

TECHNICAL MEMORANDUM

Tenmile Lakes Toxic Algae Monitoring, October 5, 2009

Prepared for: **Tenmile Lakes Basin Partnership**

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

Date: **October 13, 2009**



October 5th, 2009 toxic algal cell count results for Tenmile Lakes are as follows (see Figure 1 below for sample station location):

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)
S3	10/5/2009	1,974	0	1,974	19
S8	10/5/2009	1,112	0	1,112	50
N11	10/5/2009	4,507	0	4,507	40
N16	10/5/2009	4,599	0	4,599	193
NLR	10/5/2009	2,612,788	0	2,612,788	31,341
Z1	10/5/2009	3,197,474	0	3,197,474	182,681
Dock	10/5/2009	10,561	0	10,561	1,527

* 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 from October 5th show that *Microcystis aeruginosa* (MSAE) cell density at the standard South Lake stations S3 and S8 declined to levels below 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; Figure 2). However, both standard North Lake stations (N11 and N16) increased and exceeded the WHO Alert Level 2 guideline (Table 1; Figure 2). In past years in Tenmile Lakes such levels have been associated with microcystin toxin levels that exceeded the WHO 1 µg/L drinking water standard. Thus, home-owners should ensure that treatment systems are operating effectively. Total *Anabaena* continued to decline overall, and was below Alert Level 1 at all standard (S3, S8, N11, and N16) stations (Figure 2).

However, as noted in previous algal memos, patchy concentrations of blue-green algae continued to exist in other areas of the lake. Sample station Z1 located in the Coleman Arm area of South Lake showed a very high concentration of MSAE, with a cell density of >3 million cells/ml; and station NLR in North Lake showed a concentration of >2.6 million 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 posting guideline for *Anabaena*, with a cell density of 182,681 cells/ml. An additional sample taken near Coleman Arm at a homeowner dock (sample station 'Dock' in the Table above) showed levels below recreational guidelines, but above the Drinking Water Alert Level 2 guideline. On September 26th at this same station, algal toxin samples for microcystin were collected both near the intake of the water treatment system and from

treated tap water. The lab report for these data is attached below, and shows that near the intake microcystin toxin was 1.8 µg/L (which is above the WHO 1 µg/L drinking water standard), but that microcystin toxin was not detected in the treated tap water.

Blue-green algae (cyanobacteria) continued to comprise the majority of algal biomass at S3, S8, and N16; with the predominant species being *Microcystis*, *Aphanizomenon flos-aquae* and *Anabaena planktonica* (Appendix I).

These results show that on October 5th blue-green blooms continued to be prevalent in varying areas of both North and South Tenmile Lakes, and that given both cell density results from this date and microcystin toxin results from Sep 8th that exceeded guidelines for recreation posting, I would continue to advise against utilizing lake water for potable or recreational purposes at this 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)

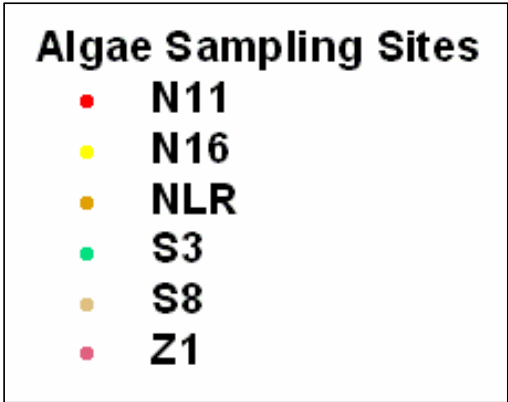
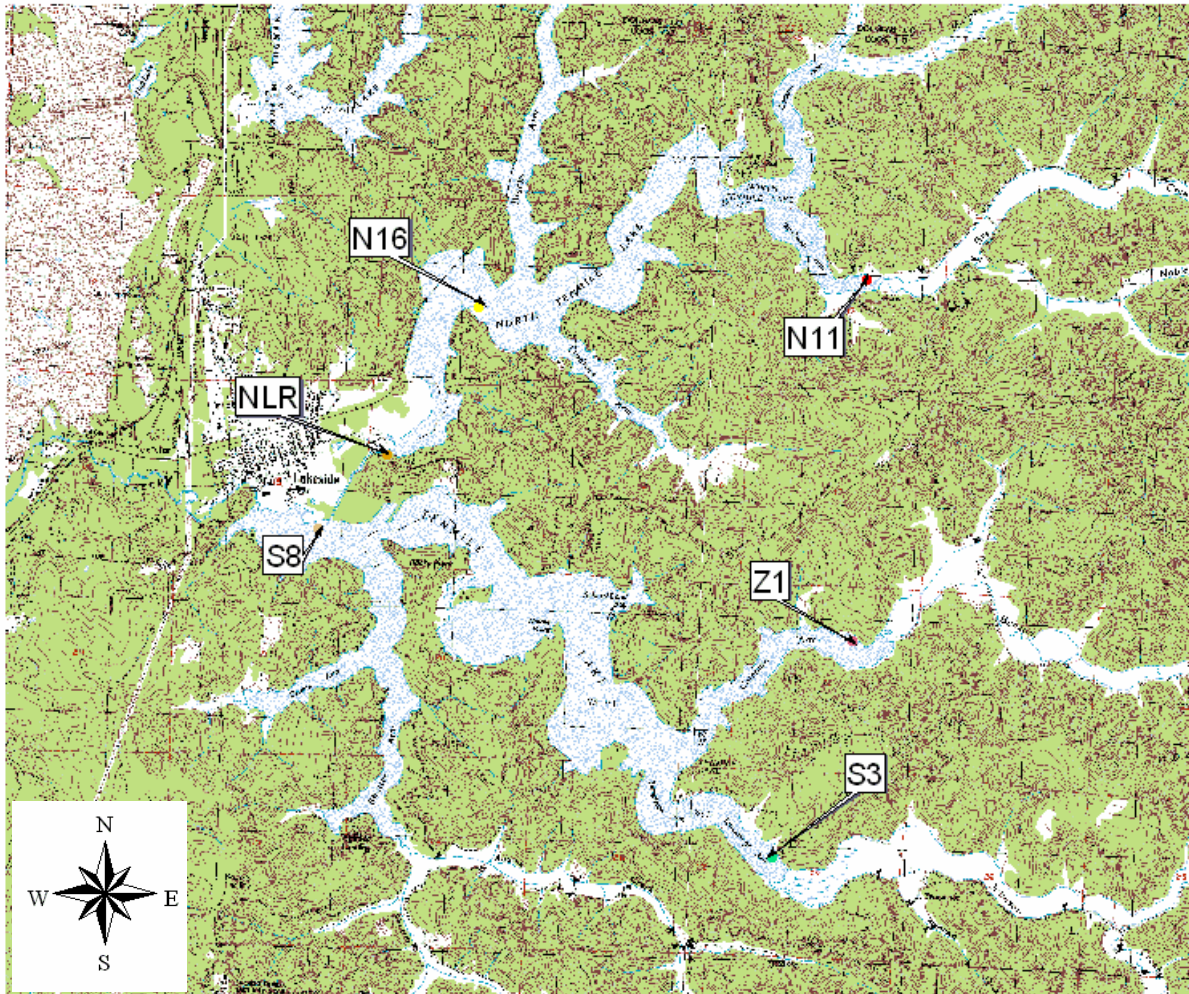


Figure1. Sample station location for potentially toxigenic cyanobacteria, Tenmile Lakes, October 5th, 2009.

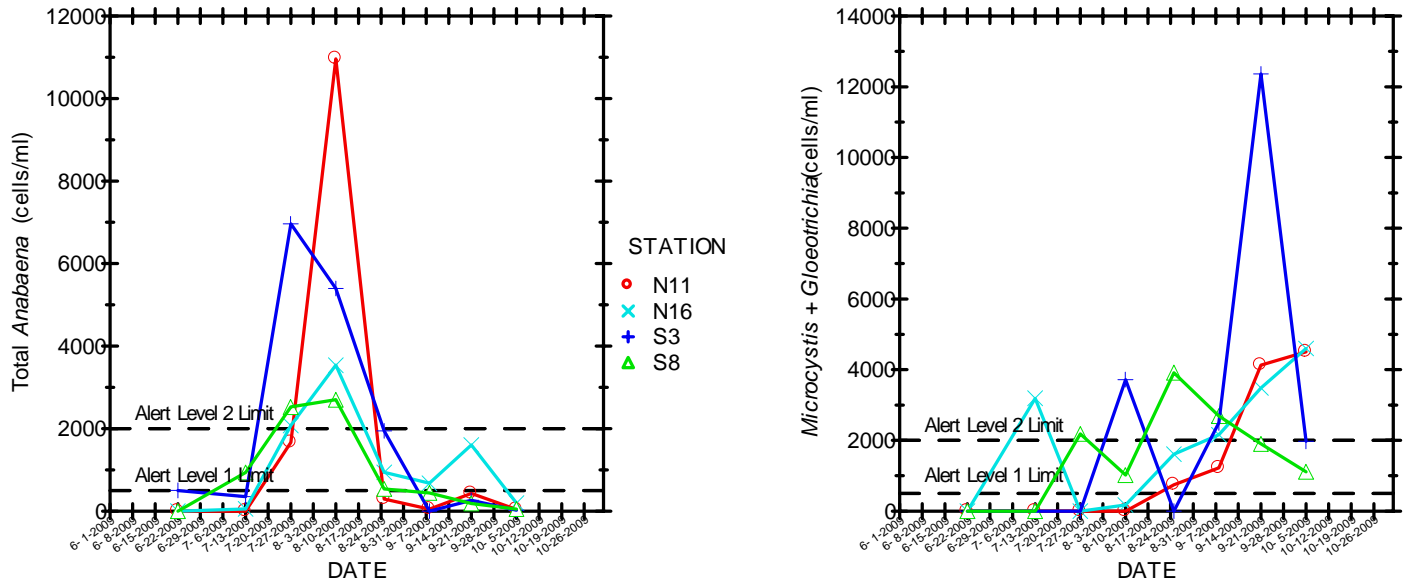


Figure 2. Trend of potentially toxic cyanobacteria in Tenmile Lakes, 2009.

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S3			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		25			
Total Biovolume (um ³ /mL):		32,128			
Trophic State Index:		25.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	11.2	45.0	15,791	49.2	bluegreen
2 Aphanizomenon flos-aquae	6.0	23.9	6,765	21.1	bluegreen
3 Sphaerocystis schroeteri	2.4	9.6	1,921	6.0	green
4 Anabaena planctonica	1.4	5.7	3,144	9.8	bluegreen
5 Rhodomonas minuta	1.0	3.8	19	0.1	cryptophyte
6 Cocconeis placentula	0.7	2.9	329	1.0	diatom
7 Dinobryon sertularia	0.7	2.9	1,289	4.0	dinoflagellate
8 Melosira ambigua	0.5	1.9	2,305	7.2	diatom
9 Melosira granulata	0.2	1.0	197	0.6	diatom
10 Anabaena flos-aquae	0.2	1.0	144	0.4	bluegreen
11 Ankistrodesmus falcatus	0.1	0.5	3	0.0	green
12 Asterionella formosa	0.1	0.5	26	0.1	diatom
13 Glenodinium sp.	0.1	0.5	84	0.3	dinoflagellate
14 Ulothrix sp.	0.1	0.5	57	0.2	green
15 Navicula viridula	0.1	0.5	54	0.2	diatom
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL =		107			
Aphanizomenon flos-aquae heterocysts/mL =		1			
Microcystis aeruginosa cells/mL =		1,974			
Anabaena planctonica cells/mL =		17			
Anabaena planctonica heterocysts/mL =					
Anabaena flos-aquae cells/mL =		2			
Aquatic Analysts		Sample ID: MV25			

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		dock			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		841			
Total Biovolume (um ³ /mL):		603,468			
Trophic State Index:		46.2			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Rhodomonas minuta	302	35.9	6,043	1.0	cryptophyte
2 Chlamydomonas sp.	79	9.4	25,615	4.2	green
3 Microcystis aeruginosa	79	9.4	84,490	14.0	bluegreen
4 Anabaena planctonica	74	8.9	204,329	33.9	bluegreen
5 Aphanizomenon flos-aquae	57	6.8	71,722	11.9	bluegreen
6 Asterionella formosa	31	3.6	6,743	1.1	diatom
7 Melosira ambigua	26	3.1	49,517	8.2	diatom
8 Cryptomonas erosa	22	2.6	11,384	1.9	cryptophyte
9 Ankistrodesmus falcatus	22	2.6	547	0.1	green
10 Fragilaria capucina mesolepta	22	2.6	16,748	2.8	diatom
11 Anabaena flos-aquae	18	2.1	14,082	2.3	bluegreen
12 Fragilaria crotonensis	13	1.6	18,758	3.1	diatom
13 Melosira granulata	13	1.6	9,392	1.6	diatom
14 Gomphonema angustatum	9	1.0	1,576	0.3	diatom
15 Sphaerocystis Schroeteri	9	1.0	3,678	0.6	green
16 Peridinium cinctum	9	1.0	36,781	6.1	dinoflagellate
17 Cocconeis placentula	9	1.0	4,028	0.7	diatom
18 Melosira distans alpigena	9	1.0	2,299	0.4	diatom
19 Navicula sp.	4	0.5	657	0.1	diatom
20 Dinobryon sertularia	4	0.5	525	0.1	dinoflagellate
21 Meridion circulare	4	0.5	1,686	0.3	diatom
22 Anabaena circinalis	4	0.5	9,327	1.5	bluegreen
23 Nitzschia frustulum	4	0.5	525	0.1	diatom
24 Glenodinium sp.	4	0.5	3,065	0.5	dinoflagellate
25 Gloeocystis ampla	4	0.5	1,121	0.2	green
26 Achnanthes minutissima	4	0.5	219	0.0	diatom
27 Epithemia turgida	4	0.5	18,609	3.1	diatom
Note: 200 count					
Aphanizomenon flos-aquae cells/mL =		1,138			
Aphanizomenon flos-aquae heterocysts/mL =		26			
Anabaena planctonica cells/mL =		1117			
Anabaena planctonica heterocysts/mL =		39			
Anabaena planctonica akinetes/mL =		13			
Anabaena flos-aquae cells/mL =		210			
Anabaena flos-aquae heterocysts/mL =		13			
Microcystis aeruginosa cells/mL =		10561			
Anabaena circinalis cells/mL =		131			
Anabaena circinalis heterocysts/mL =		4			
Aquatic Analysts			Sample ID: MV31		

Phytoplankton Sample Analysis					
	Sample:	Tenmile Lake			
	Sample Site:	N16			
	Sample Depth:				
	Sample Date:	5-Oct-09			
	Total Density (#/mL):	75			
	Total Biovolume (um³/mL):	125,041			
	Trophic State Index:	34.9			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	28.6	38.1	36,789	29.4	bluegreen
2 Melosira granulata	12.4	16.5	23,777	19.0	diatom
3 Melosira ambigua	8.5	11.3	19,006	15.2	diatom
4 Anabaena planctonica	6.6	8.8	26,418	21.1	bluegreen
5 Aphanizomenon flos-aquae	4.6	6.2	4,669	3.7	bluegreen
6 Sphaerocystis Schroeteri	3.9	5.2	4,593	3.7	green
7 Asterionella formosa	3.1	4.1	1,087	0.9	diatom
8 Chlamydomonas sp.	2.7	3.6	878	0.7	green
9 Cocconeis placentula	1.5	2.1	710	0.6	diatom
10 Anabaena flos-aquae	1.2	1.5	3,103	2.5	bluegreen
11 Rhodomonas minuta	0.8	1.0	15	0.0	cryptophyte
12 Fragilaria crotonensis	0.4	0.5	3,242	2.6	diatom
13 Synedra radians	0.4	0.5	556	0.4	diatom
14 Gloeocystis ampla	0.4	0.5	198	0.2	green
Note: 200 count.					
Microcystis aeruginosa cells/mL =	4,599				
Anabaena planctonica cells/mL =	144				
Anabaena planctonica heterocysts/mL =	3				
Aphanizomenon flos-aquae cells/mL =	74				
Aphanizomenon flos-aquae heterocysts/mL =	1				
Anabaena flos-aquae cells/mL =	46				
Aquatic Analysts			Sample ID: MV28		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		NLR			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		16,444			
Total Biovolume (um³/mL):		28,423,502			
Trophic State Index:		74.0			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	10,664	64.9	20,902,303	73.5	bluegreen
2 Chlamydomonas sp.	1,954	11.9	634,982	2.2	green
3 Anabaena planctonica	1,058	6.4	5,422,746	19.1	bluegreen
4 Rhodomonas minuta	488	3.0	9,769	0.0	cryptophyte
5 Asterionella formosa	326	2.0	143,278	0.5	diatom
6 Cocconeis placentula	244	1.5	112,343	0.4	diatom
7 Sphaerocystis schroeteri	244	1.5	162,409	0.6	green
8 Gomphonema angustatum	163	1.0	43,960	0.2	diatom
9 Melosira ambigua	163	1.0	143,848	0.5	diatom
10 Aphanizomenon flos-aquae	163	1.0	153,861	0.5	bluegreen
11 Glenodinium sp.	163	1.0	113,971	0.4	dinoflagellate
12 Gomphonema acuminatum	81	0.5	141,650	0.5	diatom
13 Nitzschia paleacea	81	0.5	7,978	0.0	diatom
14 Anabaena flos-aquae	81	0.5	54,543	0.2	bluegreen
15 Oocystis pusilla	81	0.5	35,168	0.1	green
16 Fragilaria pinnata	81	0.5	19,538	0.1	diatom
17 Gomphonema truncatum	81	0.5	110,715	0.4	diatom
18 Melosira granulata	81	0.5	179,097	0.6	diatom
19 Navicula sp.	81	0.5	12,211	0.0	diatom
20 Ankistrodesmus falcatus	81	0.5	4,070	0.0	green
21 Navicula cryptocephala	81	0.5	15,060	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =		2,612,788			
Anabaena planctonica cells/mL =		29,632			
Anabaena planctonica heterocysts/mL =		651			
Anabaena planctonica akinetes/mL =		244			
Anabaena flos-aquae cells/mL =		814			
Aphanizomenon flos-aquae cells/mL =		2,442			
Aphanizomenon flos-aquae heterocysts/mL =		81			
Aquatic Analysts			Sample ID: MV29		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		Z1			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		32,214			
Total Biovolume (um³/mL):		60,971,400			
Trophic State Index:		79.5			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	13,051	40.5	25,579,795	42.0	bluegreen
2 Aphanizomenon flos-aquae	9,251	28.7	12,239,446	20.1	bluegreen
3 Anabaena planctonica	4,130	12.8	15,115,934	24.8	bluegreen
4 Anabaena circinalis	1,652	5.1	3,753,377	6.2	bluegreen
5 Anabaena flos-aquae	1,652	5.1	2,545,755	4.2	bluegreen
6 Chlamydomonas sp.	991	3.1	322,143	0.5	green
7 Trachelomonas volvocina	661	2.1	1,245,619	2.0	euglenoid
8 Synedra rumpens	165	0.5	23,128	0.0	diatom
9 Ankistrodesmus falcatus	165	0.5	4,130	0.0	green
10 Cocconeis placentula	165	0.5	75,993	0.1	diatom
11 Tetradron minimum	165	0.5	29,736	0.0	green
12 Asterionella formosa	165	0.5	36,344	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =	3,197,474				
Anabaena planctonica cells/mL =	82,601				
Anabaena planctonica heterocysts/mL =	1,982				
Anabaena planctonica akinetes/mL =	1,817				
Anabaena circinalis cells/mL =	52,864				
Anabaena circinalis heterocysts/mL =	2,643				
Anabaena circinalis akinetes/mL =	991				
Aphanizomenon flos-aquae cells/mL =	194,277				
Aphanizomenon flos-aquae heterocysts/mL =	2,808				
Anabaena flos-aquae cells/mL =	37,996				
Anabaena flos-aquae heterocysts/mL =	1,817				
Aquatic Analysts			Sample ID: MV30		

Phytoplankton Sample Analysis					
Sample: Tenmile Lake					
Sample Site: N11					
Sample Depth:					
Sample Date: 5-Oct-09					
Total Density (#/mL): 122					
Total Biovolume (um³/mL): 163,864					
Trophic State Index: 36.8					
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Melosira granulata	30	24.7	61,319	37.4	diatom
2 Microcystis aeruginosa	26	21.5	36,054	22.0	bluegreen
3 Cocconeis placentula	12	9.7	5,424	3.3	diatom
4 Sphaerocystis Schroeteri	10	8.6	15,407	9.4	green
5 Rhodomonas minuta	7	5.9	144	0.1	cryptophyte
6 Melosira ambigua	7	5.4	20,449	12.5	diatom
7 Aphanizomenon flos-aquae	6	4.8	7,428	4.5	bluegreen
8 Asterionella formosa	5	3.8	1,715	1.0	diatom
9 Ankistrodesmus falcatus	4	3.2	98	0.1	green
10 Chlamydomonas sp.	3	2.7	1,064	0.6	green
11 Anabaena planctonica	2	1.6	7,192	4.4	bluegreen
12 Trachelomonas volvocina	2	1.6	3,704	2.3	euglenoid
13 Eunotia pectinalis	2	1.6	1,415	0.9	diatom
14 Gomphonema angustatum	1	1.1	236	0.1	diatom
15 Achnanthes minutissima	1	0.5	33	0.0	diatom
16 Gomphonema gracile	1	0.5	160	0.1	diatom
17 Cymbella affinis	1	0.5	1,179	0.7	diatom
18 Cryptomonas erosa	1	0.5	341	0.2	cryptophyte
19 Gloeocystis ampla	1	0.5	168	0.1	green
20 Synedra rumpens	1	0.5	92	0.1	diatom
21 Cymbella minuta	1	0.5	242	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL = 4,507					
Aphanizomenon flos-aquae cells/mL = 118					
Aphanizomenon flos-aquae heterocysts/mL = 1					
Anabaena planctonica cells/mL = 39					
Anabaena planctonica heterocysts/mL = 1					
Aquatic Analysts			Sample ID: MV27		



aquatic analysis ... research ... consulting

Microcystin Data Report
Project: Tenmile Lake Basin Partnership

<u>Sample Identification</u>	<u>Collected</u>
Tenmile Residence Tap	9/26/09
Tenmile Residence Intake	9/26/09

Toxin –Microcystin (MC)

Sample Preparation

The samples were ultra-sonicated to lyse all cells and release toxins. Each sample was analysed in duplicate and assay values averaged to approximate toxin concentration. A duplicate sample of Tenmile Residence Intake sample was spiked at a concentration of 1µg/L MC-LR to support quantitative capability and additional qualitative confirmation.


Analytical Methodology

Microcystin (MC)

A microcystin Enzyme-linked Immunosorbent Assay (Abraxis) was utilized for the quantitative detection of MC. The current assay is sensitive down to a detection/quantification limit of 0.15 µg/L.

<u>Sample</u>	<u>MC levels</u> (µg/L)
Tenmile Residence Tap	ND
Tenmile Residence Intake	1.8

ND = Not detected above the detection limit
 Detection Limit = 0.15 µg/L
 Limit of Quantification = 0.15 µg/L

Submitted by: 
 Mark T. Aubel, Ph.D.
 Date: 10/13/2009



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**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