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Susquehanna River Basin Commission

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Sediment and Nutrients Assessment Program

2012 Summary Report

www.srbc.net/programs/CBP/nutrientprogram.htm Publication No. 291A

About the Program

From 1984 to 1989, SRBC conducted an initial 5-year nutrient monitoring program involving 14 sampling sites to establish a database for estimating nutrient (nitrogen and phosphorus) and suspended sediment loads in the Susquehanna basin. This initial effort, funded by the Pennsylvania Department of Environmental Protection and conducted as part of the Chesapeake Bay Restoration Program, consisted of monthly base flow sampling and periodic sampling during high flows.

The sampling network — consisting of sites on the mainstem Susquehanna, major tributaries and smaller watersheds to represent different land uses — was established to: collect the data needed to enable accurate allocation of nutrient and suspended sediment loads to the mainstem Susquehanna River reaches and to the major subbasins; and to provide a long-term nutrient and suspended-sediment database and loading data in sufficient detail to track and better define nutrient loading dynamics.

After the initial effort, the monitoring sites were reduced to the following six sites to continue evaluating trends from the major subbasins: Susquehanna River at Towanda, Pa. (to estimate loads from New York State); Susquehanna River at Danville, Pa.; Susquehanna River at Marietta, Pa.; West Branch Susquehanna River at Lewisburg, Pa.; Juniata River at Newport, Pa.; and Conestoga River at Conestoga, Pa. (to provide data from a major tributary watershed with intensive agricultural activity and increasing development).

The long-term monitoring at these six sites has allowed SRBC to determine whether conditions were improving (decreasing trends), staying the same, or becoming worse (increasing trends) over the years for nitrogen, phosphorus and suspended sediment loads. SRBC releases its findings annually.

Between 2004, 2005, and 2012, the U.S. Environmental Protection Agency provided funding to significantly expand SRBC's overall monitoring network to 27 sites in the basin (Figure 1). These additional sites were added as part of the Chesapeake Bay Program's Non-tidal Monitoring Network.

Susquehanna River Basin Commission
4423 North Front St.
Harrisburg, PA 17110

This report summarizes the findings of the technical report *2012 Nutrients and Suspended Sediment in the Susquehanna River Basin*. Detailed information on monitoring sites, data collection, and data analysis can be found in the full report and on the SRBC web site at *www.srbc.net/programs/CBP/nutrientprogram.htm*.

This summary report provides an overview of the following report findings:

Nutrient and Suspended Sediment Loads and Yields

— basic information on annual and seasonal loads and yields of nutrients and suspended sediment (SS) measured during calendar year 2012 at SRBC's six long-term monitoring sites;

Data Comparisons

— data comparisons with Long-Term Means (averages) and historical baseline datasets. Significant deviations from baselines indicate a change in annual yields that warrant further evaluation; and

Nutrient and Suspended Sediment Trends

— changes over time in the concentrations of nutrients and sediment found in waterways, taking into account the effects of flow.

> "...we find better water quality conditions under relatively normal water years as opposed to those years containing even one significant storm event."
>
> *SRBC Environmental Scientist Kevin McGonigal*

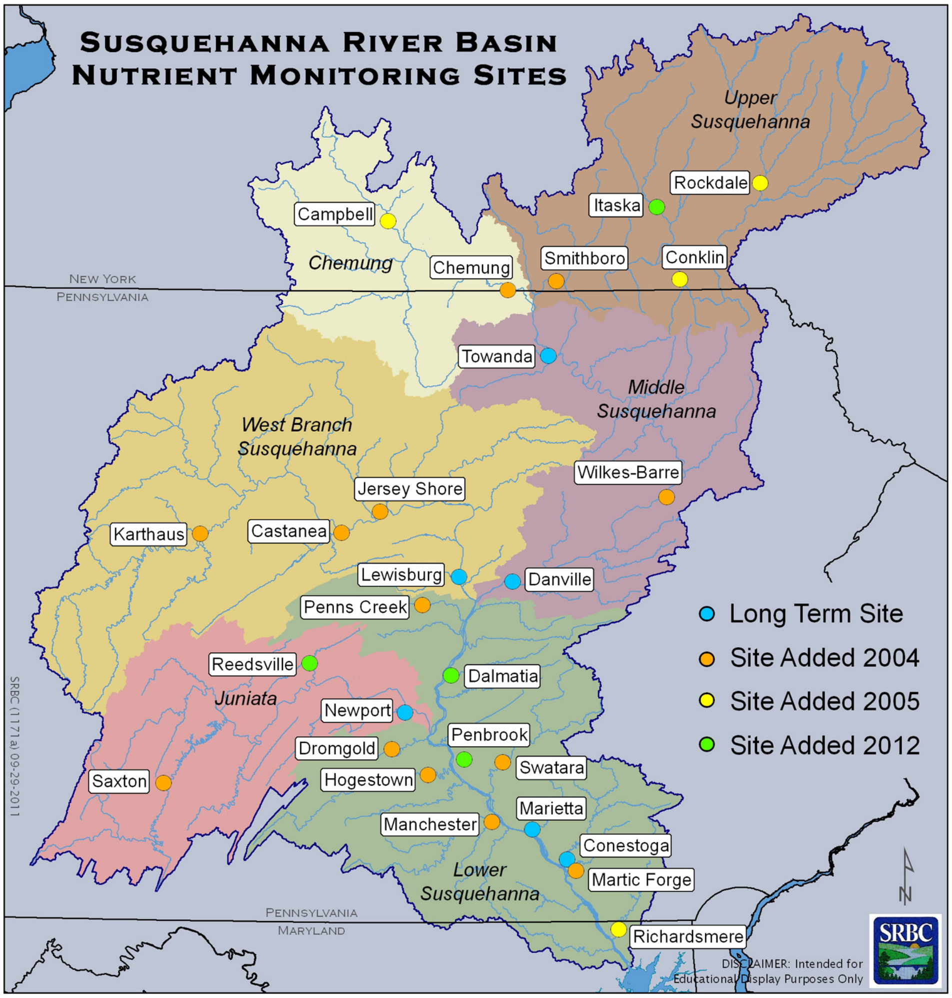
2012 Precipitation & Discharge Stats

- **2012 precipitation was near average and fairly evenly distributed throughout the year resulting in an average flow year.**
- **Several precipitation events occurred in the basin during October, December, June, and January. The most significant event, Hurricane Sandy, occurred during the end of October and had largest effects at Conestoga and Newport. At Conestoga, 8.73 inches of rain fell resulting in the 10th highest historical flow. Both sites showed large increases in TP and SS loads as a result of the hurricane.**

Flooding caused by Hurricane Sandy along the Conestoga River outside Lancaster, October 30, 2012.

Photo Credit: Casey Kreider

Figure 1. Location of Sampling Sites within the Susquehanna River Basin



Monitoring Locations

Data were collected from six sites on the Susquehanna River, three sites on the West Branch Susquehanna River, and 18 sites on smaller tributaries in the basin. These 27 sites, selected for long-term monitoring of nutrient and SS transport in the basin, are shown in Figure 1. All sites have been co-located with U.S. Geological Survey (USGS) stream gaging stations to obtain discharge data.

Parameters Monitored

All water samples were analyzed for various species of Total and Dissolved Nitrogen (TN and DN), Total and Dissolved Phosphorus (TP and DP), Total Organic Carbon (TOC), and Suspended Sediment (SS).

For Group A sites (six long-term sites), two samples were taken each month: a fixed-date sample and a base flow sample. Samples were also drawn during high flow events, targeting one per season. At Group B sites (21 additional sites), fixed-date samples were taken monthly in addition to two storm samples collected each quarter.

Nutrient and Suspended Sediment Loads & Yields

Loads and yields represent two methods for describing nutrient and SS amounts within a basin. Loads refer to the actual amount of the constituent being transported in the water column past a given point over a specific duration of time and are expressed in pounds. Yields compare the transported load with the acreage of the watershed and are expressed in lbs/acre. This allows for easy watershed comparisons.

Terms to Know

Long-Term Mean (LTM) — the average of a set of numbers over a defined number of years

Water Discharge — volume rate of water flow that is transported through a given cross-sectional area, measured as cubic feet per second (cfs)

Flow-Adjusted Concentration (FAC) — concentration of a parameter in a waterway after the effects of flow are removed

Loads and yields are calculated using the USGS ESTIMATOR model. This tool relates a constituent's concentration to water discharge, seasonal effects, and long-term trends.

The full technical report includes tables that show the loads and yields for Group A and the majority of Group B monitoring sites, as well as the average annual concentrations for each constituent. These analyses also were able to be conducted on 14 of 21 Group B sites.

KEY FINDINGS — LOADS & YIELDS

Annual loads were below LTM due to below average flows.

TN was above average at Newport during the top three flow months.

At Conestoga, Hurricane Sandy resulted in the only above average monthly SS load.

Highest TN and TP yields were found in the Lower Susquehanna Subbasin.

Lowest TN and TP yields were found at Karthaus in the West Branch.

Email: srbc@srbc.net
Web Site: www.srbc.net
P (717) 238-0423 / F (717) 238-2436

Long-Term Trends

Trends for monthly mean flow and Flow-Adjusted Concentrations (FAC) were computed using data from the stations' inception through 2012 for flow, SS, TOC, and several forms of nitrogen and phosphorus (Figure 2).

KEY FINDINGS — TRENDS

- ↔ Majority of long-term trends were unchanged from 2011.
- ↘ New downward trends for TP at Towanda and DP at Danville.

SHORT TERM TRENDS:

- ↘ TN trend was downward at 7 of the 8 Lower Susquehanna Sites.
- ↘ TON (Total Organic Nitrogen) and DON (Dissolved Organic Nitrogen) trend was downward at 4 of the 5 NY sites.
- ↘ Downward long-term TON and DON trends at Group A sites; only downward short-term trend was found at Conestoga.
- ↘ TP downward trend at all mainstem sites.
- ↘ DP downward trend at all mainstem sites except Marietta.
- ↘ Downward long-term trends in TP, DP, and DOP at Conestoga; not found in short-term trend.
- ↘ No TOC trends in NY; 12 of 15 other sites analyzed saw downward trend in TOC.
- ↘ Downward long-term SS trends at Group A sites; only downward short-term trend for SS found at Newport.

FAC trends represent the trends after the effects of flow have been removed and represent the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed.

Short-term trend analyses were conducted at all Group A and 14 Group B sites. Time periods included data from 2004/2005-2012.

Summary statistics for all sites are included in the full report.

Baseline Comparisons

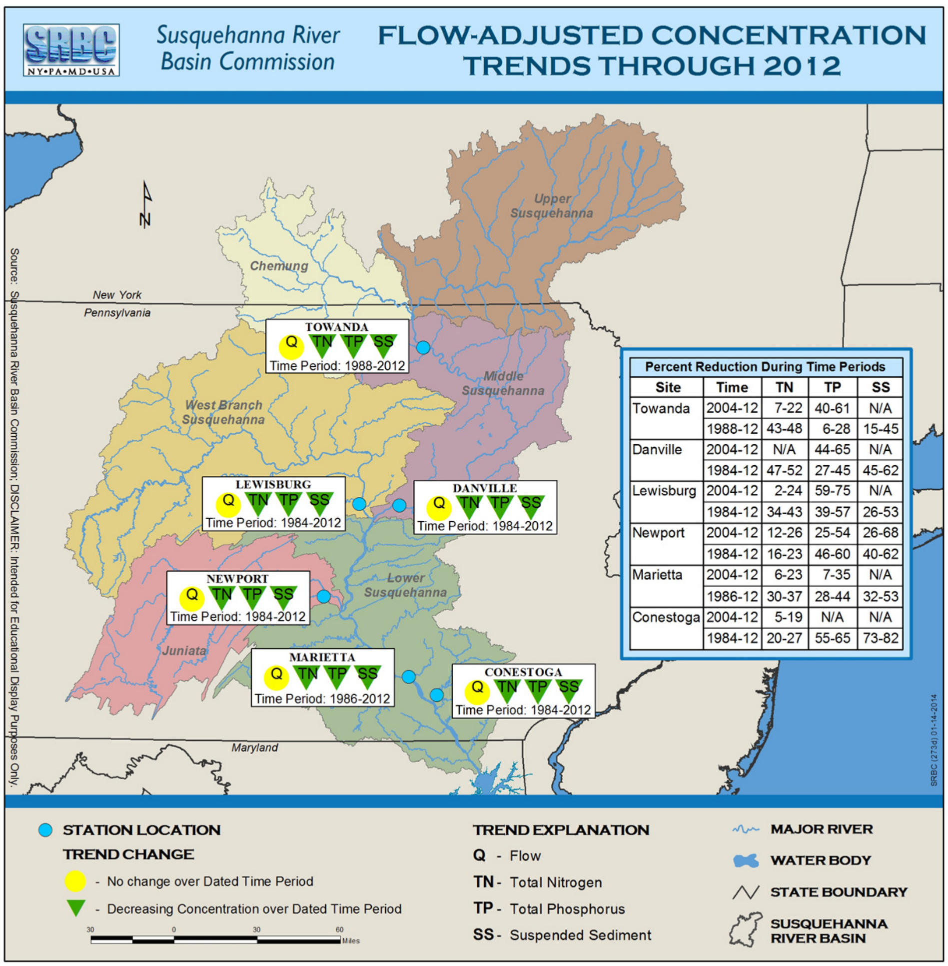
Annual fluctuations in nutrient and suspended sediment loads make it difficult to determine whether the changes were related to land use, nutrient availability, or annual water discharge. To help make that determination, historical data sets are used to create baseline relationships between annual yields and water discharge.

This report used several different baselines: (1) inital five-year period of each data set (usually 1985-1989); (2) first half of the data set [1985-1997 data]; (3) second half of the data set [usually 1998-2012]; and (4) entire data set [1985-2012].

KEY FINDINGS — BASELINE COMPARISONS

2012 Yields for TN, TP, and SS at all sites were below baseline predictions.

Figure 2. Flow-Adjusted Concentration Trends through 2012



Percent Reduction During Time Periods

Site	Time	TN	TP	SS
Towanda	2004-12	7-22	40-61	N/A
	1988-12	43-48	6-28	15-45
Danville	2004-12	N/A	44-65	N/A
	1984-12	47-52	27-45	45-62
Lewisburg	2004-12	2-24	59-75	N/A
	1984-12	34-43	39-57	26-53
Newport	2004-12	12-26	25-54	26-68
	1984-12	16-23	46-60	40-62
Marietta	2004-12	6-23	7-35	N/A
	1986-12	30-37	28-44	32-53
Conestoga	2004-12	5-19	N/A	N/A
	1984-12	20-27	55-65	73-82

SRBC's Sediment and Nutrients Assessment Program is funded largely through grants from the U.S. Environmental Protection Agency and Pennsylvania Department of Environmental Protection.

WHAT ARE THE NUMBERS TELLING US?

2012 was a near average year for both precipitation and flow on the heels of T.S. Lee, the most significant event to hit the basin since Hurricane Agnes.

Although the majority of the basin did not have a dramatic precipitation event during 2012, Conestoga, Newport, and several of the lower Group B sites were influenced by Hurricane Sandy in October. The lack of significant events at other sites, and perhaps the flushing effects of Tropical Storm Lee in 2011, contributed to exceptionally low loads of TP and SS, which are the parameters most closely associated with storm events.

Since Hurricane Sandy was a significant event at Conestoga, those parameters were elevated as expected. Specifically, when comparing LTMs for high precipitation and flow months at Marietta with their respective nutrient loads and yields, the 2012 precipitation events appear to have had little effect. The same comparison at Conestoga showed the significant impact of Hurricane Sandy with October accounting for 69 percent of the annual SS load and only 16 percent of the annual flow. This suggests that although storm events may be present during a given year, there seems to be a discharge threshold over which we see an exponential-like increase of TP and SS loads. This threshold could be linked to watershed Best Management Practices (BMPs) and their respective efficiencies and design capacities.

The most significant implication taken from the long-term and short-term trend comparison was that, in general, the rate of reductions in nitrogen appeared to slow or stop while the rate of reductions in phosphorus appear to have increased. One possible causal factor includes the timing and focus of nutrient management efforts in the watershed, which focused on nitrogen early and evolved to focus on phosphorus.

Another possible cause to consider is that although linear trends exist for the entire dataset, non-linear fluctuations exist within the dataset. These fluctuations are critical in identifying effective and/or ineffective management actions and practices.

A more simplistic analysis of the baseline regression lines supports the conclusion that early improvements appear to be larger than more recent ones. This observation exists for TN, TP, and SS, and is most apparent when the initial five-year baseline regression is compared to the most recent baseline.

The last two years in the basin were very different. For example, 2012's highest daily average flow at Marietta was only 23 percent of the highest daily average during T.S. Lee in 2011. While TP and SS yield values were below all baselines in 2012, the opposite was true for 2011. The conclusion being that we find better water quality conditions under relatively normal water years as opposed to those years containing even one significant storm event.

Jarnagin (2007) found that when either impervious surfaces cross a 10 percent threshold or urban development crosses 20 percent in a watershed, the watershed hydrograph can become flashier. Although only Conestoga and Paxton have urban land use above 20 percent, another major influence on runoff that should be considered is agricultural BMPs, many of which are designed to channel water away from fields and into waterways. Thus, the cumulative impact of urban impervious surfaces and agricultural BMPs could collectively alter streamflow dynamics.

The data clearly indicate that high flow events are the driving force behind extremely high loads of both TP and SS. Given that these events continue to occur, focusing management efforts on retaining stormwater in the watershed as opposed to channeling it to the rivers could help reduce both nutrient and SS loads and flood impacts.

All Best Management Practices, whether agricultural or urban in nature, have functional efficiencies that decrease when storm size exceeds BMP design capacities. Given that high flow events continue to occur, focusing management efforts on retaining stormwater in the watershed as opposed to channeling it to the rivers could help reduce both nutrient and SS loads and flood impacts.

Photo credit: Natural Resources Conservation Service, USDA