AQUATIC ECOSYSTEM SCIENCES, LLC

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TECH MEMO

To:	Mike Mader/Jason F. – TLBP	From:	Jake Kann
Fax:	(503) 731-4077 541-759-3711	Pages:	24
Phone:		Date:	10-19-06
Re:	*Tenmile Sampling*	CC:	Dave Stone – OHD

Sep 27th and Oct 11th toxic algal cell count results for Tenmile Lakes are described below:

Please note that in addition to the usual 4 sampling stations (S3, S8, N11, and N16; see Figure 1 below) that 2 additional samples of treated tap water and raw lake intake water were collected on each date from a home located on Lindross Arm in North Tenmile Lake. In addition, a duplicate tow was collected at N16 on Sep 27th (Station D on attached lab sheets), and an additional sample of a concentrated patch of algae (Station X on attached lab sheets) was collected on Oct 11th.

Sampling Resolution Issues

On Sep 27th *Microcystis aeruginosa* (MSAE) was not detected at any of the usual 4 sampling stations (Table1; Fig. 2). However, in a duplicate tow at N16 a level of 3553 MSAE cells/ml was detected. This level exceeded the WHO Alert Level 2 density of 2000 cells/ml (Alert Level 2 is the point at which advisories are issued for drinking water systems). These results underscore both the patchiness that algal densities exhibit in lake environments and the limitations of the resolution of laboratory determinations of algal density. For example, in a repeat analysis by Aquatic Analysts on additional sub-samples of both N16 and N16-D, results showed that while N16-D had higher density on the average than N16 (2433 vs. 828 cells/ml), that MSAE was also detected in the additional sub-sample analyses performed on N16:

Aquatic Analysts Repeated Sub-sampling for MSAE on Tenmile Sep 27 Duplicates		
Slide	**JU82**	**JU83**
Sample	**N16**	**D**
	MSAE (cells/ml)	**MSAE (cells/ml)**
Original sub-sample	0	3553
2nd sub-sample	74	2116
3rd sub-sample	2502	1523
4th sub-sample	737	2538
Mean	828	2433
±95% Confidence Interval	1852	1361

This repeated sub-sampling indicates that the 95% confidence interval for samples with low MSAE density ranged between ±1361 to ±1852 cells per ml. Although this cell density resolution would be adequate relative to the recreational standard of 40,000 cells/ml MSAE, it is not adequate relative to the drinking-water Alert Level 2 level of 2000 cells/ml. Based on these results, future laboratory analyses for potentially toxigenic cyanobacteria in drinking-water lakes or reservoirs should be performed using increased sub-sampling methodology. For example, the number of total algal units counted could be increased from the current level of 100 algal units to 200 algal units. Although this method would incur additional costs, the above data indicate that for drinking-water systems (when low levels of a species need to be determined), such an increase in precision is necessary.

Sampling of Home Water Treatment System

Cell density data from a home water treatment system located on Lindross Arm in North Tenmile show that *Anabaena* cells were detected in samples collected directly from the kitchen tap (Table 1; Stations S1 and L1). On 9/27/06 731 cells/ml of MSAE were found in the lake near the treatment system intake, and no MSAE cells were detected at the tap. However, of a total of 613 cells/ml of *Anabaena* at the intake, only ~40% were removed with 367 cells/ml remaining. Likewise, on Oct 11th, of a total of 1360 cells/ml of *Anabaena* at the intake, only ~40% were removed with 812 cells/ml remaining. It is my understanding that the treatment system consists of sand filtration, chlorination, and activated carbon filtration. At this time it is unclear where in the treatment system the failure is occurring. Although potentially toxigenic cyanobacteria levels are currently low in the lake, the potential for high tap water concentrations are possible should levels increase. This underscores the need for homeowners to ensure their treatment systems are operating effectively.

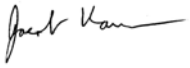
General Trends

On October 11th MSAE was detected at S3, N11, and N16 at levels exceeding the WHO Alert Level 1 density of 500 cells/ml (Alert Level 1 is the increased vigilance level for drinking water systems). However, all counts were lower then the WHO Alert Level 2 value of 2000 cells/ml. Likewise, total *Anabaena* was also greater than 500 cells/ml but lower than 2000 cells/ml at S3 and N11 (Table 2; Figure 2). A sample collected in Templeton Arm from a dense patch of algae representing a visual area of very high density (Sample X in Table 2) showed no MSAE, and had 2626 cells/ml of total *Anabaena.* It is clear that low levels of both MSAE and *Anabaena* are persisting in Tenmile Lakes.

Given the *Anabaena* value of 2626 cells/ml that exceeds WHO's Alert Level 2 value of 2000 cells/ml, and the possible variability in laboratory counts demonstrated above (±1852 cells) the potential continues to exist for cell density levels of potentially toxigenic cyanobacteria to exceed 2000 cells/ml in Tenmile Lakes.

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.

Please call if you have any questions.
Sincerely,



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References for Alert Levels

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)

Falconer et al. (WHO) 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.

Table 1. Cell Density of potentially toxigenic cyanobacteria in Tenmile Lakes, Sep 27 and Oct 11, 2006.

Lab Station ID	Description	Date	*Microcystis aeruginosa (cells/ml)*	*Anabaena flos-aquae (cells/ml)*	*Anabaena planktonica (cells/ml)*	*Anabaena circinalis (cells/ml)*	*Anabaena sp. (cells/ml)*	*Total Anabaena (cells/ml)*
S3	S3	9/27/2006	0	82		0	0	82
S8	S8	9/27/2006	0	105	209	0	0	314
N11	N11	9/27/2006	0	821	228	0	0	1049
N16	N16	9/27/2006	0	534	503	0	0	1037
D	N16-Duplicate Tow	9/27/2006	3553	162	183	0	0	345
S1	Lindross Arm at Homeowner Tap	9/27/2006	0	326	41	0	0	367
S2	Lindross Arm in Lake at Homeowner Intake	9/27/2006	735	392	221	0	0	613
S3	S3	10/11/2006	966	869	0	0	0	869
S8	S8	10/11/2006	0	211	189	27	0	427
N11	N11	10/11/2006	701	308	437	0	0	745
N16	N16	10/11/2006	780	193	266	0	0	459
X	Dense Patch in Templeton Arm	10/11/2006	0	2626	0	0	0	2626
L1	Lindross Arm at Homeowner Tap	10/11/2006	0	580	232	0	0	812
L2	Lindross Arm in Lake at Homeowner Intake	10/11/2006	0	756	571	33	0	1360

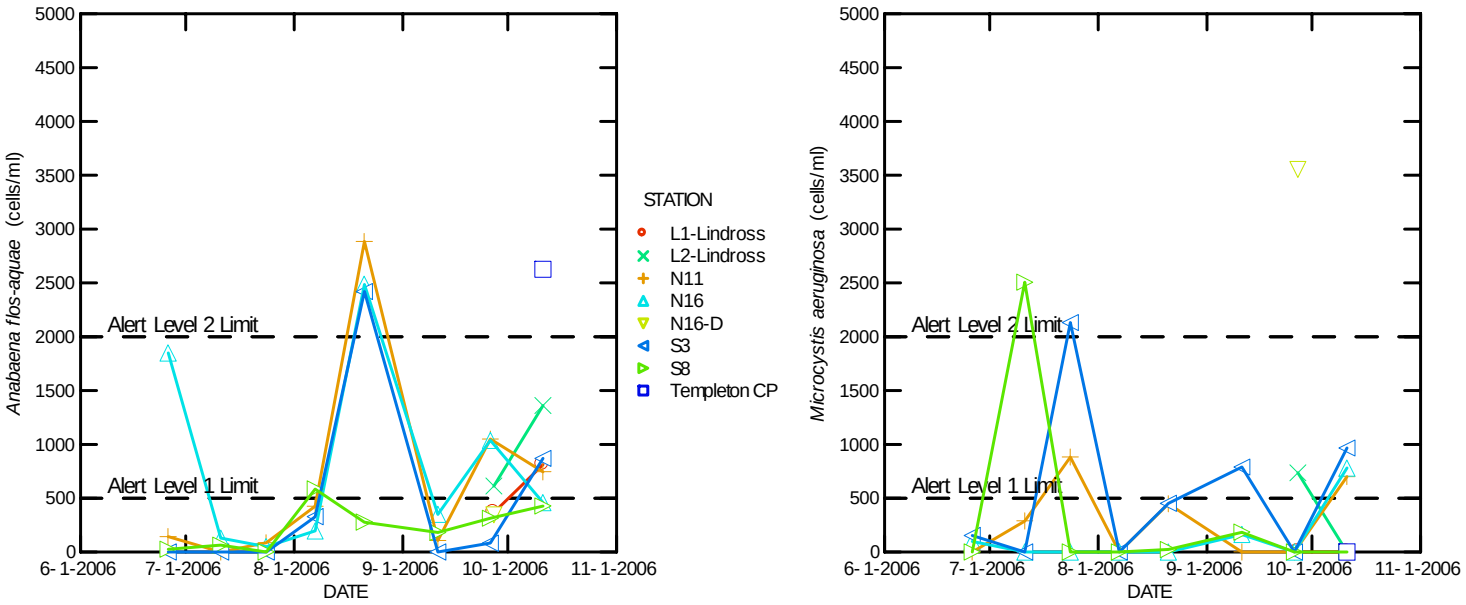
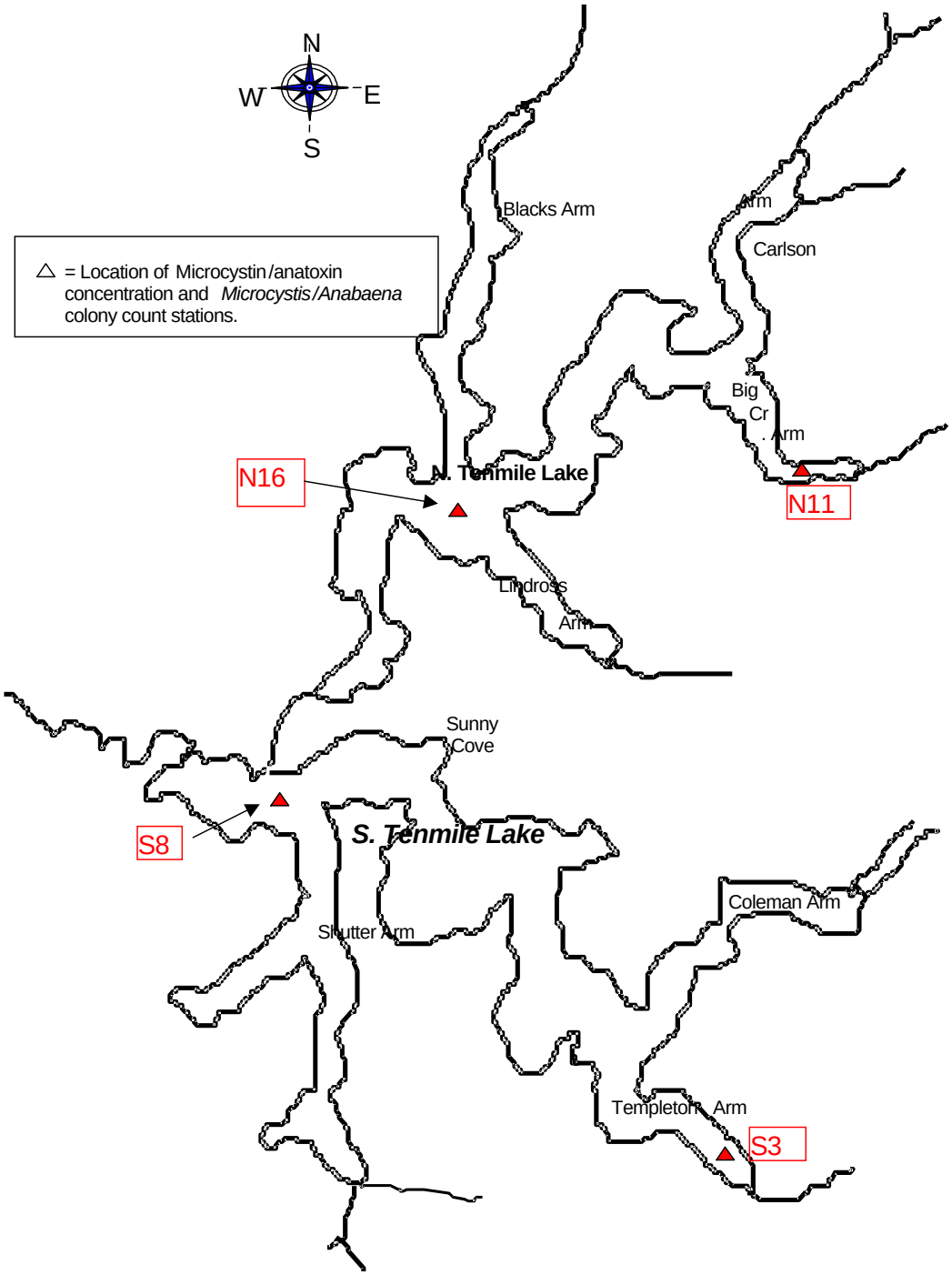


Figure. 1. Tenmile Lakes 2006 Toxic Cyanobacteria Trends

Year 2006 Tenmile Lakes Sample Site Locations



Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S3
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 133
Total Biovolume (um³/mL): 246,581
Trophic State Index: 39.8

	Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
1	Melosira granulata	51	38.5	123,464	50.1
2	Melosira granulata angustissima	37	28.2	34,607	14.0
3	Aphanizomenon flos-aquae	26	19.2	19,285	7.8
4	Anabaena flos-aquae	7	5.1	5,469	2.2
5	Melosira ambigua	7	5.1	20,033	8.1
6	Cocconeis placentula	2	1.3	782	0.3
7	Achnanthes minutissima	2	1.3	85	0.0
8	Fragilaria crotonensis	2	1.3	42,855	17.4

Anabaena flos-aquae cells/mL = 82
Anabaena flos-aquae heterocysts/mL = 5

Aphanizomenon flos-aquae cells/mL = 306
Aphanizomenon flos-aquae heterocysts/mL = 7

Aquatic Analysts **Sample ID:** JU79

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S8
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 633
Total Biovolume (um^3/mL): 1,707,080
Trophic State Index: 53.7

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira granulata	471	74.4	1,371,983	80.4
2	Melosira granulata angustissima	58	9.1	63,278	3.7
3	Aphanizomenon flos-aquae	37	5.8	39,206	2.3
4	Asterionella formosa	31	5.0	25,541	1.5
5	Melosira ambigua	16	2.5	73,926	4.3
6	Anabaena planctonica	10	1.7	38,281	2.2
7	Anabaena flos-aquae	5	0.8	7,008	0.4
8	Fragilaria crotonensis	5	0.8	87,857	5.1

Aphanizomenon flos-aquae cells/mL = 622
Aphanizomenon flos-aquae heterocysts/mL = 16

Anabaena planctonica cells/mL = 209
Anabaena planctonica heterocysts/mL = 10

Anabaena flos-aquae cells/mL = 105
Anabaena flos-aquae heterocysts/mL = 5

Aquatic Analysts

Sample ID: JU80

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N11
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 177
Total Biovolume (um^3/mL): 213,816
Trophic State Index: 38.7

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Aphanizomenon flos-aquae	54	30.3	47,205	22.1
2	Anabaena flos-aquae	36	20.2	54,983	25.7
3	Asterionella formosa	29	16.2	10,676	5.0
4	Anabaena planctonica	14	8.1	41,789	19.5
5	Unidentified flagellate	14	8.1	285	0.1
6	Rhodomonas minuta	9	5.1	178	0.1
7	Fragilaria capucina mesolepta	5	3.0	16,377	7.7
8	Melosira ambigua	5	3.0	15,762	7.4
9	Fragilaria vaucheria	2	1.0	8,221	3.8
10	Cocconeis placentula	2	1.0	821	0.4
11	Melosira granulata angustissima	2	1.0	1,338	0.6
12	Achnanthes minutissima	2	1.0	89	0.0
13	Epithemia turgida	2	1.0	15,164	7.1
14	Cryptomonas erosa	2	1.0	928	0.4

Aphanizomenon flos-aquae cells/mL = 749
Aphanizomenon flos-aquae heterocysts/mL = 21

Anabaena flos-aquae cells/mL = 821
Anabaena flos-aquae heterocysts/mL = 55
Anabaena flos-aquae akinetes/mL = 25

Anabaena planctonica cells/mL = 228
Anabaena planctonica heterocysts/mL = 7

Aquatic Analysts **Sample ID:** JU81

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N16
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL):	131
Total Biovolume (um^3/mL):	283,504
Trophic State Index:	40.8

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Asterionella formosa	43	32.6	40,376	14.2
2	Anabaena planctonica	26	20.2	92,110	32.5
3	Aphanizomenon flos-aquae	16	12.4	16,319	5.8
4	Anabaena flos-aquae	15	11.2	32,540	11.5
5	Melosira ambigua	13	10.1	31,207	11.0
6	Unidentified flagellate	7	5.6	147	0.1
7	Melosira granulata	3	2.2	7,285	2.6
8	Cryptomonas erosa	1	1.1	765	0.3
9	Rhodomonas minuta	1	1.1	29	0.0
10	Staurastrum sp.	1	1.1	353	0.1
11	Fragilaria crotonensis	1	1.1	61,813	21.8
12	Mallomonas sp.	1	1.1	559	0.2

Aphanizomenon flos-aquae cells/mL =	259
Aphanizomenon flos-aquae heterocysts/mL =	15
Anabaena flos-aquae cells/mL =	534
Anabaena flos-aquae heterocysts/mL =	41
Anabaena planctonica cells/mL =	503
Anabaena planctonica heterocysts/mL =	26

Aquatic Analysts **Sample ID:** JU82

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S1
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 122
Total Biovolume (um^3/mL): 56,232
Trophic State Index: 29.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Anabaena flos-aquae	33	26.7	21,857	38.9
2	Aphanizomenon flos-aquae	29	23.3	17,983	32.0
3	Ankistrodesmus falcatus	24	20.0	612	1.1
4	Asterionella formosa	12	10.0	2,691	4.8
5	Melosira granulata	8	6.7	4,486	8.0
6	Cyclotella stelligera	4	3.3	224	0.4
7	Crucigenia quadrata	4	3.3	347	0.6
8	Synedra rumpens	4	3.3	571	1.0
9	Anabaena planctonica	4	3.3	7,462	13.3

Aphanizomenon flos-aquae cells/mL = 285

Anabaena flos-aquae cells/mL = 326

Anabaena planctonica cells/mL = 41
Anabaena planctonica heterocysts/mL = 4

Note: Grab sample.

Aquatic Analysts

Sample ID: JU84

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S2
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 275
Total Biovolume (um^3/mL): 545,743
Trophic State Index: 45.5

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira ambigua	93	33.9	257,843	47.2
2	Asterionella formosa	59	21.4	58,238	10.7
3	Melosira granulata	44	16.1	121,329	22.2
4	Aphanizomenon flos-aquae	29	10.7	33,354	6.1
5	Anabaena flos-aquae	20	7.1	26,276	4.8
6	Anabaena planctonica	15	5.4	40,369	7.4
7	Microcystis aeruginosa	7	2.7	5,883	1.1
8	Rhodomonas minuta	2	0.9	49	0.0
9	Cocconeis placentula	2	0.9	1,128	0.2
10	Cryptomonas erosa	2	0.9	1,275	0.2

Aphanizomenon flos-aquae cells/mL =	529
Aphanizomenon flos-aquae heterocysts/mL =	15
Anabaena flos-aquae cells/mL =	392
Anabaena flos-aquae heterocysts/mL =	15
Microcystis aeruginosa cells/mL =	735
Anabaena planctonica cells/mL =	221
Anabaena planctonica heterocysts/mL =	12
Anabaena planctonica akinetes/mL =	2

Aquatic Analysts

Sample ID: JU85

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: D
Sample Depth:
Sample Date: 27-Sep-06

Total Density (#/mL): 120
Total Biovolume (um^3/mL): 170,836
Trophic State Index: 37.1

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Asterionella formosa	32	26.8	22,628	13.2
2	Melosira ambigua	30	24.6	55,798	32.7
3	Anabaena planctonica	10	8.5	33,434	19.6
4	Microcystis aeruginosa	8	7.0	28,420	16.6
5	Unidentified flagellate	7	5.6	135	0.1
6	Anabaena flos-aquae	7	5.6	10,881	6.4
7	Aphanizomenon flos-aquae	7	5.6	4,263	2.5
8	Mallomonas sp.	5	4.2	1,929	1.1
9	Rhodomonas minuta	5	4.2	102	0.1
10	Melosira granulata	4	3.5	11,630	6.8
11	Chlamydomonas sp.	2	1.4	550	0.3
12	Oocystis pusilla	1	0.7	183	0.1
13	Melosira granulata angustissima	1	0.7	211	0.1
14	Glenodinium sp.	1	0.7	592	0.3
15	Chaetoceros sp.	1	0.7	80	0.0

Microcystis aeruginosa cells/mL = 3,553

Anabaena planctonica cells/mL = 183
Anabaena planctonica heterocysts/mL = 14

Anabaena flos-aquae cells/mL = 162
Anabaena flos-aquae heterocysts/mL = 16

Aphanizomenon flos-aquae cells/mL = 68
Aphanizomenon flos-aquae heterocysts/mL = 3

Aquatic Analysts

Sample ID: JU83

Phytoplankton Sample Analysis

Sample: Temnile Lak
Sample Station: S3
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL): 71
Total Biovolume (um^3/mL): 173,542
Trophic State Index: 37.2

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Anabaena flos-aquae	32	45.5	58,229	33.6
2	Melosira granulata	24	34.5	95,529	55.0
3	Cryptomonas erosa	4	5.5	2,009	1.2
4	Aphanizomenon flos-aquae	3	4.5	3,245	1.9
5	Melosira ambigua	2	2.7	3,413	2.0
6	Microcystis aeruginosa	1	1.8	7,725	4.5
7	Asterionella formosa	1	1.8	567	0.3
8	Melosira granulata angustissima	1	1.8	805	0.5
9	Rhodomonas minuta	1	0.9	13	0.0
10	Eudorina elegans	1	0.9	2,009	1.2

Aphanizomenon flos-aquae cells/mL = 52
Aphanizomenon flos-aquae heterocysts/mL = 1

Anabaena flos-aquae cells/mL = 869
Anabaena flos-aquae heterocysts/mL = 37

Microcystis aeruginosa cells/mL = 966

Aquatic Analysts

Sample ID: JU86

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S8
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL): 350
Total Biovolume (um^3/mL): 870,582
Trophic State Index: 48.8

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira granulata	260	74.2	743,909	85.4
2	Asterionella formosa	25	7.0	17,348	2.0
3	Anabaena flos-aquae	19	5.5	14,125	1.6
4	Melosira granulata angustissima	11	3.1	9,583	1.1
5	Aphanizomenon flos-aquae	8	2.3	8,797	1.0
6	Melosira ambigua	8	2.3	25,641	2.9
7	Anabaena planctonica	8	2.3	34,572	4.0
8	Anabaena circinalis	3	0.8	1,944	0.2
9	Dinobryon sertularia	3	0.8	8,145	0.9
10	Glenodinium sp.	3	0.8	1,917	0.2
11	Fragilaria crotonensis	3	0.8	4,600	0.5

Anabaena circinalis cells/mL = 27
Anabaena circinalis heterocysts/mL = 3

Aphanizomenon flos-aquae cells/mL = 140

Anabaena flos-aquae cells/mL = 211
Anabaena flos-aquae heterocysts/mL = 8

Anabaena planctonica cells/mL = 189
Anabaena planctonica heterocysts/mL = 8

Aquatic Analysts

Sample ID: JU87

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N11
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL): 144
Total Biovolume (um^3/mL): 340,915
Trophic State Index: 42.1

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira granulata	50	35.0	94,325	27.7
2	Anabaena planctonica	18	12.6	80,000	23.5
3	Anabaena flos-aquae	14	9.7	20,653	6.1
4	Cryptomonas erosa	13	8.7	6,557	1.9
5	Aphanizomenon flos-aquae	11	7.8	14,124	4.1
6	Fragilaria crotonensis	6	3.9	51,786	15.2
7	Melosira ambigua	6	3.9	9,903	2.9
8	Melosira granulata angustissima	4	2.9	5,990	1.8
9	Asterionella formosa	4	2.9	4,346	1.3
10	Microcystis aeruginosa	3	1.9	5,605	1.6
11	Fragilaria capucina mesolepta	3	1.9	8,575	2.5
12	Denticula elegans	1	1.0	1,051	0.3
13	Cosmarium sp.	1	1.0	294	0.1
14	Ankistrodesmus falcatus	1	1.0	35	0.0
15	Rhodomonas minuta	1	1.0	28	0.0
16	Nitzschia palea	1	1.0	252	0.1
17	Achnanthes minutissima	1	1.0	70	0.0
18	Sphaerocystis schroeteri	1	1.0	785	0.2
19	Dinobryon sertularia	1	1.0	667	0.2
20	Rhopalodia gibba	1	1.0	35,869	10.5

Anabaena flos-aquae cells/mL = 308
Anabaena flos-aquae heterocysts/mL = 17
Anabaena flos-aquae akinetes/mL = 8

Microcystis aeruginosa cells/mL = 701

Anabaena planctonica cells/mL = 437
Anabaena planctonica heterocysts/mL = 8

Aphanizomenon flos-aquae cells/mL = 224
Aphanizomenon flos-aquae heterocysts/mL = 3

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N16
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL): 109
Total Biovolume (um^3/mL): 307,363
Trophic State Index: 41.4

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira ambigua	50	45.5	137,607	44.8
2	Melosira granulata	14	12.5	39,776	12.9
3	Anabaena planctonica	13	11.6	48,694	15.8
4	Anabaena flos-aquae	11	9.8	12,930	4.2
5	Mallomonas sp.	4	3.6	1,482	0.5
6	Asterionella formosa	3	2.7	643	0.2
7	Cryptomonas erosa	3	2.7	1,520	0.5
8	Aphanizomenon flos-aquae	3	2.7	3,684	1.2
9	Melosira granulata angustissima	3	2.7	731	0.2
10	Fragilaria crotonensis	2	1.8	44,211	14.4
11	Dinobryon sertularia	1	0.9	116	0.0
12	Ochromonas sp.	1	0.9	83	0.0
13	Microcystis aeruginosa	1	0.9	6,238	2.0
14	Ceratium hirundinella	1	0.9	9,552	3.1
15	Nitzschia paleacea	1	0.9	96	0.0

Anabaena flos-aquae cells/mL =	193
Anabaena flos-aquae heterocysts/mL =	19
Anabaena planctonica cells/mL =	266
Anabaena planctonica heterocysts/mL =	17
Anabaena planctonica akinetes/mL =	2
Microcystis aeruginosa cells/mL =	780
Aphanizomenon flos-aquae cells/mL =	58
Aphanizomenon flos-aquae heterocysts/mL =	1

Aquatic Analysts

Sample ID: JU89

Boat problems

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: X
Sample Depth:
Sample Date: 11-Oct-06

209 m west of S3

Total Density (#/mL):	189
Total Biovolume (um³/mL):	233,450
Trophic State Index:	39.4

	Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
1	Anabaena flos-aquae	119	63.3	175,961	75.4
2	Melosira granulata	47	24.8	25,692	11.0
3	Aphanizomenon flos-aquae	19	10.1	20,382	8.7
4	Melosira ambigua	2	0.9	11,209	4.8
5	Dinobryon sertularia	2	0.9	206	0.1

Anabaena flos-aquae cells/mL =	2,626
Anabaena flos-aquae heterocysts/mL =	59
Anabaena flos-aquae akinetes/mL =	5
Aphanizomenon flos-aquae cells/mL =	324
Aphanizomenon flos-aquae heterocysts/mL =	5

Aquatic Analysts

Sample ID: JU92

Phytoplankton Sample Analysis

Tolman at Top

Sample: Tenmile Lake
Sample Station: L1
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL): 162
Total Biovolume (um³/mL): 116,497
Trophic State Index: 34.4

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Anabaena flos-aquae	58	35.7	3,886	3.3
2	Melosira ambigua	35	21.4	40,994	35.2
3	Anabaena planctonica	23	14.3	42,455	36.4
4	Melosira granulata	19	11.4	20,416	17.5
5	Asterionella formosa	9	5.7	2,042	1.8
6	Synedra radians	2	1.4	835	0.7
7	Cyclotella meneghiniana	2	1.4	882	0.8
8	Cryptomonas erosa	2	1.4	1,206	1.0
9	Sphaerocystis schroeteri	2	1.4	325	0.3
10	Crucigenia quadrata	2	1.4	197	0.2
11	Aphanizomenon flos-aquae	2	1.4	1,462	1.3
12	Ankistrodesmus falcatus	2	1.4	58	0.0
13	Melosira granulata angustissima	2	1.4	1,740	1.5

Anabaena flos-aquae cells/mL = 580
Anabaena flos-aquae heterocysts/mL = 9

Anabaena planctonica cells/mL = 232
Anabaena planctonica heterocysts/mL = 5

Aphanizomenon flos-aquae cells/mL = 23

Aquatic Analysts

Sample ID: JU90

Phytoplankton Sample Analysis

Taken at intake

Sample: Tenmile Lake
Sample Station: L2
Sample Depth:
Sample Date: 11-Oct-06

Total Density (#/mL):	193
Total Biovolume (um^3/mL):	607,135
Trophic State Index:	46.3

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Melosira ambigua	98	50.4	264,260	43.5
2	Melosira granulata	33	16.8	91,195	15.0
3	Anabaena flos-aquae	24	12.6	50,645	8.3
4	Anabaena planctonica	21	10.9	104,416	17.2
5	Melosira granulata angustissima	5	2.5	4,877	0.8
6	Aphanizomenon flos-aquae	5	2.5	3,994	0.7
7	Mallomonas sp.	3	1.7	1,235	0.2
8	Anabaena circinalis	2	0.8	2,308	0.4
9	Fragilaria crotonensis	2	0.8	68,274	11.2
10	Ceratium hirundinella	2	0.8	15,931	2.6

Anabaena planctonica cells/mL =	571
Anabaena planctonica heterocysts/mL =	34
Anabaena flos-aquae cells/mL =	756
Anabaena flos-aquae heterocysts/mL =	60
Anabaena circinalis cells/mL =	33
Anabaena circinalis heterocysts/mL =	2
Aphanizomenon flos-aquae cells/mL =	63

Aquatic Analysts

Sample ID: JU91

October 20, 2006

Oregon Health Division **Contact Person: Ken Kauffman**
Drinking water treatment guidance **503-731-4015**
August 31, 2001 **kenneth.w.kauffman@state.or.us**

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