## TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: September 7th and 15th, 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 15th, 2011. 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 the 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.

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 and posted with public health advisory signs on August 17, 2011. Since the reservoirs have been posted, public health sampling at the reservoir locations has been

discontinued until the blooms have visible diminished and data are need for de-posting purposes. Public health sampling continues in the Klamath River below Iron Gate dam.

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 September 7 and 15, 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 results of microcystin analysis results are not yet available and will be incorporated into future memos.

The Klamath River below Iron Gate dam was posted with public health advisories on September 2, 2011 since public health sampling downstream at the I5 Bridge exceeded the state guidelines. The results from September 7 sampling confirmed that levels of MSAE were present above the state guidelines of 40,000 cell/mL. The most recent sampling on September 15 indicates that these levels may be declining.

**Table 2**. Summary of cyanobacteria public health monitoring on September 7th an 15th, 2011.

| Date | Sample | Location | Species | Biovolume ($\mu m^3$/mL) | Cells/mL |
|---|---|---|---|---|---|
| 9/7/11 | KR11848 | KRBI | Microcystis aeruginosa | 401,058 | 50,132 |
| 9/7/11 | KR11848 | KRBI | Aphanizomenon flos-aquae | 837,436 | 13,293 |
| 9/15/11 | KR11849 | KRBI | Microcystis aeruginosa | 195,433 | 24,429 |
| 9/15/11 | KR11849 | KRBI | Aphanizomenon flos-aquae | 295,969 | 4,698 |

# 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 |
| 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 |

# Appendix 2

## Laboratory Data Sheets for September 7th, 2011 Public Health Samples.

**Phytoplankton Sample Analysis**

| | |
|---|---|
| **Sample:** | Klamath Basin |
| **Sample Site:** | KR 11848 |
| **Sample Depth:** | |
| **Sample Date:** | 7-Sep-11 |
| **Total Density (#/mL):** | 5,678 |
| **Total Biovolume ($um^3$/mL):** | 1,238,493 |
| **Trophic State Index:** | 51.4 |

| | Species | Density #/mL | Density Percent | Biovolume $um^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Microcystis aeruginosa | 5,013 | 88.3 | 401,058 | 32.4 | bluegreen |
| 2 | Aphanizomenon flos-aquae | 665 | 11.7 | 837,436 | 67.6 | bluegreen |

Microcystis aeruginosa cells/mL = 50,132

Aphanizomenon flos-aquae cells/mL = 13,293

Note: Toxic Algae Only

**Aquatic Analysts** **Sample ID:** PN30

## Laboratory Data Sheets for September 15th, 2011 Public Health Samples.

**Phytoplankton Sample Analysis**

| | |
|---|---|
| **Sample:** | Klamath Basin |
| **Sample Site:** | KR 11849 |
| **Sample Depth:** | |
| **Sample Date:** | 15-Sep-11 |
| **Total Density (#/mL):** | 2,173 |
| **Total Biovolume ($um^3$/mL):** | 491,402 |
| **Trophic State Index:** | 44.7 |

| | Species | Density #/mL | Density Percent | Biovolume $um^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Microcystis aeruginosa | 1,879 | 86.5 | 195,433 | 39.8 | bluegreen |
| 2 | Aphanizomenon flos-aquae | 294 | 13.5 | 295,969 | 60.2 | bluegreen |

Microcystis aeruginosa cells/mL = 24,429

Aphanizomenon flos-aquae cells/mL = 4,698

Note: Toxic Algae Only

**Aquatic Analysts** **Sample ID:** PN31