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SUSQUEHANNA RIVER BASIN COMMISSION

Sediment and Nutrients Assessment Program

2011 Summary Report

www.srbc.net/programs/CBP/nutrientprogram.htm Publication No. 284A

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 and 2005, the U.S. Environmental Protection Agency provided funding to significantly expand SRBC's overall monitoring network to 23 sites in the basin (Figure 1). These additional sites were added as part of the Chesapeake Bay Program's Non-tidal Monitoring Network. Three additional sites added in 2012 are not part of this 2011 report.

This report summarizes the findings of the technical report *2011 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 2011 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

SRBC Environmental Scientist Kevin McGonigal displays USGS depth integrated sampler used to collect water that is analyzed for Total Nitrogen, Total Phosphorus, Total Organic Carbon, and Suspended Sediment.

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.

2011 Precipitation & Discharge Stats

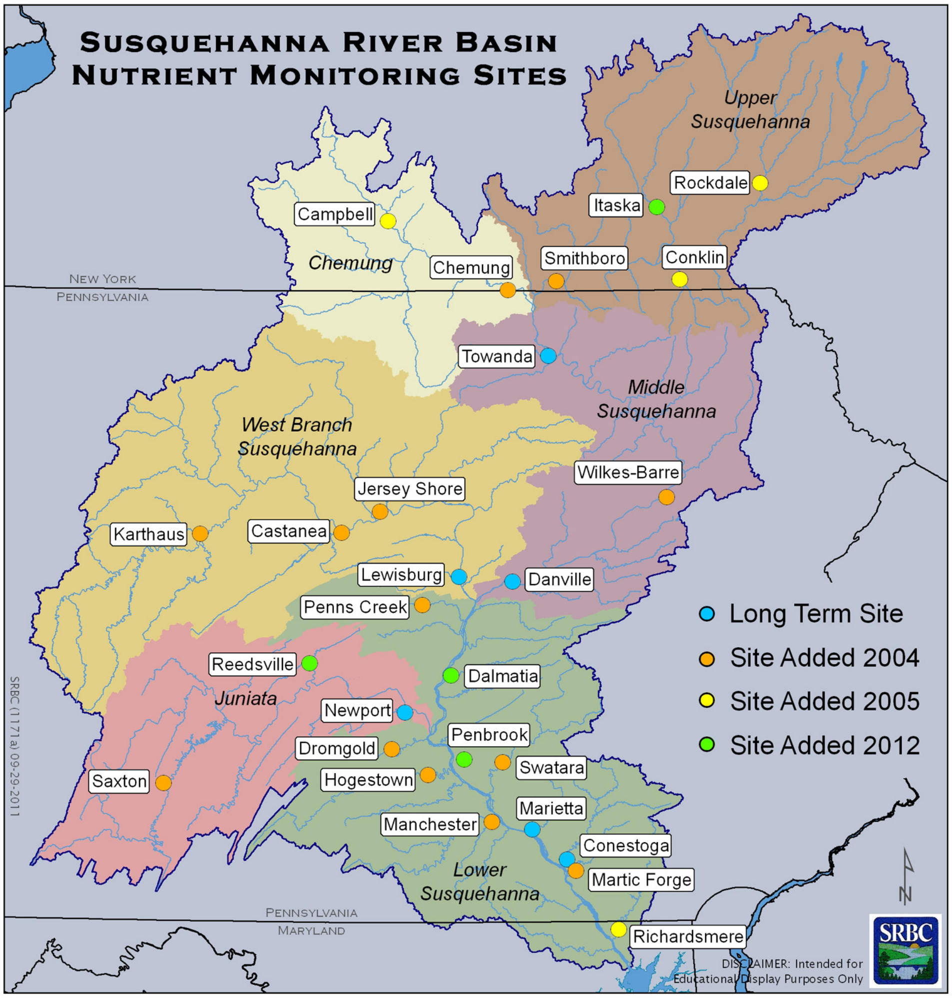
- **2011 precipitation for March, April, and September accounted for 43 percent of the total annual precipitation with September accounting for 20 percent alone. Discharge for the three months was 51 percent of the total annual flow and 256 percent of the three month Long-Term Mean.**

Tropical Storm Lee aftermath, Athens, Pa.

- **Hurricane Irene and Tropical Storm Lee brought historical rainfall and transported extreme nutrient and suspended sediment loads during August and September. Whereas Hurricane Irene affected the eastern portion of the basin, Tropical Storm Lee affected the entire basin.**

- **Tropical Storm Lee peak flow at Conestoga occurred on September 8 reaching 6.3 feet over major flood stage, second only to Hurricane Agnes in 1972. Within the lower basin, the Swatara Creek recorded peak flows 10.6 feet above the closest historical peak flow in 2006 and 12.8 feet over major flood stage.**

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 14 sites on smaller tributaries in the basin. These 23 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, 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, 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.

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 monitoring sites, as well as the average annual concentrations for each constituent.

The full report also discusses monthly flows for each of the six long-term monitoring stations. Individual loads from historically similar flow months were compared with 2011 data, and seasonal variations at each of the stations are explored.

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

KEY FINDINGS — LOADS & YIELDS

Nutrient loads during March, April, and September accounted for 40-57 percent of the annual TN load, 60-82 percent of the annual TP load, and 70-93 percent of the annual SS load.

Between September 7-12, 2011, Tropical Storm Lee transported 36 percent of the annual sediment load at Marietta.

Long-Term Trends

Trends for monthly mean flow and Flow-Adjusted Concentrations (FAC) were computed using data from the stations' inception through 2011 for flow, SS, TOC, and several forms of nitrogen and phosphorus (Figure 2).

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.

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

KEY FINDINGS — TRENDS

Trend results remained unchanged from 2010 except for the addition of a downward trend in DP at Towanda.

Changes in the magnitude of trends did change. Danville and Towanda showed larger magnitudes of improving nitrogen trends and less improvement in phosphorus species. This included no trend for TP and an upward trend for dissolved orthophosphorus at Towanda, and no trend for DP at Danville. There were large magnitude downward trends for TP at all three tributary sites as well as large downward trends in DP at Newport and Conestoga.

All sites had downward SS trends with magnitudes ranging from 16-80 percent. Conestoga had the largest trend reductions ranging from 70-80 percent.

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 peiod of each data set (usually 1985-1989); (2) first half of the data set [1985-1996 data]; (3) second half of the data set [usually 1997-2011]; and (4) entire data set [1985-2011].

KEY FINDINGS — BASELINE COMPARISONS

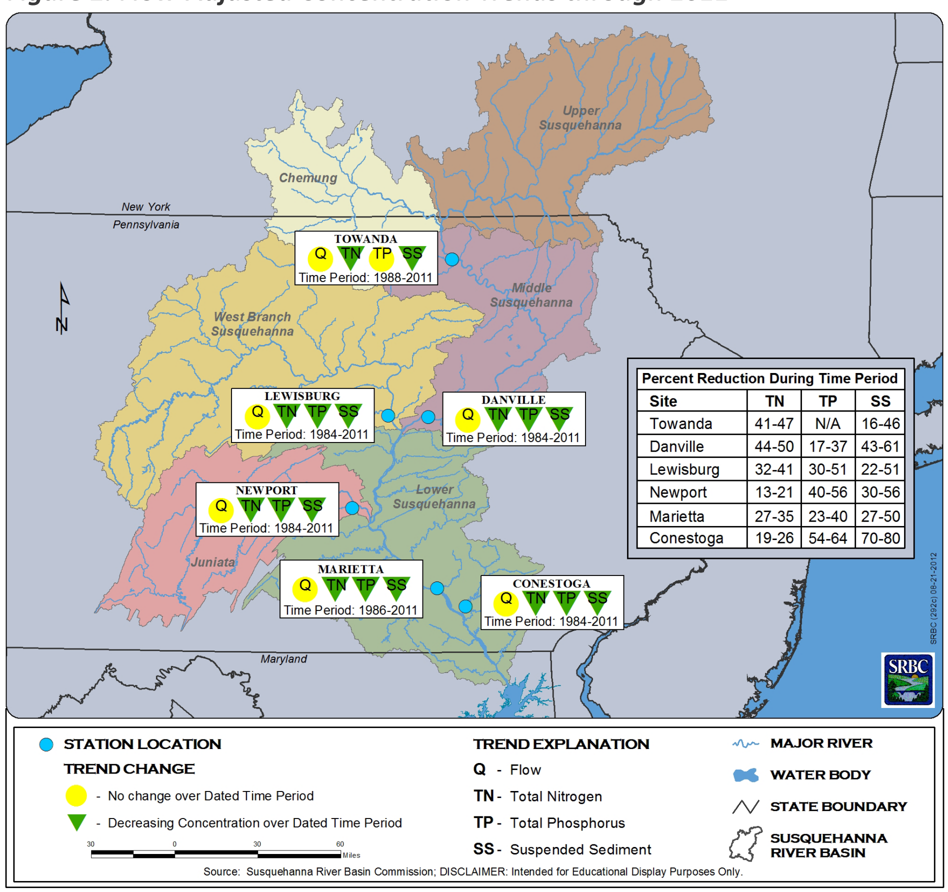
Tropical Storm Lee's effects on nutrient yields led to varied responses of TN, TP, and SS.

TN yields were below initial 5-year baseline predictions at all sites.

TP and SS at Towanda, Marietta, and Conestoga yields were above all baseline predictions.

Danville yields for TP were below all baselines while SS was above all baselines.

Annual yields at Lewisburg and Newport were below all baselines for TN, TP, and SS.



Percent Reduction During Time Period			
Site	TN	TP	SS
Towanda	41-47	N/A	16-46
Danville	44-50	17-37	43-61
Lewisburg	32-41	30-51	22-51
Newport	13-21	40-56	30-56
Marietta	27-35	23-40	27-50
Conestoga	19-26	54-64	70-80

Figure 2. Flow-Adjusted Concentration Trends through 2011

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.

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Table 1. 2011 Annual, Seasonal and Annual Long-Term Mean Precipitation (inches), Flow (cfs), Loads (in 1000's of pounds), Yields (lbs/ac/yr), Concentration (mg/L) and Trends for Total Nitrogen (TN), Total Phosphorus (TP), and Suspended Sediment (SS) at Towanda, Danville, Lewisburg, Newport, Marietta, and Conestoga, Pa.

Parameter		Period	Towanda	Danville	Lewisburg	Newport	Marietta	Conestoga
Precipitation		Winter	9.10	9.27	11.76	8.12	10.30	10.45
		Spring	16.04	16.05	17.90	16.75	17.05	14.56
		Summer	15.48	16.49	22.44	18.97	20.75	23.04
		Fall	9.50	9.54	12.57	11.72	11.50	11.66
		2011	50.11	51.35	64.67	55.56	59.60	59.72
		LTM	39.07	39.67	42.34	37.40	40.73	43.44
Flow		Winter	21,058	30,765	20,148	7,977	71,997	960
		Spring	27,652	41,646	26,424	10,513	97,148	1,134
		Summer	14,963	26,793	9,070	2,054	55,042	1,349
		Fall	16,454	27,361	19,029	3,865	70,047	1,132
		2011	20,005	31,619	18,638	7,879	73,502	1,145
		LTM	12,083	17,018	11,041	4,504	40,256	692
Total Nitrogen	Load	Winter	10,146	17,266	8,451	6,126	48,284	3,118
		Spring	12,122	20,765	9,611	7,668	58,900	3,451
		Summer	5,755	11,884	3,259	3,647	36,019	3,343
		Fall	6,660	13,232	7,745	7,393	51,676	3,808
		2011	34,683	63,147	29,066	24,834	194,879	13,720
		LTM	27,406	43,435	23,165	16,395	130,273	10,388
	Yield	2011	6.95	8.79	6.63	11.57	11.72	46
		LTM	5.49	6.05	5.29	7.64	7.83	35
	Conc.+	2011	0.88	1.01	0.79	1.60	1.35	6.09
		LTM	1.17	1.32	1.07	1.84	1.65	7.71
	Trend	*	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Total Phosphorus	Load	Winter	802	1,523	361	232	3,536	108
		Spring	1,258	2,383	570	335	5,246	133
		Summer	1,724	3,401	236	300	9,666	1,485
		Fall	351	879	232	243	2,754	161
		2011	4,135	8,186	1,399	1,110	21,202	1,887
		LTM	2,370	3,752	1,236	777	7,996	688
	Yield	2011	0.829	1.140	0.319	0.517	1.275	6.273
		LTM	0.475	0.522	0.282	0.362	0.481	2.287
	Conc.+	2011	0.105	0.132	0.038	0.072	0.147	0.837
		LTM	0.096	0.107	0.055	0.086	0.096	0.483
	Trend	*	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Suspended Sediment	Load	Winter	1,177,770	2,157,626	475,976	235,250	4,792,423	56,811
		Spring	2,152,025	3,689,698	698,866	312,548	7,064,468	52,018
		Summer	10,115,399	17,755,145	503,500	341,688	24,138,561	1,524,970
		Fall	252,126	894,929	243,330	166,620	2,148,224	50,897
		2011	13,697,320	24,497,398	1,921,672	1,056,106	38,143,676	1,684,696
		LTM	3,321,065	4,040,304	1,171,713	526,866	7,776,410	396,106
	Yield	2011	2,745	3,412	439	492	2,293	5,601
		LTM	666	563	267	245	468	1,317
	Conc.+	2011	348	394	52	68	264	747
		LTM	121	102	48	52	85	262
	Trend	*	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

** Trend time periods: Towanda 1989-2011; Marietta 1987-2011; Lewisburg, Danville, Newport, and Conestoga 1985-2011.*

+ Concentrations are calculated using total annual discharge and annual load.