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Stress Stream Analysis of a Sub-Watershed of Conesus Lake: South McMillan Creek

Joseph C. Makarewicz
The College at Brockport, jmakarew@brockport.edu

Theodore W. Lewis
The College at Brockport, tlewis@brockport.edu

Livingston County Planning Department

Lewis

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South McMillan Creek

Joseph C. Makarewicz and Theodore W. Lewis

Center for Applied Aquatic Sciences and Aquaculture

Department of Biological Sciences

SUNY Brockport

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SUMMARY

1. Stressed stream analysis was performed on the watershed of one tributary (South McMillan Creek) of Conesus Lake that had been previously recognized as contributing high levels of nutrient to the lake.
2. Nonpoint sources of the nutrients phosphorus and nitrogen and losses of sodium and soil (total suspended solids) were identified in the watershed of South McMillan Creek.
3. Storm water runoff along local highways (Marshall Road and Route 255) contributed a significant amount of phosphorus, total suspended solids and sodium to South McMillan Creek.
4. A major nitrate source in South McMillan Creek was attributed to agricultural practices at Sliker Hill Road.
5. A residential source of organic nitrogen was found near Webster's Crossing.

RECOMMENDATIONS:

1. A Remedial Action Plan should be developed by the County to remediate the areas of concern identified in this study. The Livingston County Soil and Water Conservation District would probably be the lead agency. Area farmers should be approached in the areas identified as nonpoint sources of nutrients and their agriculture practices reviewed. Potential problem areas could include over-fertilization of cropland, poor timing of fertilization, poor choice of tillage practices, improper animal waste management, etc. Corrective action is often quite simple and may have dramatic effects in final nutrient loads to Conesus Lake.
2. Best management practices (BMP) have been used for reducing nonpoint source pollution. BMP's include agronomic practices such as conservation or reduced tillage, crop rotation, vegetative cover, crop residue, and nutrient management (Johengen *et al.* 1989, Haith 1975, NYSDEC 1986). They may also include structural devices such as

grassed waterways, sediment retention basins, erosion control weirs and animal waste holding tanks. BMP's are designed to reduce sediment and nutrient transport to streams and lakes. They may benefit the farmer in the long term by decreasing fuel and fertilizer costs and by improving soil productivity. South McMillan Creek comprises 24% of the annual discharge to Conesus and any reductions in nutrient or soil loss from the watershed may have a major impact on the Lake.

3. A review of the storm water runoff plan for the appropriate municipalities should be undertaken. Storm water runoff along local highways may contribute a significant amount of nutrients to South McMillan Creek.

4. Development in the South McMillan Creek watershed should be carefully controlled. This major tributary to Conesus Lake has the highest percentage of its watershed in woodlands. Any changes in land usage could have major impacts on the Lake. Local authorities should pay closer attention to the erosion potential on construction sites and force contractors to implement some erosion prevention measures.

5. The major valley created by South McMillan Creek on the east side of Route 15 is heavily vegetated. This vegetation is buffering the loss on soil and nutrients to the creek and eventually Conesus Lake. Any major shifts in land usage (i.e. tilling, overgrazing of livestock, construction etc.) will have deleterious effects on Conesus Lake.

6. Other polluted sub-watersheds should be investigated and remediated. North McMillan Creek is one of the sub-watersheds that have the highest nutrient impact on Conesus Lake. This stream contributes a major portion of the total phosphorus and organic nitrogen to Conesus Lake.

7. As BMP's are introduced, efforts should be made to carefully monitor their effects. Success in identifying and remediating an area demonstrates the effectiveness of this program to the public and state officials that support this program.

INTRODUCTION

Since 1985, a collaborative research effort, between the State University of New York at Brockport and the Livingston County Planning Department, designed to gather and synthesize information on the "environmental health", aesthetic character and water quality of Conesus Lake has been carried out. During this period, the water quality of Conesus Lake has been characterized and its trophic status identified. A major shift in the zooplankton structure of the Lake was recognized, and the macrophytes were identified and mappcd. Also, biomanipulation experiments were conducted on the macrophytes and evaluated as a lake management strategy. In a major effort, the Conesus Lake watershed was sampled for a complete annual cycle quantifying the sub-watershed water and nutrient load to Conesus Lake. High nutrient loadings to Conesus Lake are believed to fertilize and promote the luxuriant growth of the macrophyte assemblage currently in the Lake. This accelerated macrophyte growth is viewed as a nuisance and a degradation to the quality of the resource.

Within an entire lake basin, stressed stream analysis is an approach that identifies impacted sub-watersheds and their associated streams (Makarewicz 1993). Within a stream, stressed stream analysis is an approach for determining how and where a stream and its ecological community are adversely affected by a pollution source or other disturbances. Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams. It is a technique that identifies the sources, extent, effects and severity of pollution in a watershed. In its fullest use, it combines elements of the sciences of hydrology, limnology, ecology, organismal biology and genetics in an integrated approach to analyze cause and effect relationships in disturbed stream ecosystems.

Within a sub-watershed, the stream(s) is used to monitor the "health" of the watershed. Because nutrients are easily transported by water they can be traced to their source by systematic geographic monitoring of the stream. Stressed stream analysis is a technique that divides the impacted sub-watershed into small distinct geographical units. Samples are taken at the beginning and end of each unit of the stream to determine if a nutrient source occurs within that reach. At this point, the cause and extent of pollution has been identified. If needed, the severity of the pollution within the impacted sub-watershed and or the entire watershed can then be evaluated by spatial analysis of the quantity and quality of biological indicators, such as fish and invertebrates, and by biological examination of structural and functional changes in individual organisms and populations in affected communities. Once identified, sources may be corrected using "Best Management Practices" (BMP).

Nutrient loading analysis of the Conesus Lake tributaries during 1990 - 1991 identified watersheds that supplied high loadings of nutrients to Conesus Lake (Makarewicz *et al.* 1991). In response to this information, a stressed stream analysis was performed on two watersheds (Long Point Gully and "No Name" Creek) that contributed the highest loadings of nitrate, on an areal basis, to Conesus Lake (Makarewicz and Lewis 1992). In 1993, Hanna's and Wilkins Creeks underwent stressed stream analysis and sources of phosphorus, nitrogen and sodium were identified (Makarewicz and Lewis 1993). This study is a continuation of the process to identify point and nonpoint sources of pollution in the watersheds of Conesus Lake.

South McMillan Creek was targeted for stressed stream analysis, primarily because of high nutrient loadings to Conesus Lake. In 1990-1991, the sub-watershed of South McMillan Creek was the major contributor of nutrients to Conesus Lake accounting for 25%, 23% and 39% of the total phosphorus, total nitrogen and total suspended solids, respectively entering the Lake (Makarewicz *et al.* 1991).

METHODS

Stress stream analysis was performed on three dates on South McMillan Creek (2 May, 17 May and 14 June 1994). Sampling locations are denoted on Figure 1. All samples were analysed for nitrate, total phosphorus, total kjeldahl nitrogen, sodium and total suspended solids.

During the initial stressed stream analysis on 2 May 1994, five stations were sampled on South McMillan Creek. On the subsequent sampling dates additional samples were taken on specific sub-watersheds that showed particularly high values during the previous sampling efforts.

Additional sites were added upstream from Site SM2, between Sites SM2 and SM3, a small branch of the stream that crosses Sliker Hill Road and between Sites SM4 and SM5 (Figure 1).

All sampling bottles were pre-coded so as to ensure exact identification of the particular sample. All filtration units and other processing apparatus were cleaned routinely with phosphate free RBS. Containers were rinsed prior to sample collection with the water being collected. In general, all procedures followed EPA standard methods (EPA 1979) or Standard Methods for the Analysis of Water and Wastewater (APHA 1989). Sample water for dissolved nutrient analyses (SRP, nitrate + nitrite) was filtered immediately with 0.45 μm MCI Magna Nylon 66 membrane filters and held at 4°C until analysis. Subsequent analyses were always completed within 24 hours of collection.

Nitrate + Nitrite: Dissolved nitrate + nitrite nitrogen were performed by the automated (Technicon autoanalyser) cadmium reduction method (EPA 1987).

Total Phosphorus: The persulfate digestion procedure was used prior to analysis by the automated (Technicon autoanalyser) colorimetric ascorbic acid method (APHA 1989).

Total Kjeldahl Nitrogen: Analysis was performed using a modification of the Technicon Industrial Method 329-74W/B. The following modifications were made:

1. In the sodium salicylate-sodium nitroprusside solution, sodium nitroprusside was increased to 0.4 gm/L
2. The reservoir of the autoanalyser was filled with 2M H_2SO_4 instead of distilled water.

3. Other reagents were made fresh prior to analysis.

Total Suspended Solids: APHA (1989) Method 2540D was employed for this analysis.

QUALITY CONTROL:

The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP). ELAP biannual blind proficiency test results are presented in Table 1. These data indicate that our accuracy was in general very good.

RESULTS:

Results from the initial stressed stream analysis are presented in Table 2. All five stations show relatively benign concentrations of nutrients consistent with the baseflow conditions at the time of the sample. Subsequent samples were taken during or shortly after precipitation events.

The 17 May 1994 sampling date followed heavy rain in the two days previous and it was raining during the actual sampling. The results are presented in Table 3. An obvious source of TKN was observed at Site SM2 which is located where one of the initial branches crosses Route 15. A sewer odor was also detected while sampling at this site. The SM0 site which is approximately 0.2 mile upstream did not show elevated concentrations of TKN (470 μg N/L vs. 2020 μg N/L at Site SM2)(Figure 2). A few trailer residences are between the two sites and a faulty septic system is a potential source. Site SM2B, which is a small drainage ditch that catches stormwater runoff on the south side of Marshall Road, was flowing only on this sampling date. Site SM2B showed elevated concentrations of sodium, total phosphorus (Figure 3), TKN and total suspended solids. No obvious source of pollution was observed. Site SM4B represents a small branch that flows through farmland adjacent to Sliker Hill Road. Site SM4B had elevated concentrations of nitrate, sodium, total phosphorus and TKN. The potential source appeared to be an active cow pasture that is in close proximity to the stream. This was checked further by analyzing above the cow pasture on 14 June 1994.

The 14 June 1994 sampling date followed heavy rains the previous day. Results are presented in Table 4. An additional sampling site was added upstream from Site SM4B to attempt to confirm the adjacent farm as the nutrient source. The results did confirm that the farm adjacent to South

McMillan Creek between Sliker Hill Road and Route 255 as a source of nitrate (0.31 mg N/L at Site SM4B1 above the farm and 3.95 mg N/L at Site SM4B below the farm - Figure 4). However, results also showed that this particular farm was not the sole source of the other pollutants (Figure 5). Site SM4B1 is located on Route 255 above the influence of the aforementioned farm. This site represents a small amount of flow across a woodland area with additional flow from a drainage ditch collecting stormwater runoff running along Route 255. Adjacent to this ditch on the top of a hill is another farm that does not seem to be active. Elevated levels of sodium, total phosphorus and total suspended solids were found from Site SM4B1. Thus, the ditch collecting runoff from Route 255 appears to be a source of phosphorus, sodium and total suspended solids in this area, while the active cow farm is a source of nitrates.

CONCLUSION:

In work done in 1990-91, South McMillan Creek was observed to contribute high levels of nutrients and soil to Conesus Lake (i.e. 25%, 23% and 39% of the total phosphorus, total nitrogen and total suspended solids, respectively entering the Lake). Stressed stream analysis was performed on the watershed of South McMillan Creek to identify point and nonpoint sources of nutrients. Nonpoint and probable point sources of the nutrients phosphorus and nitrogen were identified in the watershed of South McMillan Creek as follows:

1. Storm water runoff along local highways (along Marshall Road and Route 255) contribute a significant amount of phosphorus, total suspended solids and sodium to South McMillan Creek.

2. A major nitrate source in South McMillan Creek was attributed to agricultural practices (Sliker Hill Road).

3. A residential source (near trailers) of organic nitrogen was found near Webster's Crossing.

Recommendations to remediate the area are presented on pages 2 and 3.

Table 1. Results of the semi-annual ELAP Non-Potable Water Chemistry Proficiency Test, January 1994. Score definition: 4 (Highest) = satisfactory, 3 = marginal.

Analyte	Mean/Target	Result	Score
Residue			
Solids, Total Suspended	58.2 mg/L	59.4 mg/L	4
Solids, Total Suspended	30.4 mg/L	31.3 mg/L	4
Hydrogen Ion (pH)			
Hydrogen Ion (pH)	6.00	5.97	4
Hydrogen Ion (pH)	3.02	3.01	4
Organic Nutrients			
Kjeldahl Nitrogen, Total	7.28 mg/L	7.91 mg/L	4
Kjeldahl Nitrogen, Total	4.61 mg/L	5.60 mg/L	3
Phosphorus, Total	0.8 mg/L	0.8 mg/L	4
Phosphorus, Total	4.3 mg/L	4.3 mg/L	4
Total Alkalinity			
Alkalinity	59.3 mg/L $CaCO_3$	61.1 mg/L $CaCO_3$	4
Alkalinity	482.0 mg/L $CaCO_3$	486.0 mg/L $CaCO_3$	4
Inorganic Nutrients			
Nitrate (as N)	3.45 mg/L as N	3.67 mg/L as N	4
Nitrate (as N)	6.36 mg/L as N	6.24 mg/L as N	4
Orthophosphate (as P)	3.4 mg/L as P	3.4 mg/L as P	4
Orthophosphate (as P)	4.7 mg/L as P	4.7 mg/L as P	4
Minerals			
Chloride	60.0 mg/L	59.3 mg/L	4
Chloride	140.0 mg/L	139.0 mg/L	4
Wastewater Metals I and II			
Calcium, Total	29.30 mg/L	30.20 mg/L	4
Calcium, Total	69.50 mg/L	70.30 mg/L	4
Magnesium, Total	4.67 mg/L	4.62 mg/L	4
Magnesium, Total	23.40 mg/L	22.00 mg/L	4
Potassium, Total	9.97 mg/L	10.70 mg/L	4
Potassium, Total	24.90 mg/L	25.00 mg/L	4
Sodium, Total	50.10 mg/L	50.00 mg/L	4
Sodium, Total	20.70 mg/L	21.70 mg/L	4

Table 2. Water chemistry data for South McMillan Creek on 2 May 1994. TP = total phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 1 for location of stations.

Station	Nitrate (mg N/L)	Na (mg/L)	TP (μg P/L)	TKN (μg N/L)	TSS (mg/L)
SM1	0.01	11.32	25.0	480	1.6
SM2	ND	7.58	8.0	330	4.4
SM3	ND	11.04	19.1	500	13.4
SM4	ND	11.55	16.2	560	5.8
SM5	ND	11.30	10.3	690	5.0

Table 3. Water chemistry data for South McMillan Creek on 17 May 1994. TP = total phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 1 for location of stations.

Station	Nitrate (mg N/L)	Na (mg/L)	TP (μg P/L)	TKN (μg N/L)	TSS (mg/L)
SM 0	0.02	5.94	57.3	250	24.0
SM 0A	<0.04	5.80	52.6	470	20.7
SM 1	<0.04	11.72	36.7	350	1.3
SM 2	ND	5.98	64.8	2,020	35.1
SM 2A	ND	10.18	27.3	370	10.6
SM 2B	0.12	43.65	159.7	1,470	42.3
SM 3	<0.04	9.62	51.7	400	21.0
SM 4	0.04	11.43	46.1	480	20.2
SM 4A	0.06	12.94	32.9	280	17.1
SM 4B	0.62	24.38	81.7	600	25.3
SM 5	0.11	12.99	47.0	350	13.8

Table 4. Water chemistry data for South McMillan Creek on 14 June 1994. TP = total phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 1 for location of stations.

Sample Collection Date: June 14, 1994					
Station	Nitrate (mg N/L)	Na (mg/L)	TP (µg P/L)	TKN (µg N/L)	TSS (mg/L)
SM 0	0.04	7.49	20.0	280	18.8
SM 0A	0.11	7.55	26.5	250	17.2
SM 1	<0.04	32.73	49.1	560	21.7
SM 2	0.05	7.86	16.7	220	21.2
SM 3	0.06	11.99	43.7	560	22.7
SM 4	0.10	14.40	62.0	350	25.6
SM 4B	3.95	32.00	46.9	400	36.0
SM 4B1	0.31	66.78	109.5	570	120.1
SM 5	0.18	15.16	49.1	700	29.2

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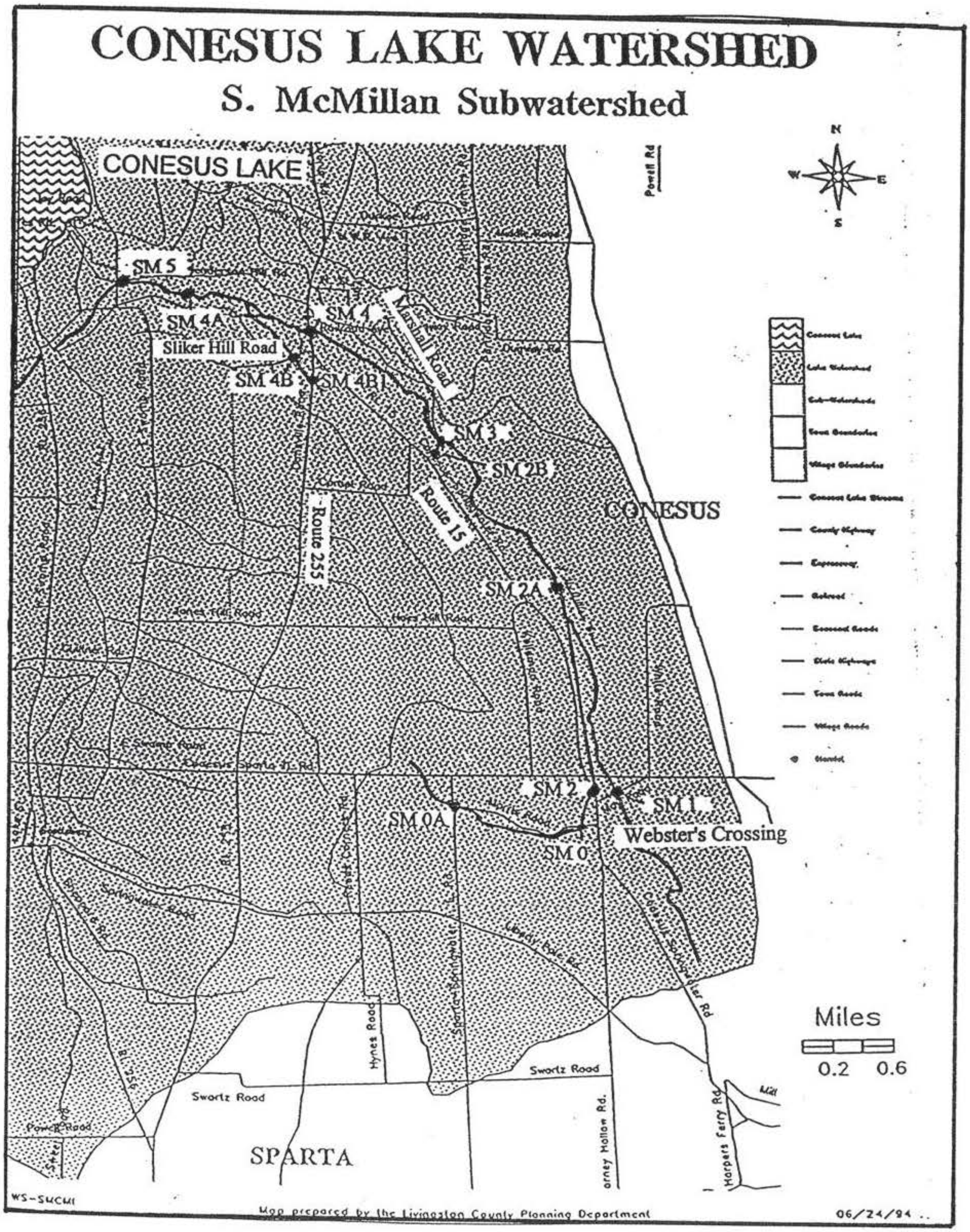

Figure 1. South McMillan Creek sub-watershed with stressed stream analysis sampling sites.

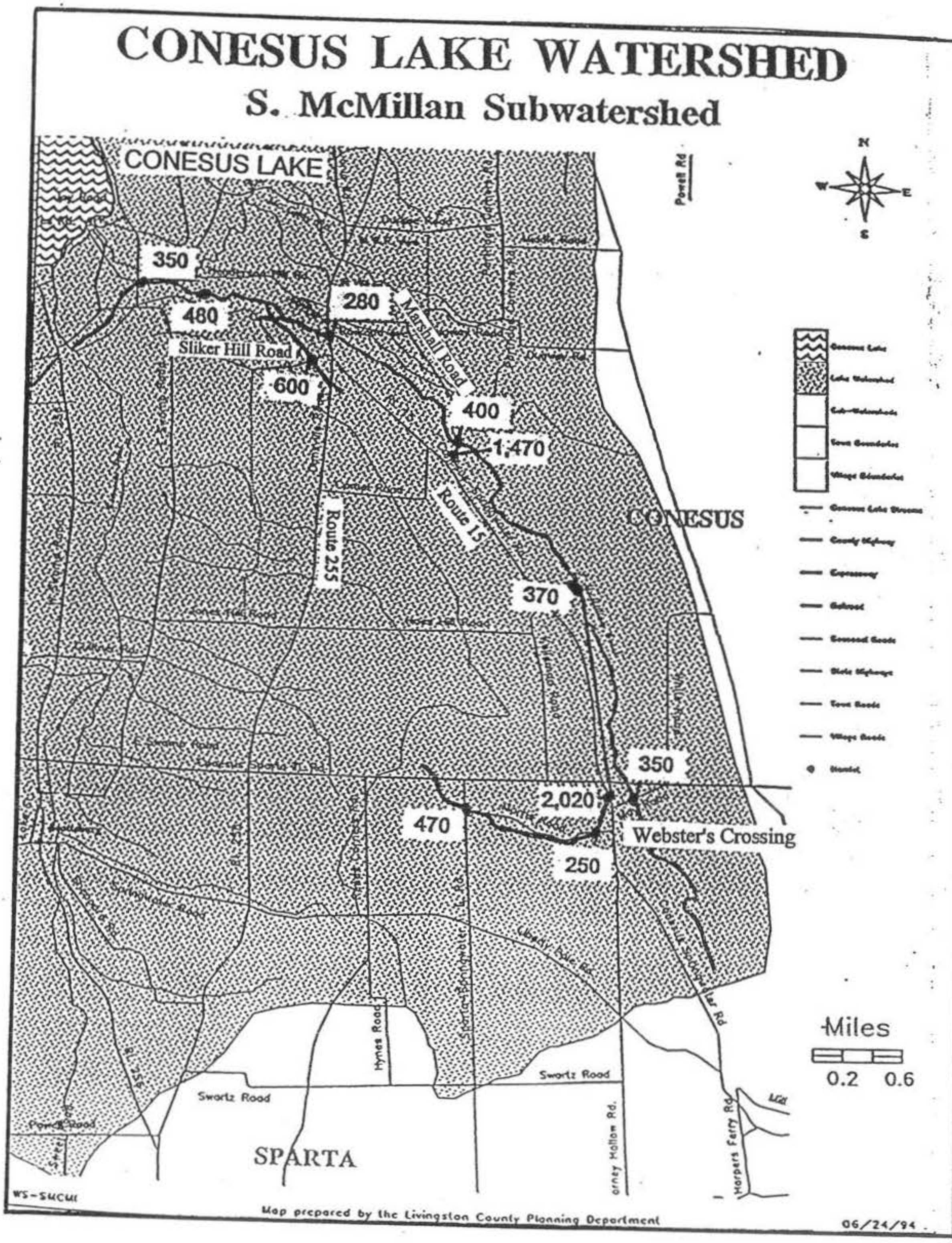

Figure 2. Total kjeldahl nitrogen concentrations (µg N/L) at sites sampled on 17 May 1994 on South McMillan Creek.

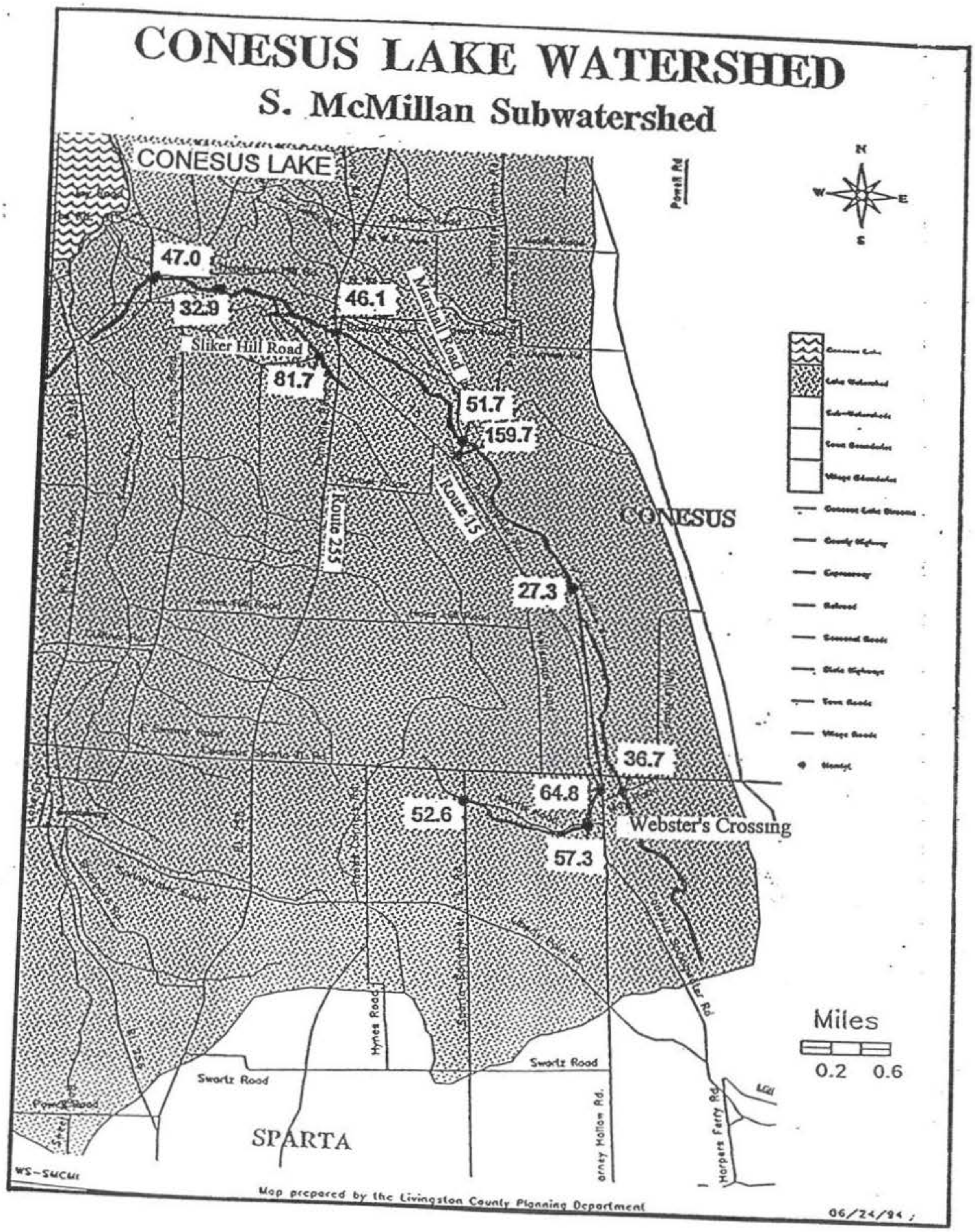

Figure 3. Total phosphorus concentrations (µg P/L) at sites sampled on 17 May 1994 on South McMillan Creek.

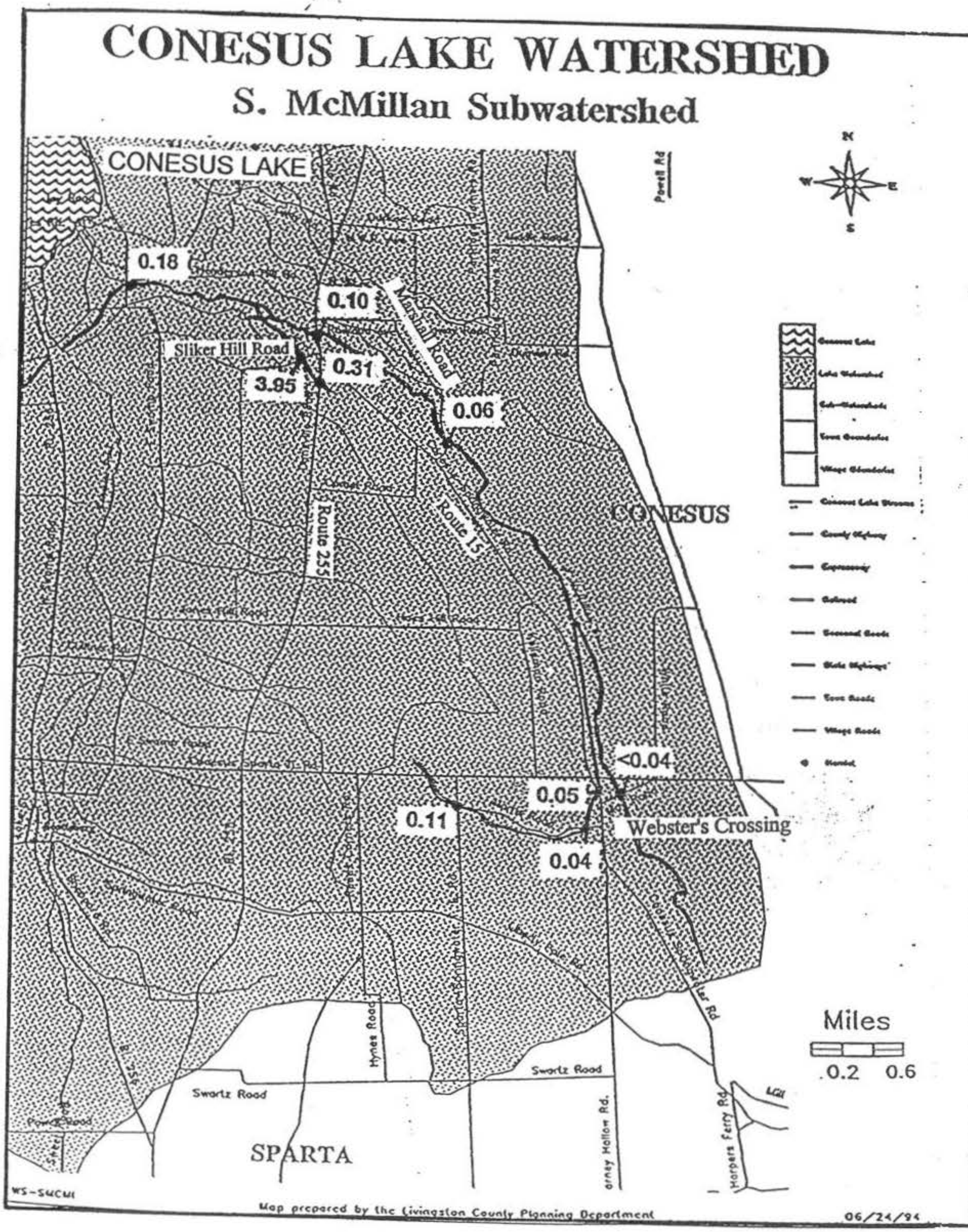

Figure 4. Nitrate concentrations (mg N/L) at sites sampled on 14 June 1994 on South McMillan Creek.

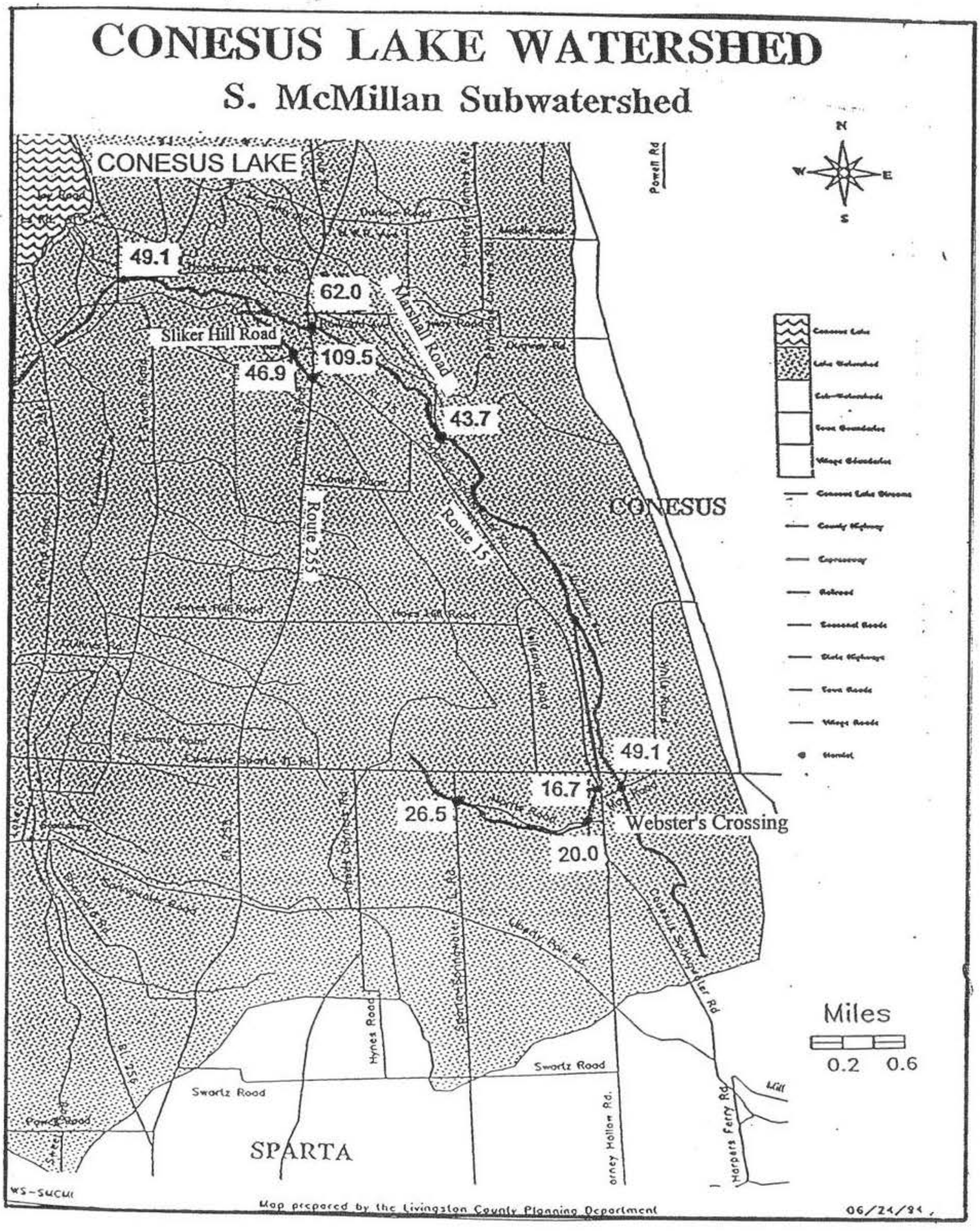

Figure 5. Total phosphorus concentrations (μg P/L) at sites sampled on 14 June 1994 on South McMillan Creek.