0.9
Stephanodiscus hantzschii	32	6.7	3,850	1.3
Aphanizomenon flos-aquae	28	5.8	25,988	8.8
Ankistrodesmus falcatus	18	3.8	550	0.2
Cocconeis placentula	18	3.8	8,433	2.9
Diatoma vulgare	18	3.8	35,933	12.2
Melosira granulata	14	2.9	40,081	13.6
Cocconeis klamathensis	14	2.9	3,850	1.3
Cyclotella stelligera	14	2.9	756	0.3
Fragilaria vaucheria	9	1.9	2,640	0.9
Nitzschia frustulum	9	1.9	1,100	0.4
Stephanodiscus binderanus	9	1.9	3,025	1.0
Gomphonema angustatum	9	1.9	2,475	0.8
Fragilaria construens	9	1.9	2,053	0.7
Nitzschia amphibia	9	1.9	880	0.3
Fragilaria capucina mesolepta	5	1.0	3,506	1.2
Achnanthes minutissima	5	1.0	229	0.1
Tetraedron minimum	5	1.0	825	0.3
Chlamydomonas sp.	5	1.0	1,490	0.5
Schroderia sp.	5	1.0	206	0.1
Navicula gregaria	5	1.0	802	0.3
Navicula cryptocephala veneta	5	1.0	435	0.1
Achnanthes lanceolata	5	1.0	825	0.3
Nitzschia paleacea	5	1.0	449	0.2
Sphaerocystis schroeteri	5	1.0	1,925	0.7
Nitzschia dissipata	5	1.0	1,233	0.4
Rhoicosphenia curvata	5	1.0	536	0.2

Aphanizomenon flos-aquae cells/mL = 413

Microcystis aeruginosa cells/mL = 321

Anabaena flos-aquae cells/mL = 1,948

Aquatic Analysts

Sample ID:

RE62