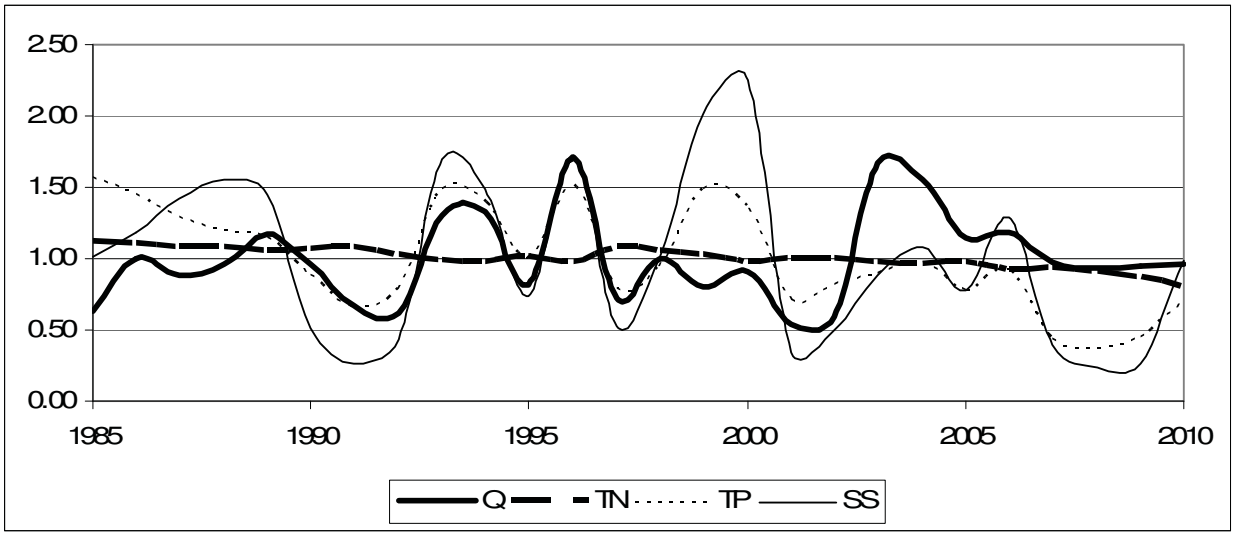

Figure 14. Annual Discharge and Calculated Annual TN, TP, and SS Concentrations Expressed as LTM Ratio

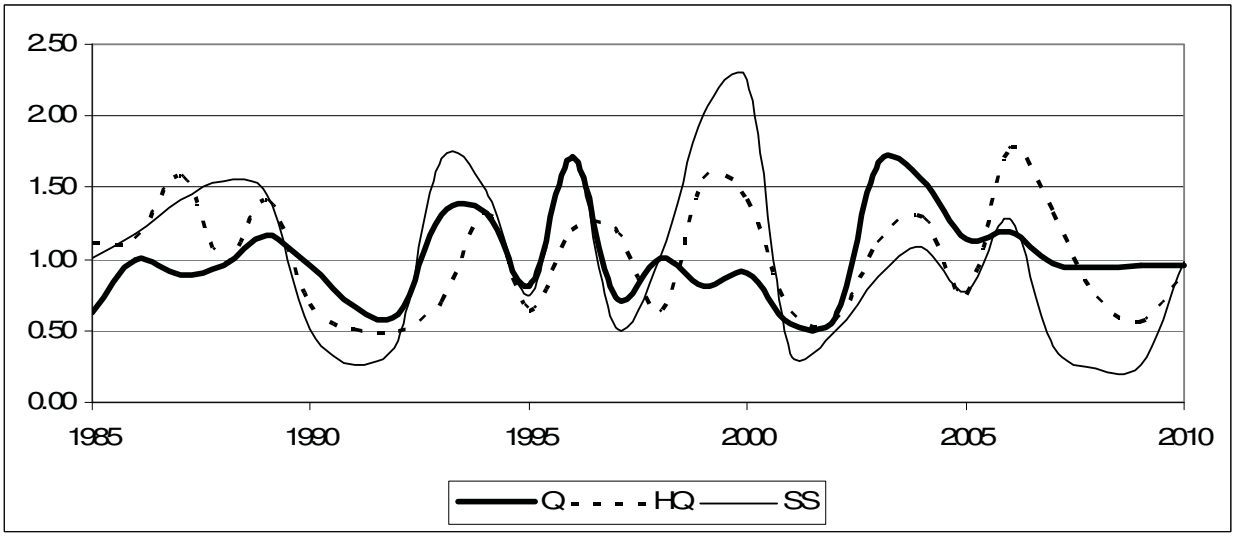

Figure 15. Annual Discharge and Annual Daily Mean High Discharge and Calculated Annual SS Concentration Expressed as LTM Ratio

2010 KEY FINDINGS

2010 precipitation was dominated by four major rainfall events during the winter months of January and March and the fall months of October and December. The March event was a nor'easter and the other three were Maddox Synoptic type events (Maddox et al., 1979). Synoptic type events are most common during the spring and early summer and again in fall and early winter. These events involve unique interactions resulting in fronts that are usually oriented southwest to northeast and involve extreme amounts of precipitation. A more specific description of the events is given in Maddox et al. (1979).

All four events resulted in substantial rainfall and subsequent rises in stream discharge at all mainstem Susquehanna sites. The fall

storms had more isolated effects on the three tributary sites where the October event resulted in comparatively small rises in flow at Newport and Lewisburg while it resulted in very high rises at the Conestoga site. The other three major events had minimal impact at Conestoga. Table 3 shows flow and nutrient amounts for the four high flow months including percentage of the annual flow and precipitation, the percent of LTM for flow, and the TN, TP, and SS percent of annual loads. For example, total precipitation for January, March, October, and December was 39 percent of the total annual precipitation. Total discharge for the same months was 61 percent of the total annual flow and 136 percent of the LTM for the same months during previous years. Regarding nutrients, these months accounted for 62-64 percent of the annual TN load, 69-77 percent of the annual TP load, and 83-91 percent of the annual SS loads.

Table 3. January, March, October, and December Total Precipitation, Flow, and Nutrient Loads as Percentage of Annual Totals and the Percent of LTM for Flow

Site	Precip	Flow	Flow LTM	TN	TP	SS
Towanda	39	61	136	63	71	88
Danville	40	59	133	62	69	83
Lewisburg	39	62	135	64	77	88
Marietta	40	60	138	63	73	91
Newport	38	60	146	64	74	88
Conestoga	38	49	118	50	60	75

Baseline comparisons have shown several changes in water quality through the data period at each site. All comparisons of 2010 yields to the initial baseline have shown dramatic improvements. Additionally, comparisons of first and second half baselines have consistently shown that water quality has improved between these two periods. Comparing both periods to the initial five-year dataset at each site shows that there were larger improvements early on in the data period and that the rate of improvements seems to have reduced somewhere in the middle of the period.

TN load ratios were consistently lower than the corresponding discharge ratios at all sites while TP and SS load ratios varied depending on whether the discharge ratio was above or below the LTM. Typically, for discharge ratios above the LTM, TP and SS load ratios were above the actual discharge ratio, whereas the load ratios tended to be below the discharge ratio when the discharge ratio was below the LTM. Thus, below LTM flow periods tend to show greatest reductions as compared to flow above the LTM. The driving factor behind this observation seemed to be the presence or absence of individual peak flow events. Implications could be that there was more bank/streambed scour or that there was more erosion from increased overland flow and less infiltration. High levels of impervious surfaces as well as subsurface drainage on farm lands potentially lead to quicker and higher hydrograph rises resulting in higher energy for streambank erosion and streambed scour. It may be that the effects of management actions are apparent during time periods where individual high flow events are absent but that they are being erased when they are present. The major implication being that management of nutrient and sediment loads is directly related to our ability to manage the impact of high flow events. With the addition of impervious surfaces and storm runoff controls that funnel water quickly into the streams and rivers, it may be that the characteristics of the hydrograph have been altered resulting in quicker, higher peaks that have higher energy and ability to scour streambanks and beds.

Flow-adjusted trends were meant to remove the effects of flow on concentrations leading to a

trend that is directly related to management action as opposed to variations in flow such as the four peak events that occurred in 2010. Consistent, basinwide trend results at all sites included downward trends for TN, DN, TON, DON, and SS. Other common trends were TP being downward at all sites except Towanda, and TOC being downward at all sites except Lewisburg. Unique findings included DP having no trend at both Towanda and Danville while DOP had upward trends at Towanda and Newport. The two sites with the most downward trends were Marietta with all downward except DNH_3 and DOP, which had no trends, and Conestoga, which had downward trends for all except TNOx and DNOx. Conestoga also was the only site to have downward trends for all phosphorus species.

2010 presented a year with significant rainfall events that were isolated to the winter and fall months and with offsetting lower flow seasons in the spring and summer. This led to the majority of loads being transported during these high flow seasons that contained the high flow storms. 2011 has presented a different flow year to date including multiple extreme events that occurred during the entire calendar year. This included a very wet winter and spring followed by sustained flow levels above the historic median values at Marietta for August through November, and drastic flooding due to Hurricane Irene and Tropical Storm Lee. Extensive monitoring was conducted during both events to capture the amounts of nutrients and SS transported through these historical events. Analysis of the peak event data will provide a unique glimpse into water quality at these long-term sites and the effects of extreme events that seem to be the major player in nutrient and SS transport.

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