

Table 35. Trend Statistics for the Conestoga River at Conestoga, Pa., January 1985 Through December 2004

Parameter	STORET Code	Time Series	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	FLOW	3.571	0.6145	-	-	-	NS
TN	600	FAC	-0.0089	0.0000	-20	-16	-13	IMPROVING
DN	602	FAC	0.0000	0.9722	-5	0	5	NS
TON	605	FAC	-0.0267	0.0000	-48	-41	-33	IMPROVING
DON	607	FAC	0.0007	0.8278	-11	1	15	NS
DNH ₃	608	FAC	-0.0645	0.0000	-76	-72	-68	IMPROVING
TNH ₃	610	FAC	-0.0700	0.0000	-79	-75	-71	IMPROVING
DKN	623	FAC	-0.0171	0.0000	-37	-29	-20	IMPROVING
TKN	625	FAC	-0.0333	0.0000	-54	-49	-42	IMPROVING
TNO _x	630	FAC	0.0020	0.1808	-2	4	10	NS
DNO _x	631	FAC	0.0029	0.0543	0	6	12	NS
TP	665	FAC	-0.0219	0.0000	-43	-35	-27	IMPROVING
DP	666	FAC	-0.0215	0.0000	-40	-35	-29	IMPROVING
DOP	671	FAC	-0.0072	0.0173	-23	-13	-3	IMPROVING
TOC	680	FAC	-0.0300	0.0000	-49	-45	-40	IMPROVING
SS	80154	FAC	-0.0423	0.0000	-65	-57	-48	IMPROVING

DISCUSSION

2004 was a significant year for loads in the Susquehanna River Basin. Unusually high flows during the summer months, specifically from Tropical Storm Ivan, led to high TP and SS values for the season. September flows ranged from 247 percent of the LTM at Conestoga to 608 percent of the LTM at Towanda. Annual flows ranged from 127.7 percent of the LTM at Danville to 157.9 percent of the LTM at Conestoga due to above average rainfall throughout the basin.

The average daily high flow for September 2004 was 497,000 cubic feet per second (cfs) at Marietta on September 20, 2004. Flows that are greater than 400,000 cfs constitute a scour event, which means that sediment that is currently deposited in the river is reintroduced into the water column due to the high flow and turbulence (Langland, 2000). Prior to 2004, the last scour event occurred on January 21, 1996, and had an average daily high of 556,000 cfs. One comparison worth noting is that prior to 1996, the previous scour event took place only three years earlier on April 3, 1993, with an average daily flow of 431,000 cfs. This means that there were three years for nutrients and sediment to accumulate in the streams and rivers before being scoured again in 1996. After 1996, there were

eight years until the next scour event in 2004, increasing the length of time for nutrients and sediment to accumulate. The difference between these three dates can be seen in Table 36. In comparison, the TN values are significantly lower for September 2004, even though it had the second highest average daily flow. Part of this is due to the lower average monthly flow as compared to 1996 and 1993.

When looking at TP and SS, higher than expected values are found as compared to 1996. This may be due to the time difference between scour events. Had the 1993 scour event not happened, the TP and SS values for 1996 might be higher than the 2004 scour event. The differences between 2004 and 1993 also are worth noting. The scouring event prior to 1993 was in 1983, (10 years prior) creating a good comparison to 2004. Table 37 shows a more in-depth analysis of 2004 versus 1993. Since flow directly influences the levels of nutrients and SS, it is not only necessary to look at the annual flow but also to look at the mean daily high flow for the year. When comparing the annual flows from two years, as a percentage, to the percentages of nutrients and SS for those years, improvements that might have occurred can be investigated. For example, at Marietta, the 2004 annual flow and daily mean high are approximately 114.5 percent

of those for 1993. Therefore, the percentages for TN, TP, and SS for these years should be roughly the same if water quality has neither improved nor degraded. However, TN in 2004 was only 95 percent of the TN in 1993 even though the flow in 2004 was greater. TP and SS both increased above the 114.5 percent flow values.

Table 38 lists the data analyses that were completed at the six Group A sites in the Susquehanna River Basin. 2004 loads for TN, TNH3, DNH3, DN, and DNO23 were all lower than the LTMs at Towanda, Danville, Lewisburg, and Conestoga. Values for 2004 were lower than the LTM at all sites for TON and DON (except for DON at Conestoga). Newport and Marietta showed increases in 2004 as compared to the LTMs for all parameters except TON and DON. 2004 values of TOC were lower than the LTM at Newport and Conestoga. SS for 2004 increased over the LTMs at all sites except Lewisburg, which is a heavily forested watershed. Additionally, there were increases at all six sites in TP and DOP as compared to the LTM.

The highest flow season was summer for all sites due, to Tropical Storm Ivan. This caused all parameters to be highest during the summer months at Conestoga. This was the only site where TN was highest during the high flow season. For Towanda, Danville, and Lewisburg, the high TN season was winter, which was the second highest flow season for these sites. DN also was highest during winter at these sites, as well as at Newport. DNO23 followed this same trend. Another interesting point is that at Marietta the highest season for TN, DN, TNH3, DNH3, TNO23, and DNO23 was fall, which was the lowest flow season. TOC, TP, and SS were all highest during the highest flow months.

Comparison with the initial 5-year baselines showed improvements in TN at Towanda,

Danville, Lewisburg, and Conestoga. Towanda and Danville also showed improvements in TN, when compared to the full program baselines. Lewisburg showed improvements in SS yields for both comparisons. Newport showed slight increases in TN and TP for both comparisons, while showing no change in SS yields. Marietta showed increases in TP and SS when compared to the initial 5-year baseline but showed no significant deviations from the predicted values for the full program baseline.

2004 showed no trend in flow at any of the six long-term sites. TN, TP, and SS showed decreasing trends at all sites except Marietta, which had no significant trends for TP. Towanda and Danville had decreasing trends for all parameters except DOP, which showed increasing trends at Towanda, Danville, Newport, and Marietta.

The places where improvements or degradations are likely occurring are where most of these analyses agree, shown in Table 38. TN showed improvements for all analyses at Towanda, Danville, Lewisburg, and Conestoga, which has a high concentration of urban and agricultural land uses. Marietta and Danville showed TP degradation for several of the analyses with the exception of trends. Danville trends showed TP to be decreasing while Marietta showed no trends for TP. SS analyses showed potential degradations for all comparisons except the trends in FACs at Towanda, Danville, Newport, and Marietta. Since most of the results were a direct result of Tropical Storm Ivan, the best analysis was likely the trends analysis as it removed the effects of flow. Trends for all parameters, shown in Table 39, were improving except for TP at Marietta. The only exceptions to this were the DOP trends for Towanda, Danville, Newport, and Marietta, which were all degrading.

Table 36. Storm Events at Marietta with High Average Daily Flows Greater Than 400,000 cfs

Month of Storm Event	Average Monthly Flow	High Daily Average Flow	Monthly TN	Monthly TP	Monthly SS
February-84	109,341	446,000	-	-	-
April-93	235,133	431,000	68,743,015	7,259,275	12,371,847,860
January-96	116,852	556,000	40,092,507	4,162,444	6,333,728,265
September-04	110,893	497,000	32,748,690	6,257,286	9,908,945,265

Table 37. Comparison of 2004 and 1993 Flows and Loads of TN, TP, and SS

Site	Parameter	2004	1993	% Difference **
Towanda	Annual Q (cfs)	15,337	13,555	113
	Avg. High Q (cfs) *	127,000	149,000	85
	TN (1000's Lbs)	31,219	35,926	87
	TP (1000's Lbs)	3,233	3,232	100
	SS (1000's Lbs)	5,409,886	4,567,110	118
Danville	Annual Q (cfs)	21,823	19,823	110
	Avg. High Q (cfs) *	205,000	186,000	110
	TN (1000's Lbs)	45,613	60,290	76
	TP (1000's Lbs)	5,622	4,932	114
	SS (1000's Lbs)	6,004,330	6,903,900	87
Lewisburg	Annual Q (cfs)	16,530	14,410	115
	Avg. High Q (cfs) *	190,000	143,000	133
	TN (1000's Lbs)	33,427	32,650	102
	TP (1000's Lbs)	2,164	1,800	120
	SS (1000's Lbs)	831,642	2,013,460	41
Newport	Annual Q (cfs)	6,862	5,952	115
	Avg. High Q (cfs) *	85,100	48,500	175
	TN (1000's Lbs)	26,608	22,312	119
	TP (1000's Lbs)	1,574	1,099	143
	SS (1000's Lbs)	1,182,830	653,740	181
Marietta	Annual Q (cfs)	56,169	49,393	114
	Avg. High Q (cfs) *	497,000	431,000	115
	TN (1000's Lbs)	179,471	188,700	95
	TP (1000's Lbs)	15,804	12,500	126
	SS (1000's Lbs)	15,887,153	10,410,900	153
Conestoga	Annual Q (cfs)	1,052	885	119
	Avg. High Q (cfs) *	10,400	9,480	110
	TN (1000's Lbs)	15,115	14,210	106
	TP (1000's Lbs)	1,124	970	116
	SS (1000's Lbs)	537,074	419,230	128

* Avg. High Q equals the average daily value that was highest for the year

** % Difference equals 2004 value divided by 1993 value

Table 38. Summary of 2004 Data Comparison to Percentage of LTM, Initial 5-Year Baseline, and Full Program Baseline, and Trends in Flow-Adjusted Concentration for TN, TP, and SS

Parameter	Site	LTM %	Baseline 89	Baseline 04	Trend
FLOW	Towanda	INC	N/A	N/A	None
	Danville	INC	N/A	N/A	None
	Lewisburg	INC	N/A	N/A	None
	Newport	INC	N/A	N/A	None
	Marietta	INC	N/A	N/A	None
	Conestoga	INC	N/A	N/A	None
TN	Towanda	DEC	DEC	DEC	DEC
	Danville	DEC	DEC	DEC	DEC
	Lewisburg	DEC	DEC	DEC	DEC
	Newport	INC	INC	INC	DEC
	Marietta	INC	DEC	DEC	DEC
	Conestoga	DEC	DEC	DEC	DEC
TP	Towanda	INC	INC	DEC	DEC
	Danville	INC	INC	INC	DEC
	Lewisburg	INC	DEC	DEC	DEC
	Newport	INC	INC	INC	DEC
	Marietta	INC	INC	INC	NS
	Conestoga	INC	DEC	DEC	DEC
SS	Towanda	INC	INC	INC	DEC
	Danville	INC	INC	INC	DEC
	Lewisburg	DEC	DEC	DEC	DEC
	Newport	INC	INC	INC	DEC
	Marietta	INC	INC	INC	DEC
	Conestoga	INC	DEC	DEC	DEC

INC = Increasing Trends DEC = Decreasing Trends N/A = Not Applicable NS = Not Significant

Table 39. Summary of 2004 Flow-Adjusted Concentration Trends at all Sites

Parameter	Towanda	Danville	Lewisburg	Newport	Marietta	Conestoga
TN	DEC	DEC	DEC	DEC	DEC	DEC
DN	DEC	DEC	DEC	DEC	DEC	NS
TON	DEC	DEC	DEC	DEC	DEC	DEC
DON	DEC	DEC	DEC	DEC	NS	NS
DNH	DEC	DEC	NS	DEC	DEC	DEC
TNH	DEC	DEC	BMDL	BMDL	DEC	DEC
DKN	DEC	DEC	BMDL	BMDL	DEC	DEC
TKN	DEC	DEC	DEC	DEC	DEC	DEC
TNOX	DEC	DEC	DEC	NS	DEC	NS
DNOX	DEC	DEC	DEC	NS	DEC	NS
TP	DEC	DEC	DEC	DEC	NS	DEC
DP	DEC	DEC	DEC	DEC	NS	DEC
DOP	INC	INC	BMDL	INC	INC	DEC
TOC	DEC	DEC	NS	DEC	DEC	DEC
SS	DEC	DEC	DEC	DEC	DEC	DEC

