1993

Stress Stream Analysis of Two Sub-Watersheds of Conesus Lake

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

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

Livingston County, NY Planning Department

STRESS STREAM ANALYSIS OF TWO SUB-WATERSHEDS OF CONESUS LAKE

Hanna's and Wilkins Creek

Joseph C. Makarewicz and Theodore W. Lewis

Center for Applied Aquatic Sciences and Aquaculture

Department of Biological Sciences

SUNY Brockport

Prepared for the

Livingston County Planning Department

Mount Morris, NY

July 1993

SUMMARY

1. Stressed stream analysis was performed on watersheds of two tributaries (Hanna's and Wilkins Creek) of Conesus Lake that had been previously recognized as contributing high levels of nutrient to the lake.
2. Nonpoint sources of the nutrient phosphorus were identified in the watersheds of Hanna's and Wilkins Creeks.
3. The major phosphorus source in Hanna's Creek was attributed to agricultural practices.
4. Nonpoint sources of phosphorus and nitrate in Wilkins Creek are probably urban runoff sources (i.e. lawn and garden fertilizer).
5. High losses of organic nitrogen, sodium and soil (total suspended solids) were identified and located in Wilkins Creek.

RECOMMENDATIONS:

1. A Remedial Action Plan should be developed by the County to remediate the areas of ceoncern 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.

3. A review of the storm water runoff plan for the Village of Livonia should be undertaken. Special attention should be placed on deicing salt application and storage. A public education program on the effects fertilization around the home can have on area watersheds may be warranted. Local authorities could also pay closer attention to the erosion potential on construction sites and force contractors to implement some erosion prevention measures.

4. Other polluted sub-watersheds should be investigated and remediated. South McMillan, North McMillan are the sub-watersheds that have the highest nutrient impact on Conesus Lake. These two streams contribute a major portion of the total phosphorus and organic nitrogen to Conesus Lake.

5. 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 mapped. 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 dissolved in waters 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). This study is a continuation of the process to identify point and nonpoint sources of pollution in the watersheds of Conesus Lake.

Hanna's Creek and Wilkins Creek were targeted for stressed stream analysis, primarily because of high concentrations of phosphorus. Hanna's Creek had the highest total phosphorus and total kjeldahl nitrogen loading on an areal basis (1.16 g P/ha/day, 10.15 g N/ha/day) (Makarewicz *et al.* 1991). Wilkins Creek had the third highest mean concentration of total phosphorus (Makarewicz *et al.* 1991). These are also the most urban of sub-watersheds within the Conesus Lake watershed.

METHODS

Stress stream analysis was performed on three dates on two tributaries of Conesus Lake. Hanna's and Wilkins Creeks were sampled on 29 March, 12 April and 1 June 1993. Sampling locations are denoted on Figures 1 and 2. All samples were analysed for nitrate, total phosphorus, soluble reactive phosphorus, total kjeldahl nitrogen, sodium and total suspended solids.

During the initial stressed stream analysis on 29 March 1993, nine stations were sampled on Wilkins Creek, while seven stations were sampled on Hanna's Creek. All sites on Wilkins and Hanna's Creeks sampled on 29 March 1993 were sampled again on 12 April 1993. Additional samples were taken on specific sub-watersheds that showed particularly high values during the first sampling effort. Two sub-watersheds on Hanna's Creek were targeted for further sampling. The branches upstream from Stations H3 and H6 were targeted due to high phosphorus concentrations. The sub-watershed upstream from Station W6 on Wilkins Creek was identified as having high concentrations of all parameters tested on 29 March. The 1 June sampling effort was undertaken to confirm previous results and to further pinpoint nutrient sources.

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).

Soluble Reactive Phosphorus: Analysis was performed using the automated (Technicon) 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.

RESULTS:

Hanna's Creek

Results from the initial stressed stream analysis are presented in Table 1. The results show an obvious source of phosphorus in the sub-watershed above Station H3 (West Branch) with another potential source in the sub-watershed above Station H6 (East Branch). Both sub-watersheds also showed a potential source for nitrate. Additional sites on these two sub-watersheds were added to the sampling scheme for the second run on 12 April 1993. Five stations were added above Site H3, while six stations were added above Site H6.

One branch (stations H3C - H3E) above the H3 site clearly contributed nearly all of the phosphorus measured at Site H3 on 12 April (Table 2, Figue 3). Total phosphorus at Sites H3A, H3C and H3E were 181.1, 211.6 and 229.4 µg P/L respectively. Interestingly, nearly all of the phosphorus at these sites was in soluble form. This section of Hanna's Creek was experiencing luxuriant growth of macrophytes and algae resulting in a very green stream bed in contrast to other adjacent branches of the stream that appeared brown and still recovering from winter.

The sub-watershed above Site H6 had one station (Site H6D) with extremely high concentrations of phosphorus and the highest TKN reading on Hanna's Creek. Site H6D drains what appears to be an abandoned livestock operation. It should be noted that the flow at this station was very low at the time of sampling. Site H6F had the highest concentration of nitrate (3.95 mg N/L) and also had very little flow.

The sampling run on 1 June 1993 was undertaken to confirm previous findings and to add additional sites between Sites H3C and H3E. Once again, Sites H3A, H3C and H3E had the highest concentrations of phosphorus (Table 3, Figure 4). Although, the percentage of soluble phosphorus was much lower. Additional Sites H3C1 and H3C2 were sampled with Site H3C2 having the highest concentration of phosphorus. Site H3E was dry at the time of sampling. Nitrate was nearly exhausted in this branch of the creek. Site H6F was dry at the time of sampling. The high nitrate concentration was confirmed at Site H6F, but the stream was barely flowing at this site.

The sub-watershed above Site H3 contributes the major portion of phosphorus to Hanna's Creek. This reach of stream runs north and parallel to Route 20A and the major portion of the watershed is in agriculture. The early season contributions of phosphorus were nearly all in the soluble form. This suggests the mobilization of the nutrient out of the soil. There was not a lot of soil loss associated with the high phosphorus levels. This is consistent with the application of inorganic fertilizer to the fields. By June, the high phosphorus levels spawned the formation of large algae mats in the stream. These algae were also using the available nitrate in the stream. Site H3C1 was a small pool in the stream. It seemed to act as a collection basin for water draining from the adjacent tilled fields. The water was probably leaching phosphorus from the soil, washing it into the stream. A review of fertilization amounts and timing is recommended for adjacent farmers.

The farm above Site H6D should be examined for a source of organic nutrients. The farm appears to be no longer active but a residual source may still be present.

Wilkins Creek

Initial stressed stream analysis results from 29 March 1993 showed that Site W6 had the highest values for TP, SRP, nitrate, sodium and TSS (Table 4). The TKN value of 910 μg N/L was of interest but this high level was never replicated in any of the subsequent analyses. Three additional sites were added to the W6 branch for the 12 April sampling run. The W6A branch showed the highest values for TP, SRP, TKN, nitrate, and TSS, while the W6C branch had the highest concentration of sodium (Table 5, Figure 5). On the 1 June confirmatory sampling run, the W6A branch once again showed the highest values for TP, SRP, TKN, nitrate, and TSS (Table 6). On this trip, the highest sodium concentration was found at Site W4.

The sub-watershed above Site W6A is the source of the highest concentrations of TP, SRP and nitrate. This branch of Wilkins Creek collects runoff along residential backyards in the Village of Livonia. There is also the terminal end of an underground culvert pipe the origin of which is unknown.

The source of sodium varied during the different events. The Livonia Central School complex represented by Site W6C, was the source of the highest sodium concentrations on 12 April, while on 1 June, the Village of Livonia contributed to the highest sodium concentration (151.96 mg/L) seen during the study. In the Village, there is a highway department garage where deicing salt is stored, which could potentially be contributing to the high sodium levels during certain precipitation events.

The data show TKN sources occurring in the small area of the watershed between East Lake Road and Wilkins Tract Road. Other high TKN concentrations were found in the very upper reaches of the stream. Another area of concern was a construction site adjacent to the Livonia Central School. An area of approximately 75 square yards was excavated and left. The area is in an elevated portion of the watershed and heavy soil erosion was occurring. Erosion during construction projects should be regulated and enforced by local watershed or building inspectors.

Table 1. Water chemistry data for Hanna's Creek on 29 March 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 1 for location of stations.

Station and Branch	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
H1(Main)	69.9	51.2	0.52	600	20.36	17.3
H2(Main)	70.5	49.0	0.60	350	20.27	18.4
H3(West)	172.6	172.6	0.98	380	27.86	12.1
H4(Main)	50.4	23.9	0.40	600	17.53	26.3
H5(Main)	51.7	14.5	0.32	620	17.69	78.6
H6(East)	72.2	51.2	0.94	540	13.42	26.7
H7(East)	46.8	18.3	0.30	540	17.83	33.2

Table 2. Water chemistry data for Hanna's Creek on 12 April 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 1 for station locations.

Station and Branch	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
H1(Main)	31.4	18.5	0.25	390	32.37	0.9
H2(Main)	31.3	23.7	0.26	410	32.26	1.4
H3(West)	79.1	74.6	0.63	290	59.64	5.0
H3A(West)	181.1	181.1	1.24	430	14.68	2.8
H3B(West Tributary)	44.8	7.8	0.04	1,080	9.92	109.6
H3C(West)	211.6	211.6	1.53	850	12.80	46.4
H3D(West Tributary)	10.9	8.1	0.86	360	3.65	3.2
H3E(West)	229.4	225.6	0.63	550	6.35	9.2
H4(Main)	27.0	23.4	0.17	500	25.11	1.8
H5(Main)	30.0	16.6	0.15	450	26.02	1.3
H6(East)	47.1	46.7	0.30	550	20.50	5.6
H6A(East)	50.7	47.1	0.20	570	21.02	5.0
H6B(East)	54.3	49.3	0.05	390	22.27	1.2
H6C(East)	55.2	53.8	0.05	380	23.71	1.8
H6D(East)	2,034.6	867.5	1.17	1,250	16.47	21.8
H6E(East)	34.4	34.4	2.19	510	23.58	2.8
H6F(East)	22.0	18.1	3.95	510	14.94	12.0
H7(East)	29.4	19.1	0.40	540	25.97	1.5

Table 3. Water chemistry data for Hanna's Creek on 1 June 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen, TSS = total suspended solids and ND = non-detectable. See Figure 1 for station locations.

Station	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
H1(Main)	49.2	18.5	0.04	550	94.28	3.4
H3A (West)	515.6	143.9	ND	690	20.14	15.7
H3B(West Tributary)	17.8	15.8	0.03	420	17.31	4.2
H3C(West)	399.8	160.2	0.03	720	28.74	13.5
H3C1(West)	792.8	283.6	0.06	1,120	24.20	11.7
H3C2(West)	325.7	189.3	0.15	810	17.07	24.8
H4(Main)	26.7	19.1	ND	530	35.05	5.2
H6F(East)	44.7	25.3	3.33	660	29.98	3.3

Table 4. Water chemistry data for Wilkins Creek on 29 March 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen and TSS = total suspended solids. See Figure 2 for location of stations.

Station and Branch	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
W1 (Main)	61.6	26.3	0.55	910	22.49	42.2
W2 (Main)	36.9	21.5	0.57	440	22.23	39.7
W3 (Main)	58.2	22.8	0.56	400	24.94	39.7
W4(North)	69.0	30.4	0.68	360	27.73	48.4
W5(South)	21.8	13.9	0.28	170	1.60	11.6
W6(North)	96.8	53.0	1.10	400	33.60	58.4
W7(South)	62.0	25.0	0.47	290	12.77	32.0
W8(South)	55.3	33.0	0.27	580	8.32	10.2
W9(South)	13.2	7.3	0.34	300	2.19	15.8

Table 5. Water chemistry data for Wilkins Creek on 12 April 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen, TSS = total suspended solids and ND = non-detectable. See Figure 2 for location of stations.

Station and Branch	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
W1(Main)	12.3	3.7	0.19	410	45.14	1.4
W2(Main)	10.9	4.4	0.30	270	45.34	5.6
W3(Main)	22.9	3.9	0.32	300	45.54	45.6
W3A(Main)	12.5	2.4	ND	420	12.92	15.5
W4(North)	17.0	7.3	0.50	230	54.92	2.1
W5(South)	6.6	3.3	0.07	150	2.01	0.9
W6(North)	26.9	20.0	1.48	270	49.64	0.5
W6A(North)	303.7	47.0	3.79	1,350	28.94	152.7
W6B(North)	30.0	14.2	0.90	160	48.00	13.8
W6C(North)	18.2	5.7	0.92	260	51.60	29.1
W7(South)	18.2	9.3	0.45	390	15.92	4.9
W8(South)	29.1	16.2	0.04	400	9.76	2.5
W9(South)	10.1	4.6	0.13	390	2.91	3.3

Table 6. Water chemistry data for Wilkins Creek on 1 June 1993. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total kjeldahl nitrogen, TSS = total suspended solids and ND = non-detectable. See Figure 2 lor station location.

Station and Branch	TP (µg P/L)	SRP (µg P/L)	Nitrate (mg N/L)	TKN (µg N/L)	Sodium (mg/L)	TSS (mg/L)
W1 (Main)	35.9	18.9	0.34	420	116.88	7.2
W4(North)	32.2	17.4	0.35	380	151.96	6.2
W5(South)	13.8	6.4	0.03	360	2.61	2.0
W6A(North)	326.9	73.9	1.00	790	107.76	60.8
W8(South)	63.5	14.8	0.17	750	20.40	6.8
W9(South)	47.5	15.0	0.04	500	2.10	0.4

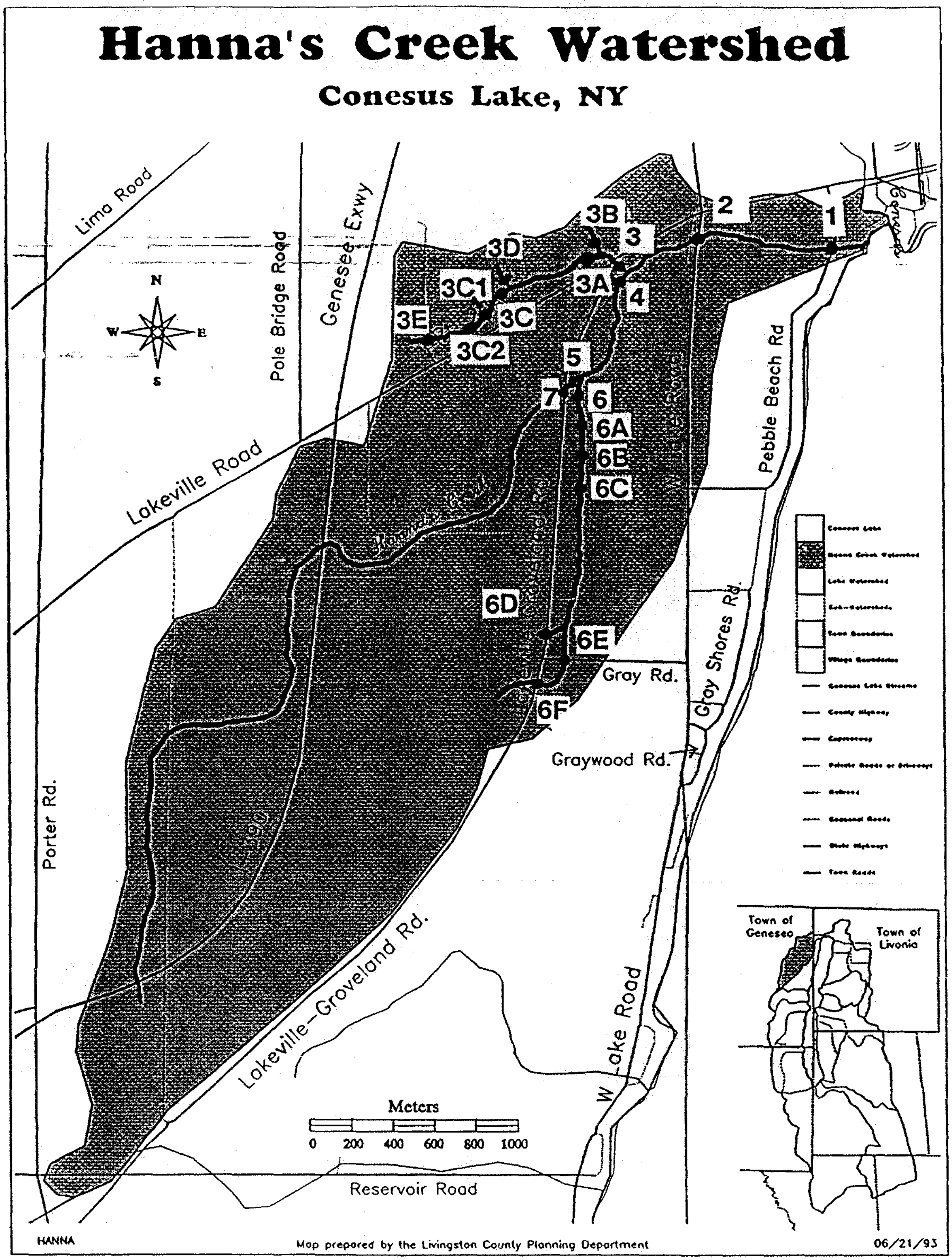

Figure 1. Hanna's Creek sub-watershed with stressed stream analysis sampling sites.

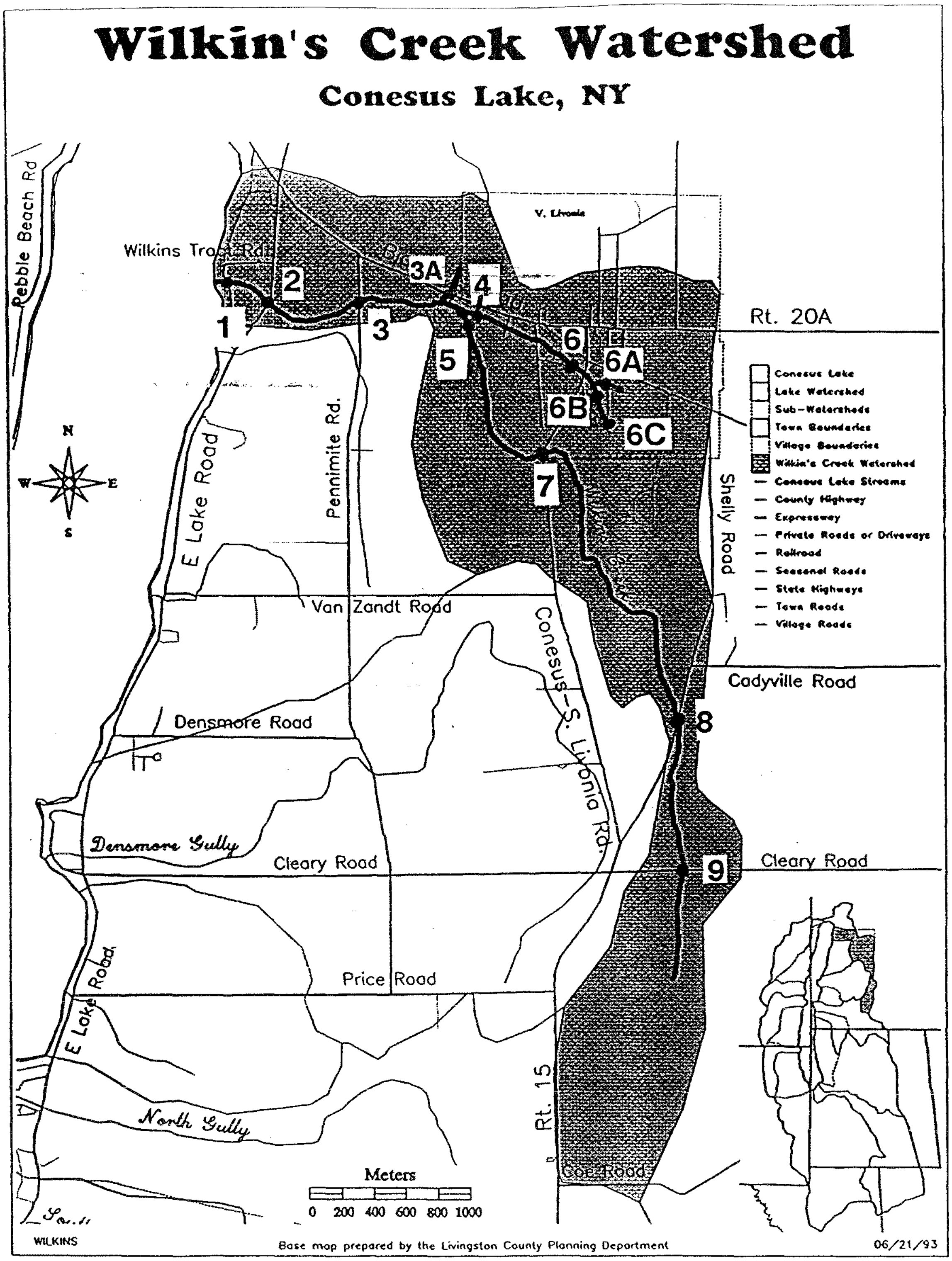

Figure 2. Wilkins Creek sub-watershed with stressed stream analysis sampling sites.

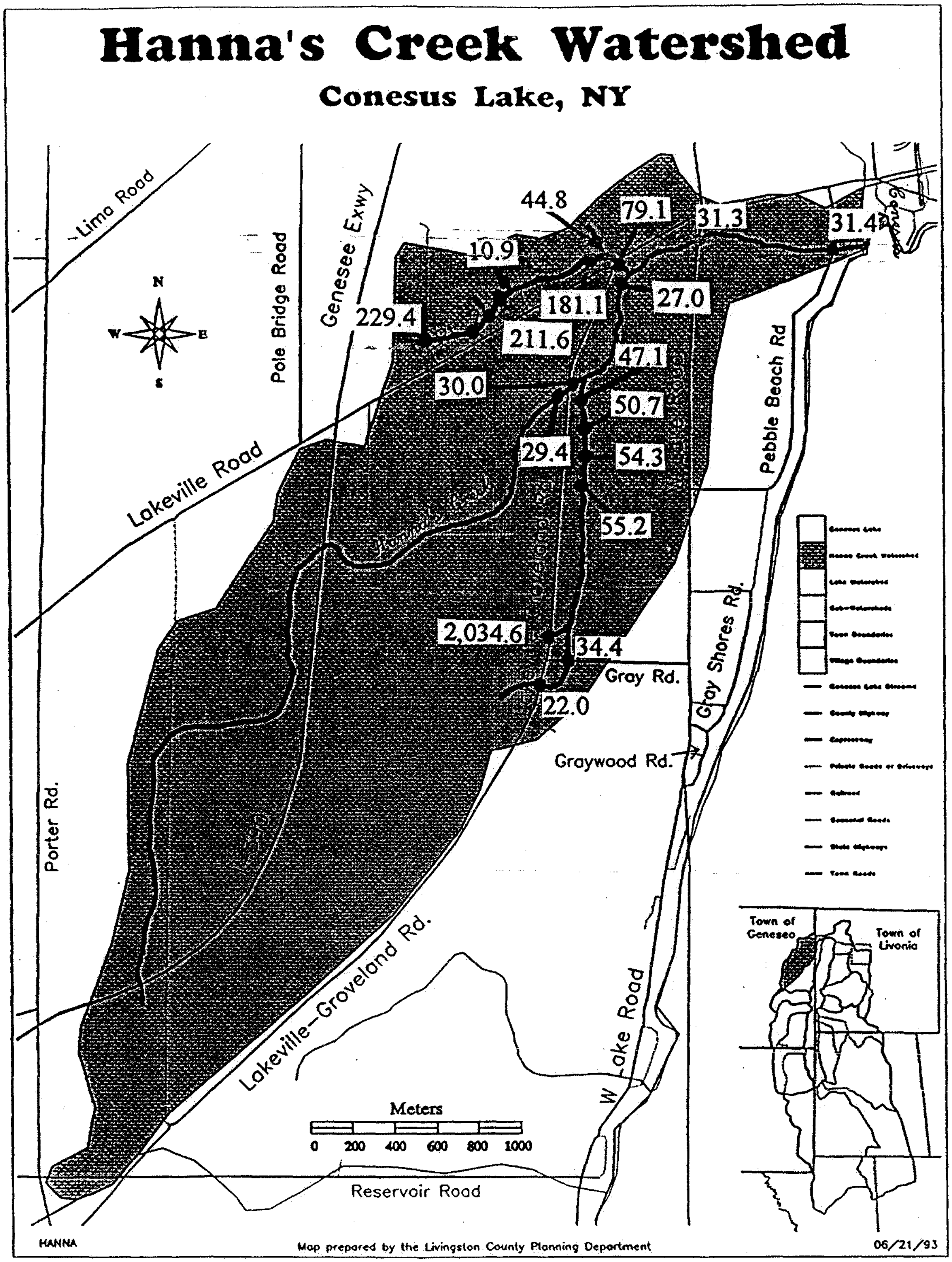

Figure 3. Total phosphorus concentrations (μg P/L) at sites sampled on 12 April 1993 on Hanna's Creek.

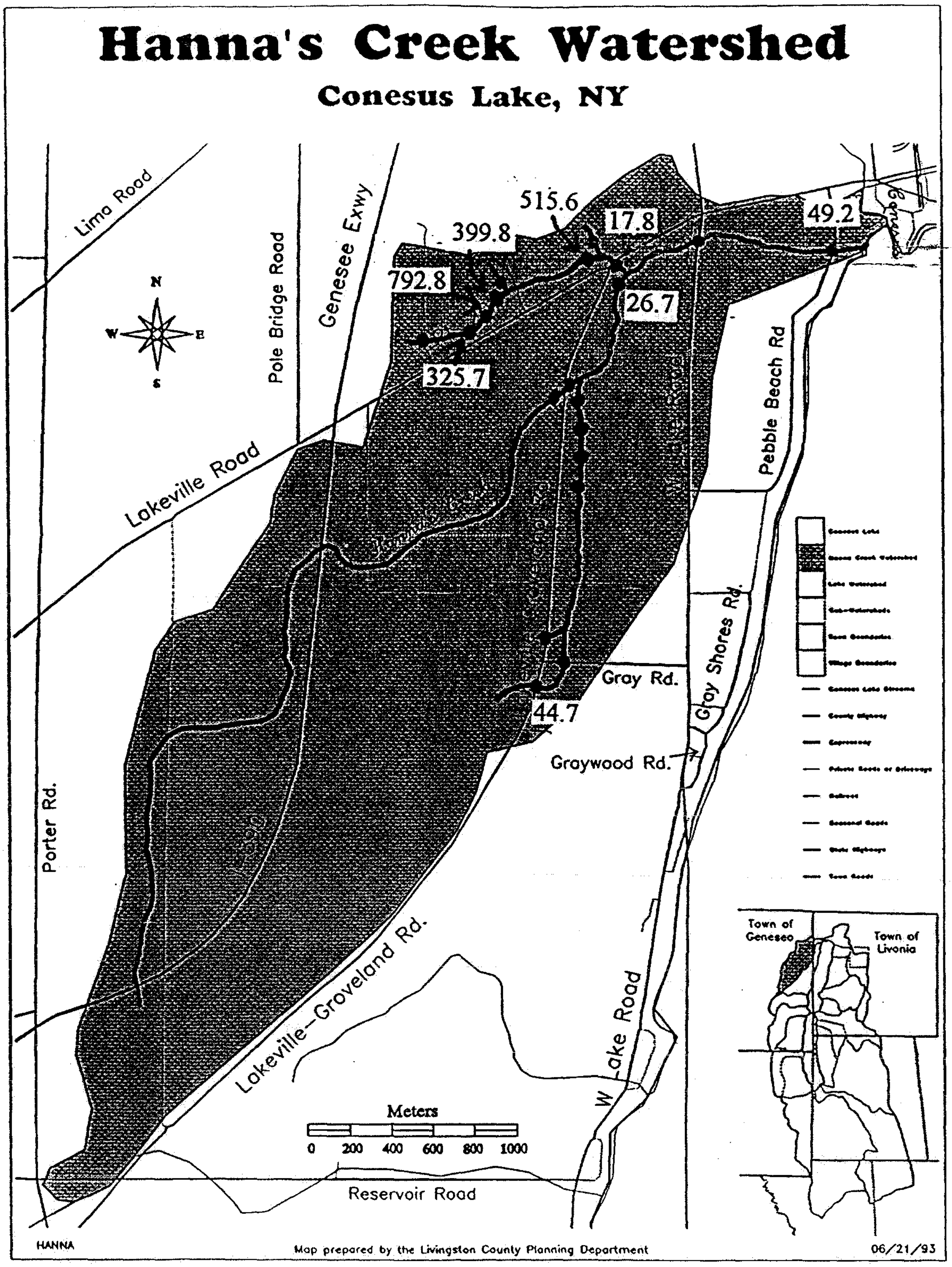

Figure 4. Total phosphorus concentrations (µg P/L) at sites sampled on 1 June 1993 on Hanna's Creek.

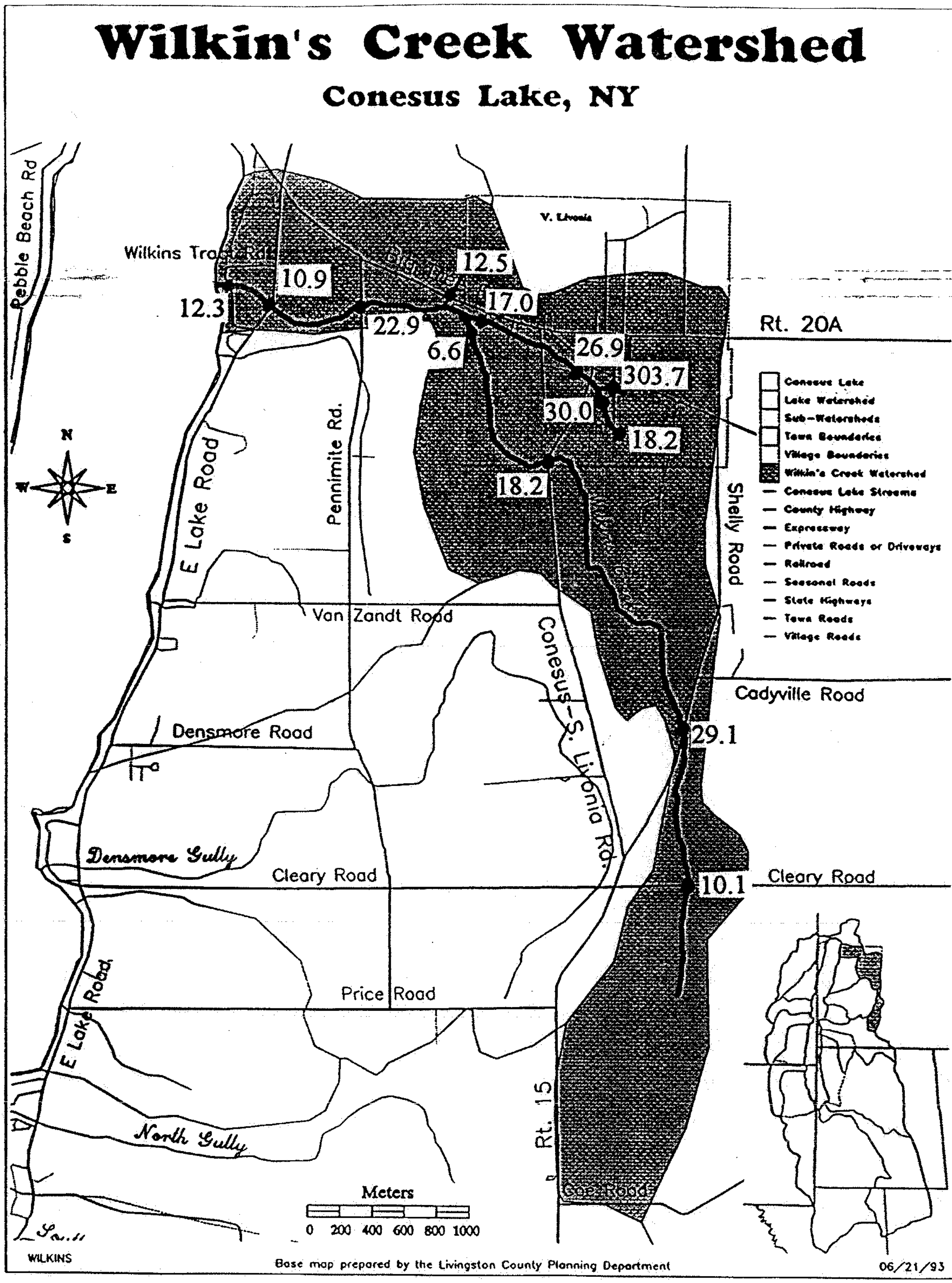

Figure 5. Total phosphorus concentrations (µg P/L) at sites sampled on 12 April 1993 on Wilkins Creek.

LITERATURE CITED

APHA 1989. Standard Methods for the Examination of Waste and Wastewater. American Public Health Association, 17th ed. New York, NY. 1134p.

EPA. 1979. Methods for the Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory. Environmental Protection Agency. Cincinnati, Ohio. EPA-600/4-79-020.

Johengen, T.H., A.M. Beeton and D.W. Rice. 1989. Evaluating the effectiveness of Best Management Practices to reduce agricultural nonpoint source pollution. Lake Reserv. Manage. 5(1):63-70.

Haith, D.A. 1975. *In:* Influence of land development and land use patterns on water quality. G.D. Gates and D.A. Haith eds. PB 248071. NTIS.

Makarewicz, J.C. and T.W. Lewis. 1992. Stress stream analysis of two sub-watersheds of Conesus Lake. Available from Drake Memorial Library, SUNY Brockport, Brockport, NY.

Makarewicz, J.C., T.W. Lewis, R. Dilcher, M. Letson and N. Puckett. 1991. Chemical Analysis and Nutrient Loading of Streams Entering Conesus Lake, NY. Available from Drake Memorial Library, SUNY Brockport, Brockport, NY.

Makarewicz, J.C. 1993. Stressed Stream Analysis. Waterworks. 9:5-12.

NYSDEC. 1986. Stream corridor management. Second Edition. Albany, NY. 111 pp.