NUTRIENT AND SUSPENDED SEDIMENT MONITORING ON THE UPPER MONOCACY RIVER, 1990-1995

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Executive Summary

Through the 1987 Chesapeake Bay Agreement, the State of Pennsylvania has committed itself to the restoration of the Chesapeake Bay, in part by reducing controllable nutrient (phosphorus and nitrogen) loads to streams and rivers. To evaluate the progress of pollution reduction programs in the Pennsylvania portion of the Monocacy River basin (a sub-basin of the Potomac River in Pennsylvania and Maryland), the State's Department of Environmental Protection joined with the Interstate Commission on the Potomac River Basin and the US Geological Survey (USGS) to establish a monitoring program. This report presents the results from the initial data collection period, water years 1990-1995 (i.e., October 1, 1989 through September 30, 1995). It includes estimates of the annual and seasonal nutrient and suspended sediment loads from the Pennsylvania portion of the Monocacy River basin and the relative contributions of point and nonpoint sources to the total loads, as well as an analysis of trends in nutrient and sediment concentrations over the monitoring period.

Water samples were collected by USGS at the site of its discharge gage near Bridgeport, MD. Samples were collected under both nonstorm and storm flow conditions using automatic and manual sampling techniques and analyzed for sediment and nutrient concentrations at USGS laboratories. Loads of total nitrogen (TN) and total phosphorus (TP) were calculated using a multivariate regression equation that relates concentration to discharge. Total Suspended Solids (TSS) loads were calculated by multiplying mean daily flows during the monitoring period by median TSS concentrations calculated for various flow ranges. Annual and seasonal loads were compared. Potential trends in nutrient and sediment concentrations were examined using the Seasonal Kendall test and supporting statistical procedures. Lastly, the relative contributions of point sources to the nutrient and sediment loads were estimated from wastewater treatment plant discharge data.

The annual mean daily discharge rates for the river fluctuated during the monitoring period, but were generally above the historic average. In general, flows were higher later in the monitoring period compared to the earlier on. TSS concentrations ranged widely. A few high-flow events were responsible for much of the TSS that was transported past the monitoring site during this time. There is some evidence that TSS concentrations increased gradually over the monitoring period, yet the observed trend may be an artifact of generally increasing flows over the monitoring period. As with TSS, both TN and TP concentrations were generally higher in storm flow samples compared to nonstorm flow samples, yet lower TN concentrations were associated with very high flows. The trend analyses suggest a decrease in TN concentrations over the monitoring period, but no apparent trend in median TP concentrations. As with TSS, the observed trend in TN concentrations may have been due to the general increase in flow during the monitored period. Point source discharges generally contributed only a small portion of the total estimated loads in all years, although TP from point sources may have been a more significant influence on the total loads in some years. As efforts to reduce nutrient and sediment loads continue, monitoring at the site should be resumed so new data can be compared with that reported here.

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Nutrient and Suspended Sediment Monitoring on the Upper Monocacy River, 1990-1995

Introduction

The Problem

The delivery of nutrients (primarily nitrogen and phosphorus) and sediment to the Chesapeake Bay has been identified as a major stress on the health of its ecosystem. These pollutants enter streams and rivers in the Bay's drainage basin from point sources such as wastewater treatment plants and nonpoint sources such as stormwater runoff, and may ultimately be delivered to the bay itself. The growing human population in the Chesapeake Bay basin and the accompanying shift in land cover from forested to agricultural and urban have increased nutrient and sediment loads to excessive levels. Although nitrogen and phosphorus occur naturally and are essential for the growth of plants that are the base of the aquatic food chain, high levels of these nutrients in the waters of the bay and its tidal tributaries allow plants to grow so well that they are detrimental to other living organisms. Large blooms of algae block sunlight and inhibit the growth of submerged aquatic vegetation that provides vital food and habitat for fish and other bay species. When the algae dies, it is decomposed by bacteria in a process that depletes the oxygen in the water, also making areas of the bay unsuitable for many organisms. In addition, eroded soil adds to these impacts by blocking sunlight while suspended in the water and burying habitat when it deposited as sediment in the lower tributaries and the bay.

The Monitoring Program

To reduce the impacts of nutrient pollution in the Chesapeake Bay, the State of Pennsylvania is working with its partners in the Chesapeake Bay Program (the States of Maryland and Virginia, the District of Columbia, and the US EPA) to reduce controllable nutrient loads to the bay by 40% (CBPO, 1987). The Monocacy River basin is a significant contributor of nonpoint source nutrients and sediments to the Potomac River, one of the major tributaries to the bay (PA DEP, 1994). Programs to reduce nutrient loss from croplands in the upper Monocacy watershed are being implemented under various state and federal programs (ICPRB, 1995). To evaluate the progress of these pollution reduction programs, it is necessary to estimate current annual loads of nutrients and suspended sediments and examine trends in loads and concentrations over time.

In 1989, the Pennsylvania Department of Environmental Protection (DEP, formerly the Department of Environmental Resources) joined with the Interstate Commission on the Potomac River Basin (ICPRB) to establish a monitoring program on the upper Monocacy River at Bridgeport, MD. The Bridgeport site receives drainage from more than three-fourths of the Pennsylvania portion of the Monocacy basin, and has been the site of a USGS discharge monitoring gage since 1942. This report presents the results of the monitoring program during its initial data collection period, water years 1990-1995 (i.e., October 1, 1989 through September 30, 1995). It includes estimates of the nutrient and suspended sediment loads from the Pennsylvania portion of the Monocacy River basin and the relative contributions of point and nonpoint sources to the total loads, as well as an analysis of trends in nutrient and sediment concentrations over the monitoring period.

Basin Characteristics

The Monocacy River drains 971 square miles, 221 of which are in Pennsylvania (Figure 1). The Bridgeport, MD site receives drainage from approximately 173 square miles, with 93% in Adams County, PA and the remainder in Frederick and Carroll Counties, MD. The monitored drainage area is bounded by the basins of Tom's Creek to the southwest, Conococheague Creek to the west, Conowago River to the north and east, and Piney Creek to the southeast. It includes the sub-basins of Rock, Alloway, and Marsh Creeks, and a small area that drains directly into the Monocacy River.

As shown in Table 1, land use in the basin is predominantly agricultural. Total agricultural uses, including row and non-row crops, hay, pasture and animal feedlot lands, constitute 65% of the Bridgeport drainage area. Urban and suburban land uses comprise only 6% of the drainage area, and the remaining 29% of the land is forested. The Marsh Creek sub-watershed, draining portions of the Catoctin Mountains, contains the bulk of the forested land, while the Alloway and Rock Creek basins are more than three-fourths agricultural (Casman, 1985).

Monitoring Methods

Sampling

Water samples were collected on the Monocacy River near Bridgeport, MD, at the site of the US Geological Survey's (USGS) gage (ID: 01639000). The site is 60 feet downstream of the bridge on State Highway 140, 4.8 miles downstream of the confluence of Rock and Marsh Creeks at the Pennsylvania-Maryland state line, and 52 miles upstream from the confluence of the Monocacy with the Potomac River (James et al., 1992). The

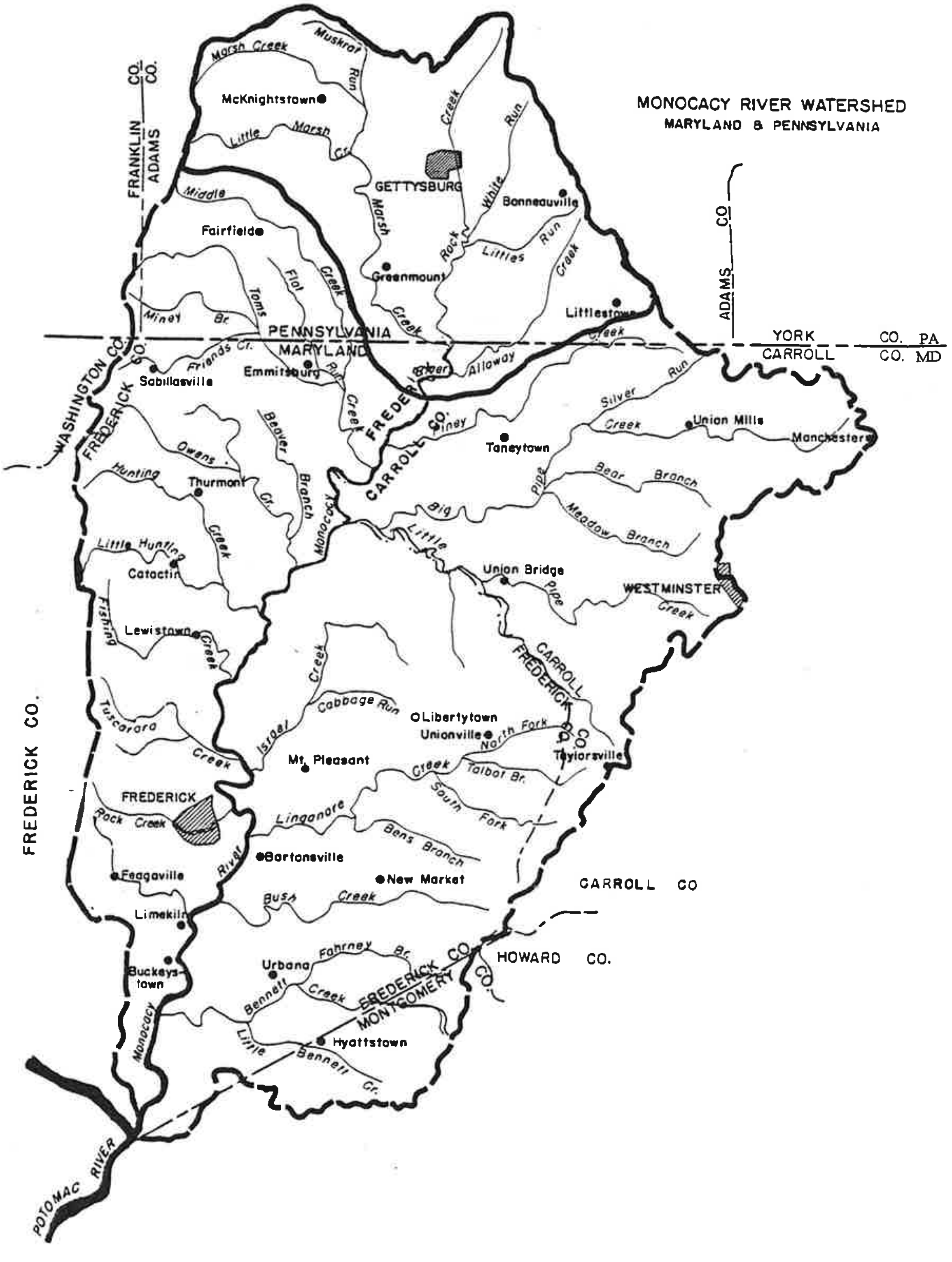

Figure 1. Monocacy River basin and approximate drainage area to Bridgeport, MD.

Table 1. Land Use in the Drainage Area to the Monocacy River at Bridgeport, MD.

Land Use Category	Area (acres)
Agricultural (Total)	**72,110**
No-till cropland	11,375
Conventional-till cropland	25,673
Non-row crops and hay	26,499
Pasture and animal feedlots	8,563
Forest	**31,419**
Urban (Total)	**6,972**
Urban, pervious (lawns, parks, etc.)	5,247
Urban, impervious (roads, buildings, etc.)	1,725
Total sub-basin land area	**110,502**

Source: Casman (1985).

constituents of primary interest are total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS). The complete list of water quality parameters that were monitored are listed in Appendix A.

Water samples were collected by the United States Geological Survey (USGS) under nonstorm and storm flow conditions. Nonstorm flow samples were collected about every month, using both manual and automated techniques. Manually collected samples were drawn at five verticals across a section of the river and composited according to the standard USGS equal discharge increment sampling procedure (USGS, 1994). Storm flow samples were collected for 3-6 storms each year. An ISCO refrigerated automatic sampler engaged when the river stage exceeded five feet. The sampler collected subsequent samples at equal flow volumes (approximately 17 million cubic feet) throughout the storm hydrograph. Samples were held at 4° C until retrieval by USGS field personnel, usually within a few hours of the storm. When field personnel were not immediately available, samples were retrieved within one or two days. For several storms, samples collected by the automatic sampler were composited over an interval of 1-12 hours. To ensure that the automatically collected samples were comparable to those collected manually, a number of nonstorm and storm flow samples were collected using both techniques. Paired sampling from water years 1990-92 showed no significant difference in the results from the two sampling techniques (Blasenstein and Haywood, 1993).

In addition to the nonstorm and storm flow sampling, a period of hourly low flow sampling was undertaken over a 48-hour period in September, 1995. The objective of this sampling was to characterize the daily fluctuations in nutrient concentrations. Additional water samples were collected manually and analyzed for concentration of suspended sediment (total suspended solids or TSS). Stream discharge data were collected continuously throughout the monitoring period.

At the time of collection, all of the nutrient samples were filtered, treated with mercuric chloride ($HgCl_2$), and packed in ice for transport to the USGS National Water Quality Laboratory in Denver, Colorado. Samples were shipped via UPS at the earliest possible time (within a day of collection). The low temperatures and the $HgCl_2$ minimize biological activity in the samples. Nutrient and suspended sediment analysis was conducted at USGS laboratories using published methods (Fishman and Freidman, 1985).

Load Estimation Techniques

Total Nitrogen and Total Phosphorus Loads

Loads of total nitrogen (TN) and total phosphorus (TP) were calculated from the measured concentrations and the associated daily mean discharge data using the multivariate equation of Cohn et al. (1992),

$$\ln(C)=a_0+a_1\ln(Q/Q_c)+a_2\ln(Q/Q_c)^2+a_3(T-T_c)+a_4(T-T_c)^2+a_5\sin(2\pi T)+a_6\cos(2\pi T \qquad (1)$$

where:

C = Concentration of the nutrient,
Q = Flow (discharge),
T = Time (in years),
Q_c, T_c = "Centering" variables used to simplify the numerical work,
a_0 ,..., a_6 = coefficients that are fit to the available data,
ϵ = an error function, assumed normally-distributed with mean zero.

The two Q terms account for the effects of flow, the polynomial T terms for time trends, and the trigonometric terms for seasonality. An advantage of this estimation equation is that it utilizes two variables, flow and time, that are readily available on a daily basis. Equation (1) has generally been found to explain between 10 and 50% of the variability in log-transformed concentration data. Note that this method is intended to characterize the data and is not derived from any mechanistic understanding of the underlying processes (Cohn et al., 1992).

Once the regression coefficients were fit to the data, the concentration of the nutrient being studied was calculated from the ln(C) using the Minimum Variance Unbiased Estimator (MVUE) of Cohn et al. (1989, 1992). MVUE removes the retransformation bias that can occur with log-linear relationships. Daily loads were then calculated from the relationship,

$$L = kQC \tag{2}$$

where:

L = load (in mass units),
k = a conversion constant.

For loads expressed in pounds, flow in cfs, and concentration in mg/L, k=5.39. Seasonal and annual loads were calculated by summing the daily loads.

Nutrient loads were calculated using an implementation of the Cohn method adapted to a Quattro Pro spreadsheet. The new version was verified by comparing the results of the spreadsheet calculations with the output of the ESTIMATOR program at the USGS Field Office in Towson, MD. For both of two different input datasets, the total load calculated by the two implementations differed by less than 0.5% (Blasenstein and Haywood, 1993).

Although the calculations used to estimate nutrient loads in this study were the same as those in the USGS method, the data collected from the Monocacy monitoring were treated in a slightly different manner to minimize serial correlation in the data and the difference in the number of nonstorm and storm flow samples. Serial correlation is the tendency for samples collected in a series to resemble each other. Samples that are serially correlated should not be treated as independent observations in a regression analysis. Although load estimates from this method have been found to be relatively insensitive to this violation (Cohn, 1992), minimizing serial correlation increases the confidence in the calculated loads. The number of nonstorm flow samples in the dataset is about half the number of storm flow samples, while the number of nonstorm flow days in a given year far exceeds the number of storm flow days. If each storm and nonstorm flow sample is used as a discrete data point, the regression could be biased in favor of the storm data, where nutrient concentrations are generally greater. To adjust for serial correlation and the disproportionately large number of storm flow samples, all samples within each storm event were aggregated into single observations. The average flow and the flow-weighted average nutrient concentration was used to represent the storm for the regression analysis (see Appendix A for the reduced dataset used in the regression and the resulting regression coefficients). Instantaneous flows and concentrations were used for all nonstorm flow samples.

Total Suspended Solids Loads

For the first three years of monitoring, suspended sediment loads were calculated by USGS based on samples taken by a local observer on a near daily basis (James et al., 1991, 1992, 1993; Blasenstein and Haywood, 1993). After water year 1992, it was determined that the daily observer data were no longer reliable so it was not used to calculate the load estimates presented in this report. Instead, TSS loads were calculated based on the laboratory-determined TSS concentrations of samples collected over all six years of the monitoring period.

Sediment loads were estimated using an adaptation of a method used to calculate nutrient and sediment loads in the Potomac River (Nemura, 1989). Samples in the dataset were designated as either nonstorm or storm flow, based on the flow conditions when they were collected (i.e., samples collected while the river stage exceeded 5 feet were considered storm flow samples, all others were considered nonstorm flow samples). Nonstorm and storm flow data subsets were then divided into flow quartiles, thereby creating a total of eight flow categories for which there were TSS concentration data. Median TSS concentrations were calculated for each of the flow categories. All days during water years 1990-1995 were classified into one of the flow categories based on the mean daily flow values reported by USGS (James et al., 1991-96). Daily sediment loads were calculated from the corresponding TSS concentrations and the mean daily flows. These daily loads were summed to produce seasonal and yearly loads.

Trend Analysis

Tracking changes in nutrient and sediment loads over time can help environmental managers assess the effectiveness of various management actions designed to reduce the loads, including nonpoint source controls and advanced wastewater treatment processes. The loads are also significantly affected by other factors such as river flow, making trend analysis a complex task. Large fluctuations in precipitation from year to year result in similar variation in river flow. Because nutrient and sediment loads are highly dependent upon flow volumes, large interannual variations in river flow may mask trends in loads. Therefore, to assess whether the desired load reductions are occurring it is appropriate to examine trends in nutrient and sediment *concentrations,* rather than those for highly flow-dependent loads. A specialized statistical package designed for analysis of water quality data called WQHYDRO (Aroner, 1996) was used for the trend analysis reported here.

Water quality data often exhibit seasonality, which is the tendency for mean values to vary at different times of the year. The Seasonal Kendall Test is a recognized method of testing for monotonic (an overall rising or falling) trends in such data. It accounts for seasonality by comparing only data associated with the same period across all years. For this report, the test was run on monthly median concentrations for TSS, TN and TP. Along with each Seasonal Kendall Test, the slope of any trend was estimated to provide an indication of how fast the changes are occurring. Because serial correlation (defined above) in the dataset will increase the chance of incorrectly concluding that a trend is present with the Seasonal Kendall Test, each dataset was checked for serial correlation using correlation analysis on a deseasonalized and detrended dataset. Also, because opposite trends in different months can cancel each other out and obscure the overall trend, a Chi-Square statistic was used to assess the homogeneity of trends across months.

Because the relationship between flow and concentration in water quality data may confound the results of a trend analysis, a second Seasonal Kendall Test was run using Flow-Adjusted Concentrations (FACs). The FACs were calculated using a nonparametric regression technique called LOWESS (Locally Weighted Scatterplot Regression Smoothing). LOWESS smooths the data by connecting the midpoints of a series of regression lines determined within a "moving window" that is passed over the data. The resulting residuals, or variation in concentration *not* related to flow, are the FACs used in the second Seasonal Kendall Test.

Point Source Loads

To determine the relative contributions of point sources to nutrient and sediment loads, five point source dischargers with flows greater than 0.05 mgd were identified within the monitored drainage area. These dischargers are the wastewater treatment plants (WWTPs) at Gettysburg, Littlestown, Cumberland Township North and South, and Bonneauville (see Appendix A for overall mean discharge and nutrient concentrations for these facilities). Data on discharges from these facilities were compiled from the records of the PA DEP

Soutcentral Regional Office in Harrisburg. PA DEP issues National Pollution Discharge Elimination System (NPDES) permits to each plant that require them to report daily discharge rates and periodic TSS and nutrient concentration data (2-8 samples monthly). For the Gettysburg plant, periodic TP measurements were also reported. PA DEP also collected grab samples during plant inspections occurring from one to three times annually. The samples were analyzed for CBOD, ammonia, nitrate/nitrite, TP, and other parameters.

Monthly averages for both daily discharge rates and concentrations of TN and TP were calculated for each of the plants. TSS loads were taken directly from the reports. For all plants except Gettysburg, the annual loads of TP were calculated from the monthly average daily discharge rates and the average TP concentration from the inspection grab samples during each water year. For the Gettysburg facility, the reported monthly average TP concentrations and the monthly average discharge were used to calculate monthly TP loads that were then summed to produce annual loads. The annual loads of TN were calculated using a method similar to the Gettysburg TP calculations. TN is traditionally calculated by summing the concentrations of the particulate and dissolved phases of ammonia-nitrogen, nitrate/nitrite-nitrogen and organic-nitrogen (Org-N). However, the grab sample data from the plant inspections do not include Org-N. Thus, there is no way to calculate the exact value of TN for each grab sample. For the purposes of load estimation, Org-N was estimated by using BOD as a surrogate for the organic matter in the sample. Viessman and Hammer (1985) report that Org-N is approximately 7-10% of BOD in wastewater effluents. Org-N was estimated here to be 10% of BOD. Due to the low concentrations of BOD in the effluents of the plants evaluated here (generally < 5 mg/L), the estimated Org-N concentrations were generally less than 5% of TN.

Results and Discussion

Stream Flow (Discharge)

Mean Daily and Annual Discharge

Table 2 presents the range and quartiles for mean daily flow values over the six-year monitoring period (note that all references to years should be interpreted as water years, running from October 1 through September 30, in accordance with the reporting practices of the USGS). Figure 2 depicts the changes in the mean daily flow during the period. Figure 3 presents the annual mean daily discharge for each of the six water years.

Table 2. Range and Quartiles for Mean Daily Discharge, Monocacy River at Bridgeport, MD, WY90-95.

Parameter	Mean Daily Flow (cfs)
Minimum	1.1
Lower quartile	27
Median	77
Upper Quartile	176
Maximum	9920
Minimum of Record (5/42-9/95)	0
Maximum of Record (5/42-9/95)	16700

Source: James et al., 1995

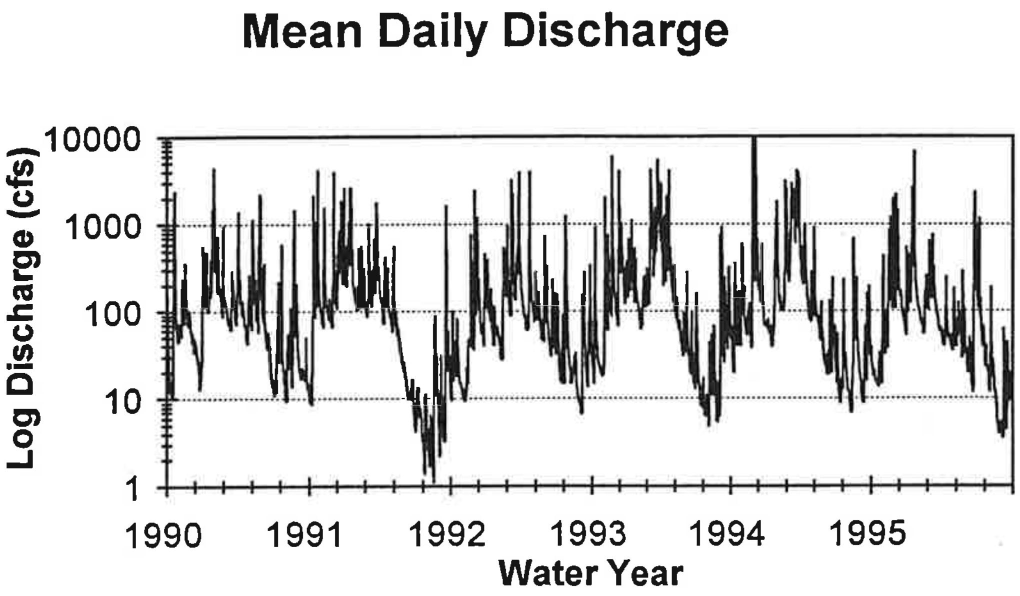

Figure 2. Mean daily discharge, Monocacy River at Bridgeport, MD, WY90-95

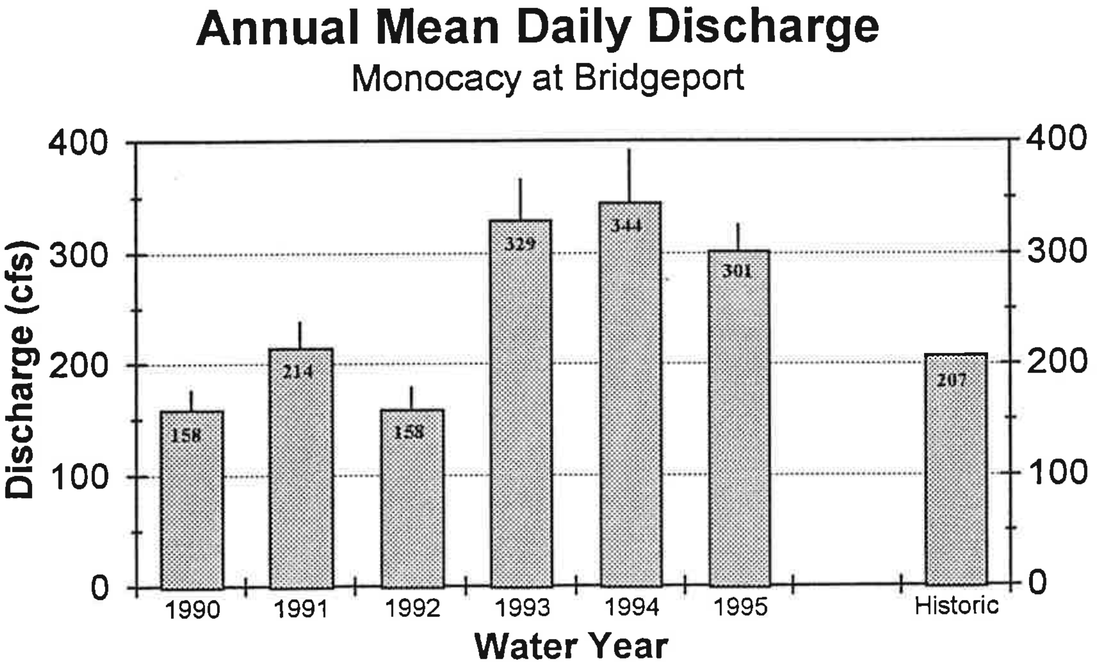

Figure 3. Annual mean daily discharge, Monocacy River at Bridgeport, MD, WY90-95. Error bars represent the standard errors of the means.

The following observations are suggested by the summary of the discharge data:

- Discharge at Bridgeport is dominated by nonstorm flow days, but large storm events can increase the river's flow by up to three orders of magnitude for short periods of time. The mean daily flows for over 80% of the days in the monitoring period were below the overall average flow for the same period (228 cfs). Mean daily flows above 1000 cfs occurred on only 100 of 2191 days (about 5%).

- Despite the predominance of nonstorm flow days, the days with the highest flows accounted for the largest portion of the total volume of discharge. The discharge from only 10% of the days accounted for 62% of the water flowing past Bridgeport during the period.

- The annual mean daily flows exceeded the historic annual mean (1942-1995) of 207 cfs in 4 of the 6 water years (Figure 3).

- Because the standard errors of the annual mean daily flows (plotted as error bars in Figure 3) do not overlap, the flows for 1993-1995 appear to have been significantly higher than those for 1990-1992.

Seasonal Discharge

On a seasonal basis, the mean daily flows were highest during January to March, followed by October to December (Figure 4). As shown in Figure 5 and Table 3, the highest seasonal mean daily flows during the five year period (823 cfs) occurred from January through March in both 1993 and 1994. In contrast, July through September of 1991 had the lowest seasonal mean daily flow (31 cfs).

Sediment Concentrations and Loads

TSS Concentrations

On 96 days during the monitoring period, 153 samples were collected for total suspended solids (TSS) analysis. Table 4 summarizes the TSS data (the complete dataset is presented in Appendix A) and Table 5 presents the flow categories and associated median TSS concentrations that were used to calculate TSS loads (as described above).

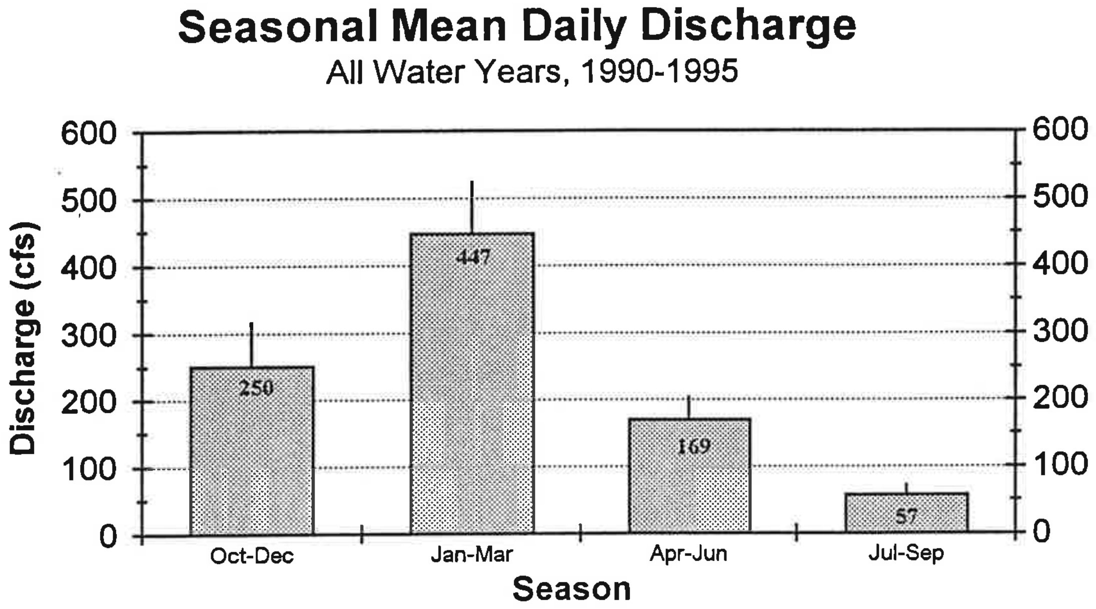

Figure 4. Seasonal mean daily discharge, Monocacy River at Bridgeport, MD, WY90-95. Error bars represent the standard errors of the means.

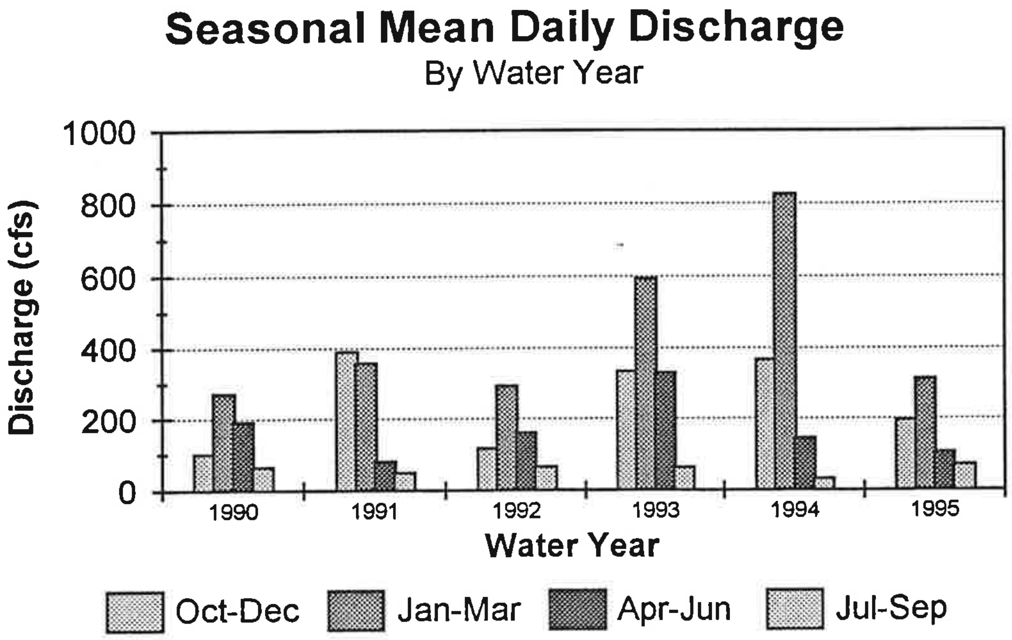

Figure 5. Seasonal mean daily discharge by water year, Monocacy River at Bridgeport, MD, 1990-1995

Table 3. Seasonal Mean Daily Discharge by Water Year, Monocacy River at Bridgeport, MD, 1990-1995

Year/Season		Mean Daily Flow (cfs)	Standard Error of the Mean
1990			
	Oct-Dec	101	27
	Jan-Mar	272	51
	Apr-Jun	192	36
	Jul-Sep	69	17
1991			
	Oct-Dec	389	74
	Jan-Mar	357	45
	Apr-Jun	80	9
	Jul-Sep	31	17
1992			
	Oct-Dec	116	30
	Jan-Mar	292	59
	Apr-Jun	160	43
	Jul-Sep	62	14
1993			
	Oct-Dec	334	85
	Jan-Mar	593	88
	Apr-Jun	329	68
	Jul-Sep	64	14
1994			
	Oct-Dec	366	139
	Jan-Mar	823	108
	Apr-Jun	145	19
	Jul-Sep	48	9
1995			
	Oct-Dec	196	39
	Jan-Mar	312	79
	Apr-Jun	105	28
	Jul-Sep	64	17

Table 4. Summary of TSS Concentration Data, Monocacy River at Bridgeport, MD, WY90-95

	All Samples	Nonstorm Samples	Storm Samples
Number of observations	153	74	79
Mean concentration (mg/L)	169	44	286
Minimum concentration (mg/L)	2	2	7
Lower quartile concentration (mg/L)	12	5	89
Median concentration (mg/L)	74	11.5	161
Upper quartile concentration (mg/L)	237	25	359
Maximum concentration (mg/L)	1650	365	1650

Table 5. Flow Categories and Median TSS Concentrations for Sediment Load Calculations

Category	Percentile	N	Minimum Flow (cfs)	Maximum Flow (cfs)	Median TSS Concentration (mg/L)
Nonstorm Sample Flow Quartiles					
1	0 - 25%	20	1.9	27	19
2	26 - 50%	18	30	67	11.5
3	51 - 75%	18	69	110	5.5
4	76-100%	19	116	1340	20.5
Storm Sample Flow Quartiles					
5	0 - 25%	20	139	2330	68.5
6	26 - 50%	19	2340	3660	124
7	51 - 75%	20	3940	5430	175.5
8	76 - 100%	20	5470	15000	583.5

The following observations are suggested by the TSS concentration data summaries in Tables 4 and 5:

- TSS concentrations ranged widely from 2 to 1650 mg/L.
- The median TSS concentration for storm flow samples greatly exceeded that for the nonstorm flow samples, as is usually the case with this type of monitoring (Table 4).
- Generally, median TSS concentrations for the nonstorm flow samples did not vary widely or consistently between flow quartiles, while median TSS concentrations for the storm flow samples increased with increased flow.

Seasonal TSS Concentrations

To compare TSS concentrations on a seasonal basis, the median concentrations in nonstorm and storm flow samples were calculated for each quarter of the water year. Figure 6 shows the median seasonal TSS concentrations and Table 6 lists the same concentrations and their corresponding associated mean instantaneous flows. Figure 7 and Table 7 present the same information on a yearly basis for both nonstorm and storm flow samples together.

Table 6. Seasonal Mean TSS Concentrations for Nonstorm and Storm Flow Samples, Monocacy River at Bridgeport, WY90-95

Season	All Samples			Nonstorm Samples			Storm Samples		
	N	Mean Inst. Flow	Mean TSS (mg/L)	N	Mean Inst. Flow	Mean TSS (mg/L)	N	Mean Inst. Flow	Mean TSS (mg/L)
Oct - Dec	63	130	4864	13	57	4	50	6113	257
Jan - Mar	17	4	820	12	216	3	5	2270	89
Apr - Jun	54	33	1496	31	108	13	23	3366	124
Jul - Sep	19	25	158	18	131	25	1	632	51

Table 7. Seasonal Mean TSS Concentrations by Water Year, Monocacy River at Bridgeport, WY90-95

Water Year/Season		N	Mean Inst. Flow	Mean TSS
1990		20	1577	83
	Oct - Dec	4	44	5
	Jan - Mar	7	1327	73
	Apr - Jun	9	2452	126
	Jul - Sep	0		
1991		39	2718	138
	Oct - Dec	30	3517	175
	Jan - Mar	2	102	3
	Apr - Jun	4	68	19
	Jul - Sep	3	3	18
1992		37	1909	97
	Oct - Dec	3	26	4
	Jan - Mar	3	160	4
	Apr - Jun	9	2528	98
	Jul - Sep	3	23	16
1993		30	2386	112
	Oct - Dec	10	3665	170
	Jan - Mar	3	511	12
	Apr - Jun	14	2382	111
	Jul - Sep	3	23	19
1994		42	4059	338
	Oct - Dec	16	10249	729
	Jan - Mar	2	1220	167
	Apr - Jun	15	122	59
	Jul - Sep	9	246	148
1995		4	284	84
	Oct - Dec	0		
	Jan - Mar	0		
	Apr - Jun	3	168	95
	Jul - Sep	1	632	51

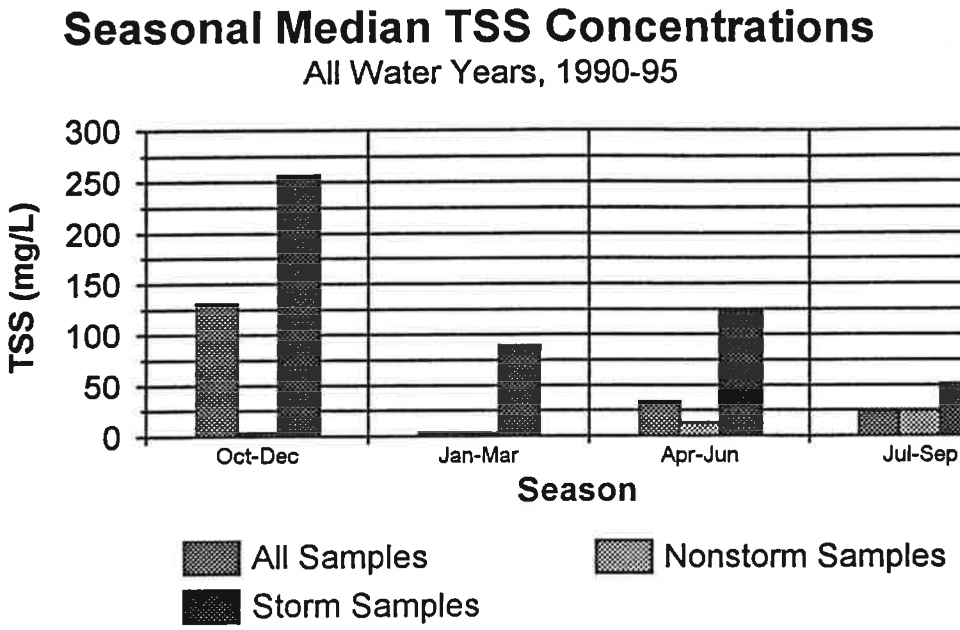

Figure 6. Seasonal mean TSS concentrations for nonstorm and storm flow samples, Monocacy River at Bridgeport, MD, WY90-95

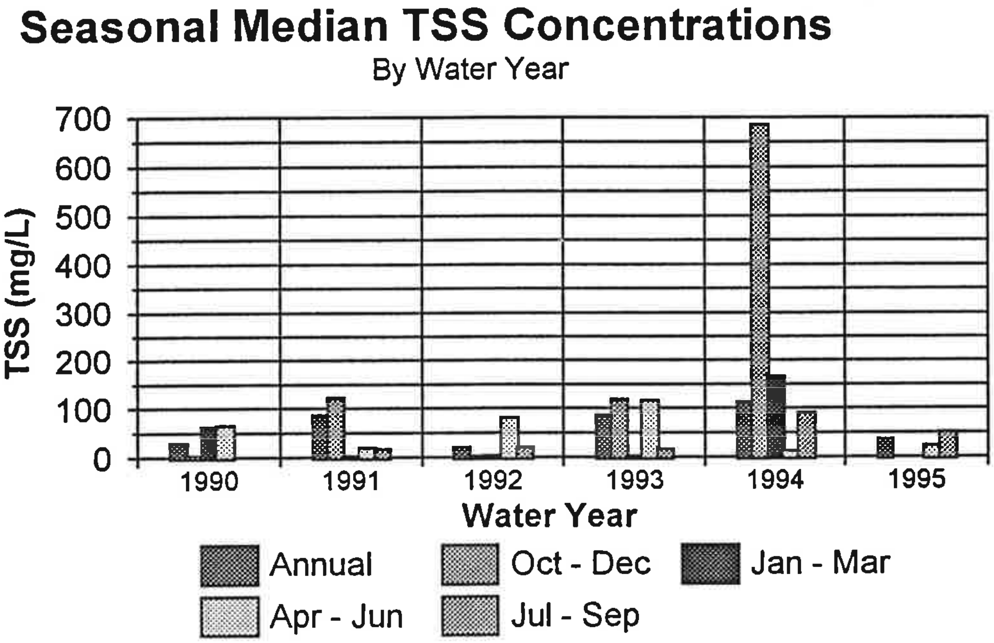

Figure 7. Seasonal median TSS concentrations by water year, Monocacy River at Bridgeport, MD, WY90-95

The following observations are suggested by the seasonal median TSS concentrations:

- The highest median TSS concentrations across all years were in storm flow samples collected in seasons when average flows were also higher, especially in October to December (Table 6).

- When the seasonal median concentrations are broken down on a yearly basis (Figure 7 and Table 7), it is evident that high flows and TSS concentrations in October to December of water year 1994 were responsible for the higher median for these months across all water years.

- Relatively high median TSS concentrations in storm flow samples during April to June (Figure 6, Table 6) may be at least partially explained by the increased availability of soils for transport to streams in the spring when temperatures are higher and farming and construction activity is generally greater.

- Median concentrations may have been lower during January to March and July to September because fewer storm flow samples were collected during these periods.

- TSS concentrations in nonstorm samples were more consistent across seasons and did not track average seasonal flows as closely compared to those for storm flow samples.

Trends in TSS Concentrations

The results of the analysis for trend in TSS concentrations are shown in Figures 8-10. Figure 8 plots the monthly median TSS concentrations over time with the Seasonal Kendall Slope superimposed. Figure 9 plots the relationship of TSS concentration to instantaneous flow, including the smoothed line produced by the LOWESS regression procedure, the residuals from which are the flow-adjusted TSS concentrations. Figure 10 shows the results of the Seasonal Kendall test on these flow-adjusted TSS concentrations.

The following observations can be made based on the results of the trend analysis:

- Both of the Seasonal Kendall Tests showed significant increasing trends in median TSS concentrations over the monitoring period ($p > 0.05$). The Chi Square test indicated that the trends were homogeneous across all months ($p > 0.05$).

- Although the trends are not necessarily linear, the slopes of the trends in the unadjusted and flow-adjusted data (6.5 and 3.5, respectively) suggest that the upward trend is gradual.

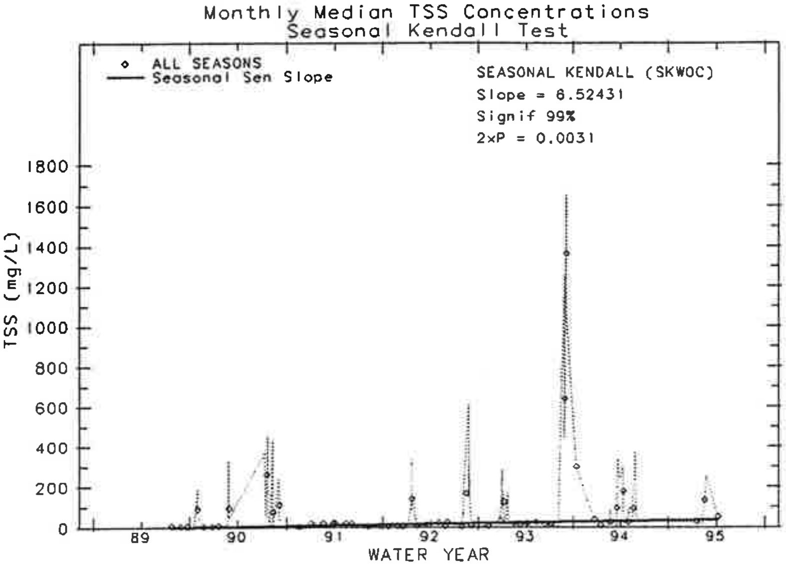

Figure 8. Results of Seasonal Kendall Test for trends in monthly median TSS concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

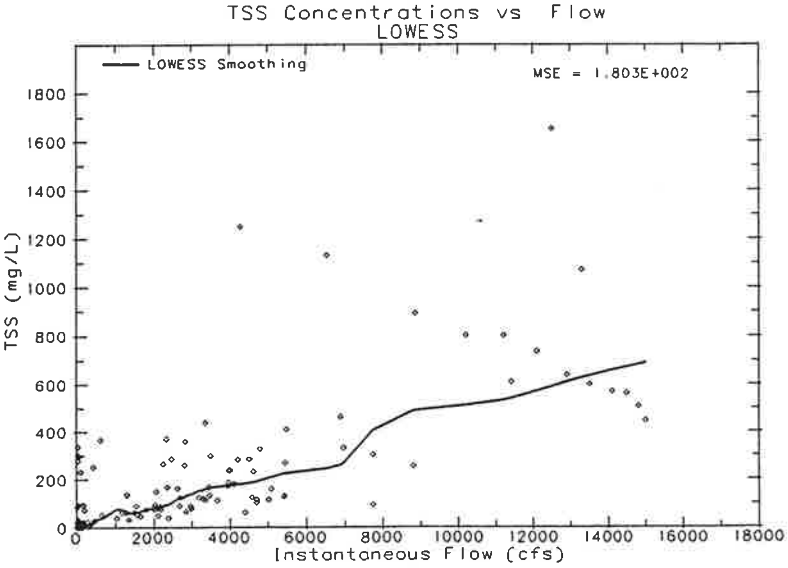

Figure 9. Results of LOWESS regression analysis of TSS concentrations and corresponding instantaneous flows, Monocacy River at Bridgeport, MD, WY90-95.

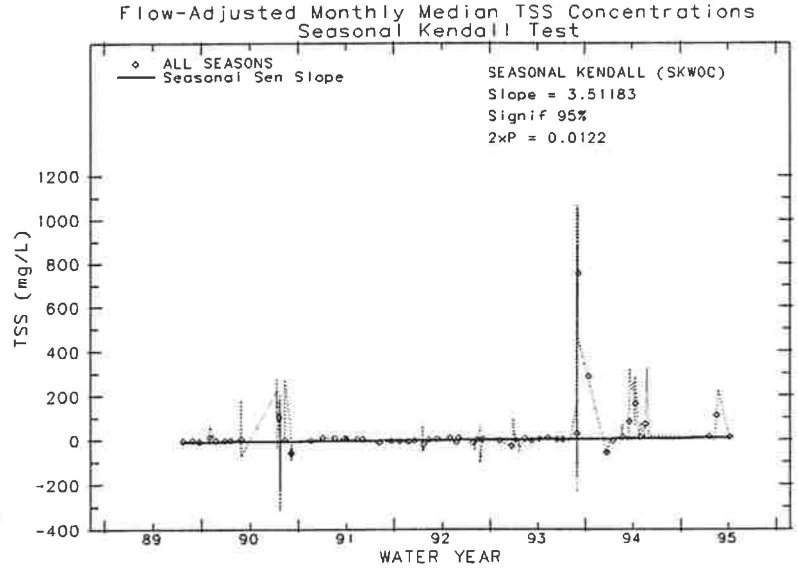

Figure 10. Results of Seasonal Kendall Test for trends in flow-adjusted monthly median TSS concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

- Flow appears to be influencing the trend in the unadjusted data since the test for trend in flow-adjusted data was significant at a lower level and the slope of the trend was more gradual compared to the unadjusted data. Additionally, the LOWESS regression plot (Figure 9) shows a direct, positive relationship between TSS concentration and flow.

- The results of the two Seasonal Kendall Tests and the LOWESS analysis suggest that the general increase in annual mean daily flow (Figure 3) over the monitored period was the major influence on the observed increasing trend in TSS concentrations.

- The tests for serial correlation in the TSS datasets were significant ($p > 0.05$). Therefore, the observed trends should be interpreted with caution, since the serial correlation increases the likelihood of incorrectly concluding that a significant trend is present.

TSS Loads

The estimated annual TSS loads are presented in Figure 11 and Table 8. The seasonal loads for each year are presented in Figure 12 and Table 8.

Table 8. Annual and Seasonal Mean Total Suspended Solids Loads, Monocacy River at Bridgeport, WY90-95.

	Load (tons)					
	1990	1991	1992	1993	1994	1995
Annual	8569	13460	8887	32804	49565	17537
Oct - Dec	1391	7534	1681	14072	30296	2432
Jan - Mar	4433	5093	4497	11683	17620	13439
Apr - Jun	2117	465	2180	6464	1324	1074
Jul - Sep	627	368	530	584	326	591

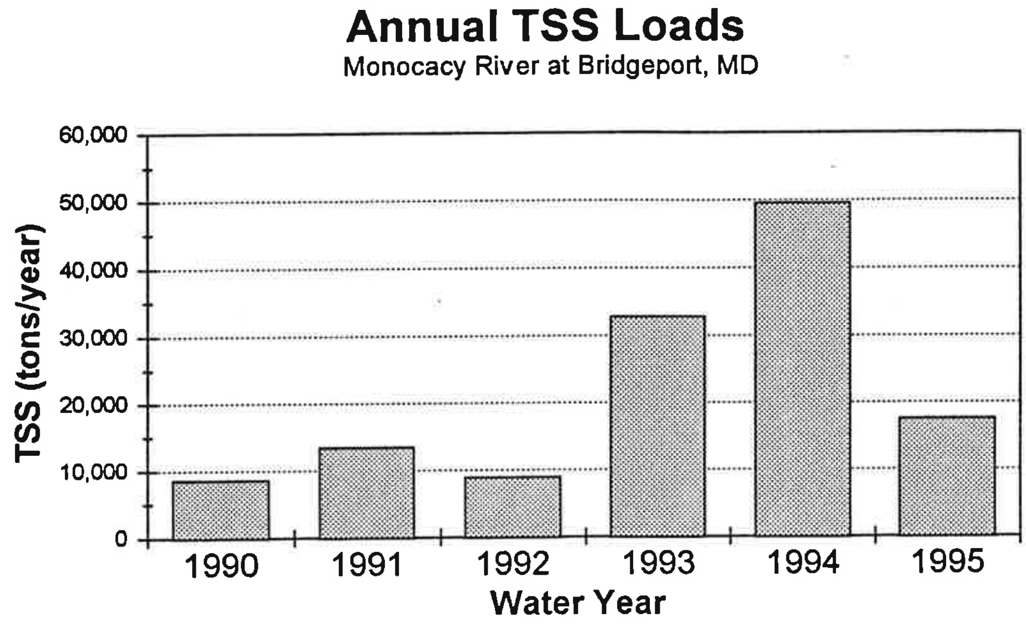

Figure 11. Annual mean total suspended solids loads, Monocacy River at Bridgeport, MD WY90-95.

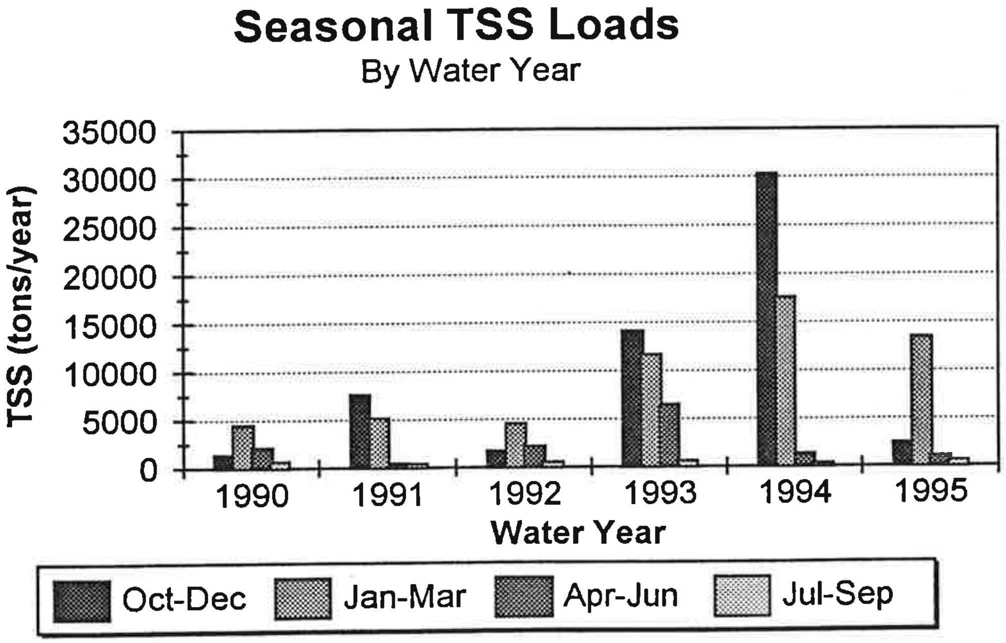

Figure 12. Seasonal mean total suspended solids loads, Monocacy River at Bridgeport, MD, WY90-95.

The estimated TSS loads suggest the following observations:

- As expected from the direct relationship between flow and TSS concentration noted above, the annual and seasonal TSS loads tracked changes in annual mean daily flows (see Figures 3-5 for comparison with flows).
- Although the significance of the differences in loads between water years was not statistically determined, loads for water years 1993 and 1994 appear significantly greater than those for the other years, owing to the higher annual mean daily flows in these years.
- Storm flows were by far the dominant contributor to the TSS loads. Although days designated as "storm flow" days made up fewer than 20% of the total number of days in the monitoring period, they accounted for about 95% of the total load over the five year period.

Nutrient Concentrations and Loads

Hourly TN and TP Concentrations

Figure 13 presents the TN and TP concentrations for samples collected during the hourly nonstorm flow sampling that was conducted over 48 hours in late water year 1995. Figure 14 plots the corresponding instantaneous flows for the samples. Both the TN and TP concentrations increased steadily over the time period, with TN concentrations nearly tripling and TP concentrations nearly doubling. The samples were taken following a slight rise in river flows over the previous two days (maximum mean daily flow = 43 cfs); therefore, the flows were returning to base flow levels throughout the period. TN and TP concentrations may have increased as flows decreased and no longer diluted out the point source loads that would be expected to dominant under low flow conditions. The LOWESS regressions presented below (Figures 21 and 24), however, suggest that concentrations of both TN and TP tend to increase as flow increases in the range of flows associated with these samples. Closer inspection of Figures 22 and 25 reveals considerable variation in the concentrations at low flows, especially for TN. It is likely that other factors such as fluctuations in point source discharges upstream contributed to the changes in nutrient concentrations. The short-term changes in the nutrient concentrations suggested by these hourly data illustrates the importance of collecting a large number of samples over a ranges of flows to develop the dataset used in the regression analysis for estimating annual and seasonal loads.

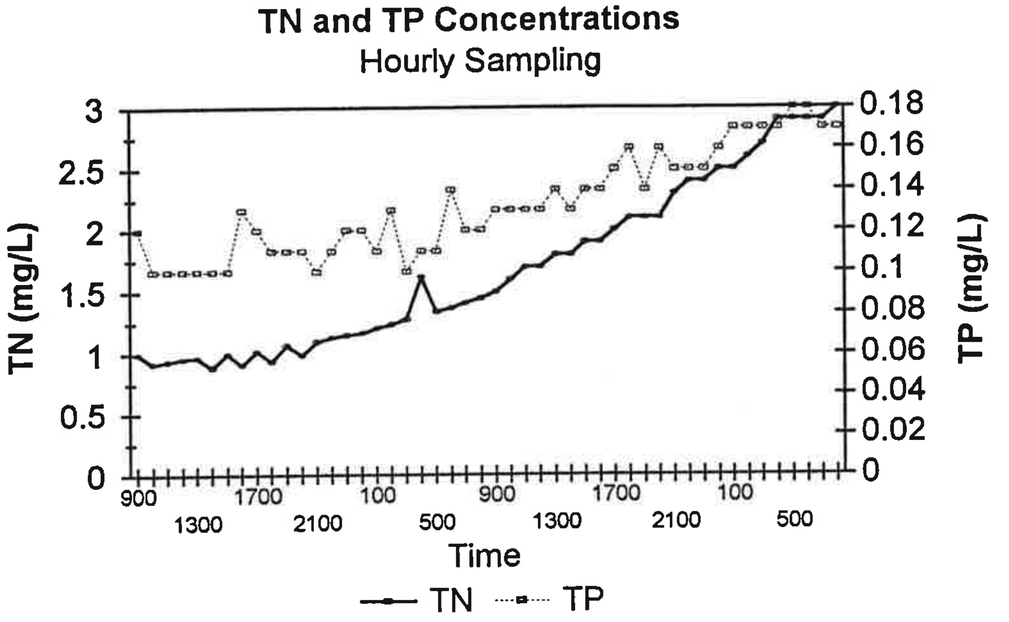

Figure 13. TN and TP concentrations in hourly samples collected September 19-21, 1995, Monocacy River at Bridgeport, MD.

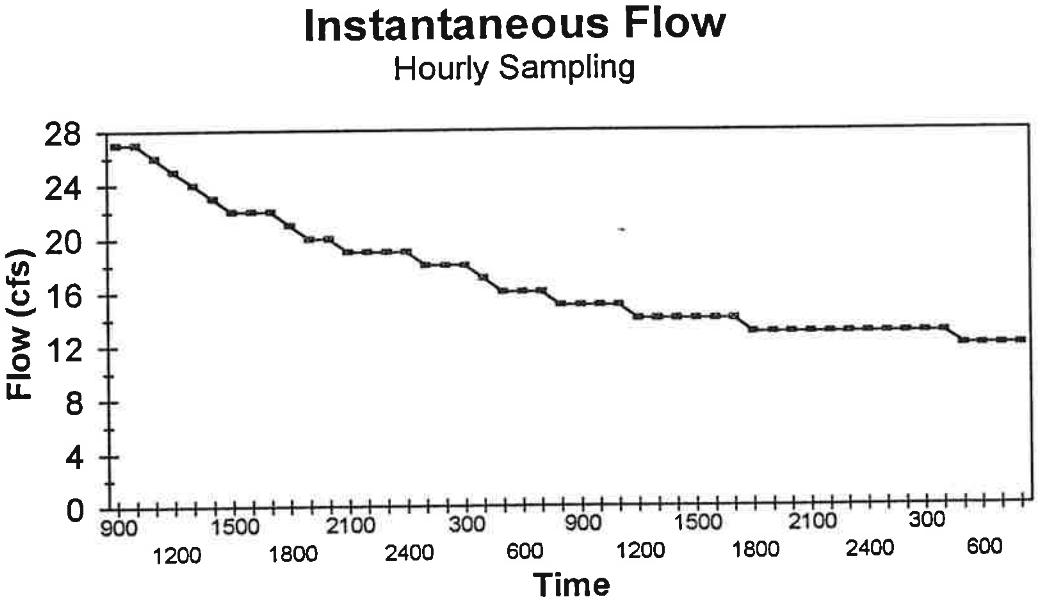

Figure 14. Instantaneous flows corresponding to hourly samples collected September 19-21, 1995, Monocacy River at Bridgeport, MD.

Nonstorm and Storm TN and TP Concentrations

On 133 days during the monitoring period, 325 samples were collected for nutrient analysis, including 33 storm days when multiple samples were drawn (please see Appendix A for the complete nutrient dataset). Tables 9-11 summarize TN, TP, and instantaneous flow data during the monitoring period. Figures 15 and 16 plot the median TN and TP concentrations for each year under nonstorm and storm flow conditions.

Table 9. Summary of Nutrient Concentration Data, Monocacy River at Bridgeport, MD, WY90-95

	All Samples		Nonstorm Flow Samples		Storm Flow Samples	
	TN	TP	TN	TP	TN	TP
Number of observations	322	324	88	90	234	234
Mean concentration (mg/L)	1.9	0.25	1.42	0.12	2.05	0.30
Minimum concentration (mg/L)	0.2	0.02	0.02	0.02	0.2	0.05
Lower quartile concentration (mg/L)	1	0.15	0.64	0.05	0.9	0.2
Median concentration (mg/L)	1.7	0.22	1.1	0.09	2.1	0.25
Upper quartile concentration (mg/L)	2.8	0.31	2.0	0.14	3.0	0.34
Maximum concentration (mg/L)	5.2	1.7	5.2	0.76	5.2	1.7

Table 10. Annual Median TN Concentrations and Corresponding Mean Instantaneous Flows, Monocacy River at Bridgeport, MD, WY90-95

Year	All Samples			Nonstorm Flow Samples			Storm Flow Samples		
	N	Mean Inst. Flow	Median TN (mg/L)	N	Mean Inst. Flow	Median TN (mg/L)	N	Mean Inst. Flow	Median TN (mg/L)
1990	35	2084	3.6	13	54	1.8	22	3289	4.1
1991	59	3722	2.7	13	60	1.3	46	4757	2.8
1992	24	2011	2.4	13	72	1.6	11	4304	2.5
1993	101	3232	1.0	11	271	0.5	90	3594	1.0
1994	69	5528	0.7	27	150	0.6	42	9242	0.7
1995	34	1979	2.3	11	467	1.9	23	2701	2.7

Table 11. Annual Median TP Concentrations and Corresponding Mean Instantaneous Flows, Monocacy River at Bridgeport, MD, WY90-95

Year	All Samples			Nonstorm Flow Samples			Storm Flow Samples		
	N	Mean Inst. Flow	Median TP (mg/L)	N	Mean Inst. Flow	Median TP (mg/L)	N	Mean Inst. Flow	Median TP (mg/L)
1990	35	2084	0.22	13	54	0.07	22	3289	0.23
1991	59	3722	0.27	13	60	0.09	46	4757	0.30
1992	24	2011	0.13	13	72	0.06	11	4304	0.26
1993	101	3232	0.19	11	271	0.06	90	3594	0.19
1994	71	5528	0.23	29	150	0.14	42	9242	0.26
1995	34	1979	0.24	11	467	0.09	23	2701	0.3

The summary of TN and TP concentration data suggests the following observations:

- For samples collected under both nonstorm and storm flow conditions, TN concentrations ranged from 0.2 to 5.2 mg/L (median = 1.7 mg/L) and TP concentrations ranged from 0.02 to 1.7 mg/L (median = 0.22 mg/L).

- Both TN and TP concentrations were generally higher in storm flow samples compared to nonstorm flow samples and the differences between the sample types were greater for TP compared to TN. For TN, the median concentrations for storm and nonstorm flow samples were 1.1 and 2.1, respectively, and the corresponding medians for TP were 0.09 and 0.25 mg/L, respectively (Table 9).

- With the exception of WY95, median TN concentrations generally declined from over the monitored period.

- Median TN concentrations associated with higher mean flows were generally lower (Table 10 and Figure 15).

- Based on Table 11 and Figure 16, there is no apparent trend in median TP concentrations from year to year and they do not appear to vary consistently with mean instantaneous flow values.

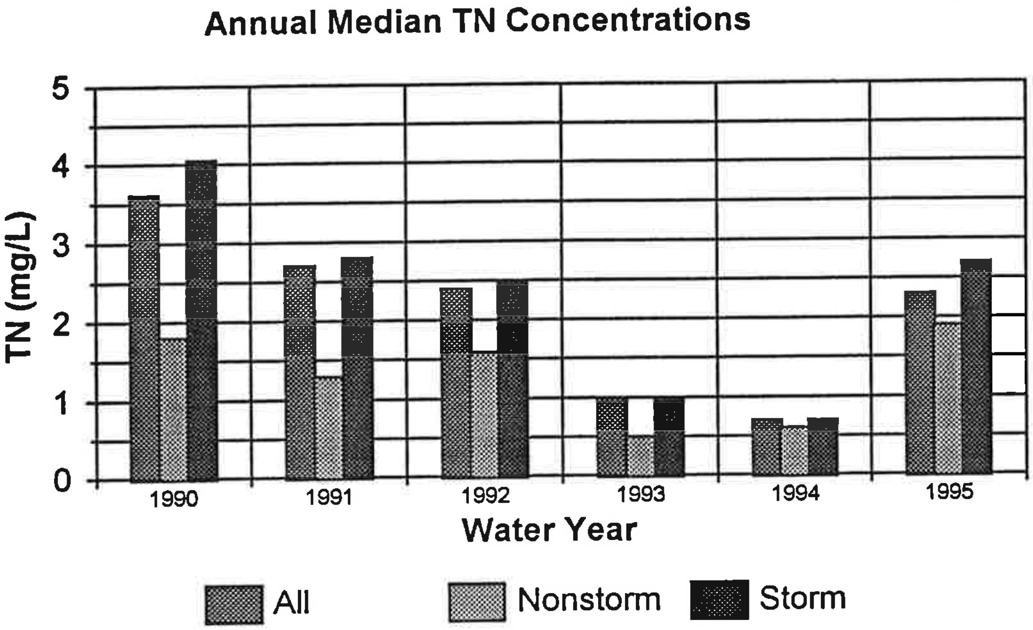

Figure 15. Annual median TN concentrations for nonstorm flow and storm flow samples, Monocacy River at Bridgeport, MD, WY90-95.

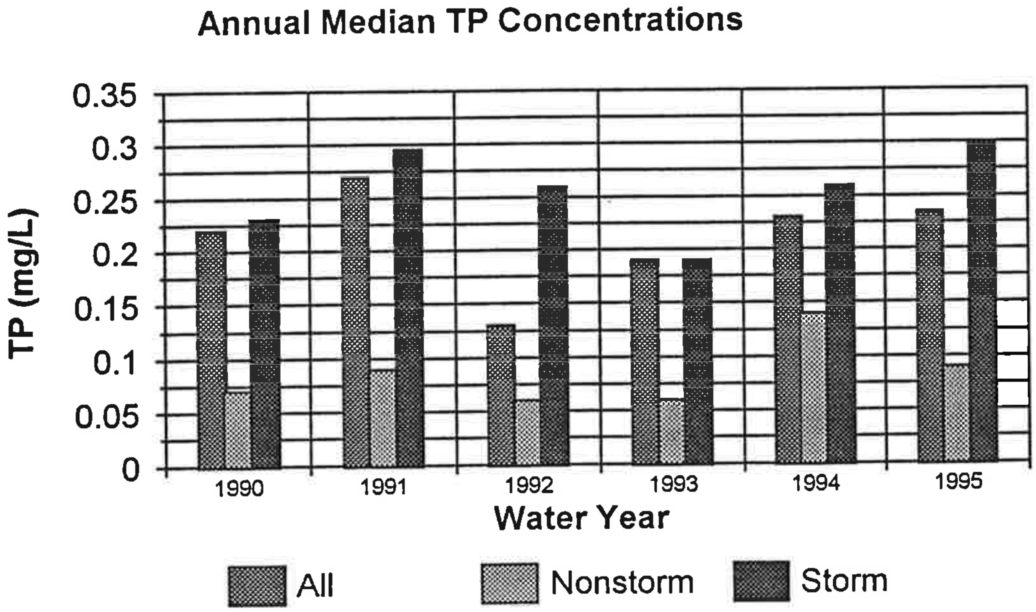

Figure 16. Annual median TP concentrations for nonstorm flow and storm flow samples at Bridgeport, MD, WY90-95.

Seasonal TN and TP Concentrations

Tables 12 and 13 summarize the median TN and TP concentrations and their corresponding mean instantaneous flows on an annual and seasonal basis. Figures 17-20 show the overall and yearly seasonal median TN and TN concentrations.

The seasonal median TN and TP concentrations suggest the following observations:

- The seasonal median TN and TP concentrations for all water years combined do not exhibit any consistent patterns in nonstorm or storm flow samples, athough for both sample types combined, median TN concentrations tended to be higher from October to March, while TP concentrations were highest from October to December.

- Storm flow samples were collected primarily within the months of October to December and April to June, both because the automatic sampling equipment did not operate in freezing temperatures and because there were fewer storms in the late summer. There is no apparent consistent bias in the median concentrations due the unequal distribution of samples between seasons indicated by the summary in Table 12.

- There does not appear to be a strong relationship between median TN and TP concentrations and mean flow, based on the summary in Table 12, for all samples combined or for the nonstorm or storm flow subsets.

- Figures 15 and 16 show that median concentrations for both TN and TP were unusually high from July to September f or storm flow samples and to a lesser extent nonstorm flow samples. The yearly breakdowns in seasonal median concentration (Figures 19 and 20) show that the higher nutrient concentrations during this time are primarily due to higher concentrations in water year 1995.

- The same breakdown in Table 13 also suggests a stronger direct relationship between flow and median TN concentrations, and to a lesser extent median TP concentrations, than was evident in the lumped seasonal summary presented in Table 12.

Table 12. Seasonal Median TN and TP Concentrations and Corresponding Mean Flows, Monocacy River at Bridgeport, WY90-95.

	Count	Mean Inst. Flow	Median TN	Median TP	Comments
All Samples					
Oct-Dec	133	5594	2.2	0.29	
Jan-Mar	21	811	2.3	0.05	
Apr-Jun	129	2540	1.1	0.18	
Jul-Sep	41	936	1.2	0.17	N = 39 for TN
Nonstorm Samples					
Oct-Dec	17	129	1.8	0.06	
Jan-Mar	13	234	2.3	0.04	
Apr-Jun	33	140	0.7	0.07	
Jul-Sep	27	187	0.9	0.15	N = 25 for TN
Storm Samples					
Oct-Dec	116	6394	2.3	0.31	
Jan-Mar	8	1749	2.1	0.14	
Apr-Jun	96	3365	1.1	0.21	
Jul-Sep	14	2382	3.4	0.47	

Table 13. Annual Seasonal Median TN and TP Concentrations and Corresponding Mean Flows for Monocacy at Bridgeport, WY90-95.

	Count	Mean Inst. Flow	Median TN	Median TP	Comments
1990	35	2084	3.6	0.22	
Oct-Dec	4	44	2.8	0.10	
Jan-Mar	6	1536	3.4	0.17	
Apr-Jun	19	3071	4.1	0.22	
Jul-Sep	6	865	2.7	0.21	
1991	59	3722	2.7	0.27	
Oct-Dec	49	4471	2.8	0.29	
Jan-Mar	2	102	2.4	0.05	
Apr-Jun	4	68	1.3	0.10	
Jul-Sep	4	4	1.0	0.17	
1992	24	2011	2.4	0.13	
Oct-Dec	3	26	1.6	0.06	
Jan-Mar	3	160	3.6	0.04	
Apr-Jun	15	3177	2.4	0.25	
Jul-Sep	3	23	1.2	0.13	
1993	101	3232	1.0	0.19	
Oct-Dec	24	4961	2.8	0.43	
Jan-Mar	3	511	0.2	0.04	
Apr-Jun	67	2969	0.9	0.18	
Jul-Sep	7	991	0.8	0.13	
1994	71	5528	0.7	0.23	N = 69 for TN
Oct-Dec	42	9160	0.7	0.26	
Jan-Mar	3	1227	0.4	0.05	
Apr-Jun	15	123	0.6	0.08	
Jul-Sep	11	205	0.9	0.17	N = 9 for TN
1995	34	1979	2.3	0.24	
Oct-Dec	11	1892	2.1	0.26	
Jan-Mar	4	481	2.0	0.06	
Apr-Jun	9	2291	2.3	0.22	
Jul-Sep	11	2392	3.5	0.57	

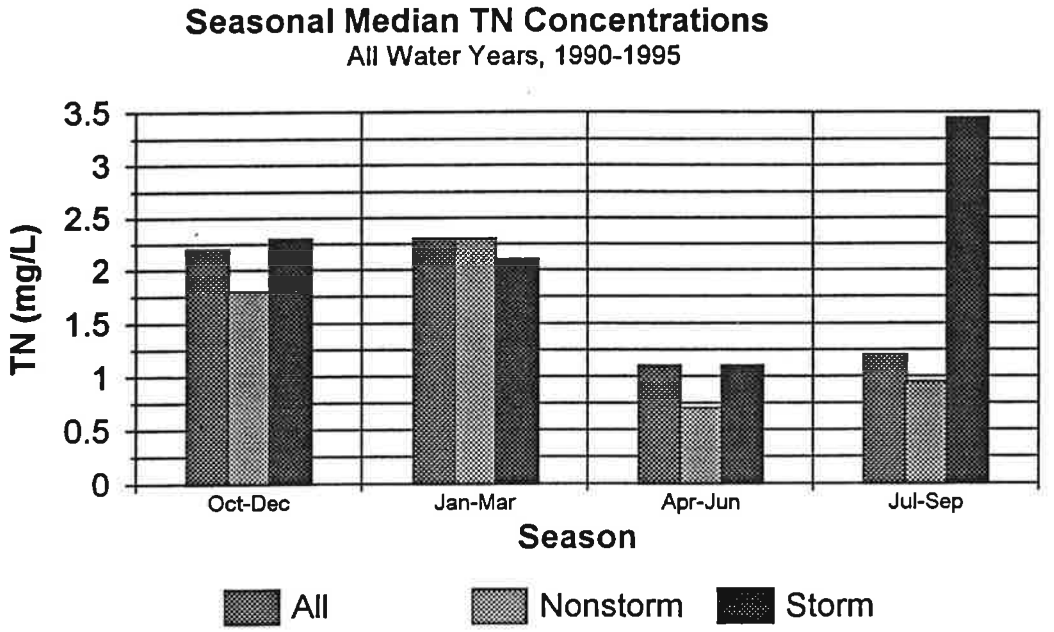

Figure 17. Seasonal median TN concentrations, Monocacy River at Bridgeport, MD, WY90-95.

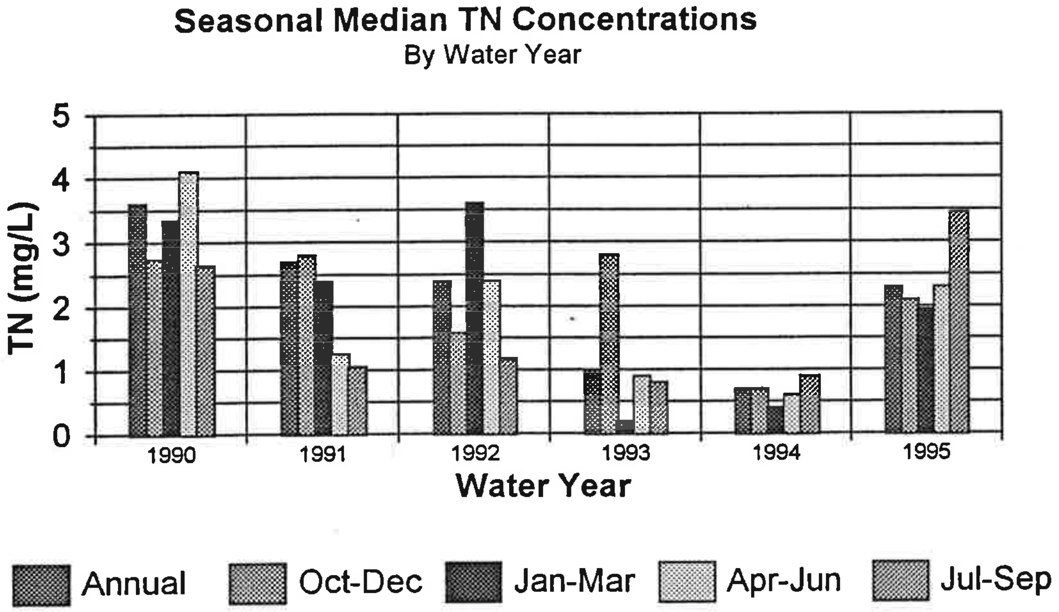

Figure 18. Seasonal median TN concentrations by water year, Monocacy River at Bridgeport, MD, WY90-95.

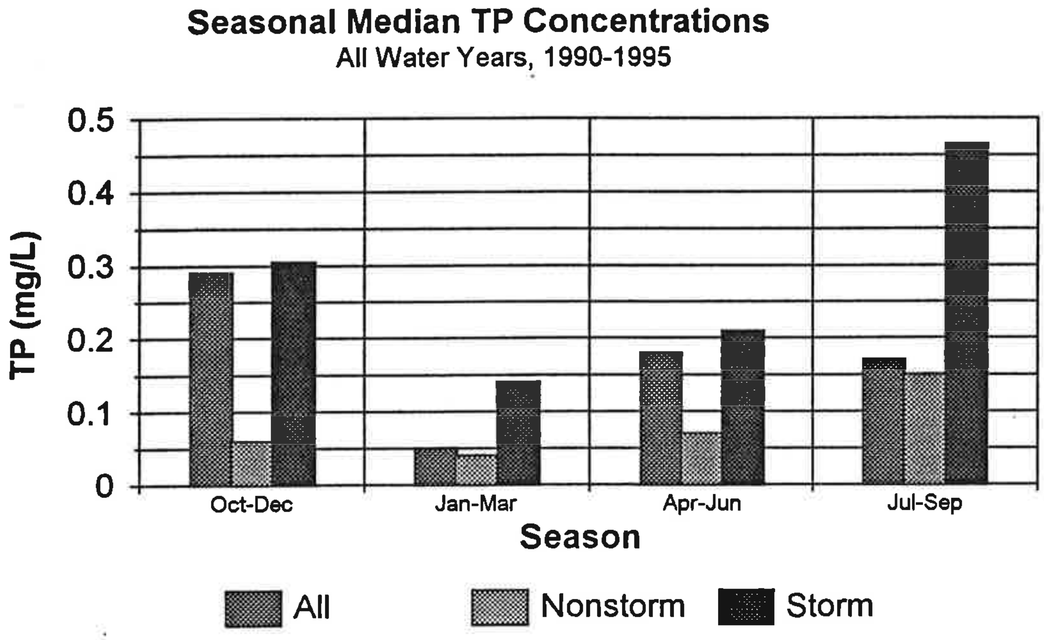

Figure 19. Seasonal median TP concentrations, Monocacy River at Bridgeport, MD, WY90-95.

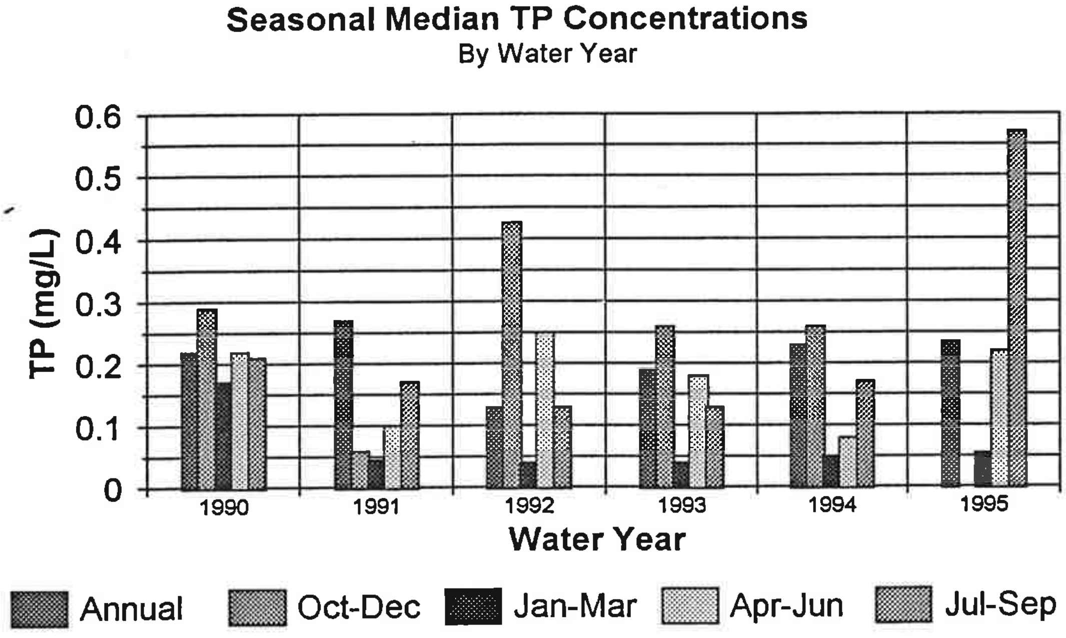

Figure 20. Seasonal median TP concentrations by water year, Monocacy River at Bridgeport, MD, WY90-95.

Trends in TN and TP Concentrations

Similar to Figures 8-10 above for TSS, Figures 21-26 present the results of the analysis for trends in monthly median TN and TP concentrations. Figures 21 and 24 plot the monthly median TN and TP concentrations, respectively, over time and the Seasonal Kendall Slope line. Figures 22 and 25 show the results of the LOWESS regression procedure, and Figures 23 and 26 show the results the Seasonal Kendall Test on the flow-adjusted TSS concentrations determined by LOWESS.

The trend analysis for median TN and TP concentrations suggests the following observations:

- For both the unadjusted and flow-adjusted median TN concentrations, the Seasonal Kendall Tests (Figures 21 and 23) indicate a highly significant trend ($p < 0.001$) toward gradually decreasing median concentrations. The Chi-Square tests indicate that the trends were homogeneous across all months ($p > 0.05$).

- The slopes of the trends were - 0.22 for the unadjusted data and -0.24 for the flow-adjusted TN data.

- The LOWESS-smoothed regression line indicates TN concentrations tend to decrease at flows above about 5000 cfs (Figure 22).

- The small size of the trend slopes and the relationship of TN concentration and flow suggests that the trend may be due to the general increase in flow during the monitored period.

- As with the TSS data, serial correlation was present in the TN data. Because the trends were so highly significant, however, it is less likely that the serial correlation would raise the true p-level to the point where the trends would be deemed not significant.

- For TP, the Seasonal Kendall Tests show no significant trend in either the unadjusted or the flow-adjusted median concentrations ($p \gg 0.05$). The Chi-Square tests indicate that the trends were homogeneous across all months ($p > 0.05$), and, therefore, the lack of a significant trend was not simply due to opposite trends offsetting each other.

- The LOWESS-smoothed regression line indicates only a slight increase in TP concentrations associated with flows above about 1000 cfs. There was no serial correlation in the TP datasets.

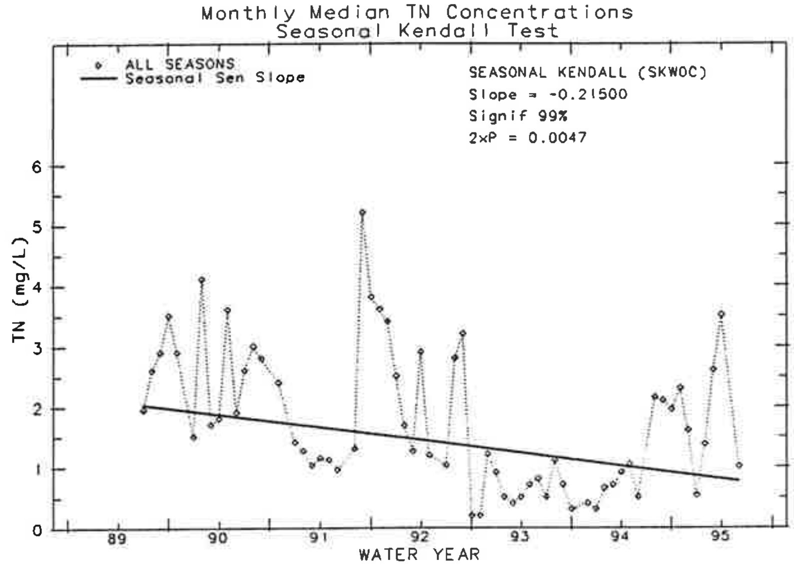

Figure 21. Results of Seasonal Kendall Test for trends in monthly median TN concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

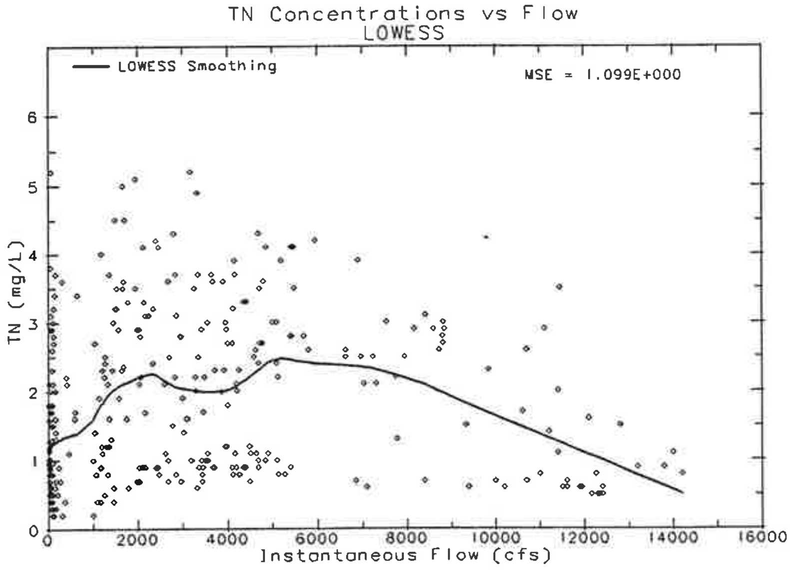

Figure 22. Results of LOWESS regression analysis of TN concentrations and corresponding instantaneous flows, Monocacy River at Bridgeport, MD, WY90-95.

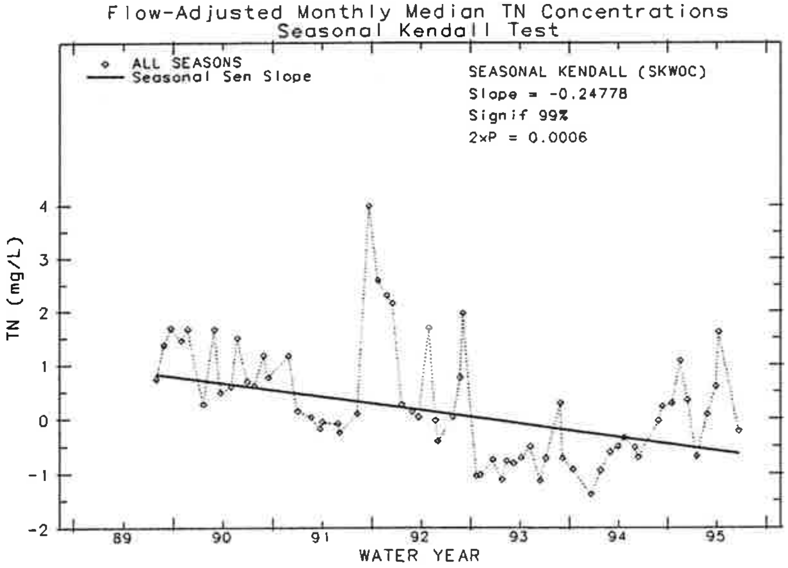

Figure 23. Results of Seasonal Kendall Test for trends in flow-adjusted monthly median TN concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

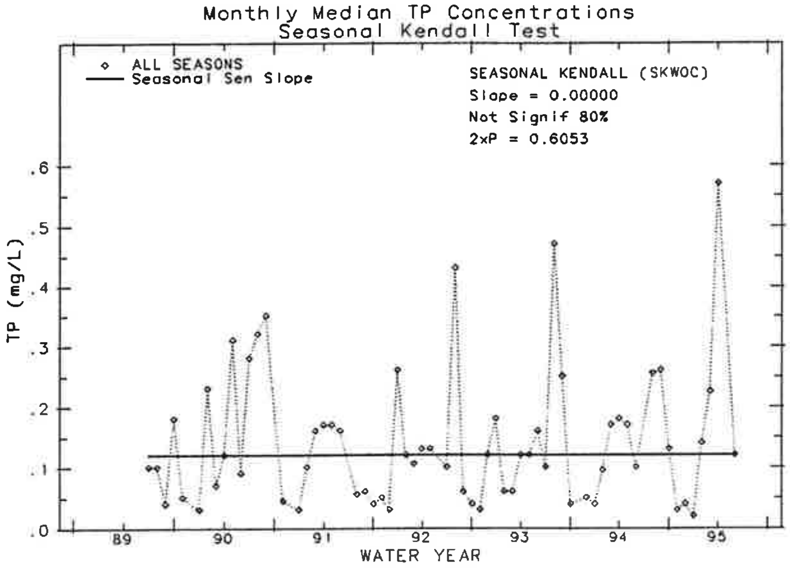

Figure 24. Results of Seasonal Kendall Test for trends in monthly median TP concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

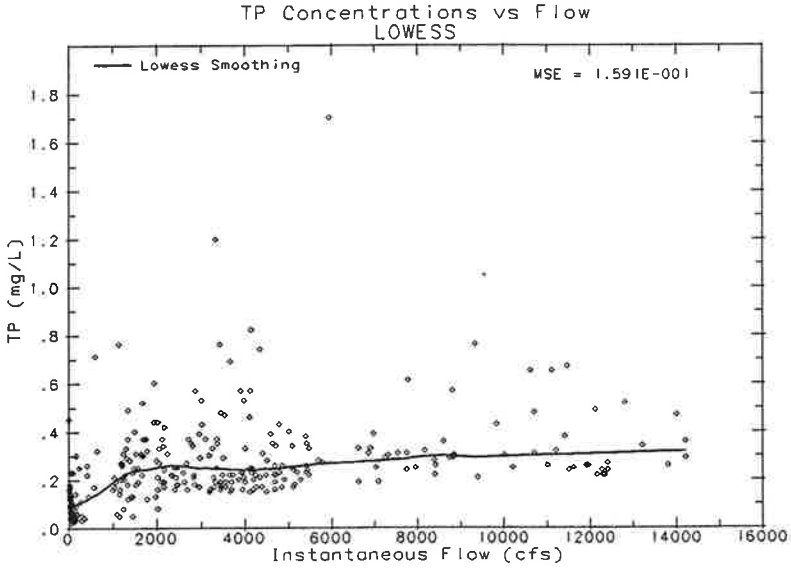

Figure 25. Results of LOWESS regression analysis of TP concentrations and corresponding instantaneous flows, Monocacy River at Bridgeport, MD, WY90-95.

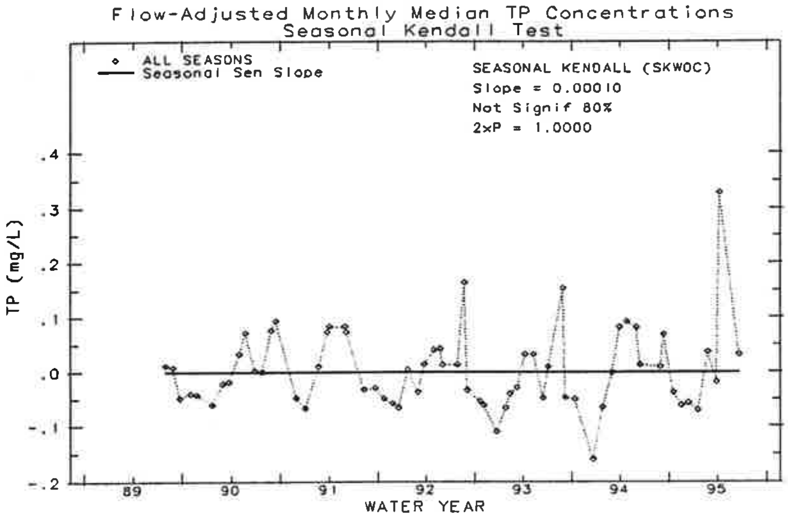

Figure 26. Results of Seasonal Kendall Test for trends in flow-adjusted monthly median TP concentrations, Monocacy River at Bridgeport, MD, WY90-95 (see text for further explanation).

TN and TP Loads

Figures 27 and 28 present the annual load estimates for TN and TP. TN loads did not track the changes in annual mean daily flows (Figure 3) to the extent that TP loads did, especially during the first two years of the monitoring period. TP loads exhibited a pattern similar to that for TSS loads (Figure 10). This relationship of TP and TSS is not surprising since phosphorus tends to adsorb to sediment particles.

Seasonal TN and TP Loads

Figures 29 and 30 show the mean seasonal nutrient loads, and Figures 31 and 32 show the seasonal means for each water year. The following observations can be made based on these loads:

- Unlike the annual loads, the seasonal loads for TN followed a pattern similar to the mean seasonal daily discharge (Figure 4). The mean seasonal TP loads also track the flows, except for the October to December period.

- For both TN and TP, seasonal loads tend to track mean seasonal flows well within each water year (Figures 5, 31 and 32). The exceptions are the high TP loads for October to December of water years 1993 and 1994, which account for the anomaly in the mean seasonal TP loads for those months across all years (Figure 30).

- Although the seasonal loads for both TN and TP generally follow the relative increases and decreases in flow, changes in the flow did not always result in proportionate increases in TN and TP loads. The resulting annual loads for TN did not track flow patterns as well as those for TP did.

Point Source Contributions to Annual Loads

Table 14 and Figure 33 summarize the point source discharge rates and loads from the major wastewater treatment plants in the Bridgeport, MD drainage area. The data suggests the following:

- Discharge rates were generally consistent over four of the six years in the monitoring period and relatively higher in water years 1993 and 1994.

- The Gettysburg facility contributed about 65% of the total discharge, Littlestown about 17 %, and the remaining three facilities about 5-7% each.

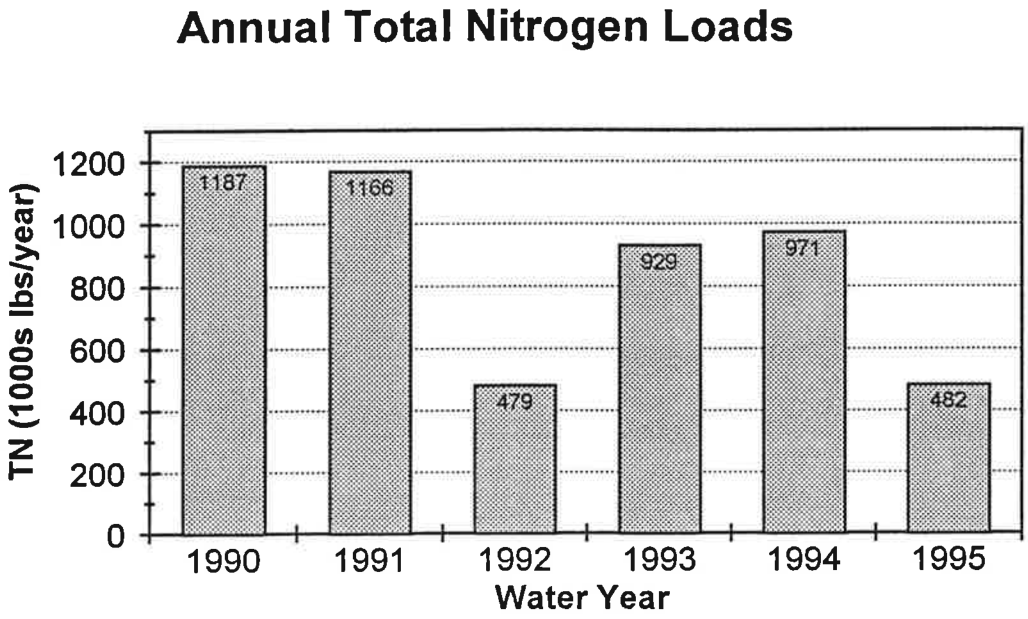

Figure 27. Annual total nitrogen loads, Monocacy River at Bridgeport, MD, WY90-95.

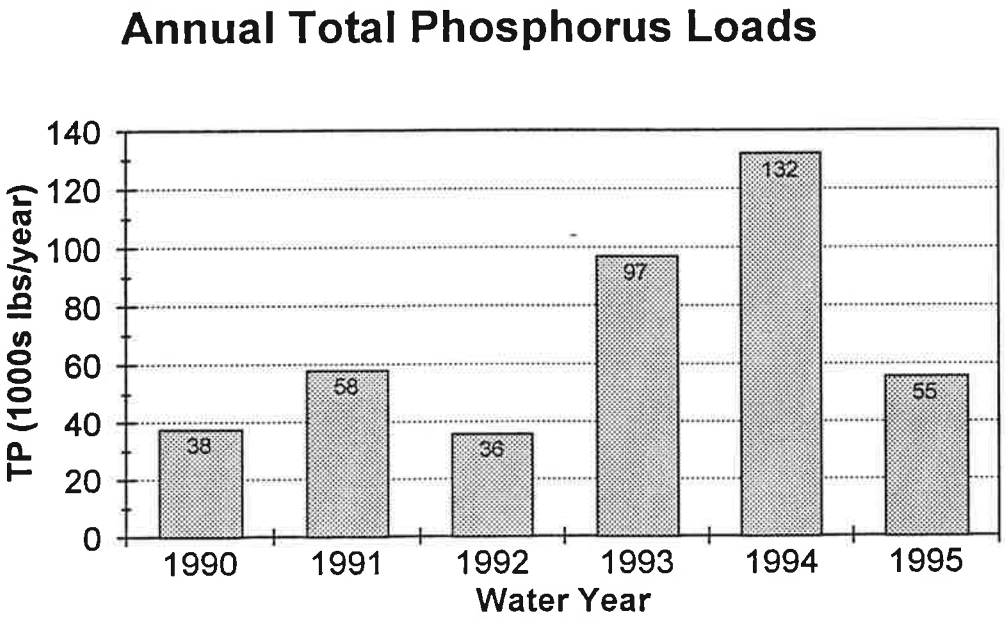

Figure 28. Annual total phosphorus loads, Monocacy River at Bridgeport, MD, WY90-95.

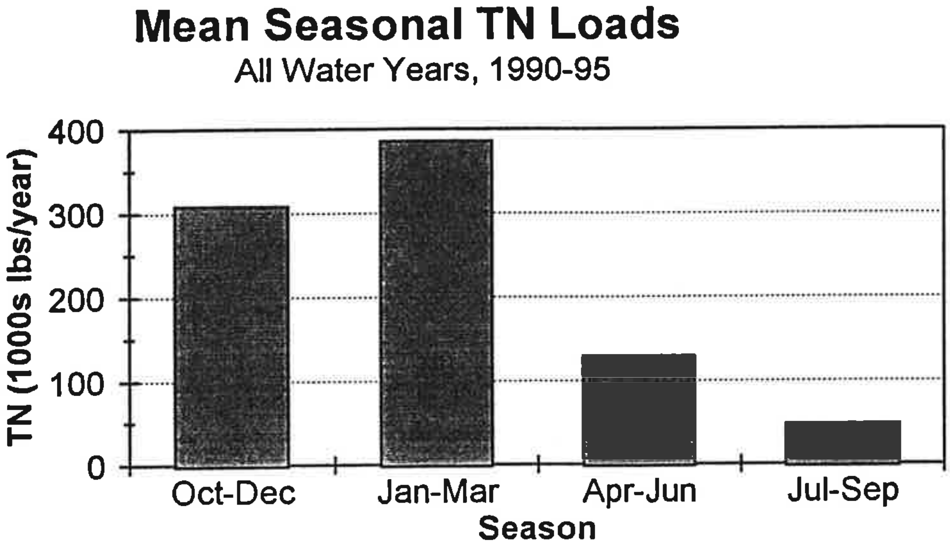

Figure 29. Mean seasonal total nitrogen loads, Monocacy River at Bridgeport, MD, WY90-95.

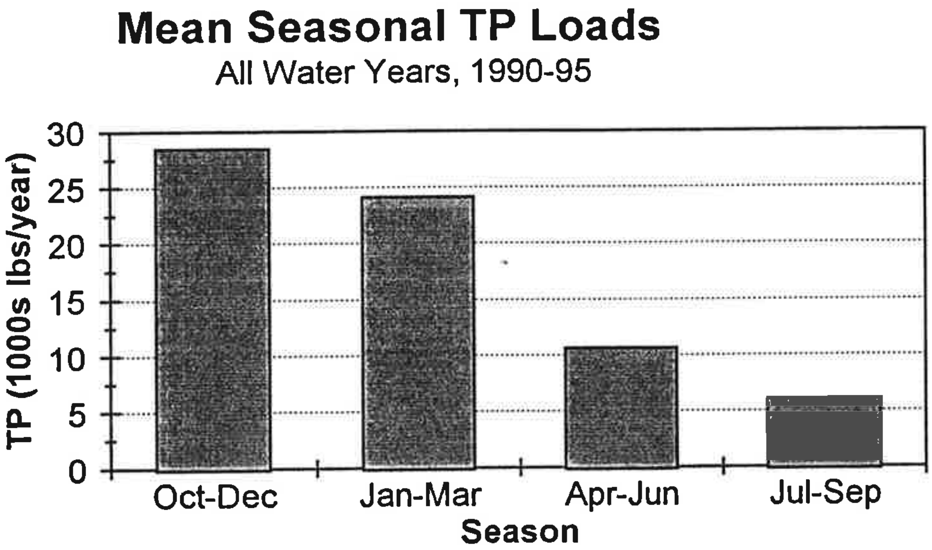

Figure 30. Mean seasonal total phosphorus loads, Monocacy River at Bridgeport, MD, WY90-95.

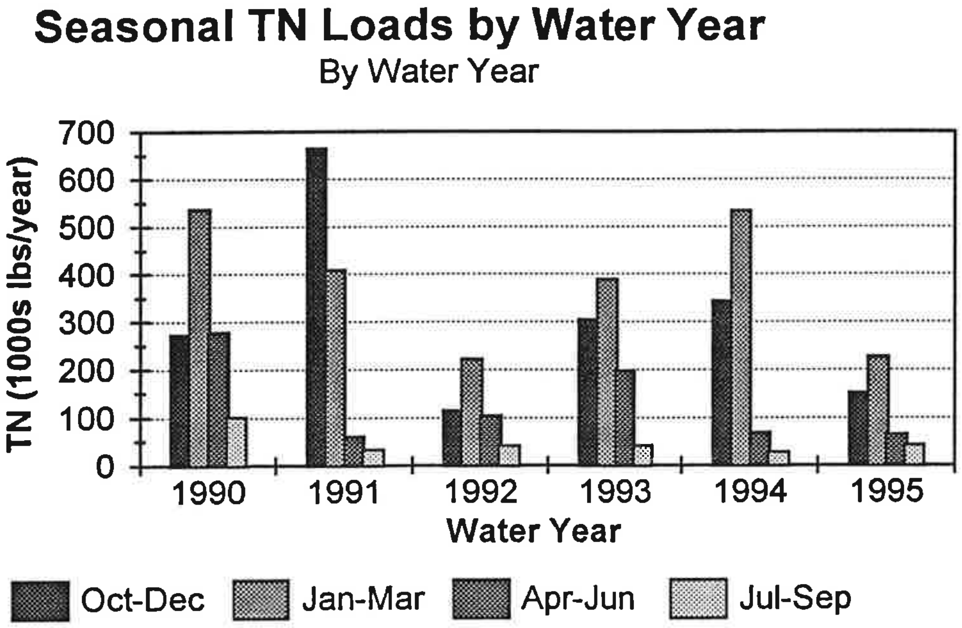

Figure 31. Seasonal total nitrogen loads by water year, Monocacy River at Bridgeport, MD, WY90-95.

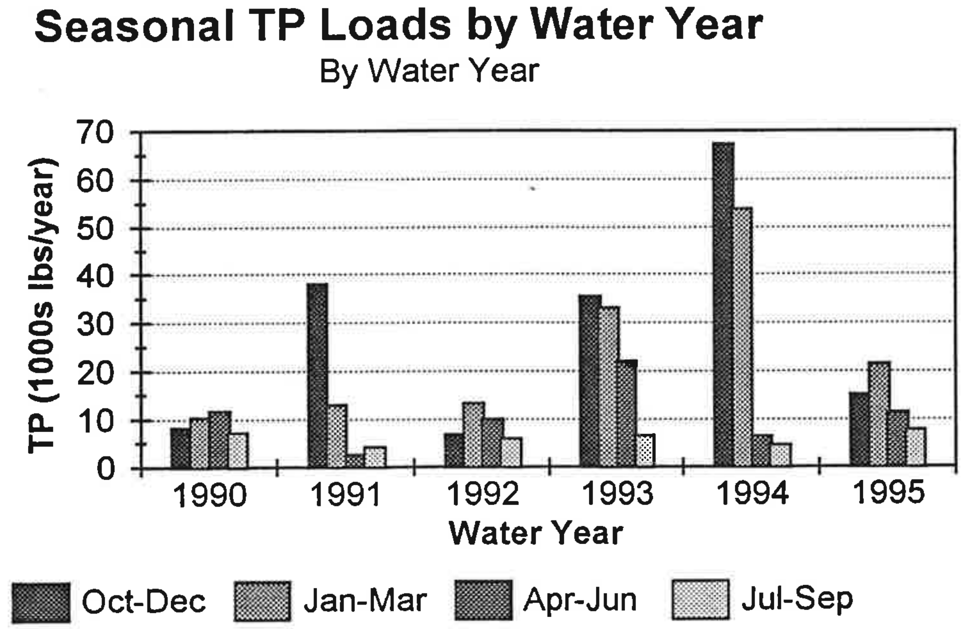

Figure 32. Seasonal total phosphorus loads by water year, Monocacy River at Bridgeport, MD, WY90-95.

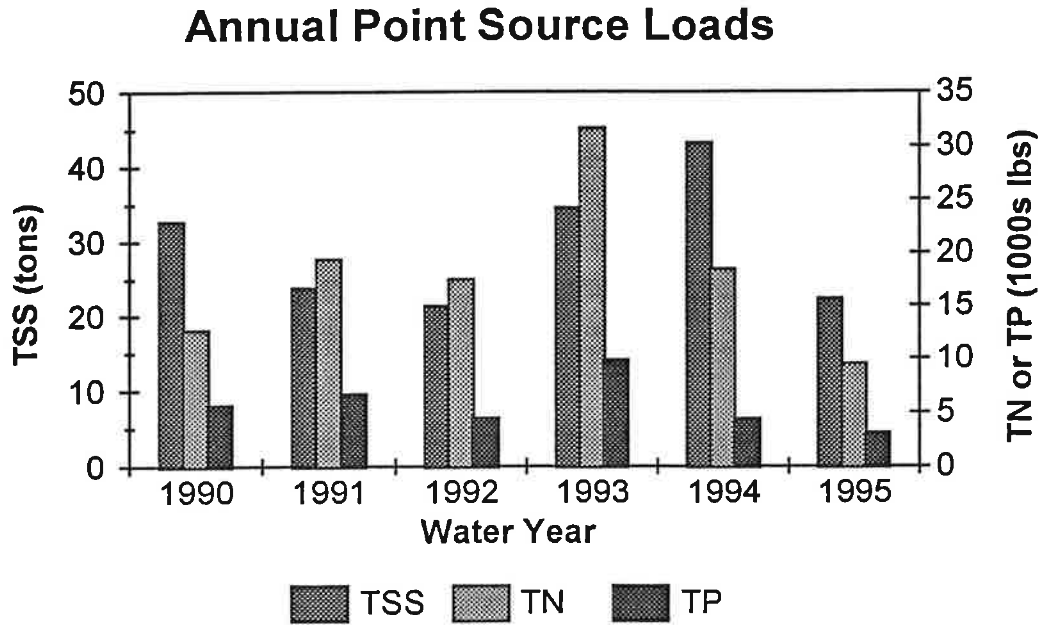

Figure 33. Point source loads of TSS, TN and TP from wastewater treatment plants located in the drainage to the Monocacy River at Bridgeport, MD, and discharging greater than 0.05 million gallons per day, WY90-95.

- Loads of TSS, TN and TP were also fairly consistent over all years, although TSS loads were relatively higher in water years 1990, 1993 and 1994 and TN loads were similarly higher in 1993.

- Because the point source TSS and TN loads made up less than 4% of the total estimated loads in all years (Table 14), it is unlikely that even those years with relatively large loads contributed significantly the total TSS and TN loads.

- In contrast, point source TP loads contributed about 8 - 21% of the total estimated TP load and may, therefore, have had more of an influence on the total loads.

Table 14. Total Discharge from Major Point Sources and Percentage of Total Discharge and Loads of TSS, TN and TP From Point Sources in the Drainage to the Monocacy River at Bridgeport, MD, WY90-95.

Water Year	Total Point Source Discharge (cfs)[1]	Percent of Total River Discharge	Percent of Total TSS	Percent of Total TN	Percent of Total TP
1990	3.16	2.00%	0.39%	1.07%	21.09%
1991	3.43	1.60%	0.18%	1.66%	16.41%
1992	3.61	2.28%	0.24%	3.64%	17.72%
1993	4.79	1.45%	0.11%	3.41%	14.42%
1994	4.71	1.37%	0.09%	1.90%	4.77%
1995	3.73	1.24%	0.13%	1.97%	8.07%

[1] Combined total of facilities discharging >0.05 mgd.

Summary

Discharge

The river's flow at Bridgeport is dominated by nonstorm flow days, but large storm events create much of the total discharge volume. The annual mean daily discharge rates fluctuated during the monitoring period, but were generally above the historic average. The highest mean daily flows occurred during the months of January to March, followed by October to December. In general, flows were higher later in the monitoring period compared to the earlier on.

TSS

TSS concentrations ranged widely: the median concentrations for storm flow samples greatly exceeded those for nonstorm flow samples, especially in October to December when flows were highest. A few high-flow events were responsible for much of the TSS that was transported past the monitoring site during this time. There is some evidence that TSS concentrations increased gradually over the monitoring period, yet the weakness of the trend in the flow-adjusted data and the tendency for TSS concentrations to be higher when flows are higher suggest that the observed trend may be an artifact of generally increasing flows over the monitoring period. In general, the annual and seasonal TSS loads tracked changes in annual mean daily flows, with storm flows accounting for nearly all of the total load over the five year period.

TN and TP

As with TSS, both TN and TP concentrations were generally higher in storm flow samples compared to nonstorm flow samples, yet lower TN concentrations were associated with very high flows. Both plots of annual median TN concentrations and a more formal trend analysis suggest a decreasing trend in TN concentrations over the monitoring period, yet there is no apparent trend in median TP concentrations. As with TSS,the observed trend in TN concentrations may have been due to the general increase in flow during the monitored period. Nutrient loads tended to track the changes in annual mean daily flows, especially TP loads. Annual and seasonal loads were substantially influenced by the occurrence of particularly large flow events.

Point Sources

Point source discharges generally contributed significantly less than 10% of the total estimated loads in all years. Point source TP, however, contributed up to 21% of the total TP load and may, therefore, have had a greater influence on the total loads.

Conclusions

- Six years of monitoring data from the Bridgeport, MD, have made it possible to characterize river flows and nutrient and sediment concentrations in water draining primarily from the Pennsylvania portion of the upper Monocacy River.

- Although annual fluctuations in flow make it difficult to determine long-term trends in nutrient and sediment loads, the data reported here will serve as baseline for pollutant concentrations and loads contributed by the Bridgeport drainage area.

- As efforts to reduce nutrient and sediment loads to streams and rivers continue, monitoring should be resumed at the site so the new data can be compared with that reported here.

References

Aroner, E. (1995), WQHYDRO - Water Quality/Hydrology/Graphics/Analysis System: User's Manual. P.O. Box 18149, Portland, OR, 97218.

Casman, Elizabeth (1985), Interstate Commission on the Potomac River Basin., unpublished data.

Chesapeake Bay Program Office (1987) *1987 Chesapeake Bay Agreement*, CBPO, Annapolis, MD.

Cohn, Timothy A.; Caulder, Dana L.; Gilroy, Edward J.; Zynjuk, Linda D.; Summers, Robert M. (1992) "The validity of a simple statistical model for estimating fluvial constituent loads: an empirical study involving nutrient loads entering Chesapeake Bay", *Water Resources Research*, 28:2353-2363.

Cohn, Timothy A.; DeLong, Lewis L.; Gilroy, Edward J.; Hirsch, Robert M.; Wells, Deborah K. (1989) "Estimating constituent loads", *Water Resources Research*, 25:937-942.

Fishman, M. J., and Friedman, L. C., Eds., 1985, Methods for Determination of Inorganic Substances in Water and Fluvial Sediments: Techniques of Water Resources Investigations of the U. S. Geological Survey, Book 5, Chapter A1, U.S. Govt. Printing Office, Washington, DC.

Gilbert, Richard O. (1987) *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York, N.Y.

Interstate Commission on the Potomac River Basin (1995) Status of the Potomac Watershed Nutrient Strategies, ICPRB Report #95-3, ICPRB, Rockville, MD.

James, R.W., Jr.; Hornlein, J.F.; Simmons, R.H.; Smigaj, M.J. (1991) *Water Resources Data, Maryland and Delaware, Water Year 1990. Volume 2. Monongahela and Potomac River Basins*, U.S. Geological Survey Water-Data Report MD-DE-90-2, Towson, MD.

James, R.W., Jr.; Hornlein, J.F.; Simmons, R.H.; Strain, B.F. (1992) *Water Resources Data, Maryland and Delaware, Water Year 1991. Volume 1. Surface-Water Data*, U.S. Geological Survey Water-Data Report MD-DE-91-1, Towson, MD.

James, R.W.; Smigaj, M.J. (1993) *Water Resources Data, Maryland and Delaware, Water Year 1992. Volume 1. Surface-Water Data*, U.S. Geological Survey Water-Data Report MD-DE-92-1, Towson, MD.

James, R.W.; Simmons, R.H., and Strain, B.F. (1994) *Water Resources Data, Maryland and Delaware, Water Year 1993. Volume 1. Surface-Water Data*, U.S. Geological Survey Water-Data Report MD-DE-93-1, Towson, MD.

James, R.W.; Simmons, R.H., and Strain, B.F. (1995) *Water Resources Data, Maryland and Delaware, Water Year 1994. Volume 1. Surface-Water Data*, U.S. Geological Survey Water-Data Report MD-DE-94-1, Towson, MD.

James, R.W.; Simmons, R.H., and Helinsky, B.M. (1996) *Water Resources Data, Maryland and Delaware, Water Year 1995. Volume 1. Surface-Water Data*, U.S. Geological Survey Water-Data Report MD-DE-95-1, Towson, MD.

Nemura, A. (1989) *Potomac River Fall-line Loadings 1987-88, Based on the Chain Bridge Automated Storm Event Monitor,* Metropolitan Washington Council of Governments, Washington, DC.

Ott, Lyman; Mendenhall, William (1990) *Understanding Statistics*, Fifth Edition, PWS-Kent Publishing, Boston, Massachusetts.

Pennsylvania Department of Enviromental Resources (1994) *Pennsylvania's Draft Nutrient Reduction Strategy*, PADER, Bureau of Land and Water Conservation and Bureau of Water Quality Management, Harrisburg, PA.

United States Geological Survey (1994) *Revision of New Division Protocol for Collecting and Processing Surface Water Samples for Low Level Analyses*, USGS Office of Water Quality Technical Memorandum 94.09, USGS, Reston, VA.

Viessman, Warren Jr.; Hammer, Mark J. (1985) *Water Supply and Pollution Control*, Fourth Edition, Harper and Row, New York, N.Y.

Appendix A. Additional Data Tables

Table A-1. Water Quality Parameters Monitored at the Monocacy River at Bridgeport, MD

Parameter	STORET ID Number
Water temperature	10
Air temperature	20
Specific conductance	95
pH, whole water, field	400
pH, whole water, lab	403
Nitrogen, total, as N	600
Nitrogen, ammonia, dissolved, as N	608
Nitrogen, ammonia, total, as N	610
Nitrogen, nitrite, dissolved, as N	613
Nitrogen, nitrite, total, as N	615
Nitrogen, ammonia + organic, dissolved, as N	623
Nitrogen, ammonia + organic, total, as N	625
Nitrogen, nitrite + nitrate, total, as N	630
Nitrogen, nitrite + nitrate, dissolved, as N	631
Phosphorus, total, as P	665
Phosphorus, dissolved, as P	666
Phosphorus, ortho, dissolved, as P	671
Carbon, total organic	680
Suspended Sediment, total	80154

Table A-2. Results of Nutrient Regressions

Value	TN	TP
R^2	0.42	0.7306142
N	114	116
a_0	0.9539	-1.972
a_1	0.0119	-0.4620
a_2	0.0101	0.0672
a_3	-0.6584	-0.0212
a_4	0.0769	0.0115
a_5	0.0745	-0.4478
a_6	0.1648	0.5365

Table A-3. Mean Flows and Median TN and TP Concentrations for Point Sources With Flows > 0.05 mgd, Monocacy River Drainage to Bridgeport, MD, WY90-95.

NPDES[1] ID	Name	Mean Flow (mgd)	Median TN (mg/L)[2]	Median TP (mg/L)
21563	Gettysburg	1.67	9.1	0.44
21229	Littlestown	0.44	17.22	2.40
24147	Cumberland Township South	0.17	16.07	0.20
24139	Cumberland Township North	0.14	18.83	0.20
28592	Bonneauville	0.15	20.50	1.82

Based on data provided by Pennsylvania Department of Environmental Protection:

[1] National Pollutant Discharge Elimination System Data

[2] TN concentration based upon estimate of organic nitrogen concentration from BOD (see text).

Table A-4. Nutrient Data Used in Regression

Date	Sample Time	Flow Inst. or Avg. (cfs)	TN Inst. or Avg. (mg/L)	TP Inst. or Avg. (mg/L)
891016	1415	11.4	0.80	0.10
891030	1100	48.0	3.10	0.10
891127	1215	85.0	2.60	0.10
891222	1045	33.0	2.90	0.04
900117	1400	158.0	3.70	0.06
900130	1508	2243.0	3.27	0.21
900222	1025	86.0	2.90	0.05
900420	1000	64.0	1.50	0.03
900508	1315	73.0	1.70	0.07
900525	1315	57.0	1.80	0.07
900530	4	3875.3	4.06	0.24
900622	935	33.0	1.70	0.07
900731	1215	15.0	1.80	0.12
900823	600	1713.3	4.05	0.36
900906	945	20.8	1.70	0.09
900927	1015	13.3	2.10	0.09
901014	1843	2966.7	2.16	0.21
901024	2148	6373.8	2.98	0.30
901101	850	100.0	3.00	0.03
901111	1923	3043.3	3.18	0.34
901127	1115	78.1	1.80	0.06
901204	1020	4022.0	2.86	0.39
901214	1045	110.0	2.80	0.03
910204	1200	110.0	2.70	0.05
910228	1030	93.0	2.10	0.04
910403	1020	150.0	1.40	0.03
910513	930	69.0	1.29	0.11
910522	945	42.0	1.22	0.09
910624	1005	9.9	1.02	0.16
910702	945	3.5	1.14	0.17
910813	1015	3.5	0.95	0.17
910829	645	7.6	1.27	0.17
910903	945	1.9	0.95	0.16
911101	1050	12.0	1.58	0.07
911107	945	11.0	1.01	0.04
911220	1130	54.0	5.20	0.06
920122	1045	44.0	3.80	0.04
920225	1115	298.0	3.60	0.05
920318	1320	137.0	3.40	0.03
920410	1050	86.0	1.50	0.04
920422	830	4609.0	2.51	0.29
920512	1045	90.0	0.96	0.04
920531	1411	1250.0	2.40	0.20

Table A-4. Nutrient Data Used in Regression (Continued)

Date	Sample Time	Flow Inst. or Avg. (cfs)	TN Inst. or Avg. (mg/L)	TP Inst. or Avg. (mg/L)
920603	1210	90.0	0.50	0.09
920623	1020	43.0	2.00	0.12
920731	1000	48.0	2.90	0.13
920824	1140	13.0	1.18	0.13
920902	1045	8.0	0.80	0.10
921010	511	1670.0	2.36	0.52
921027	1015	20.8	1.02	0.05
921103	1350	3006.3	3.06	0.50
921113	907	1310.0	2.10	0.29
921123	1505	7658.3	2.61	0.47
921203	1055	106.0	3.20	0.06
930120	1250	116.0	0.20	0.04
930204	1240	78.0	0.20	0.03
930323	1105	1340.0	1.20	0.12
930402	235	2796.5	0.98	0.21
930411	1515	2479.3	1.50	0.39
930422	205	3579.2	0.94	0.18
930426	2240	1240.0	0.50	0.08
930513	1000	196.0	0.50	0.06
930608	1015	30.1	0.40	0.06
930707	950	24.0	0.50	0.12
930809	1110	19.0	0.70	0.12
930904	800	1130.0	1.90	0.76
930908	1655	1913.3	0.81	0.14
930914	915	26.0	0.80	0.13
931004	940	65.3	0.50	0.10
931103	1130	139.0	0.60	0.14
931128	827	11610.0	1.30	0.50
931205	1047	9079.6	0.68	0.25
940112	1045	57.3	0.30	0.04
940321	1725	1226.7	0.40	0.05
940404	1200	295.0	0.20	0.03
940411	1000	360.0	0.40	0.04
940419	1030	158.0	0.30	0.04
940425	930	92.0	0.30	0.04
940502	1145	163.0	0.70	0.09
940509	1115	261.0	0.70	0.11
940516	930	86.0	0.40	0.05
940523	1030	55.0	0.40	0.05
940526	1030	1.2	1.80	0.45
940531	1015	39.2	0.60	0.10
940608	1100	31.1	0.50	0.08
940614	1045	27.4	0.60	0.08

Table A-4. Nutrient Data Used in Regression (Continued)

Date	Sample Time	Flow Inst. or Avg. (cfs)	TN Inst. or Avg. (mg/L)	TP Inst. or Avg. (mg/L)
940617	1000	160.0	1.30	0.30
940620	900	23.1	0.70	0.17
940628	1130	88.0	0.80	0.23
940705	930	17.0	0.90	0.15
940711	1030	14.0	0.90	0.18
940718	915	13.7	0.70	0.16
940722	1930	228.0	0.90	0.25
940726	1100	28.0		0.23
940802	845	16.4		0.16
940816	900	15.0	0.50	0.14
940818	1045	1290.0	1.20	0.33
940826	1115	595.0	1.70	0.71
940831	1130	30.0	0.87	0.17
940913	845	9.1	0.50	0.10
941101	1330	26.0	0.64	0.09
941116	2325	1240.0	2.20	0.31
941121	1925	3040.0	2.15	0.37
941128	1415	2380.0	2.37	0.33
941211	242	876.3	2.12	0.27
950110	1200	142.0	2.00	0.07
950116	1115	1560.0	1.90	0.19
950216	1200	75.0	2.30	0.03
950315	1200	147.0	1.60	0.04
950418	1100	60.0	0.53	0.02
950510	1115	38.0	0.53	0.06
950526	1115	407.0	2.20	0.22
950626	1622	3351.7	2.51	0.22
950701	2340	1420.0	2.30	0.13
950707	530	2809.0	3.72	0.73
950919	900	27.0	1.00	0.12

Table A-5. Full TSS Dataset

Year	Month	Day	Flow (cfs)	TSS (mg/l)
1989	10	16	11	8
1989	10	30	48	5
1989	11	27	85	2
1989	12	22	33	4
1990	1	17	158	3
1990	1	30	3950	186
1990	1	30	2340	166
1990	1	30	1520	89
1990	1	30	1160	63
1990	2	22	86	2
1990	3	28	76	3
1990	4	20	64	6
1990	5	8	73	8
1990	5	25	57	13
1990	5	29	2460	285
1990	5	29	4790	328
1990	5	29	5430	266
1990	5	29	4700	117
1990	5	29	2840	66
1990	5	29	1650	47
1990	10	13	2330	370
1990	10	13	2820	359
1990	10	13	3480	298
1990	10	13	4200	282
1990	10	14	3280	119
1990	10	14	2020	74
1990	10	14	1260	63
1990	10	19	2240	265
1990	10	23	2800	258
1990	10	23	5470	409
1990	10	23	6890	460
1990	10	23	8810	255
1990	10	23	7740	93
1990	10	24	4400	63
1990	10	24	2110	48
1990	11	1	100	5
1990	11	10	3350	438
1990	11	10	4000	238
1990	11	10	1780	74
1990	11	27	78	4
1990	12	3	3970	237
1990	12	4	4580	126
1990	12	4	5000	115
1990	12	4	5410	130

Table A-5. Full TSS Dataset (Continued)

Year	Month	Day	Flow (cfs)	TSS (mg/l)
1990	12	4	5390	129
1990	12	4	2670	88
1990	12	4	4700	105
1990	12	4	2970	79
1990	12	4	1560	51
1990	12	14	110	2
1991	2	4	110	2
1991	2	28	93	3
1991	4	3	150	18
1991	5	13	69	25
1991	5	22	42	12
1991	6	24	10	21
1991	7	2	4	20
1991	8	13	4	18
1991	9	3	2	17
1991	11	1	12	3
1991	11	7	11	3
1991	12	20	54	5
1992	1	22	44	2
1992	2	25	298	5
1992	3	18	137	4
1992	4	10	86	6
1992	4	22	6960	331
1992	4	22	5080	159
1992	4	22	5080	159
1992	4	22	3340	115
1992	4	22	1980	82
1992	5	12	90	6
1992	6	3	90	6
1992	6	23	43	19
1992	7	31	48	21
1992	8	24	13	3
1992	9	2	8	24
1992	10	27	21	2
1992	11	3	4100	179
1992	11	3	2950	89
1992	11	3	2170	75
1992	11	3	1490	62
1992	11	23	11400	608
1992	11	23	7740	301
1992	11	23	4620	232
1992	11	23	2050	149
1992	12	3	106	7
1993	1	20	116	2

Table A-5. Full TSS Dataset (Continued)

Year	Month	Day	Flow (cfs)	TSS (mg/l)
1993	2	4	78	3
1993	3	23	1340	32
1993	4	1	4500	284
1993	4	1	3430	168
1993	4	1	2680	124
1993	4	1	2020	94
1993	4	2	2620	161
1993	4	2	2160	87
1993	4	12	446	28
1993	4	22	3940	172
1993	4	22	3450	132
1993	4	22	3180	122
1993	4	22	3660	111
1993	4	23	1030	38
1993	5	13	196	16
1993	6	8	30	10
1993	7	7	24	18
1993	8	9	19	24
1993	9	14	26	16
1993	10	4	67	11
1993	11	3	139	7
1993	11	28	4280	1250
1993	11	28	6530	1130
1993	11	28	8870	891
1993	11	28	10200	799
1993	11	28	11200	799
1993	11	28	12100	734
1993	11	28	12900	637
1993	11	28	13500	599
1993	11	28	14100	568
1993	11	28	14500	561
1993	11	28	14800	505
1993	11	28	15000	446
1993	12	5	12500	1650
1993	12	5	13300	1070
1994	1	12	59	296
1994	3	22	2380	38
1994	4	4	295	7
1994	4	11	350	12
1994	4	19	158	8
1994	4	25	92	6
1994	5	2	163	23
1994	5	9	261	24
1994	5	16	86	9

Table A-5. Full TSS Dataset (Continued)

Year	Month	Day	Flow (cfs)	TSS (mg/l)
1994	5	23	55	6
1994	5	26	121	85
1994	5	31	39	26
1994	6	8	31	13
1994	6	14	27	10
1994	6	17	160	93
1994	6	20	23	336
1994	6	28	88	230
1994	7	5	17	277
1994	7	11	14	301
1994	7	22	196	73
1994	7	26	27	33
1994	8	2	16	91
1994	8	16	15	25
1994	8	18	1290	135
1994	8	26	595	365
1994	8	31	46	31
1995	4	18	60	24
1995	5	10	38	9
1995	5	26	407	252
1995	7	7	632	51

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
891016	1415			16.5	28	11.4	2.07	317	8.06	7.9	0.8		0.02		0.02		0.01	K
891030	1100			13	17	48	2.51	285	7.6		3.1		0.03		0.03		0.01	
891127	1215			3	9	85	2.76	270	7.6	7.8	2.6		0.02		0.01		0.01	K
891222	1045			0.5	-10	33	2.37	377	8.37	8	2.9		0.02		0.02		0.01	
900117	1400			1	17	158	3.1	280	8.6	7.8	3.7		0.07		0.07		0.01	K
900130	1115			4	7	3946	8.87	132	6.54	7.2	3		0.16		0.23		0.02	
900130	1315			4	8	2338	7.15	137	6.8	7.1	3.2		0.15		0.19		0.02	
900130	1600			4.5	7	1524	5.94	144	6.9	7.2	3.5		0.11		0.14		0.02	
900130	1900			4.5	2	1164	5.37	156	6.65	7.2	4		0.09		0.11		0.02	
900222	1025			3.5	10	86	2.77	245	6.74	7.5	2.9		0.01		0.02		0.01	K
900222	845			6	8	76	2.71	263	8.4		0							
900420	1000			12	14.5	64	2.63	228	8.5	8.1	1.5		0.02		0.02		0.02	
900508	1315			18	25.5	73	2.69	248	7.9	7.6	1.7		0.02		0.04		0.02	
900525	1315			18	21	57	2.58	236	7.8	8	1.8		0.03		0.02		0.01	
900529	1423			14	13	2460	7.31	198	7.6	7.3	4.1		0.14		0.2		0.02	
900529	1506					3170	8.24			7.1	5.2		0.23		0.29		0.03	
900529	1718		M	13.5	13	4790	10.1	171	7.7	7.2	3.6		0.22		0.25		0.02	
900529	1725		A	0	0	4850	10.16	0	0	7.1	4.1		0.2		0.23		0.03	
900529	1918		A	0	0	5400	10.73	0	0	7.1	4.1		0.15		0.25		0.03	
900529	1935		M	14	13	5430	10.76	154	7.6	7.2	4.1		0.21		0.24		0.02	
900529	2100					5460	10.79			7.4	4.1		0.18		0.23		0.03	
900529	2243					5190	10.52			7.2	3.9		0.16		0.21		0.03	
900530	27		M	14	12.5	4700	10	150	7.5	7.2	3.5		0.17		0.19		0.02	
900530	33		A	0	0	4870	9.97	0	0	7.2	4.3		0.14		0.18		0.03	
900530	255					3640	8.81			7.2	3.7		0.15		0.18		0.03	
900530	445			13.5	10.5	2840	7.82	162	7.5	7.3	3.7		0.17		0.19		0.03	
900530	604					2400	7.23			7.2	4.2		0.16		0.2		0.03	
900530	945			14	14	1650	6.14	178	7.6	7.4	5		0.2		0.22		0.03	
900530	1114					1480	5.87			7.5	4.5		0.19		0.22		0.04	
900622	935			23.5	25.5	33	2.37	270	7.8	7.6	1.7		0.05		0.04		0.01	
900731	1215			27	26	15	2.13	283	9.2	9.1	1.8		0.02		0.03		0.01	
900823	30					1940	6.58	225		7.4	5.1		0.11		0.22		0.02	
900823	515					1680	6.19	194		7.5	3.6		0.1		0.1		0.02	
900823	1130			19	22	1520	5.94	193	7.7	7.7	3.2		0.1		0.1		0.02	
900906	945			22.5	22.5	20.8	2.23	300	7.9	7.8	1.7		0.04		0.02		0.01	K
900927	1015			15	13	13.3	2.1	378	7.8	7.9	2.1		0.02		0.02		0.01	K
901013	1125			20	21	2330	7.14	159	7.7	7.3	2.4		0.1		0.15		0.01	
901013	1250			20	24	2820	7.8	152	7.8	7.4	2.2		0.08		0.1		0.04	
901013	1440					3270	8.37			7.4	2.2		0.04		0.08		0.02	
901013	1555			20	25	3480	8.62	126	7.5	7.2	2.2		0.05		0.08		0.03	
901013	1720					3710	8.89			7.2	2.3		0.03		0.08		0.01	
901013	1945					4180	9.43			7.2	2.1		0.03		0.08		0.01	
901013	2040			20	20	4200	9.46	112	7.8	7.3	2		0.03		0.06		0.01	
901013	2200					3850	9.06			7.2	1.99		0.02		0.08		0.01	K
901013	2250			20	19.5	3280	8.38	110	7.6	7.5	2		0.03		0.05		0.01	
901014	20			20	19.5	2020	6.7	140	7.6	7.4	2.1		0.04		0.06		0.02	
901014	150		M	20	19	1260	5.52	155	7.6	7.4	2.5		0.04		0.07		0.01	
901014	200		A			1200					2.3		0.05		0.09		0.01	
901023	305			13	12.5	4400	9.68	142	7.4		0							
901023	610			13	12	2110	6.83	164	7.5		0							
901023	1140			13	14.5	2800	7.76	208	7.7	7.3	4.3		0.08		0.09		0.01	K
901023	1224					4150	9.4			7.1	3.7		0.14		0.15		0.02	
901023	1305			13.5	16.5	5470	10.8	171	7.6	7.1	3.5		0.18		0.18		0.01	K
901023	1340			13	13	7740	12.92	118	7.5		0							
901023	1405		A			6620	11.91			7	2.8		0.14		0.15		0.01	
901023	1425		M	13	15	6890	12.16	150	7.6	7.1	3.8		0.16		0.17		0.01	
901023	1526					7530	12.73			7	3		0.14		0.14		0.01	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
901023	1635					8130					0							
901023	1637					8150	13.27			7.1	2.9		0.12		0.11		0.01	
901023	1745					8590	13.64			7	2.9		0.12		0.12		0.01	
901023	1830		M	13	14	8810	13.82	122	7.5	7.1	3		0.14		0.13		0.02	
901023	1850		A			8810	13.82			7.1	2.7		0.12		0.11		0.01	
901023	1930					8890					0							
901023	1955					8840	13.85			7	2.9		0.12		0.12		0.01	
901023	2058					8720	13.75			7	2.6		0.1		0.1		0.01	
901023	2204					8410	13.49			7.4	3.1		0.1		0.12		0.01	
901023	2314		A			7940	13.09			7.1	2.5		0.1		0.11		0.01	K
901023	2340		M	13	13	7740	12.92	118	7.5	7.1	2.2		0.1		0.1		0.01	K
901024	27					7230	12.47			7.1	2.5		0.09		0.1		0.01	K
901024	158					5690	11.02			7.1	2.8		0.3		0.29		0.01	
901024	305			13	12.5	4400	9.68	142	7.4	7.2	3.3		0.49		0.49		0.01	
901024	355					3260	8.79			7.4	3.5		0.45		0.5		0.01	
901024	610			13	12	2110	6.83	164	7.5	7.3	4.1		0.89		0.89		0.01	K
901024	755					1690	6.21			7.6	4.5		0.86		0.96		0.01	
901024	2500			13	12	2110	6.83	164	7.5		0							
901101	650			9	10.5	100	2.85	222	7.7	7.8	3		0.02		0.01		0.01	K
901110	850			9	10.5	100	2.85	222	7.7		0							
901110	1525	1650	C			3350	8.47	197		7.1	3.7		0.08		0.08		0.02	
901110	1800	1915	C			4000	9.23	172		7.2	2.7		0.06		0.08		0.01	
901111	2320	430	C			1760	6.35	183		7.2	3.3		0.11		0.13		0.01	
901127	1115			8	11	78.1	2.72	250	8	7.9	1.8		0.05		0.05		0.01	
901203	2220	45	C			3970		190			2.9		0.16		0.16		0.02	
901204	145	550	C			4580	9.88	161			2.5		0.19		0.2		0.02	
901204	650	845	C			5000	10.32	150			3		0.17		0.18		0.02	
901204	940	1120	C			5410	10.74	148			2.8		0.14		0.17		0.02	
901204	950			7.5	6	5390	10.72	140	7.5	6.9	2.8		0.15		0.15		0.02	
901204	1215	2400	C			2670	7.6	166		7	3.6		0.09		0.1		0.01	
901204	1350			8	5.5	4700	10	137	7.4	7	2.7		0.09		0.09		0.01	
901204	1710			7.5	1.5	2970	7.99	136	7.3	7	2.8		0.12		0.13		0.02	
901204	2050			7	0	1560	6	146	7.5	7.3	2.9		0.1		0.11		0.02	
901204	2220					3970	9.2	190		6.9	2.9		0.16		0.16		0.02	
901214	1045			3.5	2	110	2.9	234	7.8	7.9	2.8		0.02		0.02		0.01	K
910204	1200			5	11	110	2.81	226	7.7	7.8	2.7		0.04		0.03		0.01	
910228	1030			4	8	93	2.81	236	7.8	7.7	2.1		0.03		0.01	K	0.01	
910403	1020			8.5	8	150	3.07	205	9	8.3	1.4		0.02		0.01		0.01	
910513	930			22.5	28.5	69	2.66	220	7.5	8	1.29		0.06		0.08		0.02	
910522	945			22	23	42	2.46	253	7.5	7.6	1.22		0.08		0.08		0.04	
910624	1005			22	24	9.9	2.02	326	7.7	7.9	1.02		0.07		0.06		0.01	
910702	945			25.5	26	3.5	1.81	373	7.8	7.9	1.14		0.07		0.07		0.01	
910813	1015			25	29	3.5	1.81	583	8.1	7.9	0.95		0.01	K	0.02		0.01	K
910829	645					7.6					1.27				0.06			
910903	945			20	23	1.9	1.7	317	7.9	7.7	0.95		0.01		0.01		0.01	K
911101	1050			11.5	12	12	2.07	397	7.5	7.6	1.58		0.03		0.04		0.01	K
911107	945			4	6	11	2.04	445	7.9	7.8	1.01		0.02		0.02		0.01	K
911220	1130			-1.5	-3	54	2.55	321	7.7	7.7	5.2		0.03		0.04		0.02	
920122	1045			0.5	1.5	44	2.47	348	7.4	7.7	3.8		0.01		0.01	K	0.01	K
920225	1115			8	6	298	3.54	264	7.16	7.9	3.6		0.03		0.04		0.02	
920318	1320			5	5	137	3.02	224	7.5	8.1	3.4		0.03		0.02		0.01	
920410	1050			14	19	86	2.77	209	9.2	8.5	1.5		0.01	K	0.02		0.01	
920422	130					3910	9.13			7.3	2.3		0.18		0.18		0.02	
920422	325					5800	11.13			7.3	2.6		0.16		0.16		0.03	
920422	900		A			7020	12.28			7.3	2.1		0.22		0.22		0.03	
920422	910		M	15	18	6960	12.22	102	7	7.1	2.5		0.2		0.21		0.03	
920422	950					6790	12.07				0							

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
920422	1020					5060	11.78			7.3	3		0.19		0.16		0.02	
920422	1145		A	14.5	21	5060	10.4	110	7.1	7.2	2.4		0.17		0.16		0.03	
920422	1200		M			4680	9.98			7.4	2.4		0.16		0.18		0.02	
920422	1325			14.5	23.5	3340	8.45	122	7.2	7.2	2.5		0.17		0.19		0.03	
920422	1450					2240	7.01			7.3	3.1		0.21		0.22		0.03	
920422	1535			15	23	1980	6.64	132	7.2	7.4	2.9		0.19		0.21		0.03	
920512	1045			19	19.5	90	2.79	204	7.8	8	0.96		0.03		0.04		0.01	
920531	1215	1607	C			1250	5.51			7.4	2.4		0.11		0.11		0.02	
920603	1020					43					0							
920603	1210			18.8		90	2.8	202	7.52	7.9	2.3		0.03				0.02	
920623	1020			19	20	43	2.46	238	7.4	7.8	2		0.05		0.06		0.02	
920731	1000			25	28	48	2.51	289	7.5	7.6	2.9		0.08		0.07		0.02	
920810	1000			25.2	27.5	15	2.12	316	7.63		0							
920811	1430			26.9		15	2.12	330	8.19		0							
920813	1700			22.7		22	2.24	337	8.44		0							
920824	1140			23	24.5	13	2.07	402	7.8	8	1.18		0.07		0.07		0.01	K
920902	1045			21	21	8	1.93	24	7.4	7.7	0.797		0.08		0.08		0.01	K
921010	38	943	C			1670	6.17			7.6	2.36		0.03		0.05		0.01	
921027	1015			10.5	12	20.8	2.22	377	7.8	7.8	1.02		0.03		0.03		0.01	K
921103	850					3660	6.84	226	7.3	7.3	3.6		0.06		0.05		0.02	
921103	1112		A			4120	9.37	184	7.3	7	3.2		0.16		0.16		0.04	
921103	1125		M	11.52	18.5	4100	9.35	181	7.2	7.2	2.7		0.13		0.13		0.02	
921103	1337					3540	8.39	175	7.2	7.2	3		0.08		0.07		0.02	
921103	1455			13	22.5	2950	7.96	161	7.1	7.1	2.8		0.11		0.12		0.03	
921103	1640		M	11.5	17.5	2170	6.92	162	7	7.4	3.1		0.08		0.11		0.03	
921103	1703		A			2020	6.7	187	7.2	7.4	2.9		0.07		0.06		0.02	
921103	1855			11.5	9.5	1490	5.88	166	7.2	7.2	3.2		0.07		0.08		0.02	
921113	508	1305	C	8.5	8	1310	5.61	218	6.8	6.9	2.1		0.05		0.06		0.03	
921123	1025			0	0	11450	15.89			6.8	3.5		0.21		0.22		0.03	
921123	1050		M	15	17.5	11400	15.83	100	7	7.2	2		0.08		0.07		0.04	
921123	1114		A			11100	15.66			7	2.9		0.08		0.07		0.03	
921123	1208					10700	15.28			6.9	2.6		0.06		0.06		0.03	
921123	1303					8830	14.65			6.9	2.3		0.06		0.04		0.04	
921123	1400			0		7570	13.8				0							
921123	1403					8800	13.82			6.9	2.8		0.05		0.04		0.03	
921123	1455		M	13.5	15	7740	12.92	107	7	7	2.2		0.04		0.04		0.03	
921123	1513		A	0	0	7300	12.53			6.9	2.1		0.05		0.04		0.03	
921123	1647		A			4770	10.08			7.3	2.7		0.03		0.06		0.01	
921123	1700		M	13.5	10.2	4620	9.92	121	7.1	7	2.6		0.05		0.04		0.04	
921123	1931		A			2140	6.87			7.2	3.3		0.03		0.06		0.02	
921123	1945		M	13	10	2050	6.74	138	7.1	7.1	2.8		0.04		0.04		0.03	
921203	1055			4.5	6	106	2.88	260	7.7	6.6	3.2		0.03		0.02		0.01	K
930120	1250			1.5	5	116	2.93	227	7.2	7.8	2.4		0.03				0.01	
930204	1240			1.5	7	78	2.72	253	7.1	7.9	2.1		0.03				0.02	
930323	1105			2	4.5	1340	5.66	140	6.3	7.5	2.5		0.49				0.02	
930401	110	854	C			3020	8.65			7.2	1.92		0.08				0.01	K
930401	305					1740	6.76			7.1	2.53		0.17				0.06	
930401	615					4090	10.34		0	7.1	1.55		0.07				0.01	
930401	600					4680	11.11		6.3	7.2	1.8		0.07				0.01	
930401	830	1100	C			4640	11.05			7.4	1.63		0.09				0.01	K
930401	940					4680	11.11			7.2	1.48		0.08				0.01	K
930401	1045					4500	10.88	108	6.3	7.2	1.78		0.09				0.01	
930401	1120	1930	C			2960	8.77			7.4	1.22		0.07				0.01	
930401	1121					4340	10.67			7.4	1.3		0.04				0.01	K
930401	1315					3690	9.81			7.2	1.48		0.06				0.01	
930401	1400		M	10	16	3430	9.44	107	6.5	7.2	1.47		0.06				0.01	
930401	1420		A			3280					0							

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
930401	1540		M	10	16	2680	8.33	108	6.4	7.2	1.34		0.06				0.01	K
930401	1545		A			2680	8.33			7.2	1.63		0.06				0.01	K
930401	1750			10	13.5	2020	7.25	108	6.4	7.3	1.69		0.07				0.01	
930401	1915					1760	6.83			7.3	1.43		0.07				0.01	
930401	2100	100	C			1340					2.36		0.28				0.01	
930401	2245					2780	8.49			7.3	2.38		0.37				0.02	
930402	55					3970	10.19			7.2	2.08		0.31				0.02	
930402	130	345	C			1170	5.64			7.3	1.54		0.19				0.01	
930402	245					4390	10.74			7.2	1.53		0.18				0.01	
930402	400	1145	C			999					1.08		0.2				0.01	
930402	435					4190	10.48			7.2	1.61		0.23				0.02	
930402	650					3420	9.43			7.3	1.69		0.24				0.01	
930402	850			10	12	2620	8.25	116	7.2	7.3	1.91		0.28				0.01	
930402	928					2450	7.98			7.3	1.59		0.24				0.01	
930402	1230		M	10	13	2160	7.49	119	7.4	7.3	1.73		0.17				0.01	
930402	1245					2160					0							
930402	1255		A			2160	7.49			7.4	1.74		0.17				0.01	
930402	1635					1970	7.18			7.4	1.62		0.09				0.01	
930402	2100					1340	6			7.4	2.36		0.28				0.01	
930402	2120					1450	6.22			7.5	1.43		0.08				0.01	
930403	335					1150	5.59			7.4	2		0.31				0.01	
930403	400					999	5026			7.3	1.88		0.2				0.01	
930410	1915					3000	8.82			7.3	2.82		0.11				0.02	
930410	2137					3500	9.54			7.3	1.71		0.18				0.02	
930410	2345					3450	9.47			7.4	2.28		0.33				0.03	
930411	215					3090	8.96			7.4	2.22		0.22				0.02	
930411	630					1390	6.09			7.4	2.02		0.19				0.02	
930412	1125			11	10.5	446	3.93	165	7.5	7.6	2.3		0.06				0.02	
930421	2335					2430	7.95			7	1.58		0.12				0.01	
930421	2335	350	C			3550					1.5		0.22				0.01	
930422	205					4150	10.42			6.9	1.8		0.32				0.02	
930422	350					4900	11.38			6.9	1.69		0.26				0.02	
930422	435	605	C			5100	11.6			6.9	1.5		0.22				0.01	
930422	520					5130	11.63			6.9	1.36		0.25				0.01	
930422	650					4840	11.3			7	1.59		0.2				0.01	
930422	745	1300	C			3660	9.77			7	1.53		0.18				0.01	
930422	830					4110	10.37			7.1	1.41		0.15				0.01	
930422	900			10	4	3940	10.15	106	7.3	7	1.86		0.18				0.02	
930422	1040					3450	9.48			7.1	1.54		0.15				0.01	
930422	1210			9	7	3180	9.09	105	7.1	7.2	1.63		0.19				0.01	
930422	1300					3190	9.1			7.1	1.71		0.18				0.01	
930422	1410	1710	C			2850	10.03			7.4	1.45		0.16				0.01	
930422	1510		M	8.5	6.5	3660	9.77	103	7.2	7.1	1.55		0.15				0.01	
930422	1515		A			3680	9.8			7.2	1.49		0.14				0.01	
930422	1710					4250	10.56			7.4	1.41		0.15				0.01	
930422	1800	1945	C			4480	10.85			7.5	1.77		0.15				0.01	
930422	1855					4490	10.87			7.4	1.32		0.13				0.01	
930422	2040	1110	C			4250	10.56			7.4	1.38		0.14				0.01	
930422	2240					3430	9.44			7.4	1.42		0.22				0.01	
930422	2335					3550	9.61			6.9	1.73		0.24				0.02	
930423	140					2100	7.39			7.4	1.81		0.33				0.02	
930423	650					1180	5.67			7.4	1.99		0.51				0.02	
930423	915			8.5	12	1030	5.33	129	7.4	7.4	2.22		0.57				0.02	
930423	2040					2480	8.02			7.5	1.52		0.33				0.01	
930426	2240					1240	5.79			7.4	1.24		0.18				0.01	
930513	1000			20	15	196	3.23	205	7.5	7.4	1.01		0.07				0.02	
930608	1015			21	21	30.1	2.34	254	7.4	7.7	0.99		0.07				0.01	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
930707	950			28	31	24	2.27	284	7.2	7.8	1.6		0.04				0.02	
930707	2500										0							
930809	1110			23.5	23	19	2.21	536	8.9	8.8	1.5		0.03				0.05	
930904	800					1130	5.56			7.9	3.2		0.04				0.01	K
930908	1300					2020	7.25			7.7	2.4		0.08				0.01	
930908	1615					2400	7.9			7.4	2.9		0.12				0.03	
930908	2015					1320	5.95			7.2	2.7		0.09				0.03	
930914	915			20	25.5	28	2.32	259	7.5	7.6	2.6		0.09				0.02	
931004	940			15	15	65.3		304	7.3	7.5	2.6		0.07				0.01	
931103	1130			7	8	139		250	7.1	7.4	2.5		0.03				0.01	
931128	400					5940				7	5.6		0.1				0.02	
931128	510					7760				6.8	2.7		0.07				0.01	
931128	605					9320				6.7	2.8		0.05				0.02	
931128	700					10600				7.1	3		0.05				0.02	
931128	745					11400				6.8	2.4		0.04				0.02	
931128	830					12100				7	2.8		0.05				0.01	
931128	915					12800				6.8	2.7		0.04				0.01	
931128	955					13200				6.7	2		0.03				0.01	
931128	1045					13800				6.7	2		0.03				0.01	
931128	1125					14000				6.9	2.2		0.02				0.01	
931128	1215					14200				6.9	1.9		0.03				0.01	
931128	1255					14200				7.2	1.9		0.03				0.01	
931204	2340					1200	5.71			7.4	2.8		0.2				0.01	K
931205	310					3360	9.35			7.2	2.6		0.2				0.01	K
931205	450					5400	11.89			7.1	1.9		0.09				0.01	K
931205	605					6840	13.19			7.1	2.2		0.08				0.01	K
931205	710					8380	14.44			7	1.54		0.08				0.01	K
931205	835					10000	15.66			7	1.57		0.07				0.01	K
931205	925					10700	16.15			7	1.58		0.06				0.01	K
931205	1010					11200	16.46			7	2.31		0.05				0.01	K
931205	1045		M	8.5	7.5	11600	16.66	84	6.5	7	1.55		0.09				0.01	K
931205	1100		A			11600	16.74			6.9	1.43		0.04				0.01	K
931205	1145					11900	16.93			7	1.41		0.05				0.01	K
931205	1230					12150	17.08			6.9	1.27		0.06				0.01	K
931205	1315					12330	17.2			7	1.26		0.05				0.01	K
931205	1400					12400	17.27			7	1.25		0.04				0.01	K
931205	1445					12400	17.24			7	1.35		0.04				0.01	K
931205	1515		M	8.5	8	12300	17.2	74	6.6	6.9	1.25		0.04				0.01	K
931205	1516			8.5	8	12300	17.2	74	6.6		0							
931205	1530		A			12260	17.15			7	1.57		0.11				0.05	
931205	1615					11840	16.95			7	1.41		0.04				0.01	K
931205	1700					11500	16.66			7	1.39		0.08				0.01	K
931205	1740					11000	16.31			7	1.61		0.11				0.01	K
931205	1830					10200	15.81			7	1.44		0.06				0.01	K
931205	1925					9380	15.19			7	1.46		0.08				0.01	K
931205	2020					8390	14.45			7	1.62		0.06				0.01	K
931205	2125					7080	13.4			7.1	1.52		0.1				0.01	K
931205	2240					5270	11.77			6.8	1.8		0.06				0.01	K
931206	30					3310	9.27			7.2	1.7		0.06				0.01	K
931206	955					1060	5.41			7.1	2.4		0.06				0.01	K
940112	1045			0	0.5	57.3	2.59	452	6.4	7.5	2.7		0.06				0.01	K
940321	1600					1080	5.02				1.6		0.08				0.02	
940321	1710					1150	5.33				1.5		0.08				0.03	
940321	1800					1270	5.54				0							
940321	1850					1450	5.87				1.8		0.09				0.03	
940321	1935					1660	6.15				0							
940321	2015					1860	6.47				0							

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
940321	2050					2060	6.9				0							
940321	2120					2240	7.02				0							
940322	1230			3	13.5	2380	7.21	114	7.1	7.5	0							
940404	1200			11	15	295	3.53	155	7.5	7.7	1.4		0.01				0.03	
940411	1000			11	13	360	3.71	187	7.6	7.6	1.36		0.04				0.03	
940419	1030			15	25	158	3.11	180	8.6	8	0.91		0.01		0.02		0.01	K
940425	930			15.5	25.5	92	2.8	200	8.6	7.7	0.65		0.02				0.02	
940502	1145			17	16.5	163	3.12	201	7.2	7.2	1.54		0.08				0.04	
940509	1115			13	20	261	3.43	155	7.2	7.3	1.57		0.06				0.02	
940516	930			18.5	21	86	2.77	196	7.2	7.5	0.97		0.05				0.01	
940523	1030			19	29	55	2.56	225	7.2	7.5	0.98		0.02				0.01	
940526	1030			19.5	22	1.2	2.91	216	7	6.8	3.3		0.6				0.07	
940531	1015			20.5	25	39.2	2.43	223	7	7.4	1.29		0.05				0.02	
940608	1100			25	25.5	31.1	2.35	269	7.4	7	0.61		0.02				0.01	K
940614	1045			26	33	27.4	2.31	300	7.3	7.5	0.75		0.04				0.01	
940617	1000			25	27.5	160	3.11	242	6.9	6.8	3.6		0.51				0.07	
940620	900			26.5	24.5	23.1	2.26	307	7.01	7.4	1.66		0.1				0.05	
940628	1130			24		88	2.78	268	6.9	6.9	2.4		0.11				0.06	
940705	930			26	32.5	17	2.17	278	7.9		1.22		0.03				0.01	K
940711	1030			26	24		2.12	320	7.68		0.95		0.02				0.01	K
940718	915			25.5	29	13.74	2.11	328	7.24		0.75		0.01				0.01	K
940722	1930			26			3.24	252	7.2		1.7		0.1				0.03	
940726	1100			25	23.5		2.31	224	7.1		0							
940802	845			26	26	16.4	2.16	334	8.59		0							
940816	900			22	24	15	2.13	419	7.2	7.6	0.83		0.03				0.01	K
940818	1045			20.5	23.5	1290	5.57	185	7.2	9	2.04		0.07				0.02	
940826	1115			21	29	595	4.29	163	6.9	7	3		0.06				0.02	
940831	1130			21.5	27		2.34	271	7.2	7.4	1.74		0.01	K			0.01	K
940913	845			18	18.5	9.1	2	340	7.4	7.5	0.55		0.02				0.01	K
941101	1330			13	10	26	2.29	396	7.4		0.64	K	0.015			K	0.01	
941116	2325					1240	5.49				2.2		0.11				0.01	
941121	1655					2590	7.49				2.1	K	0.015				0.03	
941121	2000			10	13	3410	8.54	177	7.1		2.9		0.12				0.01	
941121	2130					4000	9.23				1.8	K	0.015				0.02	
941121	2355					2160	6.9				1.69	K	0.015				0.02	
941128	1045					2710	7.65				2.5		0.04				0.01	
941128	1745					2050	6.72				2.2		0.02				0.01	
941210	2235					1640	6.12				2.3		0.03			K	0.01	
941211	315					419	3.86				2.1		0.06				0.01	
941211	650					570	6.02				1.6		0.03			K	0.01	
950110	1200			0.5	-1	142	3.04	206	7.6		2		0.02				0.01	
950116	1115			10.5	8	1560	5.99	144	7		1.9		0.04				0.01	
950216	1200			1	6	75	2.7	277	7.6		2.3		0.02			K	0.01	
950315	1200			10	18	147	3.06	233	7.8		1.6	K	0.015			K	0.01	
950418	1100			11.5	16	60	2.57	247	8.6		0.53	K	0.015			K	0.01	
950510	1115			16.5	20	38	2.43	253	7.5		0.53		0.05				0.01	
950526	1115			21	33	407	3.83	236	7.3		2.2		0.19				0.07	
950625	2115					4240	9.33				2.3		0.1				0.03	
950626	30					6620	11.91				2.5		0.11				0.03	
950626	250					5110	10.39				2.2		0.11				0.03	
950627	500					1660	6.15				3.5	K	0.015				0.03	
950627	805					1450	5.82				3	K	0.015				0.03	
950627	1130					1030	5.13				2.7	K	0.015				0.02	
950701	2340					1420	5.78				2.3		0.05				0.02	
950706	2045					3320	8.43				4.9		0.48				0.04	
950706	2200					4140	9.39				3.9		0.31				0.04	
950706	2310					4340	9.62				3.3		0.3				0.03	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	End Time	Type	W temp (C) (00010)	A Temp (C) (00020)	Inst. Q (cfs) (00061)	Stage (ft) (00065)	Cond. (mmhos) (00095)	pH (F) (00400)	pH (L) (00403)	TN (mg/L) (00600)	Rem	NH3-N (d) (mg/L) (00608)	Rem	NH3-N (t) (mg/L) (00610)	Rem	NO2-N (d) (mg/L) (00613)	Rem
950707	25					3900	9.12				3.6		0.33				0.04	
950707	200					2860	7.85				3.1		0.28				0.04	
950707	400					1840	6.59				3.5		0.26				0.03	
950707	620					1340	5.66				3.7		0.47				0.04	
950707	1415			22.5	27	632	4.4	207	7.2		3.4		0.27				0.04	
950919	900			17.5		27	2.31	458	7.1		1		0.03				0.02	
950919	1000			17.5		27	2.3	459	7.4		0.92		0.03				0.01	
950919	1100			18		26	2.29	461	7.4		0.94		0.03				0.02	
950919	1200			18.5		25	2.28	463	7.5		0.96		0.04				0.02	
950919	1300			19		24	2.27	465	7.5		0.97		0.04				0.01	
950919	1400			19		23	2.26	464	7.6		0.89		0.04				0.01	
950919	1500			19.5		22	2.25	465	7.7		1		0.04				0.01	
950919	1600			19.5		22	2.24	465	7.7		0.91		0.04				0.01	
950919	1700			19.5		22	2.24	466	7.7		1.02		0.04				0.01	
950919	1800			19.5		21	2.23	469	7.7		0.94		0.05				0.02	
950919	1900			19.5		20	2.22	469	7.7		1.07		0.06				0.01	
950919	2000			19.5		20	2.22	470	7.6		0.99		0.05				0.01	
950919	2100			19.5		19	2.21	472	7.6		1.1		0.05				0.01	
950919	2200			19.5		19	2.21	474	7.6		1.13		0.04				0.01	
950919	2300			19.5		19	2.2	474	7.5		1.15		0.04				0.01	
950919	2400			19.5		19	2.2	474	7.5		1.17		0.04				0.01	
950920	100			19.5		18	2.19	474	7.5		1.21		0.05				0.02	
950920	200			19.5		18	2.18	473	7.4		1.24		0.04				0.01	
950920	300			19.5		18	2.18	475	7.4		1.28		0.06				0.01	
950920	400			19		17	2.17	476	7.4		1.62		0.06				0.02	
950920	500			19		16	2.16	477	7.4		1.34		0.06				0.01	
950920	600			19		16	2.16	477	7.3		1.37		0.05				0.01	
950920	700			19		16	2.15	478	7.3		1.41		0.1				0.02	
950920	800			19		15	2.14	479	7.3		1.45		0.06				0.02	
950920	900			19		15	2.14	479	7.4		1.5		0.06				0.02	
950920	1000			19		15	2.13	480	7.4		1.6		0.06				0.01	
950920	1100			19		15	2.13	482	7.4		1.7		0.05				0.02	
950920	1200			19		14	2.12	483	7.4		1.7		0.06				0.02	
950920	1300			19.5		14	2.12	463	7.4		1.8		0.05				0.02	
950920	1400			19.5		14	2.12	485	7.4		1.8		0.05				0.02	
950920	1401			19.5		14	2.12	485	7.4		0							
950920	1500			19.5		14	2.11	488	7.4		1.9		0.05				0.02	
950920	1600			20		14	2.11	490	7.4		1.9		0.05				0.02	
950920	1700			20		14	2.11	492	7.4		2		0.05				0.02	
950920	1800			20		13	2.1	493	7.5		2.1		0.05				0.02	
950920	1900			20		13	2.1	495	7.3		2.1		0.05				0.02	
950920	2000			20		13	2.09	498	7.4		2.1		0.05				0.03	
950920	2100			20		13	2.09	500	7.4		2.3		0.05				0.02	
950920	2200			20		13	2.09	502	7.4		2.4		0.05				0.03	
950920	2300			20		13	2.09	506	7.4		2.4		0.05				0.03	
950920	2400			20		13	2.09	509	7.4		2.5		0.05				0.03	
950921	100			19.5		13	2.09	513	7.4		2.5		0.06				0.02	
950921	200			19.5		13	2.09	517	7.3		2.6		0.05				0.03	
950921	300			19.5		13	2.09	519	7.3		2.7		0.06				0.03	
950921	400			19.5		13	2.09	525	7.3		2.9		0.05				0.04	
950921	500			19.5		12	2.08	528	7.3		2.9		0.06				0.03	
950921	600			19.5		12	2.08	530	7.3		2.9		0.06				0.03	
950921	700			19.5		12	2.07	532	7.3		2.9		0.07				0.03	
950921	800			19.5		12	2.07	533	7.3		3		0.06				0.03	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
891016	1415	0.01		0.3		0.5		0.3		0.31		0.1		0.06		0.07		6
891030	1100	0.01		0.5		0.8		2.3		2.2		0.1		0.08		0.05		4.1
891127	1215	0.01	K	0.4		0.6		2		2		0.1		0.05		0.05		3.1
891222	1045	0.01	K	0.6		0.6		2.3		2.3		0.04		0.04		0.03		3.6
900117	1400	0.01	K	0.7		0.6		3.1		3		0.06		0.04		0.04		3
900130	1115	0.06		0.8		0.9		2.1		1.9		0.23		0.16		0.16		13
900130	1315	0.06		0.6		0.9		2.3		2.1		0.22		0.15		0.15		9.6
900130	1600	0.04		0.6		0.9		2.6		2.3		0.18		0.11		0.11		8.3
900130	1900	0.03		0.4		1.1		2.9		2.6		0.16		0.09		0.09		7.6
900222	1025	0.01	K	0.3		0.5		2.4		2.2		0.05		0.01	K	0.03		2.7
900222	845																	
900420	1000	0.01		0.6		0.8		0.7		0.8		0.03		0.02		0.01	K	3.5
900508	1315	0.02		0.6		0.7		1		1		0.07		0.05		0.05		5.6
900525	1315	0.01		0.3		0.4		1.4		1.4		0.07		0.04		0.04		3.5
900529	1423	0.05		0.7		1.7		2.4		2.4		0.25		0.18		0.16		22
900529	1506	0.07		0.9		2.9		2.3		2.3		0.3		0.19		0.18		
900529	1716	0.01	K	1		2		1.6		1.6		0.23		0.16		0.16		16
900529	1725	0.06		1.2		2.4		1.7		1.8		0.26		0.17		0.15		
900529	1918	0.07		1.2		2.4		1.7		1.7		0.23		0.17		0.13		
900529	1935	0.03		0.8		2.4		1.7		1.7		0.24		0.17		0.14		20
900529	2100	0.07		1.2		2.2		1.9		1.8		0.22		0.16		0.14		
900529	2243	0.06		0.8		1.8		2.1		2		0.23		0.14		0.14		
900530	27	0.05		1.1		1.3		2.2		2.2		0.22		0.16		0.14		13
900530	33	0.06		1		2.1		2.2		2.1		0.22		0.15		0.14		
900530	255	0.05		0.7		1.3		2.4		2.4		0.22		0.16		0.15		
900530	445	0.05		1.1		1.1		2.6		2.5		0.22		0.17		0.15		11
900530	604	0.06		1.3		1.5		2.7		2.6		0.25		0.17		0.15		
900530	845	0.05		1.1		2.1		2.9		2.8		0.22		0.17		0.15		9.6
900530	1114	0.06		1.2		1.6		2.9		2.8		0.25		0.16		0.14		
900622	935	0.04		0.7		0.6		1.1		1.1		0.07		0.08		0.07		4.3
900731	1215	0.02		0.6		1.3		0.5		0.5		0.12		0.06		0.04		9.2
900823	30	0.04		1		3.6		1.5		1.6		0.44		0.19		0.17		
900823	515	0.03		1		2		1.6		1.6		0.3		0.21		0.18		
900823	1130	0.03		1		1.5		1.7		1.7		0.31		0.22		0.18		15
900906	945	0.01		0.8		0.7		1		1		0.09		0.08		0.06		5.8
900927	1015	0.01	K	0.4		0.5		1.6		1.6		0.09		0.07		0.07		4.1
901013	1125	0.05		1		1.6		0.8		0.8		0.22		0.14		0.14		27
901013	1250	0.05		1.4		1.3		0.9		0.9		0.21		0.19		0.19		22
901013	1440	0.05		0.9		1.3		0.9		0.9		0.21		0.2		0.14		
901013	1555	0.05		1		1.3		0.9		1		0.22		0.16		0.16		21
901013	1720	0.05		0.9		1.4		0.9		0.9		0.22		0.16		0.14		
901013	1845	0.05		0.9		1.2		0.9		0.9		0.24		0.12		0.12		
901013	2040	0.05		1		1.1		0.9		0.9		0.2		0.12		0.12		20
901013	2200	0.05		0.9		1.1		0.89		0.85		0.2		0.12		0.11		
901013	2250	0.04		0.9		1.1		0.9		0.9		0.17		0.14		0.13		14
901014	20	0.04		0.9		1.1		1		1		0.21		0.16		0.06		13
901014	150	0.04		1.1		1.4		1.1		1.1		0.22		0.18		0.08		15
901014	200	0.04		1.2		1.1		1.2		1.1		0.27		0.15		0.15		
901023	305																	
901023	610																	
901023	1140	0.03		0.8		2		2.3		2.3		0.34		0.19		0.19		18
901023	1224	0.04		0.8		1.8		1.9		1.9		0.23		0.21		0.2		
901023	1305	0.03		0.9		1.8		1.7		1.6		0.33		0.23		0.22		26
901023	1340																	11
901023	1405	0.03		0.7		1.2		1.4		1.4		0.33		0.22		0.2		
901023	1425	0.05		0.9		2.5		1.4		1.4		0.33		0.22		0.21		20
901023	1526	0.05		0.7		1.7		1.3		1.3		0.31		0.21		0.2		

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
901023	1635																	
901023	1637	0.03		0.7		1.7		1.2		1.2		0.32		0.21		0.19		
901023	1745	0.04		0.7		1.7		1.2		1.2		0.36		0.21		0.19		
901023	1830	0.05		0.8		1.9		1.1		1.1		0.3		0.21		0.2		14
901023	1850	0.04		0.6		1.5		1.2		1.1		0.29		0.21		0.18		
901023	1930																	
901023	1955	0.05		0.6		1.7		1.2		1.1		0.3		0.19		0.18		
901023	2056	0.04		0.6		1.4		1.2		1.1		0.29		0.21		0.17		
901023	2204	0.03		0.7		1.9		1.2		1.2		0.26		0.2		0.17		
901023	2314	0.03		0.6		1.3		1.2		1.2		0.25		0.18		0.16		
901023	2340	0.03		0.9		1		1.2		1.2		0.24		0.18		0.16		11
901024	27	0.03		0.7		1.2		1.3		1.3		0.29		0.16		0.15		
901024	158	0.04		0.8		1.4		1.4		1.4		0.28		0.19		0.18		
901024	305	0.03		1.2		1.7		1.6		1.6		0.31		0.23		0.21		13
901024	355	0.03		1.2		1.5		2		1.9		0.33		0.23		0.21		
901024	610	0.03		1.5		2.2		1.9		1.8		0.37		0.25		0.24		11
901024	755	0.03		1.5		2.1		2.4		2.3		0.37		0.28		0.25		
901024	2500																	
901101	850	0.01	K	0.7		0.6		2.4		2.4		0.03		0.02		0.02		2.9
901110	850																	2.9
901110	1525	0.04		0.7		1.8		1.9		1.7		0.37		0.23		0.2		
901110	1800	0.03		1		1.2		1.5		1.4		0.33		0.22		0.19		
901111	2320	0.03		1.1		1.3		2		2		0.32		0.23		0.2		
901127	1115	0.01		0.5		0.4		1.4		1.4		0.06		0.03		0.03		4.4
901203	2220	0.02		1		1.6		1.3		1.5		0.53		0.19		0.18		
901204	145	0.01		0.8		1.3		1.2		1.3		0.39		0.2		0.19		
901204	650	0.02		0.9	K	1.5		1.5		1.5		0.4		0.22		0.21		
901204	940	0.06		0.8		1.3		1.5		1.6		0.35		0.21		0.2		
901204	950	0.02		1		1.3		1.5		1.4		0.38		0.21		0.22		13
901204	1215	0.05		0.8		1.1		2.5		2.5		0.27		0.15		0.16		
901204	1350	0.02		1		1.3		1.4		1.4		0.34		0.18		0.19		12
901204	1710	0.06		0.9		1.2	K	1.6		1.6		0.29		0.17		0.17		12
901204	2050	0.04		0.8	K	1.1		1.8		1.8		0.25		0.15		0.16		11
901204	2220	0.02		1		1.6		1.3		1.5		0.53		0.19		0.18		
901214	1045	0.01		0.3		0.6		2.2		2.2		0.03		0.02		0.02		3.1
910204	1200	0.01		0.9		0.7		2		2		0.05		0.05		0.02		2.4
910228	1030	0.01	K	0.4		0.3		1.8		1.8		0.04		0.02		0.02		2.9
910403	1020	0.01	K	0.3		0.3		1.1		1.1		0.03		0.02		0.01		3
910513	930	0.03		0.7		0.7		0.59		0.59		0.11		0.08		0.07		4.6
910522	945	0.04		0.6		0.4		0.82		0.85		0.09		0.07		0.05		4.4
910624	1005	0.01	K	0.6		0.9		0.12		0.096		0.16		0.08		0.08		5
910702	945	0.02		0.6		1		0.14		0.15		0.17		0.1		0.1		5.9
910813	1015	0.01		0.5		0.9		0.05	K	0.05	K	0.17		0.05		0.04		8.3
910828	845	0.02				0.7		0.57				0.17						
910903	945	0.01	K	0.6		0.9		0.05	K	0.05	K	0.16		0.06		0.03		7.9
911101	1050	0.01		0.8		0.6		0.98		0.99		0.07		0.05		0.02		7
911107	945	0.01	K	0.5		0.5		0.51		0.48		0.04		0.02		0.03		6.6
911220	1130	0.02		0.5		0.4		4.8		4.8		0.06		0.05		0.05		3.3
920122	1045	0.01		0.3		0.3		3.5		3.5		0.04		0.02		0.02		3.5
920225	1115	0.02		0.6		0.5		3.1		3.1		0.05		0.05		0.03		4.8
920318	1320	0.01	K	0.2		0.2		3.2		3.1		0.03		0.02		0.03		3.1
920410	1050	2.000E-02		0.3		0.4		1.1		1		0.04		0.01		0.01		3.5
920422	130	0.03		1		1.3		1		0.98		0.23		0.09		0.06		
920422	325	0.03		1		1.6		1		1		0.27		0.1		0.08		
920422	900	0.02		1.2		1.1		1		1		0.25		0.12		0.11		
920422	910	0.03		0.9		1.5		1		1		0.39		0.13		0.11		19
920422	950																	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
920422	1020	0.03		1.1		1.9		1.1		1.1		0.34		0.14		0.11		
920422	1145	0.03		0.9		1.2		1.2		1.2		0.25		0.15		0.12		15
920422	1200	0.03		1.1		1.1		1.3		1.2		0.26		0.16		0.12		
920422	1325	0.05		1.1		1.2		1.3		1.3		0.25		0.16		0.13		14
920422	1450	0.03		1.3		1.6		1.5		1.5		0.31		0.15		0.12		
920422	1535	0.06		1		1.5		1.4		1.4		0.28		0.15		0.14		16
920512	1045	0.01		0.3		0.4		0.56		0.55		0.04		0.02		0.03		5.4
920531	1215	0.02		0.6		0.9		1.5		1.5		0.2		0.13		0.1		
920603	1020																	
920603	1210					0.5				1.8		0.09		0.07		0.06		
920623	1020	0.03		0.6		0.7		1.3		1.3		0.12		0.1		0.09		7.1
920731	1000	0.02		0.6		0.7		2.2		2.2		0.13		0.11		0.1		6.9
920810	1000																	
920811	1430																	
920813	1700																	
920824	1140	0.01	K	0.4		0.6		0.58		0.61		0.13		0.1		0.08		4.8
920902	1045	0.01	K	0.5		0.7		0.097		0.091		0.1		0.1		0.08		5
921010	38	0.02		0.5		1.4		0.96		0.98		0.52		0.16		0.16		
921027	1015	0.01	K	0.4		0.5		0.52		0.51		0.05		0.03		0.02		5.7
921103	850	0.03		0.7		2.2		1.4		1.4		0.69		0.19		0.18		
921103	1112	0.03		1.9		2		1.2		1.2		0.57		0.42		0.23		
921103	1125	0.03		0.8		1.4		1.3		1.3		0.48		0.27		0.24		17
921103	1337	0.03		0.9		1.6		1.4		1.4		0.47		0.24		0.21		
921103	1455	0.03		0.9		1.2		1.6		1.5		0.39		0.26		0.23		16
921103	1640	0.03		1.1		1.4		1.7		1.7		0.42		0.25		0.23		17
921103	1703	0.03		0.9		1.3		1.6		1.6		0.44		0.22		0.2		
921103	1855	0.03		0.9		1.4		1.8		1.8		0.4		0.24		0.22		12
921113	508	0.04		0.7		0.8		1.3		1.4		0.29		0.14		0.11		
921123	1025	0.04		0.8		2.5		1		1		0.67		0.18		0.14		
921123	1050	0.03		0.6		1		1		1		0.38		0.16		0.14		21
921123	1114	0.03		0.7		1.9		1		1		0.65		0.16		0.13		
921123	1208	0.03		0.6		1.5		1.1		1.1		0.48		0.17		0.14		
921123	1303	0.03		0.5		1.2		1.1		1.1		0.43		0.16		0.15		
921123	1400																	
921123	1403	0.04		0.6		1.7		1.1		1.1		0.57		0.16		0.14		
921123	1455	0.03		0.6		1		1.2		1.2		0.31		0.16		0.14		17
921123	1513	0.03		0.6		0.9		1.2		1.2		0.3		0.16		0.14		
921123	1647	0.03		0.6		1.2		1.5		1.5		0.43		0.16		0.13		
921123	1700	0.03		0.6		1.1		1.5		1.5		0.35		0.18		0.15		12
921123	1931	0.03		0.7		1.2		2.1		2.1		0.34		0.16		0.12		
921123	1945	0.03		0.5		1		1.8		1.8		0.33		0.15		0.13		12
921203	1055	0.02		0.4		0.4		2.8		2.6		0.06		0.03		0.03		3.5
930120	1250			0.3		0.2	K			2.2		0.04		0.02		0.02		3
930204	1240			0.3		0.2				1.9		0.03		0.03		0.02		
930323	1105			0.8		1.2				1.3		0.12		0.13		0.07		7
930401	110			0.9		1.4				0.52		0.43		0.02		0.05		
930401	305			1.8		1.6				0.93		0.37		0.32		0.21		
930401	615			0.5		0.9				0.65		0.25		0.08		0.07		
930401	800			0.5		1				0.6		0.16		0.04		0.07		
930401	830			0.9		1.1				0.53		0.24		0.04		0.05		
930401	940			0.5		0.9				0.58		0.19		0.05		0.07		
930401	1045			0.7		1.1				0.66		0.28		0.07		0.08		16
930401	1120			0.7		0.7				0.52		0.17		0.07		0.05		
930401	1121			0.3		0.9				0.4		0.21		0.04		0.05		
930401	1315			0.5		0.9				0.58		0.19		0.04		0.06		
930401	1400			0.4		0.8				0.67		0.16		0.04		0.07		12
930401	1420																	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
930401	1540			0.4		0.7				0.64		0.16		0.04		0.06		9.3
930401	1545			0.5		1				0.63		0.16		0.04		0.06		
930401	1750			0.5		0.9				0.79		0.16		0.05		0.06		9.7
930401	1915			0.6		0.8				0.83		0.12		0.07		0.06		
930401	2100			0.9		1.6				0.76		0.37		0.08		0.1		
930401	2245			0.9		1.5				0.88		0.35		0.12		0.12		
930402	55			1.2		1.2				0.88		0.21		0.1		0.11		
930402	130			0.9		0.9				0.64		0.2		0.08		0.08		
930402	245			0.8		0.9				0.63		0.17		0.07		0.07		
930402	400			0.6		0.2				0.86		0.16		0.07		0.08		
930402	435			0.9		0.9				0.71		0.16		0.08		0.08		
930402	650			1.1		1				0.69		0.18		0.07		0.08		
930402	850			0.6		1.1				0.81		0.19		0.08		0.1		10
930402	928			0.9		0.9				0.69		0.18		0.07		0.08		
930402	1230			0.6		0.9				0.63		0.19		0.07		0.08		10
930402	1245																	
930402	1255			0.8		0.9				0.84		0.17		0.07		0.08		
930402	1635			0.5		0.7				0.92		0.13		0.04		0.06		
930402	2100			0.9		1.6				0.76		0.37		0.08		0.1		
930402	2120			1.2		0.6				0.83		0.13		0.05		0.05		
930403	335			0.8		0.9				1.1		0.14		0.09		0.08		
930403	400			0.6		1				0.88		0.16		0.07		0.08		
930410	1915			0.5		1.9				0.92		0.53		0.1		0.08		
930410	2137			0.8		1				0.71		0.29		0.12		0.09		
930410	2345			1.7		1.7				0.58		0.48		0.16		0.13		
930411	215			1.1		1.6				0.62		0.37		0.13		0.1		
930411	630			0.8		1.3				0.72		0.28		0.12		0.11		
930412	1125			0.5		1.1				1.2		0.13		0.06		0.05		6.4
930421	2335			0.6		0.9				0.68		0.21		0.12		0.11		
930421	2335			0.7		1				0.5		0.17		0.08		0.1		
930422	205			1.2		1.1				0.7		0.25		0.16		0.15		
930422	350			0.8		1.1				0.59		0.2		0.15		0.12		
930422	435			0.7		1				0.5		0.17		0.08		0.1		
930422	520			0.8		0.8				0.56		0.16		0.14		0.11		
930422	650			0.7		1				0.59		0.17		0.14		0.1		
930422	745			0.7		0.9				0.63		0.15		0.14		0.09		
930422	830			0.7		0.8				0.61		0.15		0.13		0.09		
930422	900			0.8		1.2				0.66		0.16		0.1		0.1		14
930422	1040			0.7		0.9				0.64		0.17		0.12		0.09		
930422	1210			0.6		1				0.63		0.15		0.1		0.1		9.1
930422	1300			0.8		1				0.71		0.16		0.14		0.1		
930422	1410			2		0.8				0.65		0.16		0.12		0.09		
930422	1510			0.6		0.9				0.65		0.15		0.1		0.1		10
930422	1515			0.6		0.9				0.59		0.16		0.14		0.09		
930422	1710			1		0.8				0.61		0.17		0.08		0.09		
930422	1800			2		1.2				0.57		0.22		0.11		0.08		
930422	1855			1.9		0.7				0.62		0.15		0.1		0.09		
930422	2040			2		0.8				0.58		0.17		0.11		0.08		
930422	2240			1.9		0.7				0.72		0.19		0.11		0.1		
930422	2335			0.8		1.1				0.63		0.19		0.11		0.12		
930423	140			2.3		0.9				0.71		0.19		0.12		0.11		
930423	850			2.4		1.2				0.79		0.27		0.17		0.16		
930423	915			1.2		1.4				0.82		0.21		0.16		0.14		7.9
930423	2040			2.1		0.8				0.72		0.18		0.14		0.12		
930428	2240			2.1		0.5				0.74		0.08		0.04		0.02		
930513	1000			0.5		0.5				0.51		0.06		0.04		0.02		4.1
930608	1015			0.5		0.4				0.59		0.06		0.05		0.03		4.7

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
930707	950			0.4		0.5				1.1		0.12		0.06		0.08		
930707	2500																	7.9
930809	1110			0.5		0.7				0.8		0.12		0.05		0.03		9.1
930904	800			0.7		1.9				1.3		0.78		0.31		0.3		
930908	1300			0.8		0.7				1.7		0.08		0.1		0.07		
930908	1615			0.9		0.9				2		0.16		0.17		0.15		
930908	2015			0.9		0.8				1.9		0.18		0.2		0.19		
930914	915			0.9		0.8				1.8		0.13		0.15		0.12		7.7
931004	940			0.5		0.5				2.1		0.1		0.09		0.09		5.3
931103	1130			0.4		0.6				1.9		0.14		0.06		0.06		6.2
931128	400			1.2		4.2				1.4		1.7		0.11		0.12		
931128	510			1.1		1.3				1.4		0.61		0.14		0.12		
931128	605			1.1		1.5				1.3		0.76		0.14		0.13		
931128	700			0.8		1.7				1.3		0.65		0.13		0.13		
931128	745			0.6		1.1				1.3		0.38		0.14		0.14		
931128	830			0.8		1.6				1.2		0.49		0.13		0.13		
931128	915			0.6		1.5				1.2		0.52		0.13		0.13		
931128	955			0.6		0.9				1.1		0.34		0.13		0.13		
931128	1045			0.5		0.9				1.1		0.28		0.13		0.13		
931128	1125			0.5		1.1				1.1		0.47		0.12		0.12		
931128	1215			0.7		0.8				1.1		0.29		0.13		0.12		
931128	1255			0.6		0.8				1.1		0.36		0.12		0.13		
931204	2340			1.5		1.1				1.7		0.26		0.1		0.1		
931205	310			0.5		0.9				1.7		0.35		0.12		0.09		
931205	450			0.8		0.9				1		0.26		0.15		0.14		
931205	605			0.5		0.7				1.5		0.31		0.14		0.11		
931205	710			0.6		0.7				0.84		0.28		0.14		0.13		
931205	835			0.8		0.7				0.87		0.3		0.15		0.15		
931205	925			0.6		0.7				0.88		0.31		0.15		0.14		
931205	1010			1.5		1.4				0.91		0.32		0.16		0.15		
931205	1045			0.8		0.7				0.85		0.25		0.17		0.15		9.4
931205	1100			0.4		0.6				0.83		0.25		0.17		0.14		
931205	1145			0.5		0.6				0.81		0.28		0.14		0.14		
931205	1230			0.4		0.5				0.77		0.22		0.14		0.13		
931205	1315			0.5		0.5				0.76		0.22		0.13		0.13		
931205	1400			0.5		0.5				0.75		0.27		0.13		0.13		
931205	1445			0.4		0.6				0.75		0.24		0.13		0.12		
931205	1515			0.5		0.5				0.75		0.22		0.13		0.13		13
931205	1516																	
931205	1530			1.1		0.8				0.77		0.24		0.17		0.12		
931205	1615			0.5		0.6				0.81		0.26		0.13		0.13		
931205	1700			0.6		0.6				0.79		0.24		0.13		0.13		
931205	1740			1		0.8				0.81		0.28		0.13		0.11		
931205	1830			0.5		0.6				0.84		0.25		0.11		0.11		
931205	1925			1.1		0.6				0.86		0.21		0.12		0.11		
931205	2020			0.5		0.7				0.92		0.22		0.1		0.11		
931205	2125			1.4		0.6				0.92		0.19		0.1		0.1		
931205	2240			0.9		0.8				1		0.2		0.1		0.11		
931206	30			0.9		0.8				1.1		0.19		0.09		0.09		
931206	955			0.6		0.8				1.6		0.19		0.08		0.09		
940112	1045			0.3		0.3				2.4		0.04		0.05		0.03		2.8
940321	1600			1.1		0.4				1.2		0.06		0.06		0.05		
940321	1710			0.8		0.4				1.1		0.05		0.04		0.05		
940321	1800																	
940321	1850			0.8		0.4				1.2		0.05		0.04		0.04		
940321	1935																	
940321	2015																	

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
940321	2050																	
940321	2120																	
940322	1230																	
940404	1200			0.2	K	0.2	K			1.2		0.03		0.03		0.03		
940411	1000			0.2		0.4				0.96		0.04		0.03		0.03		
940419	1030			0.2		0.3				0.61		0.04		0.02		0.02		
940425	930			0.2		0.3				0.35		0.04		0.02		0.02		
940502	1145			0.6		0.7				0.84		0.09		0.05		0.04		
940509	1115			0.6		0.7				0.67		0.11		0.07		0.06		
940516	930			0.2		0.4				0.57		0.05		0.03		0.03		
940523	1030			0.2		0.4				0.58		0.05		0.03		0.03		
940526	1030			1.4		1.8				1.5		0.45		0.29		0.3		
940531	1015			0.3		0.8				0.69		0.1		0.07		0.07		
940608	1100			0.4		0.5				0.11		0.08		0.04		0.04		
940614	1045			0.3		0.6				0.15		0.08		0.05		0.05		
940617	1000			1.1		1.3				2.3		0.3		0.24		0.22		
940620	900			0.7		0.7				0.98		0.17		0.12		0.12		
940628	1130			0.5		0.8				1.6		0.23		0.18		0.15		
940705	930			0.4		0.9				0.32		0.15		0.05		0.05		
940711	1030			0.5		0.9				0.05	K	0.18		0.09		0.07		
940718	915			0.4		0.7				0.05	K	0.16		0.1		0.08		
940722	1930			0.5		0.9				0.8		0.25		0.17		0.15		
940726	1100											0.23						
940802	845											0.16						
940816	900			0.3		0.5				0.33		0.14		0.8		0.07		
940818	1045			0.05		1.2				0.84		0.33		0.11		0.12		
940826	1115			0.5		1.7				1.3		0.71		0.24		0.21		
940831	1130			0.3		0.87				0.67		0.17		0.12		0.09		
940913	845			0.4		0.5				0.05	K	0.1		0.07		0.02		
941101	1330			0.3		0.5				0.14		0.09		0.02		0.02		
941116	2325			0.8		1				1.2		0.31		0.18		0.16		
941121	1655			1.1		1				1.1		0.23		0.14		0.06		
941121	2000			0.7		1.7				1.2		0.76		0.23		0.2		
941121	2130			0.6		0.7				1.1		0.19		0.13		0.11		
941121	2355			0.7		0.7				0.99		0.24		0.14		0.09		
941128	1045			0.6		1.1				1.4		0.37		0.16		0.16		
941128	1745			0.5		0.8				1.4		0.27		0.19		0.16		
941210	2235			0.5		1.1				1.2		0.31		0.1		0.09		
941211	315			0.6		1				1.1		0.26		0.1		0.1		
941211	650			0.6		0.6				1		0.17		0.12		0.11		
950110	1200			0.3		0.3				1.7		0.07		0.05		0.05		
950116	1115			0.7		0.8				1.1		0.19		0.13		0.1		
950216	1200			0.2		0.2				2.1		0.03	K	0.01		0.03		
950315	1200			0.3		0.4				1.2		0.04		0.02		0.02		
950418	1100			0.4		0.4				0.13		0.02		0.03		0.01		
950510	1115			0.3		0.4				0.13		0.06		0.04		0.04		
950526	1115			0.7		0.8				1.4		0.22		0.15		0.14		
950625	2115			0.7		1.1				1.2		0.22		0.11		0.08		
950626	30			0.8		1				1.5		0.19		0.12		0.09		
950626	250			0.6		1.1				1.1		0.24		0.09		0.06		
950627	500			0.9		1.4				2.1		0.3		0.14		0.08		
950627	805			0.8		1.2				1.8		0.23		0.12		0.08		
950627	1130			0.8		0.9				1.9		0.17		0.11		0.07		
950701	2340			0.6		0.7				1.6		0.13		0.1		0.1		
950706	2045			1.4		2.8				2.1		1.2		0.61		0.64		
950708	2200			0.2		1.7				2.2		0.82		0.67		0.63		
950706	2310			0.2		1.5				1.8		0.74		0.38		0.32		

Table A-6. Complete Dataset for Nutrients and Ancillary Parameters (Continued)

Date	Time	NO2-N (t) (mg/L) (00615)	Rem	TKN (d) (mg/L) (00623)	Rem	TKN (t) (mg/L) (00625)	Rem	NO2+NO3-N (t) (mg/L) (00630)	Rem	NO2+NO3-N (d) (mg/L) (00631)	Rem	TP (mg/L) (00665)	Rem	Diss P (mg/L) (00666)	Rem	Ortho PO4 (d) (mg/L) (00671)	Rem	TOC (mg/L) (00680)
950707	25			1.2		1.6				2		0.57		0.4		0.39		
950707	200			0.2		1.3				1.8		0.57		0.37		0.38		
950707	400			1.3		1.7				1.8		0.6		0.37		0.38		
950707	620			1.6		1.8				1.9		0.49		0.33		0.33		
950707	1415			0.5		1.2				2.2		0.32		0.28		0.28		
950919	900			0.4		0.6				0.4		0.12		0.09		0.09		
950919	1000			0.4		0.5				0.42		0.1		0.1		0.09		
950919	1100			0.4		0.5				0.44		0.1		0.1		0.09		
950919	1200			0.5		0.5				0.46		0.1		0.09		0.09		
950919	1300			0.5		0.5				0.47		0.1		0.09		0.09		
950919	1400			0.6		0.4				0.49		0.1		0.09		0.09		
950919	1500			0.4		0.5				0.5		0.1		0.09		0.08		
950919	1600			0.6		0.4				0.51		0.13		0.11		0.09		
950919	1700			0.6		0.5				0.52		0.12		0.11		0.09		
950919	1800			0.6		0.4				0.54		0.11		0.1		0.1		
950919	1900			0.7		0.5				0.57		0.11		0.1		0.09		
950919	2000			0.6		0.4				0.59		0.11		0.11		0.1		
950919	2100			0.6		0.5				0.6		0.1		0.1		0.1		
950919	2200			0.4		0.5				0.63		0.11		0.09		0.1		
950919	2300			0.4		0.5				0.65		0.12		0.09		0.1		
950919	2400			0.4		0.5				0.67		0.12		0.1		0.1		
950920	100			0.6		0.5				0.71		0.11		0.1		0.1		
950920	200			0.4		0.5				0.74		0.13		0.1		0.1		
950920	300			0.6		0.5				0.78		0.1		0.1		0.1		
950920	400			0.5		0.8				0.82		0.11		0.11		0.1		
950920	500			0.6		0.5				0.84		0.11		0.1		0.11		
950920	600			0.4		0.5				0.87		0.14		0.11		0.11		
950920	700			0.5		0.5				0.91		0.12		0.1		0.11		
950920	800			0.5		0.5				0.95		0.12		0.12		0.11		
950920	900			0.5		0.5				1		0.13		0.1		0.06		
950920	1000			0.5		0.6				1		0.13		0.11		0.08		
950920	1100			0.4		0.6				1.1		0.13		0.12		0.08		
950920	1200			0.5		0.6				1.1		0.13		0.12		0.09		
950920	1300			0.5		0.6				1.2		0.14		0.11		0.12		
950920	1400			0.5		0.6				1.2		0.13		0.12		0.08		
950920	1401																	
950920	1500			0.5		0.6				1.3		0.14		0.14		0.12		
950920	1600			0.4		0.6				1.3		0.14		0.12		0.12		
950920	1700			0.5		0.6				1.4		0.15		0.13		0.13		
950920	1800			0.5		0.6				1.5		0.16		0.13		0.13		
950920	1900			0.5		0.6				1.5		0.14		0.13		0.13		
950920	2000			0.5		0.6				1.5		0.16		0.13		0.13		
950920	2100			0.5		0.7				1.6		0.15		0.13		0.13		
950920	2200			0.5		0.7				1.7		0.15		0.14		0.14		
950920	2300			0.6		0.6				1.8		0.15		0.15		0.14		
950920	2400			0.5		0.6				1.9		0.16		0.15		0.14		
950921	100			0.7		0.6				1.9		0.17		0.15		0.13		
950921	200			0.6		0.6				2		0.17		0.15		0.15		
950921	300			0.6		0.6				2.1		0.17		0.14		0.15		
950921	400			0.5		0.6				2.3		0.17		0.15		0.15		
950921	500			0.5		0.6				2.3		0.18		0.16		0.15		
950921	600			0.5		0.6				2.3		0.18		0.15		0.15		
950921	700			0.7		0.6				2.3		0.17		0.14		0.15		
950921	800			0.6		0.6				2.4		0.17		0.16		0.15		