

TECHNICAL MEMORANDUM

Tenmile Lakes Toxic Algae Monitoring, October 20, 2009

Prepared for: **Tenmile Lakes Basin Partnership**

Prepared by: **Jacob Kann, Ph.D.**

Date: **October 23, 2009**



October 20th, 2009 toxic algal cell count results for Tenmile Lakes are as follows (see Figure 1 below for sample station location):

Table 1. Cell density of potentially toxigenic cyanobacteria in Tenmile Lakes, October 20, 2009.

Station	Date	<i>Microcystis</i> (cells/ml)	<i>Gloeotrichia</i> (cells/ml)	Total <i>Microcystis</i> + <i>Gloeotrichia</i>	Total <i>Anabaena</i> (cells/ml)
N16	10/20/2009	6,797	0	6,797	540
NLR	10/20/2009	601,663	0	601,663	15,077
Z1	10/20/2009	4,664,468	0	4,664,468	853,143

* Exceeds World Health Organization Alert Level 1 increased vigilance guideline level of 500 cells ml⁻¹ for potentially toxigenic species in drinking water systems.

** Exceeds World Health Organization Alert Level 2 public health posting guideline level of 2000 cells ml⁻¹ for potentially toxigenic species in drinking water systems

*** Exceeds State of Oregon Recreational Guideline Levels of 40,000 cells/ml for *Microcystis* or 100,000 cell/ml for *Anabaena*

Samples received from this date (other samples collected will be processed by the lab at a later date) show that both *Microcystis aeruginosa* (MSAE) and total *Anabaena* exceeded drinking water and recreational posting guidelines at stations NLR and Z1 (Table 1; Figure 1). MSAE cell density at the standard North Lake station N16 also exceeded the WHO Alert Level 2 guideline of 2000 cells/ml (at which time DHS and local health services typically issue a public alert for drinking water lakes and reservoirs) (Table 1).

Sample station Z1 located in the Coleman Arm area of South Lake continued to show a very high concentration of MSAE, with a cell density of >4.5 million cells/ml; and station NLR in North Lake showed a concentration of >600,000 cells/ml (Table 1). Such MSAE levels can be associated with microcystin toxin levels that constitute a high probability of adverse health effects for recreational users of the lake. State of Oregon posting guidelines for recreational water bodies are 40,000 cells/ml for *Microcystis* and 100,000 cells/ml for *Anabaena*. Station Z1 also exceeded the 100,000 cells/ml posting guideline for total *Anabaena*. Moreover, *Anabaena flos-aquae* (Appendix I: 770,835 cells/ml), a species more commonly associated with neurotoxin production than *A. planctonica*, dominated at station Z1.

Blue-green algae (cyanobacteria) continued to comprise the majority of algal biomass at all three of the above stations (Appendix I) and given cell density results from this date that exceeded guidelines for recreation posting, I would again continue to advise against utilizing lake water for potable or recreational purposes at his time.

Due to the patchy nature of blue-green algal blooms it is possible for higher Microcystis aeruginosa and Anabaena flos-aquae densities (and therefore higher microcystin toxin and anatoxin concentrations to be

present in areas not sampled in this survey, particularly along shorelines or during calm conditions of little to no wind. Given the lakes' demonstrated history of toxic blooms, and the fact that all areas of the lake cannot be tested at all times, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification (attached). In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance. Moreover, because pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

References for Alert Levels

- Carey, C.C., and J.F. Haney, and K.L. Cottingham. 2007. First report of microcystin-LR in the cyanobacterium *Gloeotrichia echinulata*. *Environmental toxicology* 22:337-339.
- Kann, J. 2007. Tenmile Lakes Toxic Algal Sampling Program: 2006 Data Summary Report. Tenmile Lakes Basin Partnership, Lakeside OR 97520
- Falconer et al. 1999. Safe levels and safe practices. Pages 155-177 in: I. Chorus and J. Bartram, editors. *Toxic Cyanobacteria in water: a guide to their public health consequences*. World Health Organization Report. E & FN Spon, London and New York.
- Stone, D., and W. Bress. 2007. Addressing Public Health Risks for Cyanobacteria in Recreational Freshwaters: The Oregon and Vermont Framework. *Integrated Environmental Assessment and Management*; 3(1): 137 - 143 (2007). http://www.oregon.gov/DHS/ph/hab/docs/Stone_cyano_rec.pdf
- Yoo, S.R., W.W. Carmichael, R.C. Hoehn, and S.E. Hrudy. 1995. Cyanobacterial (blue-green algal) toxins: a resource guide. AWWA Research Foundation and American Water Works Association. Denver, CO. 229 p. (ISBN 0-89867-824-2)

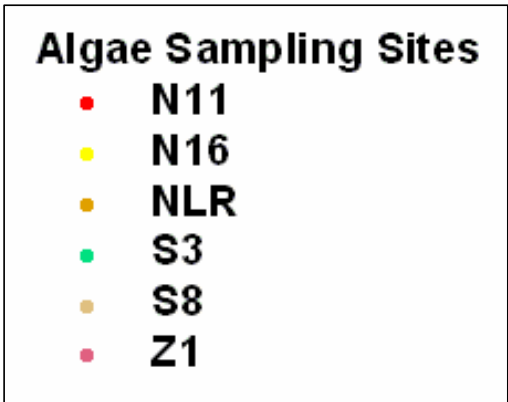
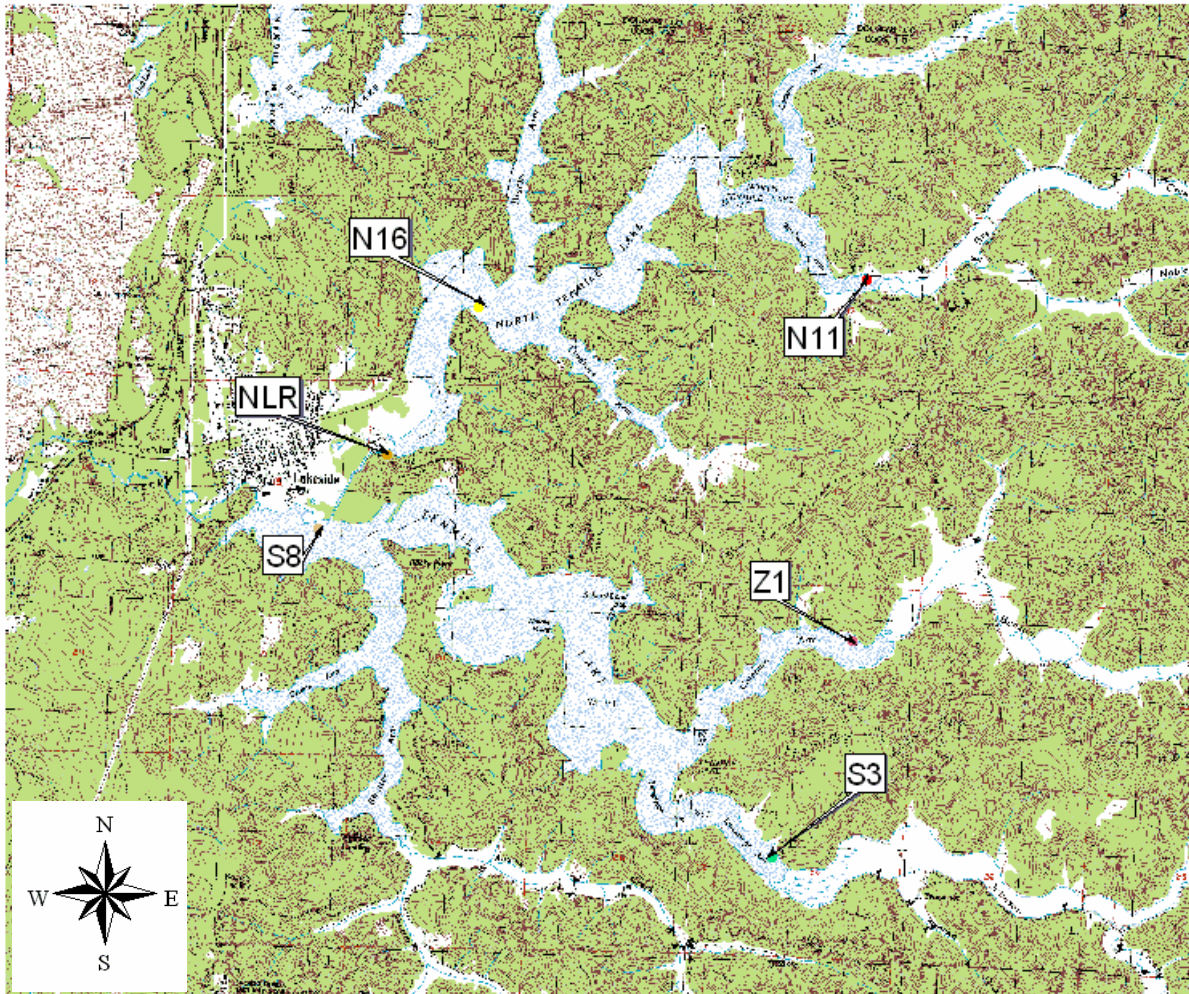


Figure1. Sample station location for potentially toxigenic cyanobacteria in Tenmile Lakes, 2009.

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N16			
Sample Depth:					
Sample Date:		20-Oct-09			
Total Density (#/mL):		96			
Total Biovolume (um³/mL):		164,554			
Trophic State Index:		36.9			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	45.9	47.8	54,378	33.0	bluegreen
2 Anabaena planctonica	13.5	14.0	64,012	38.9	bluegreen
3 Aphanizomenon flos-aquae	9.3	9.7	14,613	8.9	bluegreen
4 Anabaena flos-aquae	6.5	6.8	11,749	7.1	bluegreen
5 Mallomonas sp.	6.0	6.3	2,521	1.5	chrysophyte
6 Chlamydomonas sp.	2.3	2.4	754	0.5	green
7 Melosira granulata	2.3	2.4	3,827	2.3	diatom
8 Dinobryon sertularia	1.9	1.9	3,340	2.0	dinoflagellate
9 Melosira ambigua	1.4	1.4	1,639	1.0	diatom
10 Dictyosphaerium ehrenbergianum	0.9	1.0	668	0.4	green
11 Asterionella formosa	0.9	1.0	919	0.6	diatom
12 Nitzschia palea	0.9	1.0	167	0.1	diatom
13 Chrysosphaerella sp.	0.9	1.0	557	0.3	chrysophyte
14 Cryptomonas erosa	0.9	1.0	482	0.3	cryptophyte
15 Sphaerocystis Schroeteri	0.5	0.5	260	0.2	green
16 Achnanthes lanceolata	0.5	0.5	84	0.1	diatom
17 Ankistrodesmus falcatus	0.5	0.5	12	0.0	green
18 Ceratium hirundinella	0.5	0.5	4,546	2.8	dinoflagellate
19 Cyclotella stelligera	0.5	0.5	26	0.0	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =	6,797				
Anabaena flos-aquae cells/mL =	175				
Anabaena flos-aquae heterocysts/mL =	7				
Anabaena planctonica cells/mL =	350				
Anabaena planctonica heterocysts/mL =	7				
Anabaena planctonica akinetes/mL =	1				
Aphanizomenon flos-aquae cells/mL =	232				
Aphanizomenon flos-aquae heterocysts/mL =	6				
Aquatic Analysts			Sample ID:	MV32	

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		NLR			
Sample Depth:					
Sample Date:		20-Oct-09			
Total Density (#/mL):		3,128			
Total Biovolume (um³/mL):		6,868,250			
Trophic State Index:		63.7			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	1,426	45.6	4,813,305	70.1	bluegreen
2 Rhodomonas minuta	364	11.6	7,274	0.1	cryptophyte
3 Chlamydomonas sp.	247	7.9	80,380	1.2	green
4 Anabaena planctonica	218	7.0	998,383	14.5	bluegreen
5 Anabaena flos-aquae	204	6.5	614,087	8.9	bluegreen
6 Coconeis placentula	160	5.1	73,615	1.1	diatom
7 Nitzschia palea	116	3.7	20,950	0.3	diatom
8 Glenodinium sp.	102	3.3	71,287	1.0	dinoflagellate
9 Aphanizomenon flos-aquae	58	1.9	73,324	1.1	bluegreen
10 Fragilaria crotonensis	44	1.4	54,993	0.8	diatom
11 Gomphonema angustatum	29	0.9	5,237	0.1	diatom
12 Asterionella formosa	29	0.9	6,401	0.1	diatom
13 Sphaerocystis Schroeteri	15	0.5	2,037	0.0	green
14 Pinnularia sp.	15	0.5	5,819	0.1	diatom
15 Navicula sp.	15	0.5	2,182	0.0	diatom
16 Melosira ambigua	15	0.5	8,569	0.1	diatom
17 Synedra radians	15	0.5	5,237	0.1	diatom
18 Navicula pupula	15	0.5	3,928	0.1	diatom
19 Synedra rumpens	15	0.5	2,037	0.0	diatom
20 Eunotia pectinalis	15	0.5	10,475	0.2	diatom
21 Gomphonema subclavatum	15	0.5	8,729	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =	601,663				
Aphanizomenon flos-aquae cells/mL =	1,164				
Anabaena planctonica cells/mL =	5,456				
Anabaena planctonica heterocysts/mL =	175				
Anabaena flos-aquae cells/mL =	9,165				
Anabaena flos-aquae heterocysts/mL =	291				
Aquatic Analysts			Sample ID: MV34		

**Oregon Health Division
Drinking water treatment guidance
August 31, 2001**

DHS Contact Information:

Harmful Algae Program Coordinator: Laura Boswell at (971) 673 – 0438

If she is not available call the main line for the Office of Environmental
Public Health at: (971) 673 – 0440 or

Toll Free: (877) 290 – 6767 and press 0. Ask for Laura Boswell

1. Treatment systems should consist of sand filtration followed by chlorination, followed by activated charcoal filtration. It is essential that sand filtration be done before disinfection to remove as many algal cells as possible without killing or rupturing them.
2. Chlorination systems should be capable of maintaining at least 1 ppm of chlorine residual for at least 20 minutes contact time before the water enters the activated charcoal system.
3. The final step in the process should be effective activated charcoal treatment to remove toxin remaining after the sand filtration and disinfection processes.
4. All treatment equipment used should meet NSF standard 53, and should be adequately sized to treat the maximum amount of water that you use. Treatment equipment needs regular monitoring and servicing to assure that it functions properly.
5. Ideally all water entering your home should be treated as recommended. It is possible to treat only water used in the kitchen, but this increases chances that animals or pets would inadvertently drink untreated water.

As more monitoring is done and toxin levels are measured this advisory may be altered. The advisory is to remain in effect until specifically changed or lifted by county and state health officials.

FACT SHEET

TOXIC *MICROCYSTIS* BLOOMS IN TENMILE LAKES

(information modified from Oregon Health Division Document: Hazards from *Microcystis aeruginosa* in Fresh Water – <http://www.ohd.hr.state.or.us/esc/docs/mafact.htm>)

➤ **What is a toxic bloom of *Microcystis aeruginosa*?**

Microcystis aeruginosa is a species of blue-green algae that grows naturally in many surface waters. In most bodies of fresh water and most weather conditions it does not pose a hazard to wildlife or human beings. However, under certain conditions (such as when the water is warm with abundant nutrients) *Microcystis aeruginosa* can grow more rapidly than normal. The result can be excessive numbers of large colonies that form floating masses on the water surface or that are dispersed within the water column. These occurrences are called "algal blooms". *Microcystis aeruginosa* can produce natural toxins (called microcystins) that are very potent, and these toxins are higher in concentration during bloom conditions. The microcystin toxins are produced and contained inside the *Microcystis* cells, and are released to the water when the cells die and disintegrate. Also, since the cells are very small, they can be ingested along with the water. Toxin levels in a water body tend to be higher near shorelines and at the surface of the water where animal and human contact is most likely.

➤ **What are the primary toxic effects of these blooms?**

The primary toxic effect of microcystins is on the liver. At very high doses, death of liver cells and destruction of blood vessels in the liver can result in serious injury and possibly death. Though less is known about the long-term effects of microcystin toxins, animal studies have shown these toxins can cause chronic liver damage and may promote the formation of liver tumors. These effects are more likely to occur if exposure is frequent over a long period of time.

The levels of toxin necessary to produce immediate or acute illness in humans and animals are much higher than levels that may cause chronic liver injury. Drinking water standards are usually based on chronic effects. Currently, there is no drinking water standard in the U.S. for microcystins. Canada, Australia, and Great Britain have developed a guideline level of 1 microgram toxin per liter of water, or 1 part per billion (1 ppb). During algal blooms, toxin levels can greatly exceed 1 ppb.

➤ **How is it determined when the water becomes safe once a bloom is reported?**

Changes in weather or in other conditions in a water body influence the growth of blue-green algae. Generally, cooler weather, rainfall, and reduced sunshine will lead to reductions in algal growth and toxin levels. Algal blooms generally peak and die off rapidly and toxin levels in the water decline over days or weeks. Only blue-green algae experts can distinguish visually between different kinds of algal growth, and are able to determine when blooms have disappeared. Testing of the water is the only way to be certain that toxin levels are no longer dangerous.

➤ **When does the Oregon Health Division Issue Warnings?**

Drinking Water -- When measured or estimated toxin levels reach 1 ug/l the Department of Human Services, Office of Public Health Systems issues public advisories or warnings. These will include warnings regarding the use of water for drinking or food preparation unless the water has been treated following specific guidelines for destroying and removing toxins. Animals should be kept away from water during periods when microcystin toxin levels exceed 1 ug/l, because drinking the water can cause serious or even fatal illness.

Contact Recreation -- If levels are high enough to pose hazards for swimming, water-skiing or other direct skin contact activities, the advisories will warn against water contact. Generally skin hazards occur where the water has a green or blue-green color or where there are visible clumps or mats of algae present in the water. When measured toxin levels reach 5 ug/L or cell counts reach 15,000 cells/ml, contact recreation is considered unsafe.

➤ **Can testing ensure that all areas of the lake are safe?**

No, due to the patchy nature of blue-green algal blooms it is possible for higher *Microcystis* densities (and therefore higher microcystin toxin concentrations) to be present in areas not sampled in a given survey, particularly along shorelines or during calm conditions of little to no wind. **Therefore, when a lake has a demonstrated history of algal toxicity or the presence of known toxin producing algal species, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification. In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance.**

➤ **Are domestic animals at risk during blooms?**

Yes, pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

➤ **Is it safe to eat fish and other aquatic life?**

Clams, mussels, snails and other shellfish should not be eaten during microcystin advisory periods, but it is believed that fish can be safely eaten if they are cleaned and all internal organs discarded. Internal organs of such fish may be toxic even to animals.

➤ **How much does testing cost?**

Samples must be shipped to qualified laboratories for analysis. A microscopic determination to quantify the number of Microcystis colonies and cells costs \$90 per sample. A specialized test to analyze for the microcystin toxin concentration costs \$100 per sample (overnight shipping costs not included), and for anatoxins the cost is \$250/sample .

- NOTE: A fact sheet about microcystin toxin and its effects may be found on the Web at www.dhs.state.or.us/publichealth/esc/docs/mafact.cfm