

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project

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Introduction

This technical memorandum summarizes the results for the 2018 public health monitoring for cyanobacteria species and an associated toxin, microcystin, from Upper Klamath Lake and within PacifiCorp's Klamath Hydroelectric Project (Project) from Keno reservoir to the Klamath River downstream Iron Gate Dam. Microcystin results from 2018 baseline monitoring are also included in the results summaries below. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE) which is known to produce microcystin. This monitoring also assesses the presence of other potentially-toxic cyanobacteria, including *Dolichospermum* sp., and others. 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.

Results from the baseline and public health sampling are used in coordination with the appropriate public health authority to determine if public health advisories are warranted^{1,2}. In addition to PacifiCorp's website (www.pacificorp.com/es/hydro/hl/kr.html#), these memos are also posted on the Klamath Basin Monitoring Program's (KBMP) website (www.kbmp.net) and inform the Blue Green Algae tracker on the KBMP website.

The data in Appendix 1 and Appendix 2 summarize results from all of the 2018 public health sampling events to date and microcystin results from the 2018 baseline sampling events.

¹ The California State Water Resources Control Board (SWRCB) provides guidelines for posting advisories in recreation water (California SWRCB 2016) for Project waters in California. SWRCB recommends posting advisories in recreation waters at three levels based on laboratory testing for microcystin. The posting levels are Caution, Warning, and Danger at microcystin concentrations of 0.8, 6, and 20 µg/L respectively. Toxin producing cells at concentrations of over 4,000 cells/mL or blooms, scums, or mats would result in posting at the Caution level.

² Postings of Project waters in Oregon are coordinated with the Oregon Health Authority (OHA). The health advisory guideline in Oregon waters is microcystin concentrations of 4 µg/L (OHA 2018) or more, over 100,000 cells/mL of all toxicogenic species combined, or over 40,000 cells/mL of *Microcystis* spp. or *Planktothrix* spp. (OHA 2016).

Methods

PacifiCorp and the Oregon Department of Environmental Quality (ODEQ) are conducting public health sampling at ten sites (Table 1). Samples are collected and sent for laboratory analysis of potentially toxigenic cyanobacteria, notably MSAE and microcystin, from:

- Three shoreline sites in Upper Klamath Lake, Oregon
- One shoreline site in Keno Reservoir, Oregon
- One shoreline site in J.C. Boyle Reservoir, Oregon
- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir), California
- One Klamath River site below Iron Gate Dam near the hatchery bridge, California

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Upper Klamath Lake, Keno Reservoir, J.C Boyle Reservoir, Copco Reservoir, Iron Gate Reservoir, and the Klamath River during 2018.			
Location	Approximate River Mile	Sampling Entity	Site ID
Upper Klamath Lake at Eagle Ridge County Park	N/A	ODEQ	UKEP
Upper Klamath Lake at Howard's Bay Park	N/A	ODEQ	UKHP
Upper Klamath Lake at Moore Park	N/A	ODEQ	UKMP
Keno Reservoir at Keno Park	234.0	ODEQ	KEKP
J.C. Boyle Reservoir at Topsy Campground	225.0	ODEQ	BRTC
Copco Reservoir at Mallard Cove	201.5	PacifiCorp	CRMC
Copco Reservoir at Copco Cove	200.0	PacifiCorp	CRCC
Iron Gate Reservoir at Camp Creek	192.8	PacifiCorp	IRCC
Iron Gate Reservoir at John Williams Campground	192.4	PacifiCorp	IRJW
Klamath River below Iron Gate dam near Hatchery Bridge	189.7	PacifiCorp	KRBI

Samples are planned to be taken once in May, November and December and twice per month in June, July, August, September, and October.

In addition to public health sampling, monthly and bi-monthly baseline sampling for microcystin is conducted by PacifiCorp and the U.S. Bureau of Reclamation (BOR) from May through October at 12 locations extending from Link Dam to the Klamath River downstream of Iron Gate Reservoir (Table 2).

Table 2. Sites of microcystin baseline monitoring from Link Dam to the Klamath River downstream of Iron Gate reservoir during 2018.				
Site Description	Approximate River Mile	Depth (m)	Sampling Entity	Site ID
Link Dam	254.4	0.5	BOR	KR254.4
Keno Reservoir at Miller Island	246.0	0.5	BOR	KR246.0
Klamath River below Keno Dam near a USGS Gage	231.8	0.5	BOR	KBK
Klamath River below JC Boyle Reservoir	224.6	0.5	PacifiCorp	KR22460
Klamath River at USGS Gage	219.5	0.5	PacifiCorp	KR21950
Klamath River above Shovel Creek	206.4	0.5	PacifiCorp	KR20642
Copco Reservoir at Buoy Line (surface)	198.7	0.5	PacifiCorp	KR19874
Copco Reservoir at Buoy Line (integrated)	198.7	0-8	PacifiCorp	KR19874
Klamath River below Copco 2 Reservoir	196.5	0.5	PacifiCorp	KR19645
Iron Gate Reservoir at Log Boom (surface)	190.2	0.5	PacifiCorp	KR19019
Iron Gate Reservoir at Log Boom (integrated)	190.2	0-8	PacifiCorp	KR19019
Klamath River below Hatchery Bridge	189.7	0.5	PacifiCorp	KR18973

Public health samples are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring). Samples collected for potentially toxic phytoplankton are preserved in Lugol’s solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The samples are labeled “Rush” for timely analysis and only potentially toxic cyanobacteria are identified and enumerated. 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 U.S. Environmental Protection Agency (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 with a detection limit of 0.10 µg/L and a quantification limit of 0.15 µg/L. 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.

Results

All public health samples (Table 3) and baseline microcystin samples (Tables 4 and 5) were collected as planned. Appendix 3 includes the raw phytoplankton results for the samples reported in Table 3.

Table 3. Summary of available public health laboratory algal identification and enumeration and microcystin results from sampling October 2018.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	DKFA ⁽³⁾	Other ^{(4),(5), (6), (7), (8), (9), (10), (11), or (12)}	Microcystin (µg/L)
10/16/2018	11:22	UKEP	N/A	ODEQ	UKEP18010	SG	NA	NA	NA	NA	0.41
10/16/2018	11:37	UKHP	N/A	ODEQ	UKHP18010	SG	NA	NA	NA	NA	1.2
10/16/2018	11:52	UKMP	N/A	ODEQ	UKMP18010	SG	NA	NA	NA	NA	4
10/16/2018	XX:XX	KEKP	234	ODEQ	KEKP18010	SG	NA	NA	NA	NA	NS
10/16/2018	10:30	BRTC	225	ODEQ	BRTC18010	SG	NA	NA	NA	NA	ND
10/13/2018	17:55	CRMC	201.5	PacifiCorp	KR18845	SG	NA	NA	NA	NA	0.54
10/13/2018	14:20	CRCC	200.0	PacifiCorp	KR18846	SG	NA	NA	NA	NA	0.39
10/13/2018	13:20	IRCC	192.8	PacifiCorp	KR18847	SG	NA	NA	NA	NA	0.82
10/13/2018	13:05	IRJW	192.4	PacifiCorp	KR18848	SG	NA	NA	NA	NA	0.6
10/13/2018	9:10	KRBI	189.7	PacifiCorp	KR18849	SG	NA	NA	NA	NA	0.19
10/23/2018	11:26	UKEP	N/A	ODEQ	UKEP18011	SG	NA	NA	NA	NA	0.18
10/23/2018	11:44	UKHP	N/A	ODEQ	UKHP18011	SG	NA	NA	NA	NA	0.4
10/23/2018	11:59	UKMP	N/A	ODEQ	UKMP18011	SG	NA	NA	NA	NA	1
10/23/2018	XX:XX	KEKP	234	ODEQ	KEKP18011	SG	NA	NA	NA	NA	NS
10/23/2018	10:38	BRTC	225	ODEQ	BRTC18011	SG	NA	NA	NA	NA	0.12 ^{C1, J}
10/28/2018	13:10	CRMC	201.5	PacifiCorp	KR18850	SG	NA	NA	NA	NA	0.14 ^{C1, J}
10/28/2018	12:30	CRCC	200.0	PacifiCorp	KR18851	SG	NA	NA	NA	NA	0.83
10/28/2018	12:00	IRCC	192.8	PacifiCorp	KR18852	SG	NA	NA	NA	NA	0.40
10/28/2018	11:45	IRJW	192.4	PacifiCorp	KR18853	SG	NA	NA	NA	NA	0.16
10/28/2018	11:05	KRBI	189.7	PacifiCorp	KR18854	SG	NA	NA	NA	NA	0.31

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL).

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria) sp.*, ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum sp.*, ⁷*Lyngbya sp.*, ⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, ¹¹*Pseudanabaena spp.*, or ¹²*Limnothrix sp.*

"NA" indicates Not Applicable; analyses for toxic algae from public health samples are only conducted from May – July.

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L).

"NS" indicates Not Sampled.

"C1" indicates the reported concentration for this analyte is below the quantitation limit.

"J" indicates the reported result for this analyte should be considered an estimated value.

Table 4. Summary of October 2018 baseline laboratory microcystin results for samples collected in Oregon.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
10/16//2018	10:45	KR254.4	246.0	BOR	2018KHSA-73	0.5	0.16
10/16//2018	12:00	KR246.0	231.8	BOR	2018KHSA-76	0.5	ND
10/16//2018	9:45	KBK	231.8	BOR	2018KHSA-77	0.5	ND
10/14//2018	8:15	KR22460	224.6	PacifiCorp	KR18136	0.5	0.21
10/14//2018	8:50	KR21950	219.5	PacifiCorp	KR18137	0.5	0.18
10/30//2018	9:50	KR254.4	246.0	BOR	2018KHSA-79	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L).

Table 5. Summary of October 2018 baseline laboratory microcystin results for samples collected in California.							
Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
10/13/2018	17:10	KR20642	206.4	PacifiCorp	KR18132	0.5	0.38
10/13/2018	8:45	KR18973	189.7	PacifiCorp	KR18122	0.5	0.27
10/13/2018	14:55	KR19874	198.7	PacifiCorp	KR18128	0.5	0.14 ^{C1, J}
10/13/2018	15:05	KR19874	198.7	PacifiCorp	KR18129	0-8	0.24
10/13/2018	13:45	KR19645	196.5	PacifiCorp	KR18127	0.5	0.36
10/13/2018	10:40	KR19019	190.2	PacifiCorp	KR18123	0.5	0.26
10/13/2018	11:00	KR19019	190.2	PacifiCorp	KR18124	0-8	0.5
10/28/2018	11:10	KR18973	189.7	PacifiCorp	KR18138	0.5	0.12 ^{C1, J}

"C1" indicates the reported concentration for this analyte is below the quantitation limit.

"J" indicates the reported result for this analyte should be considered an estimated value.

References

California SWRCB 2016. Draft Statewide Voluntary Guidance on CyanoHABs in Recreational Waters. Available online at:

http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/docs/triggers.pdf

Oregon Health Authority. 2016. Oregon Harmful Algal Bloom Surveillance (HABS) Program – Public Health Advisory Guidelines, Harmful Algae Blooms in Freshwater Bodies. 27 pp.

https://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Pages/resources_for_samplers.aspx

Oregon Health Authority. 2018. Oregon Public Health Division – Blue-green Algae Advisory. Electronic mail advising changes to guideline values. Distributed May 17, 2019 1648.

Appendix 1

Cyanobacteria Species and Microcystin Data for 2018 Public Health Samples

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	DKFA ⁽³⁾	Other ^{(4),(5), (6), (7), (8), (9), (10), or (11)}	Microcystin (µg/L)
5/30/2018	11:15	UKEP	N/A	ODEQ	UKEP18001	SG	27,561	76,069	9,822	0	0.16 ^{J, A2}
5/30/2018	11:31	UKHP	N/A	ODEQ	UKHP18001	SG	126	11,569	471	0	0.41 ^{J, A2}
5/30/2018	11:46	UKMP	N/A	ODEQ	UKMP18001	SG	0	9,577	4,672	0	0.11 ^{J, A2}
5/30/2018	10:31	KEKP	234	ODEQ	KEKP18001	SG	867	93,886	23,678	0	1.0 ^{J, A2}
5/30/2018	10:15	BRTC	225	ODEQ	BRTC18001	SG	0	546	0	0	ND ^{J, A2}
5/29/2018	13:00	CRMC	201.5	PacifiCorp	KR18800	SG	0	0	0	0	ND
5/29/2018	12:30	CRCC	200.0	PacifiCorp	KR18801	SG	0	0	65	0	ND
5/29/2018	11:40	IRCC	192.8	PacifiCorp	KR18802	SG	0	0	0	0	ND
5/29/2018	11:30	IRJW	192.4	PacifiCorp	KR18803	SG	0	76	0	0	ND
5/29/2018	10:30	KRBI	189.7	PacifiCorp	KR18804	SG	0	0	0	0	ND
6/20/2018	12:05	UKEP	N/A	ODEQ	UKEP18002	SG	0	5,683,065	0	0	4.0
6/20/2018	12:22	UKHP	N/A	ODEQ	UKHP18002	SG	152,881	6,206,983	3,363,390	5,136,814 ⁽⁵⁾	33
6/20/2018	12:38	UKMP	N/A	ODEQ	UKMP18002	SG	0	14,093,750	0	0	1.2
6/20/2018	11:24	KEKP	234	ODEQ	KEKP18002	SG	0	2,596,132	0	0	1.6
6/20/2018	11:08	BRTC	225	ODEQ	BRTC18002	SG	0	12,659	112	0	ND
6/9/2018	17:30	CRMC	201.5	PacifiCorp	KR18805	SG	0	0	0	401 ⁽¹⁰⁾	ND
6/9/2018	15:45	CRCC	200.0	PacifiCorp	KR18806	SG	0	0	161	0	ND
6/9/2018	12:20	IRCC	192.8	PacifiCorp	KR18807	SG	0	173	885	0	ND
6/9/2018	12:00	IRJW	192.4	PacifiCorp	KR18808	SG	0	85	466	254 ⁽¹⁰⁾	0.13 ^{C1, J}
6/9/2018	19:40	KRBI	189.7	PacifiCorp	KR18809	SG	0	43	35	0	ND
6/26/2018	13:41	UKEP	N/A	ODEQ	UKEP18003	SG	0	1,270,693	0	0	0.18
6/26/2018	13:57	UKHP	N/A	ODEQ	UKHP18003	SG	0	1,529,172	0	873,813 ⁽⁵⁾	9.1
6/26/2018	14:15	UKMP	N/A	ODEQ	UKMP18003	SG	0	155,011	0	0	ND
6/26/2018	13:00	KEKP	234	ODEQ	KEKP18003	SG	0	1,322,607	0	0	0.21
6/26/2018	12:43	BRTC	225	ODEQ	BRTC18003	SG	0	136,397	0	609 ⁽¹⁰⁾	ND
6/25/2018	14:30	CRMC	201.5	PacifiCorp	KR18810	SG	0	2,349	0	17,681 ⁽¹⁰⁾	ND
6/25/2018	13:05	CRCC	200.0	PacifiCorp	KR18811	SG	0	922	44	6 ⁽¹⁰⁾	ND
6/25/2018	12:30	IRCC	192.8	PacifiCorp	KR18812	SG	4,883	178	3,924	133 ⁽¹⁰⁾	0.59
6/25/2018	12:15	IRJW	192.4	PacifiCorp	KR18813	SG	1,179	0	2,587	0	0.10 ^{C1, J}
6/25/2018	11:45	KRBI	189.7	PacifiCorp	KR18814	SG	0	0	0	0	ND
7/10/2018	12:52	UKEP	N/A	ODEQ	UKEP18004	SG	0	16,388,798	0	0	3.8 ^{J, A2}
7/10/2018	13:13	UKHP	N/A	ODEQ	UKHP18004	SG	0	1,539,413	0	0	4.2 ^{J, A2}
7/10/2018	13:27	UKMP	N/A	ODEQ	UKMP18004	SG	0	2,634,092	0	0	0.29 ^{J, A2}
7/10/2018	12:05	KEKP	234	ODEQ	KEKP18004	SG	0	502,567	0	0	0.16 ^{J, A2}
7/10/2018	11:47	BRTC	225	ODEQ	BRTC18004	SG	389	29,548	0	0	ND ^{J, A2}
7/18/2018	20:25	CRMC	201.5	PacifiCorp	KR18815	SG	1,819	9,311	0	364 ⁽¹⁰⁾	0.36
7/18/2018	17:15	CRCC	200.0	PacifiCorp	KR18816	SG	17,241	810,030	2,495	0	2.6
7/18/2018	14:20	IRCC	192.8	PacifiCorp	KR18817	SG	41,963	71,211	0	0	8.5
7/18/2018	13:45	IRJW	192.4	PacifiCorp	KR18818	SG	115,685	45,306	0	0	4
7/18/2018	19:05	KRBI	189.7	PacifiCorp	KR18819	SG	8,016	8,988	0	0	3
7/23/2018	13:02	UKEP	N/A	ODEQ	UKEP18005	SG	0	113,087	0	0	ND
7/23/2018	13:19	UKHP	N/A	ODEQ	UKHP18005	SG	1,534	78,695	0	0	1.3
7/23/2018	13:42	UKMP	N/A	ODEQ	UKMP18005	SG	0	575,218	0	0	ND

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Table A1 cont.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	DKFA ⁽³⁾	Other ^{(4),(5), (6), (7), (8), (9), (10), or (11)}	Microcystin (µg/L)
7/23/2018	11:52	KEKP	234	ODEQ	KEKP18005	SG	0	4,303	0	430 ⁽¹²⁾	ND
7/23/2018	11:34	BRTC	225	ODEQ	BRTC18005	SG	0	256	0	0	ND
7/28/2018	15:00	CRMC	201.5	PacifiCorp	KR18820	SG	9,466	41,082	631	0	2
7/28/2018	13:45	CRCC	200.0	PacifiCorp	KR18821	SG	8,636,650	8,528,000	0	0	5000
7/28/2018	13:20	IRCC	192.8	PacifiCorp	KR18822	SG	90,038	1,972,557	0	0	22
7/28/2018	12:45	IRJW	192.4	PacifiCorp	KR18823	SG	127,100	2,427,293	0	0	47
7/28/2018	17:30	KRBI	189.7	PacifiCorp	KR18824	SG	0	5,157	0	0	0.84
8/7/2018	11:25	UKEP	N/A	ODEQ	UKEP18006	SG	NA	NA	NA	NA	3.5
8/7/2018	11:47	UKHP	N/A	ODEQ	UKHP18006	SG	NA	NA	NA	NA	0.11 ^{C1, J}
8/7/2018	12:05	UKMP	N/A	ODEQ	UKMP18006	SG	NA	NA	NA	NA	0.2
8/7/2018	10:32	KEKP	234	ODEQ	KEKP18006	SG	NA	NA	NA	NA	ND
8/7/2018	10:02	BRTC	225	ODEQ	BRTC18006	SG	NA	NA	NA	NA	ND
8/11/2018	16:50	CRMC	201.5	PacifiCorp	KR18825	SG	NA	NA	NA	NA	4
8/11/2018	13:15	CRCC	200.0	PacifiCorp	KR18826	SG	NA	NA	NA	NA	7600
8/11/2018	12:15	IRCC	192.8	PacifiCorp	KR18827	SG	NA	NA	NA	NA	30
8/11/2018	12:00	IRJW	192.4	PacifiCorp	KR18828	SG	NA	NA	NA	NA	12
8/11/2018	17:45	KRBI	189.7	PacifiCorp	KR18829	SG	NA	NA	NA	NA	0.37
8/20/2018	11:58	UKEP	N/A	ODEQ	UKEP18007	SG	NA	NA	NA	NA	25
8/20/2018	12:12	UKHP	N/A	ODEQ	UKHP18007	SG	NA	NA	NA	NA	29
8/20/2018	12:25	UKMP	N/A	ODEQ	UKMP18007	SG	NA	NA	NA	NA	2.5
8/20/2018	11:18	KEKP	234	ODEQ	KEKP18007	SG	NA	NA	NA	NA	4.7
8/20/2018	11:00	BRTC	225	ODEQ	BRTC18007	SG	NA	NA	NA	NA	ND
8/25/2018	16:15	CRMC	201.5	PacifiCorp	KR18830	SG	NA	NA	NA	NA	39
8/25/2018	15:00	CRCC	200.0	PacifiCorp	KR18831	SG	NA	NA	NA	NA	2100
8/25/2018	14:20	IRCC	192.8	PacifiCorp	KR18832	SG	NA	NA	NA	NA	5400 ^{C2, J}
8/25/2018	14:00	IRJW	192.4	PacifiCorp	KR18833	SG	NA	NA	NA	NA	42
8/25/2018	18:10	KRBI	189.7	PacifiCorp	KR18834	SG	NA	NA	NA	NA	8.1
9/10/2018	11:26	UKEP	N/A	ODEQ	UKEP18008	SG	NA	NA	NA	NA	2.4
9/10/2018	11:40	UKHP	N/A	ODEQ	UKHP18008	SG	NA	NA	NA	NA	17
9/10/2018	11:55	UKMP	N/A	ODEQ	UKMP18008	SG	NA	NA	NA	NA	3.1
9/10/2018	10:47	KEKP	234	ODEQ	KEKP18008	SG	NA	NA	NA	NA	160
9/10/2018	10:32	BRTC	225	ODEQ	BRTC18008	SG	NA	NA	NA	NA	0.3
9/17/2018	18:50	CRMC	201.5	PacifiCorp	KR18835	SG	NA	NA	NA	NA	3200
9/17/2018	15:55	CRCC	200.0	PacifiCorp	KR18836	SG	NA	NA	NA	NA	540
9/17/2018	15:00	IRCC	192.8	PacifiCorp	KR18837	SG	NA	NA	NA	NA	28
9/17/2018	14:45	IRJW	192.4	PacifiCorp	KR18838	SG	NA	NA	NA	NA	17
9/17/2018	11:05	KRBI	189.7	PacifiCorp	KR18839	SG	NA	NA	NA	NA	9.1
9/18/2018	11:43	UKEP	N/A	ODEQ	UKEP18009	SG	NA	NA	NA	NA	8.5
9/18/2018	11:59	UKHP	N/A	ODEQ	UKHP18009	SG	NA	NA	NA	NA	28
9/18/2018	12:13	UKMP	N/A	ODEQ	UKMP18009	SG	NA	NA	NA	NA	26
9/18/2018	11:00	KEKP	234	ODEQ	KEKP18009	SG	NA	NA	NA	NA	410
9/18/2018	10:45	BRTC	225	ODEQ	BRTC18009	SG	NA	NA	NA	NA	0.34
9/22/2018	11:30	CRMC	201.5	PacifiCorp	KR18840	SG	NA	NA	NA	NA	38
9/22/2018	10:20	CRCC	200.0	PacifiCorp	KR18841	SG	NA	NA	NA	NA	2500
9/22/2018	9:50	IRCC	192.8	PacifiCorp	KR18842	SG	NA	NA	NA	NA	25
9/22/2018	9:30	IRJW	192.4	PacifiCorp	KR18843	SG	NA	NA	NA	NA	870
9/22/2018	8:55	KRBI	189.7	PacifiCorp	KR18844	SG	NA	NA	NA	NA	3.1
10/16/2018	11:22	UKEP	N/A	ODEQ	UKEP18010	SG	NA	NA	NA	NA	0.41

Table A1 cont.

Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
10/16/2018	11:37	UKHP	N/A	ODEQ	UKHP18010	SG	NA	NA	NA	NA	1.2
10/16/2018	11:52	UKMP	N/A	ODEQ	UKMP18010	SG	NA	NA	NA	NA	4
10/16/2018	XX:XX	KEKP	234	ODEQ	KEKP18010	SG	NA	NA	NA	NA	NS
10/16/2018	10:30	BRTC	225	ODEQ	BRTC18010	SG	NA	NA	NA	NA	ND
10/13/2018	17:55	CRMC	201.5	PacifiCorp	KR18845	SG	NA	NA	NA	NA	0.54
10/13/2018	14:20	CRCC	200.0	PacifiCorp	KR18846	SG	NA	NA	NA	NA	0.39
10/13/2018	13:20	IRCC	192.8	PacifiCorp	KR18847	SG	NA	NA	NA	NA	0.82
10/13/2018	13:05	IRJW	192.4	PacifiCorp	KR18848	SG	NA	NA	NA	NA	0.6
10/13/2018	9:10	KRBI	189.7	PacifiCorp	KR18849	SG	NA	NA	NA	NA	0.19
10/23/2018	11:26	UKEP	N/A	ODEQ	UKEP18011	SG	NA	NA	NA	NA	0.18
10/23/2018	11:44	UKHP	N/A	ODEQ	UKHP18011	SG	NA	NA	NA	NA	0.4
10/23/2018	11:59	UKMP	N/A	ODEQ	UKMP18011	SG	NA	NA	NA	NA	1
10/23/2018	XX:XX	KEKP	234	ODEQ	KEKP18011	SG	NA	NA	NA	NA	NS
10/23/2018	10:38	BRTC	225	ODEQ	BRTC18011	SG	NA	NA	NA	NA	0.12 ^{C1, J}
10/28/2018	13:10	CRMC	201.5	PacifiCorp	KR18850	SG	NA	NA	NA	NA	0.14 ^{C1, J}
10/28/2018	12:30	CRCC	200.0	PacifiCorp	KR18851	SG	NA	NA	NA	NA	0.83
10/28/2018	12:00	IRCC	192.8	PacifiCorp	KR18852	SG	NA	NA	NA	NA	0.40
10/28/2018	11:45	IRJW	192.4	PacifiCorp	KR18853	SG	NA	NA	NA	NA	0.16
10/28/2018	11:05	KRBI	189.7	PacifiCorp	KR18854	SG	NA	NA	NA	NA	0.31

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL).

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria) sp.*, ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum sp.*, ⁷*Lyngbya sp.*, ⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, or ¹¹*Pseudanabaena spp.*

“ND” value indicates a result less than the laboratory analytical detection limit (0.1 µg/L).

“NS” indicates Not Sampled.

“A2” indicates the sample was received above the recommended temperature range.

“C1” indicates the reported concentration for this analyte is below the quantitation limit.

“C2” indicates the reported concentration for this analyte is above the calibration range of the instrument.

“J” indicates the reported result for this analyte should be considered an estimated value.

“0” value indicates non-detect by analytical laboratory.

“NA” indicates Not Applicable; analyses for toxic algae from public health samples are only conducted from May – July.

Appendix 2

Microcystin Data for 2018 Baseline Samples

Table A2-1. Summary of 2018 baseline laboratory microcystin results for samples collected in Oregon.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/8/2018	10:50	KR246.0	246.0	BOR	2018KHSA-22	0.5	ND
5/8/2018	08:45	KBK	231.8	BOR	2018KHSA-23	0.5	ND
5/13/2018	17:30	KR22460	224.6	PacifiCorp	KR18047	0.5	ND
5/13/2018	17:00	KR21950	219.5	PacifiCorp	KR18048	0.5	ND
6/4/2018	11:00	KR246.0	246.0	BOR	2018KHSA-32	0.5	ND
6/4/2018	8:40	KBK	231.8	BOR	2018KHSA-33	0.5	0.10 ^{C1, J}
6/10/2018	8:30	KR22460	224.6	PacifiCorp	KR18064	0.5	ND
6/10/2018	9:30	KR21950	219.5	PacifiCorp	KR18065	0.5	ND
7/10/2018	8:00	KR254.4	246.0	BOR	2018KHSA-40	0.5	0.18
7/10/2018	12:10	KR246.0	231.8	BOR	2018KHSA-43	0.5	ND

Table A2-1 cont.

Date	Date	Date	Date	Date	Date	Date	Date
7/10/2018	9:35	KBK	231.8	BOR	2018KHSA-44	0.5	0.1 ^{C1, J}
7/19/2018	7:50	KR22460	224.6	PacifiCorp	KR18082	0.5	ND
7/19/2018	8:40	KR21950	219.5	PacifiCorp	KR18083	0.5	ND
7/24/2018	9:15	KR254.4	246.0	BOR	2018KHSA-46	0.5	ND
8/7/2018	9:40	KR254.4	246.0	BOR	2018KHSA-51	0.5	ND ^{A2, J}
8/7/2018	11:15	KR246.0	231.8	BOR	2018KHSA-54	0.5	ND ^{A2, J}
8/7/2018	8:55	KBK	231.8	BOR	2018KHSA-55	0.5	ND ^{A2, J}
8/12/2018	8:50	KR22460	224.6	PacifiCorp	KR18100	0.5	ND
8/12/2018	9:40	KR21950	219.5	PacifiCorp	KR18101	0.5	ND
8/21/2018	9:30	KR254.4	246.0	BOR	2018KHSA-57	0.5	0.2 ^{A2, J}
9/11/2018	9:40	KR254.4	246.0	BOR	2018KHSA-62	0.5	3.2
9/11/2018	11:00	KR246.0	231.8	BOR	2018KHSA-65	0.5	2.7
9/11/2018	8:45	KBK	231.8	BOR	2018KHSA-66	0.5	1.2
9/18/2018	7:20	KR22460	224.6	PacifiCorp	KR18118	0.5	0.36
9/18/2018	8:05	KR21950	219.5	PacifiCorp	KR18119	0.5	0.1 ^{C1, J}
9/25/2018	9:30	KR254.4	246.0	BOR	2018KHSA-68	0.5	1.1
10/16//2018	10:45	KR254.4	246.0	BOR	2018KHSA-73	0.5	0.16
10/16//2018	12:00	KR246.0	231.8	BOR	2018KHSA-76	0.5	ND
10/16//2018	9:45	KBK	231.8	BOR	2018KHSA-77	0.5	ND
10/14//2018	8:15	KR22460	224.6	PacifiCorp	KR18136	0.5	0.21
10/14//2018	8:50	KR21950	219.5	PacifiCorp	KR18137	0.5	0.18
10/30//2018	9:50	KR254.4	246.0	BOR	2018KHSA-79	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L).

"C1" indicates the reported concentration for this analyte is below the quantitation limit.

"J" indicates the reported result for this analyte should be considered an estimated value.

"A2" indicates the sample was received above the recommended temperature range.

Table A2-2. Summary of 2018 baseline laboratory microcystin results for samples collected in California.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/12/2018	16:10	KR20642	206.4	PacifiCorp	KR18043	0.5	ND
5/13/2018	11:00	KR19874	198.7	PacifiCorp	KR18039	0.5	ND
5/13/2018	11:10	KR19874	198.7	PacifiCorp	KR18040	0-8	ND
5/12/2018	14:15	KR19645	196.5	PacifiCorp	KR18038	0.5	ND
5/12/2018	11:50	KR19019	190.2	PacifiCorp	KR18034	0.5	ND
5/12/2018	12:00	KR19019	190.2	PacifiCorp	KR18035	0-8	ND
6/9/2018	16:50	KR20642	206.4	PacifiCorp	KR18060	0.5	ND
6/9/2018	14:20	KR19874	198.7	PacifiCorp	KR18056	0.5	ND
6/9/2018	14:30	KR19874	198.7	PacifiCorp	KR18057	0-8	ND
6/9/2018	13:00	KR19645	196.5	PacifiCorp	KR18055	0.5	ND
6/9/2018	9:30	KR19019	190.2	PacifiCorp	KR18051	0.5	ND
7/18/2018	20:50	KR20642	206.4	PacifiCorp	KR18078	0.5	ND
7/18/2018	19:15	KR18973	189.7	PacifiCorp	KR18068	0.5	NS
7/18/2018	15:55	KR19874	198.7	PacifiCorp	KR18074	0.5	1
7/18/2018	16:15	KR19874	198.7	PacifiCorp	KR18075	0-8	1.1
7/18/2018	14:50	KR19645	196.5	PacifiCorp	KR18073	0.5	3.6
7/18/2018	11:30	KR19019	190.2	PacifiCorp	KR18069	0.5	46
7/18/2018	11:55	KR19019	190.2	PacifiCorp	KR18070	0-8	2.1
7/28/2018	14:40	KR20642	206.4	PacifiCorp	KR18085	0.5	NS
7/28/2018	17:20	KR18973	189.7	PacifiCorp	KR18084	0.5	1.1

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Table A2-2 cont.							
Site ID	Site ID	Site ID	Site ID	Site ID	Site ID	Site ID	Site ID
8/11/2018	16:00	KR20642	206.4	PacifiCorp	KR18096	0.5	ND
8/11/2018	18:25	KR18973	189.7	PacifiCorp	KR18086	0.5	0.7
8/11/2018	13:40	KR19874	198.7	PacifiCorp	KR18092	0.5	18
8/11/2018	13:50	KR19874	198.7	PacifiCorp	KR18093	0-8	3
8/11/2018	12:50	KR19645	196.5	PacifiCorp	KR18091	0.5	5.7
8/11/2018	10:00	KR19019	190.2	PacifiCorp	KR18087	0.5	9
8/11/2018	10:10	KR19019	190.2	PacifiCorp	KR18088	0-8	4.3
8/25/2018	18:20	KR18973	189.7	PacifiCorp	KR18102	0.5	12
9/17/2018	18:20	KR20642	206.4	PacifiCorp	KR18114	0.5	0.28
9/17/2018	11:15	KR18973	189.7	PacifiCorp	KR18104	0.5	12
9/17/2018	16:25	KR19874	198.7	PacifiCorp	KR18110	0.5	0.98
9/17/2018	16:40	KR19874	198.7	PacifiCorp	KR18111	0-8	2
9/17/2018	15:30	KR19645	196.5	PacifiCorp	KR18109	0.5	66
9/17/2018	13:00	KR19019	190.2	PacifiCorp	KR18105	0.5	570
9/17/2018	13:10	KR19019	190.2	PacifiCorp	KR18106	0-8	30
9/22/2018	8:55	KR18973	189.7	PacifiCorp	KR18120	0.5	5.4
9/22/2018	11:00	KR20642	189.7	PacifiCorp	KR18121	0.5	0.24
10/13/2018	17:10	KR20642	206.4	PacifiCorp	KR18132	0.5	0.38
10/13/2018	8:45	KR18973	189.7	PacifiCorp	KR18122	0.5	0.27
10/13/2018	14:55	KR19874	198.7	PacifiCorp	KR18128	0.5	0.14 ^{C1, J}
10/13/2018	15:05	KR19874	198.7	PacifiCorp	KR18129	0-8	0.24
10/13/2018	13:45	KR19645	196.5	PacifiCorp	KR18127	0.5	0.36
10/13/2018	10:40	KR19019	190.2	PacifiCorp	KR18123	0.5	0.26
10/13/2018	11:00	KR19019	190.2	PacifiCorp	KR18124	0-8	0.5
10/28/2018	11:10	KR18973	189.7	PacifiCorp	KR18138	0.5	0.12 ^{C1, J}

“ND” value indicates a result less than the laboratory analytical detection limit (0.1 µg/L).

“NS” indicates Not Sampled.

“C1” indicates the reported concentration for this analyte is below the quantitation limit.

“J” indicates the reported result for this analyte should be considered an estimated value.

Appendix 3 Laboratory Phytoplankton Results

No results. Analyses for toxic algae from public health samples are only conducted from May – July.