NUTRIENTS AND SUSPENDED SEDIMENT TRANSPORTED IN THE SUSQUEHANNA RIVER BASIN, 2009, AND TRENDS, JANUARY 1985 THROUGH DECEMBER 2009

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**Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).*

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ABSTRACT

Nutrient and suspended-sediment (SS) samples were collected under base flow and stormflow conditions during calendar year 2009 for Group A sites listed in Table 2. Fixed date samples also were collected at these sites as well as at Group B sites listed in Table 2. All samples were analyzed for nitrogen and phosphorus species, total organic carbon (TOC), and SS.

Precipitation for 2009 was above average at all Group A sites except at Lewisburg, which was 1.84 inches below the long-term mean (LTM). Rainfall amounts above the LTM ranged from 1.39 inches above LTM at Marietta to 2.73 inches above LTM at Conestoga. Winter rainfall amounts were below LTM at all sites including 4.66 inches lower at Conestoga. Spring amounts were above LTM for all sites ranging from 0.57 at Lewisburg to 3.73 at Newport. Although precipitation rates were mostly above LTM values, 2009 flow values were below the LTM at all sites. Highest departures from the LTM were at Newport and Towanda with 85 percent of the LTM. Individual monthly flows were above the LTM for June, August, and October at most sites.

This report utilizes several methods to compare nutrient and SS loads and yields including: (1) comparison with the LTM; (2) comparison with baseline data; and (3) flow-adjusted concentration trend analysis.

Annual loads for all parameters were below the LTM at all sites except for dissolved phosphorus (DP), dissolved orthophosphate (DOP), and TOC. DP and DOP were above the LTM at Towanda, Danville, and Lewisburg. DOP and TOC were above the LTM at Newport. Conestoga 2009 values were below LTM for all parameters including substantially lower than LTM values for total phosphorus (TP), SS, total organic nitrogen (TON), and dissolved organic nitrogen (DON).

2009 seasonal flows were highest for winter at all sites except Newport and Conestoga. This resulted in the highest load of all parameters being transported during winter at Towanda, Danville, and Lewisburg, with TOC at Lewisburg being the only exception. Flow was lowest during summer at all stations except Conestoga, resulting in lowest loads delivered during the season. Conestoga flows were distinctly different from past years with winter being the lowest flow season.

Lower than predicted yields in total nitrogen (TN), TP, and SS were found in 2009 for all baseline comparisons at all sites, except for TP at Towanda and TP at Danville for the second half baseline comparison. This comparison remained unchanged from 2008. Seasonal yields of TP at Towanda were higher than baseline predictions for all seasons. 2009 annual yields were dramatically lower than baseline predictions at Conestoga for TN, TP, and SS.

All trends for 2009 remained unchanged from 2008 except DON at Conestoga, which changed from a downward trend to no significant trend. TN, TP, and SS trends were improving at all sites except for TP at Towanda, which had no significant trend. Upward trends were found at Towanda and Newport for DOP. The most southern site, Marietta, showed downward trends for all parameters except DOP,

which had no significant trend due to more than 20 percent of the values being below the method detection limit (BMDL). This also occurred for dissolved ammonia nitrogen (DNH_3) at Towanda, Danville, Lewisburg, and Newport. No significant trends were found for flow for the time period.

INTRODUCTION

Nutrients and SS entering the Chesapeake Bay (Bay) from the Susquehanna River Basin contribute to nutrient enrichment problems in the Bay (USEPA, 1982). The Pennsylvania Department of Environmental Protection (PADEP) Bureau of Laboratories, the U.S. Environmental Protection Agency (USEPA), the U.S. Geological Survey (USGS), and the Susquehanna River Basin Commission (SRBC) conducted a 5-year intensive study at 12 sites from 1985-89 to quantify nutrient and SS transported to the Bay via the Susquehanna River Basin. In 1990, the number of sampling sites was reduced to five long-term monitoring stations. An additional site was included in 1994.

In October 2004, 13 additional sites (two in New York and 11 in Pennsylvania) were added as part of the Chesapeake Bay Program's Non-tidal Water Quality Monitoring Network. In October 2005, four more sites (three in New York and one in Maryland) were added to the existing network. This project involves monitoring efforts conducted by all six Bay state jurisdictions, USEPA, USGS, and SRBC to create a uniform non-tidal monitoring network for the entire Bay watershed.

PURPOSE OF REPORT

The purpose of this report is to present basic information on annual and seasonal loads and yields of nutrients and SS measured during calendar year 2009. Comparisons are made to LTM and to various baselines, including baselines created from the initial five years of data, the first half of the dataset, the second half of the dataset, and those created from the entire dataset for each site. Additionally, seasonal baselines were created using the initial five years of data from each site. Seasonal and annual variations in loads are discussed, as well as the results of flow-adjusted trend analyses for the period January 1985 through December 2009 for various forms of nitrogen and phosphorus, SS, TOC, and discharge.

DESCRIPTION OF THE SUSQUEHANNA RIVER BASIN

The Susquehanna River (Figure 1) drains an area of 27,510 square miles (Susquehanna River Basin Study Coordination Committee, 1970), and is the largest tributary to the Chesapeake Bay. The Susquehanna River originates in the Appalachian Plateau of southcentral New York, flows into the Valley and Ridge and Piedmont Provinces of Pennsylvania and Maryland, and joins the Bay at Havre de Grace, Md. The climate in the Susquehanna River Basin varies considerably from the low lands adjacent to the Bay in Maryland to the high elevations, above 2,000 feet, of the northern headwaters in central New York State. The annual mean temperature ranges from 53^o F (degrees Fahrenheit) near the Pennsylvania-Maryland border to 45^o F in the northern part of the basin. Annual precipitation in the basin averages 39.15 inches and is fairly well distributed throughout the year.

Land use in the Susquehanna River Basin, shown in Table 1, is predominantly rural with woodland accounting for 69 percent; agriculture, 21 percent; and urban, 7 percent. Woodland occupies the higher elevations of the northern and western parts of the basin and much of the mountain and ridge land in the Juniata and Lower Susquehanna Subbasins. Woods and grasslands occupy areas in the lower part of the basin that are unsuitable for cultivation because the slopes are too steep, the soils are too stony, or the soils are poorly drained. The Lower Susquehanna Subbasin contains the highest density of agriculture operations within the watershed. However, extensive areas are cultivated along the river valleys in southern New York and along the West Branch Susquehanna River from Northumberland, Pa., to Lock Haven, Pa., including the Bald Eagle Creek Valley.

Figure 1. The Susquehanna River Basin, Subbasins, and Population Centers

Table 1. 2000 Land Use Percentages for the Susquehanna River Basin and Selected Tributaries

Site Location	Waterbody	Water/ Wetland	Urban	Agricultural			Forest	Other
				Row Crops	Pasture/Hay	Total		
Original Sites (Group A)								
Towanda	Susquehanna	2	5	17	5	22	71	0
Danville	Susquehanna	2	6	16	5	21	70	1
Lewisburg	West Branch Susquehanna	1	5	8	2	10	84	0
Newport	Juniata	1	6	14	4	18	74	1
Marietta	Susquehanna	2	7	14	5	19	72	0
Conestoga	Conestoga	1	24	12	36	48	26	1
Enhanced Sites (Group B)								
Campbell	Cohocton	3	4	13	6	19	74	0
Rockdale	Unadilla	3	2	22	6	28	66	1
Conklin	Susquehanna	3	3	18	4	22	71	1
Smithboro	Susquehanna	3	5	17	5	22	70	0
Chemung	Chemung	2	5	15	5	20	73	0
Wilkes-Barre	Susquehanna	2	6	16	5	21	71	0
Karthaus	West Branch Susquehanna	1	6	11	1	12	80	1
Castanea	Bald Eagle	1	8	11	3	14	76	1
Jersey Shore	West Branch Susquehanna	1	4	6	1	7	87	1
Penns Creek	Penns	1	3	16	4	20	75	1
Saxton	Raystown Branch Juniata	< 0.5	6	18	5	23	71	0
Dromgold	Shermans	1	4	15	6	21	74	0
Hogestown	Conodoguinet	1	11	38	6	44	43	1
Hershey	Swatara	2	14	18	10	28	56	0
Manchester	West Conewago	2	13	12	36	48	36	1
Martic Forge	Pequea	1	12	12	48	60	25	2
Richardsmere	Octoraro	1	10	16	47	63	24	2
Entire Basin	Susquehanna River Basin	2	7	14	7	21	69	1

Major urban areas in the Upper and Chemung Subbasins are located along river valleys, and they include Binghamton, Elmira, and Corning, N.Y. Urban areas in the Middle Susquehanna include Scranton and Wilkes-Barre, Pa. The major urban areas in the West Branch Susquehanna Subbasin are Williamsport, Renovo, and Clearfield, Pa. Lewistown and Altoona, Pa., are the major urban areas within the Juniata Subbasin. Major urban areas in the Lower Susquehanna Subbasin include York, Lancaster, Harrisburg, and Sunbury, Pa.

NUTRIENT MONITORING SITES

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 listed in Table 2, and their general locations are shown in Figure 2.

Table 2. Data Collection Sites and Their Drainage Areas

USGS ID Number	Original Sites (Group A)	Subbasin	Short Name	Drainage Area (Sq Mi)
01531500	Susquehanna River at Towanda, Pa.	Middle Susquehanna	Towanda	7,797
01540500	Susquehanna River at Danville, Pa.	Middle Susquehanna	Danville	11,220
01553500	West Branch Susquehanna River at Lewisburg, Pa.	W Branch Susquehanna	Lewisburg	6,847
01567000	Juniata River at Newport, Pa.	Juniata	Newport	3,354
01576000	Susquehanna River at Marietta, Pa.	Lower Susquehanna	Marietta	25,990
01576754	Conestoga River at Conestoga, Pa.	Lower Susquehanna	Conestoga	470
	Enhanced Sites (Group B)			
01502500	Unadilla River at Rockdale, N.Y.	Upper Susquehanna	Rockdale	520
01503000	Susquehanna River at Conklin, N.Y.	Upper Susquehanna	Conklin	2,232
01515000	Susquehanna River at Smithboro, N.Y.	Upper Susquehanna	Smithboro	4,631
01529500	Cohocton River at Campbell, N.Y.	Chemung	Campbell	470
01531000	Chemung River at Chemung, N.Y.	Chemung	Chemung	2,506
01536500	Susquehanna River near Wilkes-Barre, Pa.	Middle Susquehanna	Wilkes-Barre	9,960
01542500	West Branch Susquehanna River near Karthaus, Pa.	W Branch Susquehanna	Karthaus	1,462
01548085	Bald Eagle Creek near Castanea, Pa.	W Branch Susquehanna	Castanea	420
01549760	West Branch Susquehanna River near Jersey Shore, Pa.	W Branch Susquehanna	Jersey Shore	5,225
01555000	Penns Creek at Penns Creek, Pa.	Lower Susquehanna	Penns Creek	301
01562000	Raystown Branch Juniata River at Saxton, Pa.	Juniata	Saxton	756
01568000	Shermans Creek near Dromgold, Pa.	Lower Susquehanna	Dromgold	200
01570000	Conodoguinet Creek near Hogestown, Pa.	Lower Susquehanna	Hogestown	470
01573560	Swatara Creek near Hershey, Pa.	Lower Susquehanna	Hershey	483
01574000	West Conewago Creek near Manchester, Pa.	Lower Susquehanna	Manchester	510
01576787	Pequea Creek near Martic Forge, Pa.	Lower Susquehanna	Pequea	155
01578475	Octoraro Creek at Richardsmere, Md.	Lower Susquehanna	Richardsmere	177

SAMPLE COLLECTION AND ANALYSIS

Samples were collected to measure nutrient and SS concentrations during various flows in 2009. For Group A sites, two samples were collected per month: one near the twelfth of the month (fixed date sample) and one during monthly base flow conditions. Additionally, at least four high flow events were sampled, targeting one per season. When possible, a second high flow event was sampled after spring planting in the basin. During high flow sampling events, samples were collected daily during the rise and fall of the hydrograph. The goal was to gather a minimum of three samples on the rise and three samples on the fall, with one sample as close to peak flow as possible.

For Group B sites, fixed date monthly samples were collected during the middle of each month during 2009. Additionally, two storm samples were collected per quarter at each site. All samples were collected by hand with USGS depth integrating samplers. At each site between three and 10 depth integrated verticals were collected across the water column and then composited to obtain a representative sample of the entire waterbody.

Whole water samples were collected and analyzed for nitrogen and phosphorus species, TOC, total suspended solids (TSS), and SS. For Group B sites, SS samples were only collected during storm events. Additionally, filtered samples were collected to analyze for dissolved nitrogen (DN) and DP species. All Pennsylvania samples were delivered to the PADEP Laboratory in Harrisburg. New York samples were sent to Columbia Analytical Services in Rochester, N.Y. SS samples for Group A sites were completed at SRBC, while samples for Group B sites were analyzed at the USGS sediment laboratory in Louisville, Kentucky. Additionally, one of each of the two storm samples per storm was submitted to the USGS sediment laboratory for analysis of sand/fine content. The parameters and laboratory methods used are listed in Table 3.

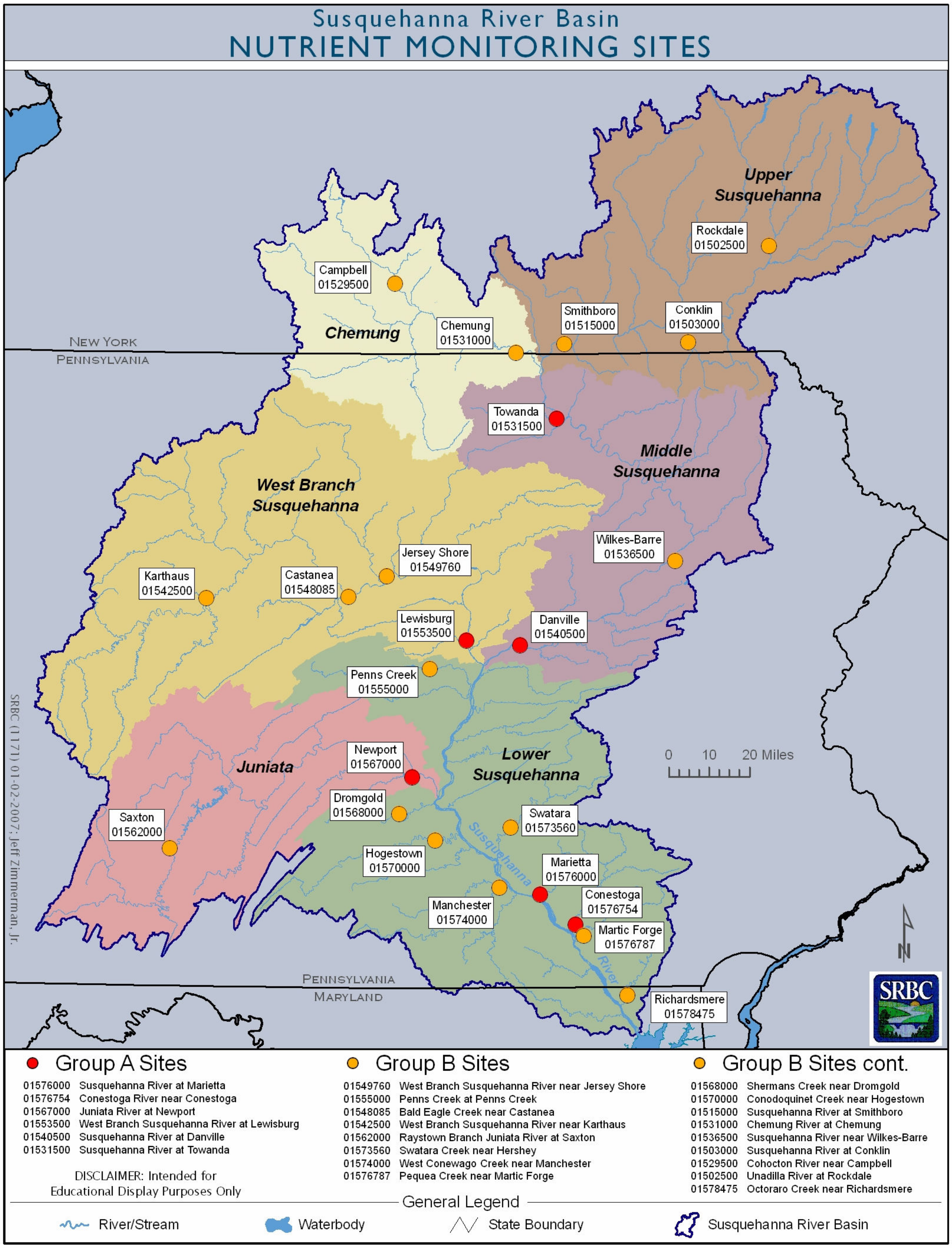


Figure 2. Locations of Sampling Sites Within the Susquehanna River Basin

Table 3. Water Quality Parameters, Laboratory Methods, and Detection Limits

Parameter	Laboratory	Methodology	Detection Limit (mg/l)	References
Total Ammonia (TNH_3)	PADEP	Colorimetry	0.020	USEPA 350.1
	CAS*	Colorimetry	0.010	USEPA 350.1R
Dissolved Ammonia (DNH_3)	PADEP	Block Digest, Colorimetry	0.020	USEPA 350.1
		Block Digest, Colorimetry	0.010	USEPA 350.1R
Total Nitrogen (TN)	PADEP	Persulfate Digestion for TN	0.040	Standard Methods #4500-N_{org}-D
Dissolved Nitrogen (DN)	PADEP	Persulfate Digestion	0.040	Standard Methods #4500-N_{org}-D
Total Organic Nitrogen (TON)	N/A	TN minus TNH_3 and TNOx	N/A	N/A
Dissolved Organic Nitrogen (DON)	N/A	DN minus DNH_3 and DNOx	N/A	N/A
Total Kjeldahl Nitrogen (TKN)	CAS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Dissolved Kjeldahl Nitrogen (DKN)	CAS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Total Nitrite plus Nitrate (TNOx)	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
	CAS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Nitrite plus Nitrate (DNOx)	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
	CAS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Orthophosphate (DOP)	PADEP	Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Dissolved Phosphorus (DP)	PADEP	Block Digest, Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Total Phosphorus (TP)	PADEP	Persulfate Digest, Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Total Organic Carbon (TOC)	PADEP	Combustion/Oxidation	0.50	SM 5310D
	CAS*	Chemical Oxidation	0.05	GEN 415.1/9060
Total Suspended Solids (TSS)	PADEP	Gravimetric	5.0	USGS I-3765
	CAS*	Residue, non-filterable	1.1	SM2540D
Suspended Sediment Fines & Sand	USGS	**		
Suspended Sediment (SS)	SRBC	**		
	USGS	**		

* Columbia Analytical Services, Rochester, N.Y. (New York sites only)
** TWRI Book 3, Chapter C2 and Book 5, Chapter C1, Laboratory Theory and Methods for Sediment Analysis (Guy and others, 1969)

PRECIPITATION

Precipitation data were obtained from long-term monitoring stations operated by the U.S. Department of Commerce. The data are published as Climatological Data–Pennsylvania, and as Climatological Data–New York by the National Oceanic and Atmospheric Administration (NOAA) at the National Climatic Data Center in Asheville, North Carolina. Quarterly and annual data from these sources were compiled across the subbasins of the Susquehanna River Basin and are reported in Table 4 for Group A sites.

Precipitation for 2009 was above average at all Group A sites except Lewisburg. Highest departure from the LTM for precipitation was recorded at Conestoga, Pa., with 2.73 inches above the LTM. Highest precipitation months occurred during April to June at all sites, with an average of 2.33 inches above the LTM. January to March had the lowest precipitation amounts with an average of 2.66 inches below the LTM. Lower rainfall during the frozen ground months coupled with higher flows during spring and summer when plant uptake and infiltration are higher likely resulted in below LTM flows for 2009.

Table 4. Summary of Annual Precipitation for Selected Areas in the Susquehanna River Basin, Calendar Year 2009

River Location	Season	Calendar Year 2009 Precipitation Inches	Average Long-term Precipitation inches	Departure From Long-term inches
Susquehanna River above Towanda, Pa.	January-March	7.15	7.56	-0.41
	April-June	12.41	10.54	1.87
	July-September	12.56	11.17	1.39
	October-December	8.87	9.14	-0.27
	Yearly Total	40.99	38.41	2.58
Susquehanna River above Danville, Pa.	January-March	6.87	7.74	-0.87
	April-June	12.60	10.69	1.91
	July-September	12.77	11.38	1.39
	October-December	8.89	9.26	-0.37
	Yearly Total	41.13	39.07	2.06
West Branch Susquehanna River above Lewisburg, Pa.	January-March	4.83	8.40	-3.57
	April-June	11.60	11.03	0.57
	July-September	12.66	12.43	0.23
	October-December	10.59	9.66	0.93
	Yearly Total	39.68	41.52	-1.84
Juniata River above Newport, Pa.	January-March	4.29	7.74	-3.45
	April-June	13.46	9.73	3.73
	July-September	9.26	10.05	-0.79
	October-December	11.15	8.97	2.18
	Yearly Total	38.16	36.49	1.67
Susquehanna River above Marietta, Pa.	January-March	5.24	8.21	-2.97
	April-June	13.13	10.73	2.4
	July-September	12.34	11.52	0.82
	October-December	10.58	9.44	1.14
	Yearly Total	41.29	39.90	1.39
Conestoga River above Conestoga, Pa.	January-March	4.26	8.92	-4.66
	April-June	14.23	10.74	3.49
	July-September	15.15	12.59	2.56
	October-December	11.92	10.58	1.34
	Yearly Total	45.56	42.83	2.73

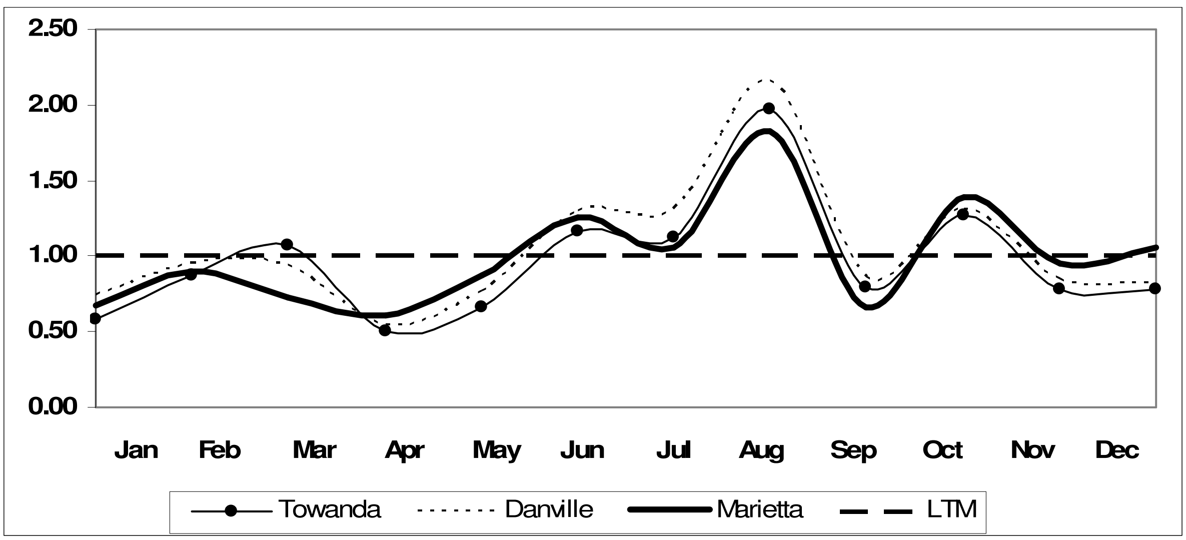
WATER DISCHARGE

Water discharge data were obtained from the USGS and are listed in Table 5. Monthly water discharge ratios are plotted in Figure 3 for all sites. The water discharge ratio is the actual flow for the time period divided by the LTM for the same time period. Thus, a value of one equals the 2009 flow being the same as the LTM, while a value of three equals the 2009 flow being three times the volume of the LTM. Discharge values were below the LTM all sites for 2009. Highest departures from the LTM were at Newport and Towanda at 85 percent of LTM. Mainstem sites had above LTM flows during June, August, and October. Flows levels at tributary sites were at or above LTM during August, October, and December.

Table 5. Annual Water Discharge, Calendar Year 2009

Site	Years of Record	Long-term Annual Mean cfs[1]	2009	
			Mean cfs	Percent of LTM[2]
Towanda	21	11,755	10,031	85
Danville	25	16,492	14,903	90
Lewisburg	25	10,785	9,247	86
Newport	25	4,372	3,705	85
Marietta	23	38,933	34,659	89
Conestoga	25	676	642	95

[1] Cubic feet per second [2] Long-term mean



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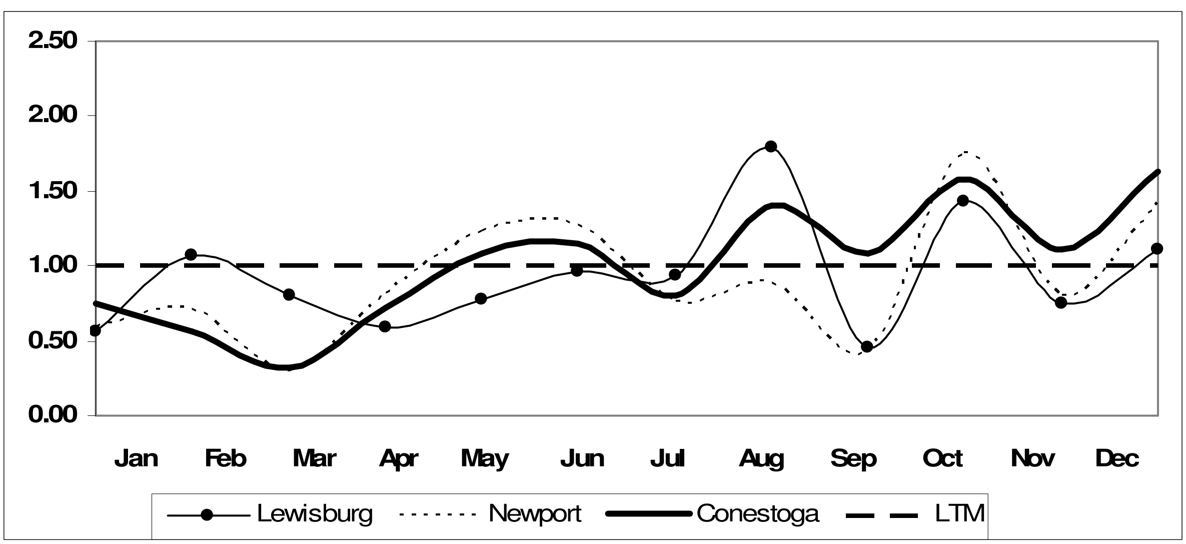

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Figure 3. Discharge Ratios for Long-term Sites, Susquehanna Mainstem Sites (A) and Tributaries (B)

2009 NUTRIENT AND SUSPENDED-SEDIMENT LOADS AND 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 comparisons between watersheds. This project reports loads and yields for the constituents listed in Table 6 as computed by the Minimum Variance Unbiased Estimator (ESTIMATOR) described by Cohn and others (1989). This estimator relates the constituent concentration to water discharge, seasonal effects, and long-term trends, and computes the best-fit regression equation. Daily loads of the constituents then were calculated from the daily mean water discharge records. The loads were reported along with the estimates of accuracy.

Identifying sites where the percentage of LTM for a constituent was different than the percentage of LTM for discharge may show potential areas where improvements or degradations have occurred for that particular constituent. One item to note is that nutrients and SS increase with increased flow (Ott and others, 1991; Takita, 1996, 1998). This increase, however, is not as linear at higher flows as at lower ones. Individual high flow events tend to produce higher loads, especially for TP and SS, than would be predicted by a simple comparison with the LTM.

Tables 7-19 show the loads and yields for the Group A monitoring stations, as well as an associated error value. They also show the average annual concentration for each constituent. Comparisons have been made to the LTMs for all constituents. Seasonal loads and yields for all parameters and all sites are listed in Table 20 for loads and Table 21 for yields. For the purposes of this project, January through March is winter, April through June is spring, July through September is summer, and October through December is fall. Monthly loads and yields for TN, TP, and SS at all long-term sites are listed in Tables 22 through 25.

2009 SUMMARY STATISTICS FOR ALL SITES

Load and trend analyses were unable to be completed at Group B sites because samples have not been collected at the stations for a sufficient number of years. Therefore, summary statistics have been calculated for these sites, as well as the long-term sites for comparison. Summary statistics are listed in Tables 26 through 30 and include minimum, maximum, median, mean, and standard deviation values taken from the raw 2009 dataset.

Table 6. List of Analyzed Parameters, Abbreviations, and STORET Codes

Parameter	Abbreviation	STORET Code
Discharge	Q	00060
Total Nitrogen as N	TN	00600
Dissolved Nitrogen as N	DN	00602
Total Organic Nitrogen as N*	TON	00605
Dissolved Organic Nitrogen as N*	DON	00607
Total Ammonia as N	TNH_3	00610
Dissolved Ammonia as N	DNH_3	00608
Total Nitrate + Nitrite as N	TNOx	00630
Dissolved Nitrate + Nitrite as N	DNOx	00631
Total Phosphorus as P	TP	00665
Dissolved Phosphorus as P	DP	00666
Dissolved Orthophosphate as P	DOP	00671
Total Organic Carbon	TOC	00680
Suspended sediment (fine)	SSF	70331
Suspended sediment (sand)	SSS	70335
Suspended Sediment (total)	SS	80154

*These are calculated values and not directly analyzed.

Table 7. Annual Water Discharges, Annual Loads, Yields, and Average Concentration of Total Nitrogen, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85.3	16,749	61.0	3.2	3.357	5.502	0.848	71.5
Danville	14,903	90	28,134	65.3	3.5	3.918	6.003	0.959	72.2
Lewisburg	9,247	86	15,446	66.4	4.8	3.525	5.312	0.849	77.4
Newport	3,705	85	12,167	75.4	3.5	5.668	7.515	1.668	89.6
Marietta	34,659	89	93,634	72.7	4.2	5.629	7.741	1.372	81.7
Conestoga	642	95	7,692	74.8	3.5	25.571	34.203	6.086	78.7

Table 8. Annual Water Discharges and Annual Loads and Yields of Total Phosphorus, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	1,831	78.2	8.8	0.367	0.469	0.093	91.7
Danville	14,903	90	2,564	71.5	9.6	0.357	0.499	0.087	79.2
Lewisburg	9,247	86	876	69.7	13.0	0.200	0.287	0.048	81.3
Newport	3,705	85	512	65.8	10.2	0.238	0.362	0.070	78.2
Marietta	34,659	89	4,169	55.2	7.9	0.251	0.454	0.061	62.0
Conestoga	642	95	295	44.9	9.1	0.981	2.182	0.233	47.3

Table 9. Annual Water Discharges and Annual Loads and Yields of Total Suspended Sediment, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	687,675	23.6	14.6	137	584	34.8	27.7
Danville	14,903	90	993,839	30.8	12.5	138	449	33.9	34.1
Lewisburg	9,247	86	319,530	27.7	17.4	73	263	17.6	32.3
Newport	3,705	85	214,017	42.0	17.9	100	238	29.3	49.8
Marietta	34,659	89	2,422,253	37.0	14.8	146	394	35.5	41.5
Conestoga	642	95	87,968	25.2	19.6	292	1,162	69.6	26.5

Table 10. Annual Water Discharges and Annual Loads and Yields of Total Ammonia, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	617	45.6	12.6	0.124	0.271	0.031	53.4
Danville	14,903	90	1,067	49.8	12.4	0.149	0.299	0.036	55.1
Lewisburg	9,247	86	579	55.0	13.1	0.132	0.240	0.032	64.2
Newport	3,705	85	255	67.1	13.9	0.119	0.177	0.035	79.7
Marietta	34,659	89	2,826	61.5	13.6	0.170	0.277	0.041	69.0
Conestoga	642	95	147	57.6	15.4	0.490	0.852	0.117	60.6

Table 11. Annual Water Discharges and Annual Loads and Yields of Total Nitrate plus Nitrite, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	9,263	56.9	4.2	1.86	3.26	0.469	66.7
Danville	14,903	90	16,419	64.5	4.7	2.29	3.55	0.560	71.3
Lewisburg	9,247	86	11,023	73.2	4.6	2.52	3.44	0.606	85.3
Newport	3,705	85	9,072	75.8	3.5	4.23	5.57	1.244	84.2
Marietta	34,659	89	68,334	75.0	5.0	4.11	5.48	1.002	84.3
Conestoga	642	95	6,963	83.7	4.9	23.15	27.67	5.509	88.1

Table 12. Annual Water Discharges and Annual Loads and Yields of Total Organic Nitrogen, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	6,231	62.1	6.8	1.25	2.01	0.316	72.8
Danville	14,903	90	9,421	59.4	6.7	1.31	2.21	0.321	65.7
Lewisburg	9,247	86	4,308	58.4	12.7	0.98	1.68	0.237	68.1
Newport	3,705	85	2,870	72.6	12.4	1.34	1.84	0.393	86.2
Marietta	34,659	89	23,156	67.9	9.2	1.39	2.05	0.339	76.3
Conestoga	642	95	692	37.2	11.6	2.30	6.19	0.548	39.1

Table 13. Annual Water Discharges and Annual Loads and Yields of Dissolved Phosphorus, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	1,043	126.4	10.5	0.209	0.165	0.053	148.2
Danville	14,903	90	1,267	118.8	12.9	0.177	0.149	0.043	131.4
Lewisburg	9,247	86	507	104.7	18.8	0.116	0.111	0.028	122.1
Newport	3,705	85	245	66.4	10.0	0.114	0.172	0.034	78.8
Marietta	34,659	89	1,424	62.5	9.3	0.086	0.137	0.021	70.2
Conestoga	642	95	182	71.9	7.4	0.605	0.842	0.144	75.7

Table 14. Annual Water Discharges and Annual Loads and Yields of Dissolved Orthophosphate, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	849	183.9	12.3	0.170	0.093	0.043	215.5
Danville	14,903	90	980	165.3	16.9	0.136	0.083	0.033	183.0
Lewisburg	9,247	86	416	177.6	22.0	0.095	0.054	0.023	207.1
Newport	3,705	85	184	85.5	11.6	0.086	0.100	0.025	101.5
Marietta	34,659	89	1,032	82.9	10.3	0.062	0.075	0.015	93.2
Conestoga	642	95	152	72.6	7.7	0.506	0.696	0.120	76.5

Table 15. Annual Water Discharges and Annual Loads and Yields of Dissolved Ammonia, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	549	51.7	11.4	0.110	0.213	0.028	60.6
Danville	14,903	90	975	52.1	12.8	0.136	0.261	0.033	57.6
Lewisburg	9,247	86	550	60.6	12.2	0.126	0.207	0.030	70.6
Newport	3,705	85	185	56.5	14.3	0.086	0.152	0.025	67.1
Marietta	34,659	89	2,464	61.9	13.2	0.148	0.239	0.036	69.6
Conestoga	642	95	142	60.8	15.6	0.471	0.775	0.112	64.0

Table 16. Annual Water Discharges and Annual Loads and Yields of Dissolved Nitrogen, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	15,473	64.5	3.8	3.10	4.81	0.784	75.6
Danville	14,903	90	25,850	70.3	3.7	3.60	5.12	0.881	77.8
Lewisburg	9,247	86	14,786	71.7	4.5	3.37	4.71	0.812	83.6
Newport	3,705	85	11,204	76.8	3.3	5.22	6.80	1.536	91.2
Marietta	34,659	89	82,750	73.6	4.5	4.97	6.76	1.212	82.6
Conestoga	642	95	7,434	78.4	3.9	24.71	31.51	5.882	82.6

Table 17. Annual Water Discharges and Annual Loads and Yields of Dissolved Nitrate plus Nitrite Nitrogen, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	9,311	57.8	4.4	1.866	3.231	0.472	67.7
Danville	14,903	90	16,435	65.1	4.7	2.289	3.515	0.560	72.1
Lewisburg	9,247	86	11,007	73.6	4.6	2.512	3.411	0.605	85.9
Newport	3,705	85	9,096	76.6	3.5	4.237	5.531	1.247	91.0
Marietta	34,659	89	68,547	75.7	5.1	4.121	5.442	1.005	85.1
Conestoga	642	95	6,839	83.7	4.9	22.735	27.149	5.411	88.2

Table 18. Annual Water Discharges and Annual Loads and Yields of Dissolved Organic Nitrogen, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	4,838	68.6	7.7	0.970	1.413	0.245	80.4
Danville	14,903	90	7,029	70.5	6.2	0.979	1.388	0.240	78.0
Lewisburg	9,247	86	3,651	73.1	10.8	0.833	1.140	0.201	85.2
Newport	3,705	85	1,823	72.5	9.8	0.849	1.171	0.250	86.2
Marietta	34,659	89	13,248	68.6	10.1	0.797	1.161	0.194	77.0
Conestoga	642	95	493	43.2	10.6	1.638	3.794	0.390	45.5

Table 19. Annual Water Discharges and Annual Loads and Yields of Total Organic Carbon, Calendar Year 2009

Site	2009 Discharge cfs	Discharge % of LTM	2009 Load thousands of lbs	Load % of LTM	Prediction Error %	2009 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2009 Ave. Conc. mg/l	Conc. % of LTM
Towanda	10,031	85	61,004	74.6	3.1	12.23	16.38	3.089	87.5
Danville	14,903	90	89,089	78.1	3.0	12.41	15.88	3.036	86.5
Lewisburg	9,247	86	37,288	82.5	4.5	8.51	10.32	2.048	96.2
Newport	3,705	85	23,575	84.4	4.9	10.98	13.02	3.232	100.2
Marietta	34,659	89	200,454	84.8	3.6	12.05	14.21	2.938	95.3
Conestoga	642	95	5,237	69.9	5.3	17.41	24.90	4.143	73.6

Table 20. ***Seasonal Mean Water Discharges and Loads of Nutrients and Suspended Sediment, Calendar Year 2009***

Station	Season	Mean Q cfs	TN	TNOx	TON	TNH_3	DN	DNOx	DON	DNH_3	TP	DP	DOP	TOC	SS
			Thousands of pounds												
Towanda	Fall	9,356	3,733	2,099	1,302	143	3,573	2,120	1,069	120	405	273	229	14,686	105,575
	Winter	14,545	6,838	4,132	2,099	276	6,355	4,149	1,614	244	679	331	272	18,969	358,010
	Spring	10,392	4,168	2,155	1,714	134	3,796	2,165	1,339	126	454	259	204	15,738	148,998
	Summer	5,934	2,011	878	1,116	65	1,747	878	816	59	293	180	141	11,610	75,094
Danville	Fall	14,305	6,865	4,205	2,068	255	6,499	4,218	1,690	235	629	333	265	22,303	229,083
	Winter	20,165	10,771	6,887	2,917	460	10,125	6,902	2,256	430	872	407	313	25,153	375,641
	Spring	15,821	6,910	3,650	2,670	238	6,182	3,647	1,890	211	640	316	238	23,273	233,944
	Summer	9,609	3,589	1,677	1,766	115	3,045	1,668	1,194	99	423	212	164	18,360	155,171
Lewisburg	Fall	10,533	4,425	3,247	1,193	160	4,264	3,251	1,032	148	261	146	115	11,821	98,603
	Winter	12,140	5,577	4,052	1,455	229	5,343	4,054	1,193	227	294	155	129	10,753	130,929
	Spring	9,284	3,581	2,459	1,063	129	3,423	2,446	917	123	204	130	111	8,485	57,176
	Summer	5,196	1,864	1,264	598	61	1,756	1,256	508	53	117	77	61	6,230	32,823
Newport	Fall	4,717	4,392	3,235	1,014	77	4,022	3,256	643	55	209	101	79	8,542	97,293
	Winter	3,127	2,560	2,074	434	44	2,446	2,076	316	33	55	32	23	3,820	14,036
	Spring	5,708	4,378	3,178	1,167	107	3,954	3,183	679	78	201	85	61	8,833	95,627
	Summer	1,318	838	584	254	27	782	581	184	19	45	28	21	2,380	7,061
Marietta	Fall	37,953	28,818	21,089	6,766	863	25,752	21,266	3,965	752	1,391	532	397	59,845	849,782
	Winter	40,946	29,276	22,680	5,876	1,003	26,552	22,744	3,594	889	1,030	318	221	48,275	664,247
	Spring	40,265	23,938	16,908	6,707	658	20,518	16,869	3,600	565	1,107	324	229	56,573	627,549
	Summer	20,048	11,603	7,657	3,806	303	9,928	7,669	2,090	258	640	249	186	35,762	280,675
Conestoga	Fall	917	2,675	2,382	253	70	2,520	2,344	146	67	132	77	65	1,998	47,530
	Winter	466	1,586	1,463	128	21	1,567	1,430	112	20	28	20	17	729	4,745
	Spring	693	2,043	1,823	199	33	1,988	1,791	151	32	65	37	30	1,387	20,523
	Summer	496	1,387	1,295	112	23	1,359	1,274	84	22	68	48	41	1,122	15,169

Table 21. Seasonal Mean Water Discharges and Yields of Nutrients and Suspended Sediment, Calendar Year 2009

Station	Season	Mean Q cfs	TN	TNOx	TON	TNH_3	DN	DNOx	DON	DNH_3	TP	DP	DOP	TOC	SS
			Lbs/acre												
Towanda	Fall	9,356	0.75	0.42	0.26	0.03	0.72	0.42	0.21	0.02	0.081	0.055	0.046	2.94	21.16
	Winter	14,545	1.37	0.83	0.42	0.06	1.27	0.83	0.32	0.05	0.136	0.066	0.055	3.80	71.74
	Spring	10,392	0.84	0.43	0.34	0.03	0.76	0.43	0.27	0.03	0.091	0.052	0.041	3.15	29.86
	Summer	5,934	0.24	0.18	0.22	0.01	0.35	0.18	0.16	0.01	0.059	0.036	0.028	2.33	15.05
Danville	Fall	14,305	0.96	0.59	0.29	0.04	0.91	0.59	0.24	0.03	0.088	0.046	0.037	3.11	31.90
	Winter	20,165	1.50	0.96	0.41	0.06	1.41	0.96	0.31	0.06	0.121	0.057	0.044	3.50	52.31
	Spring	15,821	0.96	0.51	0.37	0.03	0.86	0.51	0.26	0.03	0.089	0.044	0.033	3.24	32.58
	Summer	9,609	0.50	0.23	0.25	0.02	0.42	0.23	0.17	0.01	0.059	0.030	0.023	2.56	21.61
Lewisburg	Fall	10,533	1.01	0.74	0.27	0.04	0.97	0.74	0.24	0.03	0.060	0.033	0.026	2.70	22.50
	Winter	12,140	1.27	0.92	0.33	0.05	1.22	0.93	0.27	0.05	0.067	0.035	0.029	2.45	29.88
	Spring	9,284	0.82	0.56	0.24	0.03	0.78	0.56	0.21	0.03	0.047	0.030	0.025	1.94	13.05
	Summer	5,196	0.43	0.29	0.14	0.01	0.40	0.29	0.12	0.01	0.027	0.018	0.014	1.42	7.49
Newport	Fall	4,717	2.05	1.51	0.47	0.04	1.87	1.52	0.30	0.03	0.097	0.047	0.037	3.98	45.33
	Winter	3,127	1.19	0.97	0.20	0.02	1.14	0.97	0.15	0.02	0.026	0.015	0.011	1.78	6.54
	Spring	5,708	2.04	1.48	0.54	0.05	1.84	1.48	0.32	0.04	0.094	0.040	0.028	4.11	44.55
	Summer	1,318	0.39	0.27	0.12	0.01	0.36	0.27	0.09	0.01	0.021	0.013	0.010	1.11	3.29
Marietta	Fall	37,953	1.73	1.27	0.41	0.05	1.55	1.28	0.24	0.05	0.084	0.032	0.024	3.60	51.09
	Winter	40,946	1.76	1.36	0.35	0.06	1.60	1.37	0.22	0.05	0.062	0.019	0.013	2.90	39.93
	Spring	40,265	1.44	1.02	0.40	0.04	1.23	1.01	0.22	0.03	0.067	0.019	0.014	3.40	37.73
	Summer	20,048	0.70	0.46	0.23	0.02	0.60	0.46	0.13	0.02	0.038	0.015	0.011	2.15	16.87
Conestoga	Fall	917	8.89	7.92	0.84	0.23	8.38	7.79	0.49	0.22	0.439	0.256	0.216	6.64	158.01
	Winter	466	5.27	4.86	0.43	0.07	5.21	4.75	0.37	0.07	0.093	0.066	0.057	2.42	15.77
	Spring	693	6.79	6.06	0.66	0.11	6.61	5.95	0.50	0.11	0.216	0.123	0.100	4.61	68.23
	Summer	496	4.61	4.31	0.37	0.08	4.52	4.24	0.28	0.07	0.226	0.160	0.136	3.73	50.43

Table 22. 2009 Monthly Flow in CFS and TN, TP, and SS in Thousands of Pounds at Susquehanna River Sites: Towanda, Danville, and Marietta

Month	Towanda				Danville				Marietta			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	8,315	1,318	85	16,003	14,602	2,683	179	49,964	32,594	8,607	258	131,831
February	11,166	1,652	131	44,730	16,884	2,849	204	71,706	39,018	8,747	293	185,161
March	23,827	3,868	463	297,277	28,694	5,239	489	253,971	51,039	11,922	479	347,255
April	12,764	1,847	165	47,626	18,108	2,886	224	69,604	45,647	9,455	364	203,461
May	8,238	1,102	110	26,335	13,660	1,981	176	57,266	39,516	7,846	365	205,307
June	10,244	1,219	179	75,037	15,766	2,043	240	107,074	35,657	6,637	378	218,781
July	5,808	674	90	19,452	9,634	1,208	133	43,129	19,623	3,609	184	72,057
August	8,437	951	152	48,394	13,282	1,672	220	94,679	27,348	5,517	342	173,733
September	3,479	386	51	7,248	5,787	709	70	17,363	12,943	2,477	114	34,885
October	8,510	1,066	159	60,771	12,447	1,844	223	110,736	31,465	7,686	492	346,831
November	8,667	1,104	112	21,438	13,711	2,094	190	62,420	32,297	7,890	356	191,123
December	10,867	1,563	134	23,366	16,739	2,927	216	55,927	49,916	13,242	543	311,828
Annual#	10,027	16,750	1,831	687,677	14,943	28,135	2,564	993,839	34,755	93,635	4,168	2,422,253

Annual flow is average for the year

Table 23. 2009 Monthly Flow in CFS and TN, TP, and SS in Thousands of Pounds at Susquehanna River Tributary Sites: Lewisburg, Newport, and Conestoga

Month	Lewisburg				Newport				Conestoga			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	7,533	1,282	50	11,936	3,157	953	21	5,477	597	702	14	2,889
February	13,293	1,922	104	49,454	3,769	979	21	6,057	460	492	8	1,155
March	15,705	2,373	140	69,539	2,517	628	13	2,502	340	392	6	701
April	11,457	1,555	83	24,410	6,349	1,655	57	23,517	628	649	15	4,184
May	9,192	1,184	68	17,988	6,662	1,734	91	52,142	756	752	25	8,697
June	7,207	842	53	14,778	4,081	989	53	19,968	694	642	25	7,642
July	4,628	565	32	6,883	1,573	336	17	3,073	425	405	16	2,773
August	8,198	936	68	23,459	1,311	281	16	2,430	551	513	27	6,332
September	2,680	363	17	2,481	1,062	221	12	1,558	512	469	25	6,064
October	9,182	1,203	85	41,105	3,820	1,181	74	36,167	753	715	43	14,425
November	7,876	1,091	56	15,138	2,957	850	32	7,760	659	653	24	4,718
December	14,457	2,131	120	42,360	7,316	2,361	103	53,366	1,332	1,307	65	28,387
Annual#	9,284	15,447	876	319,531	3,715	12,168	510	214,017	642	7,691	293	87,967

Annual flow is average for the year

Table 24. 2009 Monthly Flow in CFS and TN, TP, and SS Yields in lbs/acre at Susquehanna River Sites: Towanda, Danville, and Marietta

Month	Towanda				Danville				Marietta			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	8,315	0.26	0.017	3.21	14,602	0.37	0.025	6.96	32,594	0.52	0.016	7.93
February	11,166	0.33	0.026	8.96	16,884	0.40	0.028	9.99	39,018	0.53	0.018	11.13
March	23,827	0.78	0.093	59.57	28,694	0.73	0.068	35.37	51,039	0.72	0.029	20.88
April	12,764	0.37	0.033	9.54	18,108	0.40	0.031	9.69	45,647	0.57	0.022	12.23
May	8,238	0.22	0.022	5.28	13,660	0.28	0.025	7.97	39,516	0.47	0.022	12.34
June	10,244	0.24	0.036	15.04	15,766	0.28	0.033	14.91	35,657	0.40	0.023	13.15
July	5,808	0.14	0.018	3.90	9,634	0.17	0.019	6.01	19,623	0.22	0.011	4.33
August	8,437	0.19	0.030	9.70	13,282	0.23	0.031	13.19	27,348	0.33	0.021	10.44
September	3,479	0.08	0.010	1.45	5,787	0.10	0.010	2.42	12,943	0.15	0.007	2.10
October	8,510	0.21	0.032	12.18	12,447	0.26	0.031	15.42	31,465	0.46	0.030	20.85
November	8,667	0.22	0.022	4.30	13,711	0.29	0.026	8.69	32,297	0.47	0.021	11.49
December	10,867	0.31	0.027	4.68	16,739	0.41	0.030	7.79	49,916	0.80	0.033	18.75
Annual#	10,027	3.36	0.367	137.81	14,943	3.92	0.357	138.40	34,755	5.63	0.251	145.62

Annual flow is average for the year

Table 25. 2009 Monthly Flow in CFS and TN, TP, and SS Yields in lbs/acre at Susquehanna River Tributary Sites: Lewisburg, Newport, and Conestoga

Month	Lewisburg				Newport				Conestoga			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	7,533	0.29	0.011	2.72	3,157	0.44	0.010	2.55	597	2.33	0.047	9.60
February	13,293	0.44	0.024	11.29	3,769	0.46	0.010	2.82	460	1.64	0.027	3.84
March	15,705	0.54	0.032	15.87	2,517	0.29	0.006	1.17	340	1.30	0.020	2.33
April	11,457	0.35	0.019	5.57	6,349	0.77	0.027	10.96	628	2.16	0.050	13.91
May	9,192	0.27	0.016	4.10	6,662	0.81	0.042	24.29	756	2.50	0.083	28.91
June	7,207	0.19	0.012	3.37	4,081	0.46	0.025	9.30	694	2.13	0.083	25.41
July	4,628	0.13	0.007	1.57	1,573	0.16	0.008	1.43	425	1.35	0.053	9.22
August	8,198	0.21	0.016	5.35	1,311	0.13	0.007	1.13	551	1.71	0.090	21.05
September	2,680	0.08	0.004	0.57	1,062	0.10	0.006	0.73	512	1.56	0.083	20.16
October	9,182	0.27	0.019	9.38	3,820	0.55	0.034	16.85	753	2.38	0.143	47.96
November	7,876	0.25	0.013	3.45	2,957	0.40	0.015	3.62	659	2.17	0.080	15.68
December	14,457	0.49	0.027	9.67	7,316	1.10	0.048	24.86	1,332	4.35	0.216	94.37
Annual#	9,284	3.53	0.200	72.92	3,715	5.67	0.238	99.70	642	25.57	0.974	292.44

Annual flow is average for the year

Table 26. Temperature, Dissolved Oxygen, Conductivity, and pH Summary Statistics of Samples Collected During 2009

Station	Temperature (C°)					Dissolved Oxygen (mg/L)					Conductivity (umhos/cm)					pH (S.U.)				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.1	24.4	10.7	11.2	8.0	6.25	13.33	10.59	10.33	2.34	169	483	302	310	76	7.1	8.4	7.6	7.7	0.45
Cohocton	0.4	26.5	10.7	11.5	8.3	7.60	13.15	9.72	10.52	1.75	273	756	460	459	124	7.0	8.0	7.4	7.4	0.32
Conklin	0.1	24.7	13.1	13.0	8.5	7.62	13.50	10.60	10.15	1.69	108	231	191	176	36	6.6	7.6	7.1	7.1	0.33
Smithboro	0.1	21.8	10.7	11.5	7.4	7.17	13.15	10.19	10.18	1.93	115	283	194	197	53	6.8	8.5	7.4	7.5	0.56
Unadilla	0.1	23.7	9.4	11.9	8.4	7.82	13.55	10.27	10.32	1.80	139	292	242	235	41	6.8	7.8	7.3	7.3	0.25
Castanea	0.2	21.5	11.4	11.8	7.3	8.26	17.33	10.91	11.33	2.67	195	371	276	276	55	6.8	8.8	7.5	7.4	0.52
Conestoga	3.2	24.5	11.9	13.5	6.6	8.41	17.26	10.16	10.78	2.39	378	840	575	573	110	7.5	8.3	7.8	7.9	0.21
Danville	0.1	26.7	13.7	15.9	9.3	6.95	12.70	9.85	9.95	1.76	133	287	210	207	37	6.6	7.8	7.1	7.1	0.33
Dromgold	0.9	22.5	11.7	9.0	6.9	7.68	14.78	11.06	11.58	2.04	102	240	161	160	40	6.9	8.5	7.7	7.6	0.51
Hershey	3.2	23.0	14.6	14.7	6.5	8.11	13.04	10.19	9.96	1.56	155	311	251	255	46	7.5	7.9	7.7	7.7	0.14
Hogestown	2.0	24.1	13.5	12.7	6.4	6.81	13.86	10.66	11.13	2.07	212	526	380	385	100	7.5	8.5	7.9	7.8	0.31
Jersey Shore	0.1	23.4	12.3	11.5	8.3	8.11	19.02	11.39	10.78	3.02	138	314	221	203	57	6.7	7.7	7.1	7.0	0.28
Karthaus	0.2	26.1	12.2	11.9	7.9	7.47	17.39	10.80	10.52	2.62	273	615	379	340	103	6.0	7.2	6.7	6.7	0.31
Lewisburg	0.1	24.3	12.4	12.0	8.7	7.82	19.12	10.93	10.46	2.92	115	268	201	202	40	6.5	7.8	6.9	6.8	0.32
Manchester	3.4	28.7	14.3	13.8	6.9	8.06	14.55	11.07	11.17	1.93	172	339	258	258	46	7.4	8.6	7.6	7.8	0.37
Marietta	3.8	27.0	12.0	14.6	7.5	8.05	15.54	10.97	11.01	2.08	147	299	222	218	33	7.5	8.5	7.9	7.9	0.29
Martic Forge	4.7	21.2	10.8	12.7	5.3	8.84	14.58	11.48	11.38	1.92	268	527	416	423	85	7.5	8.4	7.9	7.9	0.24
Newport	1.9	26.6	13.4	14.0	6.8	6.72	14.68	10.41	10.57	2.21	177	312	243	243	39	7.3	9.1	8.0	8.0	0.48
Penns Creek	0.1	22.5	10.0	10.8	6.9	6.67	18.52	11.35	11.08	2.88	145	242	199	194	31	6.8	8.1	7.3	7.3	0.45
Saxton	0.8	27.4	12.4	12.9	8.0	9.40	13.98	11.32	11.28	1.16	126	399	237	253	90	7.4	8.8	7.9	7.9	0.42
Towanda	0.1	24.3	11.6	12.7	8.9	7.07	13.68	10.10	10.27	1.94	130	333	233	232	53	6.7	8.2	7.2	7.3	0.37
Wilkes-Barre	0.1	25.1	12.8	13.6	9.0	7.37	13.33	9.97	9.99	1.72	133	334	226	226	49	6.8	7.9	7.3	7.3	0.33
Richardsmere	3.8	26.6	12.1	14.0	7.0	9.17	15.05	11.20	11.34	1.69	175	276	248	237	30	7.3	8.7	7.8	7.9	0.35

Table 27. Total Nitrogen Species Summary Statistics of Samples Collected During 2009, in mg/L

Station	Total Nitrogen					Total Ammonium					Total Nitrate plus Nitrite					Total Organic Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.59	1.30	0.89	0.91	0.23	0.01	0.118	0.035	0.046	0.036	0.209	0.983	0.453	0.480	0.206	0.216	0.757	0.364	0.387	0.154
Cohocton	0.71	1.75	1.13	1.15	0.30	0.02	0.092	0.045	0.049	0.026	0.274	1.250	0.795	0.727	0.290	0.231	0.725	0.300	0.377	0.157
Conklin	0.40	0.92	0.63	0.64	0.15	0.01	0.104	0.030	0.039	0.024	0.148	0.728	0.260	0.341	0.173	0.078	0.549	0.241	0.262	0.131
Smithboro	0.54	1.05	0.75	0.76	0.14	0.01	0.075	0.031	0.032	0.022	0.184	0.815	0.382	0.398	0.196	0.117	0.619	0.322	0.329	0.150
Unadilla	0.55	1.17	0.81	0.83	0.20	0.01	0.086	0.030	0.035	0.022	0.106	0.986	0.437	0.512	0.245	0.088	0.869	0.240	0.283	0.195
Castanea	0.87	2.41	1.36	1.39	0.41	0.02	0.060	0.020	0.028	0.013	0.600	1.600	1.070	1.105	0.306	0.030	1.400	0.200	0.277	0.360
Conestoga	4.41	9.16	6.63	6.72	1.37	0.02	0.520	0.060	0.088	0.102	3.720	8.700	6.340	6.239	1.569	0.030	1.250	0.340	0.469	0.341
Danville	0.57	2.01	0.94	0.86	0.33	0.02	0.090	0.036	0.020	0.022	0.180	2.000	0.614	0.490	0.393	0.120	0.590	0.304	0.320	0.123
Dromgold	1.32	3.19	1.75	1.60	0.49	0.02	0.050	0.026	0.020	0.011	0.930	2.120	1.430	1.430	0.297	0.080	1.650	0.324	0.155	0.413
Hershey	2.82	4.09	3.49	3.53	0.35	0.02	0.150	0.047	0.030	0.040	1.890	3.940	3.108	3.265	0.529	0.080	0.960	0.333	0.200	0.297
Hogestown	2.54	4.95	3.89	3.96	0.71	0.02	0.070	0.030	0.030	0.014	1.760	4.670	3.465	3.580	0.789	0.060	1.900	0.396	0.250	0.458
Jersey Shore	0.40	1.47	0.67	0.65	0.27	0.02	0.060	0.030	0.020	0.016	0.290	0.790	0.454	0.415	0.133	0.040	1.140	0.185	0.085	0.283
Karthaus	0.25	1.75	0.57	0.49	0.38	0.02	0.110	0.041	0.030	0.027	0.170	0.680	0.334	0.310	0.133	0.020	1.400	0.198	0.110	0.351
Lewisburg	0.47	2.02	0.89	0.82	0.31	0.02	0.110	0.034	0.020	0.023	0.330	1.010	0.651	0.640	0.208	0.040	1.020	0.210	0.155	0.196
Manchester	1.00	3.88	2.57	2.53	0.69	0.02	0.110	0.030	0.045	0.032	0.670	3.390	2.000	1.863	0.649	0.210	1.940	0.350	0.622	0.503
Marietta	0.96	2.02	1.30	1.34	0.28	0.02	0.110	0.030	0.038	0.022	0.530	1.610	0.980	1.012	0.296	0.110	0.660	0.260	0.295	0.140
Martic Forge	5.21	9.44	6.51	7.04	1.33	0.02	0.240	0.060	0.097	0.078	3.180	9.510	6.155	6.336	1.966	0.010	1.900	0.900	0.964	0.567
Newport	0.98	3.33	1.49	1.61	0.47	0.02	0.110	0.030	0.034	0.020	0.810	1.750	1.180	1.200	0.248	0.060	2.210	0.230	0.380	0.439
Penns Creek	0.92	2.18	1.43	1.49	0.41	0.02	0.110	0.030	0.039	0.026	0.760	1.900	1.075	1.135	0.357	0.030	0.840	0.250	0.316	0.236
Saxton	1.18	2.69	1.64	1.73	0.36	0.02	0.060	0.020	0.027	0.014	0.890	1.830	1.410	1.389	0.274	0.080	1.480	0.160	0.337	0.430
Towanda	0.45	1.23	0.75	0.80	0.20	0.02	0.060	0.020	0.025	0.010	0.090	1.070	0.440	0.474	0.258	0.090	0.740	0.300	0.299	0.144
Wilkes-Barre	0.51	1.07	0.78	0.79	0.19	0.02	0.070	0.025	0.033	0.018	0.040	1.010	0.380	0.408	0.258	0.010	0.590	0.395	0.351	0.158
Richardsmere	4.68	8.50	6.35	6.48	1.18	0.02	0.210	0.095	0.094	0.065	3.810	8.260	5.630	5.896	1.458	0.030	1.670	0.600	0.574	0.449

Table 28. Dissolved Nitrogen Species Summary Statistics of Samples Collected During 2009, in mg/L

Station	Dissolved Nitrogen					Dissolved Ammonium					Dissolved Nitrate plus Nitrite					Dissolved Organic Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.50	1.29	0.75	0.82	0.25	0.010	0.111	0.051	0.052	0.034	0.209	0.983	0.465	0.509	0.243	0.159	0.405	0.240	0.258	0.069
Cohocton	0.69	1.59	1.22	1.18	0.33	0.019	0.089	0.039	0.045	0.025	0.274	1.250	0.795	0.726	0.291	0.231	0.718	0.401	0.408	0.131
Conklin	0.41	0.90	0.61	0.63	0.17	0.013	0.066	0.029	0.033	0.018	0.148	0.730	0.261	0.341	0.173	0.081	0.467	0.232	0.256	0.114
Smithboro	0.45	1.00	0.63	0.69	0.21	0.010	0.076	0.029	0.035	0.023	0.184	0.815	0.384	0.423	0.241	0.131	0.334	0.216	0.230	0.064
Unadilla	0.39	1.32	0.78	0.83	0.30	0.010	0.060	0.025	0.032	0.018	0.106	0.986	0.436	0.511	0.246	0.113	0.739	0.215	0.282	0.173
Castanea	0.78	2.13	1.35	1.34	0.36	0.020	0.060	0.020	0.025	0.011	0.590	1.570	1.070	1.095	0.303	0.050	1.120	0.165	0.238	0.283
Conestoga	4.34	9.16	6.58	6.57	1.43	0.020	0.500	0.050	0.081	0.098	3.720	8.700	6.310	6.162	1.564	0.090	0.830	0.290	0.386	0.240
Danville	0.35	1.99	0.86	0.81	0.35	0.020	0.080	0.031	0.020	0.017	0.180	2.000	0.609	0.490	0.394	0.120	0.410	0.229	0.210	0.091
Dromgold	1.29	2.90	1.71	1.56	0.41	0.020	0.040	0.023	0.020	0.007	0.930	2.120	1.423	1.430	0.298	0.050	1.390	0.282	0.145	0.340
Hershey	2.39	4.09	3.41	3.50	0.45	0.020	0.160	0.045	0.030	0.041	1.900	3.940	3.100	3.245	0.523	0.070	0.760	0.268	0.190	0.237
Hogestown	2.38	4.95	3.84	3.93	0.74	0.020	0.050	0.028	0.025	0.009	1.760	4.670	3.461	3.570	0.794	0.030	1.830	0.356	0.170	0.448
Jersey Shore	0.32	1.47	0.64	0.60	0.27	0.020	0.060	0.025	0.020	0.012	0.290	0.770	0.448	0.415	0.129	0.010	1.150	0.178	0.080	0.297
Karthaus	0.24	1.63	0.54	0.46	0.35	0.020	0.080	0.033	0.025	0.019	0.170	0.680	0.329	0.300	0.133	0.010	1.290	0.182	0.110	0.324
Lewisburg	0.47	1.16	0.82	0.82	0.21	0.020	0.090	0.031	0.020	0.020	0.330	0.960	0.648	0.640	0.205	0.010	0.340	0.147	0.120	0.089
Manchester	0.95	3.64	2.34	2.35	0.64	0.020	0.110	0.030	0.044	0.031	0.650	3.390	2.000	1.849	0.651	0.130	1.400	0.280	0.458	0.321
Marietta	0.76	2.02	1.22	1.22	0.32	0.020	0.060	0.030	0.030	0.013	0.530	1.610	0.980	1.007	0.295	0.040	0.370	0.160	0.178	0.079
Martic Forge	4.25	9.17	6.46	6.78	1.54	0.020	0.220	0.045	0.081	0.072	3.180	9.480	6.080	6.263	1.895	0.280	1.230	0.625	0.656	0.275
Newport	0.95	3.33	1.42	1.49	0.46	0.020	0.100	0.020	0.027	0.016	0.810	1.760	1.150	1.191	0.246	0.060	2.220	0.140	0.275	0.410
Penns Creek	0.92	1.98	1.30	1.39	0.34	0.020	0.110	0.020	0.033	0.024	0.700	1.880	1.080	1.115	0.366	0.040	0.530	0.220	0.245	0.151
Saxton	1.09	2.69	1.59	1.64	0.37	0.020	0.060	0.020	0.024	0.011	0.890	1.830	1.420	1.389	0.278	0.050	1.480	0.145	0.241	0.366
Towanda	0.27	1.21	0.68	0.71	0.23	0.020	0.040	0.020	0.022	0.005	0.090	1.060	0.440	0.471	0.255	0.030	0.430	0.200	0.212	0.101
Wilkes-Barre	0.28	1.04	0.67	0.69	0.24	0.020	0.070	0.020	0.029	0.015	0.040	1.010	0.385	0.408	0.257	0.150	0.460	0.240	0.267	0.096
Richardsmere	4.48	8.43	6.18	6.32	1.27	0.020	0.210	0.095	0.090	0.063	3.810	8.260	5.560	5.838	1.462	0.030	0.850	0.465	0.466	0.271

Table 29. Phosphorus Species and Total Suspended Solids Summary Statistics of Samples Collected During 2009, in mg/L

Station	Total Phosphorus					Dissolved Phosphorus					Orthophosphorus					Total Suspended Solids				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.029	0.156	0.088	0.090	0.039	0.032	0.090	0.050	0.058	0.024	0.023	0.088	0.049	0.055	0.026	2.2	111	6.8	22.6	32.6
Cohocton	0.020	0.132	0.061	0.070	0.033	0.016	0.068	0.048	0.046	0.016	0.015	0.068	0.038	0.042	0.017	1.4	103	4.0	15.7	26.9
Conklin	0.014	0.128	0.066	0.066	0.035	0.008	0.087	0.031	0.039	0.023	0.008	0.079	0.031	0.035	0.024	2.4	77	7.5	16.6	20.9
Smithboro	0.023	0.183	0.052	0.064	0.045	0.012	0.060	0.025	0.032	0.017	0.012	0.059	0.023	0.029	0.018	1.6	71	13.1	23.6	22.2
Unadilla	0.012	0.191	0.054	0.067	0.045	0.008	0.071	0.037	0.039	0.020	0.008	0.070	0.037	0.037	0.021	2.6	149	6.1	19.5	39.0
Castanea	0.013	0.108	0.028	0.037	0.026	0.010	0.091	0.012	0.024	0.023	0.010	0.078	0.010	0.019	0.019	5.0	18	5.0	7.2	4.1
Conestoga	0.044	0.468	0.156	0.187	0.116	0.027	0.314	0.109	0.128	0.073	0.018	0.274	0.091	0.107	0.064	5.0	150	16.0	27.4	34.2
Danville	0.020	0.142	0.075	0.071	0.032	0.010	0.121	0.042	0.037	0.026	0.010	0.106	0.032	0.022	0.024	5.0	60	18.7	14.0	17.1
Dromgold	0.013	0.147	0.038	0.028	0.034	0.010	0.091	0.025	0.018	0.021	0.010	0.070	0.018	0.014	0.015	5.0	30	9.1	5.0	7.5
Hershey	0.024	0.352	0.072	0.049	0.089	0.018	0.110	0.035	0.028	0.025	0.013	0.089	0.029	0.025	0.020	5.0	178	24.9	9.0	48.8
Hogestown	0.010	0.136	0.037	0.024	0.034	0.010	0.094	0.022	0.016	0.021	0.010	0.043	0.016	0.014	0.010	5.0	106	16.9	5.5	25.9
Jersey Shore	0.010	0.076	0.037	0.033	0.024	0.010	0.072	0.027	0.010	0.023	0.010	0.059	0.022	0.010	0.017	5.0	26	8.9	5.0	6.9
Karthaus	0.010	0.065	0.026	0.019	0.019	0.010	0.037	0.014	0.010	0.008	0.010	0.034	0.014	0.010	0.007	5.0	48	11.1	6.0	11.9
Lewisburg	0.012	0.114	0.040	0.036	0.028	0.010	0.099	0.026	0.012	0.024	0.010	0.083	0.021	0.010	0.019	5.0	38	9.5	5.0	9.3
Manchester	0.046	0.470	0.091	0.157	0.128	0.028	0.265	0.074	0.109	0.076	0.019	0.236	0.057	0.091	0.066	5.0	260	8.0	33.2	63.5
Marietta	0.021	0.200	0.046	0.061	0.047	0.010	0.050	0.014	0.019	0.011	0.010	0.034	0.011	0.015	0.008	5.0	160	12.0	25.3	37.7
Martic Forge	0.032	1.042	0.159	0.364	0.382	0.017	0.676	0.114	0.218	0.223	0.012	0.629	0.099	0.192	0.201	5.0	350	19.0	77.3	114.8
Newport	0.019	0.137	0.042	0.051	0.031	0.012	0.058	0.018	0.026	0.015	0.010	0.045	0.015	0.021	0.012	5.0	74	8.0	15.1	17.2
Penns Creek	0.010	0.296	0.034	0.058	0.075	0.010	0.155	0.021	0.036	0.040	0.010	0.135	0.018	0.028	0.035	5.0	86	7.0	16.9	21.9
Saxton	0.010	0.268	0.021	0.043	0.065	0.010	0.027	0.010	0.013	0.005	0.010	0.024	0.010	0.012	0.004	5.0	292	5.0	31.3	73.8
Towanda	0.019	0.195	0.060	0.073	0.043	0.013	0.101	0.042	0.044	0.023	0.012	0.077	0.035	0.036	0.019	5.0	174	10.0	25.4	38.0
Wilkes-Barre	0.020	0.156	0.053	0.068	0.043	0.011	0.066	0.028	0.032	0.018	0.010	0.055	0.021	0.025	0.014	5.0	106	13.0	25.6	29.1
Richardsmere	0.063	0.546	0.128	0.174	0.136	0.030	0.195	0.092	0.101	0.053	0.021	0.173	0.075	0.084	0.048	5.0	266	7.0	33.6	66.0

Table 30. Flow, Total Organic Carbon, Total Kjeldahl, and Dissolved Kjeldahl Summary Statistics of Samples Collected During 2009, in mg/L

Station	Flow (cfs)					Total Organic Carbon					Total Kjeldahl Nitrogen					Dissolved Kjeldahl Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	308	18,575	2,096	3,468	4,627	2.4	4.6	3.4	3.6	0.79	0.24	0.80	0.38	0.43	0.17	0.25	0.47	0.29	0.31	0.07
Cohocton	65	3,158	281	532	805	2.8	6.7	3.7	4.1	1.16	0.26	0.77	0.33	0.43	0.17	0.30	0.74	0.44	0.45	0.12
Conklin	1,009	17,469	3,331	4,360	4,061	1.5	5.4	3.0	3.3	1.25	0.10	0.58	0.27	0.30	0.14	0.10	0.48	0.27	0.29	0.12
Smithboro	2,728	49,359	8,405	11,088	11,066	1.7	5.6	3.1	3.4	1.28	0.13	0.69	0.35	0.36	0.16	0.16	0.41	0.27	0.27	0.07
Unadilla	273	4,711	517	1,137	1,408	1.5	5.4	3.2	3.1	1.14	0.14	0.91	0.27	0.32	0.20	0.14	0.76	0.24	0.31	0.17
Castanea	314	1,602	549	771	442	1.4	2.4	1.8	1.8	0.33	0.08	1.42	0.23	0.01	0.36	0.07	1.14	0.19	0.26	0.28
Conestoga	299	2,190	563	767	505	1.9	6.2	3.3	3.7	1.34	0.03	1.29	0.51	0.54	0.35	0.13	0.90	0.46	0.47	0.25
Danville	4,819	70,814	15,999	11,966	13,155	1.6	5.6	2.9	2.7	0.98	0.01	0.61	0.33	0.35	0.13	0.14	0.45	0.26	0.23	0.09
Dromgold	53	1,044	427	241	370	1.2	5.9	2.6	2.3	1.38	0.10	1.67	0.35	0.18	0.41	0.07	1.41	0.31	0.17	0.34
Hershey	337	5,333	1,320	758	1,379	1.4	9.7	3.0	2.6	2.18	0.10	1.06	0.38	0.23	0.31	0.09	0.78	0.31	0.21	0.24
Hogestown	169	3,659	1,067	595	1,160	1.4	6.5	2.7	2.1	1.38	0.08	1.94	0.43	0.28	0.46	0.05	1.87	0.38	0.20	0.45
Jersey Shore	1,443	22,904	8,053	6,748	6,289	1.1	2.9	1.6	1.4	0.53	0.08	1.16	0.22	0.13	0.28	0.03	1.17	0.19	0.10	0.29
Karthaus	424	4,815	2,040	1,871	1,462	0.9	2.9	1.5	1.3	0.58	0.04	1.43	0.24	0.17	0.35	0.03	1.31	0.22	0.15	0.32
Lewisburg	2,423	25,991	9,096	7,229	6,257	1.2	3.8	1.8	1.6	0.68	0.01	1.08	0.24	0.19	0.20	0.01	0.39	0.17	0.16	0.09
Manchester	110	9,109	682	1,701	2,355	2.4	12.3	4.3	5.7	3.10	0.23	2.03	0.37	0.67	0.53	0.15	1.49	0.32	0.50	0.35
Marietta	9,623	135,571	29,672	37,955	27,015	1.7	4.9	2.6	2.8	0.92	0.15	0.71	0.28	0.32	0.14	0.10	0.51	0.20	0.22	0.10
Martic Forge	97	791	160	287	222	1.3	11.3	3.7	4.7	3.50	0.07	2.03	0.97	1.08	0.63	0.30	1.39	0.73	0.75	0.32
Newport	982	23,016	3,547	5,354	5,332	1.8	5.9	2.5	2.8	1.03	0.08	2.26	0.27	0.41	0.44	0.08	2.26	0.16	0.30	0.41
Penns Creek	128	2040	348	544	543	1.4	6.4	2.1	2.8	1.44	0.08	0.95	0.30	0.36	0.25	0.08	0.55	0.25	0.28	0.16
Saxton	86	13,995	721	2,015	3,648	1.6	9.5	2.4	2.9	1.96	0.10	1.51	0.19	0.37	0.44	0.07	1.51	0.17	0.27	0.37
Towanda	2,487	67,929	6,655	11,005	12,411	1.8	6.7	2.6	3.1	1.23	0.11	0.76	0.32	0.32	0.14	0.05	0.45	0.22	0.23	0.10
Wilkes-Barre	3,762	74,402	12,339	17,243	16,921	2.0	6.0	3.6	3.5	1.19	0.06	0.61	0.42	0.38	0.16	0.03	0.50	0.25	0.28	0.12
Richardsmere	85	1,511	225	395	399	2.3	11.6	3.7	4.4	2.34	0.12	1.88	0.65	0.68	0.47	0.05	0.98	0.49	0.53	0.31

COMPARISON OF THE 2009 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

Annual fluctuations of nutrient and SS loads and water discharge create difficulties in determining whether the changes observed were related to land use, nutrient availability, or simply annual water discharge. Ott and others (1991) used the relationship between annual loads and annual water discharge to provide a method to reduce the variability of loadings due to discharge. This was accomplished by plotting the annual yields against the water-discharge ratio. This water-discharge ratio is the ratio of the annual mean discharge to the LTM discharge. Data from the initial five-year study (1985-89) were used to provide a best-fit linear regression line to be used as the baseline relationship between annual yields and water discharge. It was hypothesized that as future yields and water-discharge ratios were plotted against the baseline, any significant deviation from the baseline would indicate that some change in the annual yield had occurred, and that further evaluations to determine the reason for the change were warranted.

Several different baselines were developed for this report. The data collected in 2009 were compared with the 1985-89 baselines, where possible. Monitoring at some of the stations was started after 1987; therefore, a baseline was established for the five-year period following the start of monitoring. Additionally, 2009 yield values were plotted against baselines developed from years prior to 2009 including the first half of the dataset (usually 1985-1996), the second half of the dataset (usually 1997-2008), and the entire dataset (usually 1985-2009).

The results of these analyses are shown in Tables 31 and 32. The R^2 value represents the strength of the correlation between the two parameters in the regression. An R^2 of one means that there is perfect correlation between the two variables–flow and the individual parameter. The closer the R^2 is to a value of one, the better the regression line is for accurately using one variable (flow) to predict the other. R^2 values less than 0.5 have poor predictive value (< 50 percent) and have been noted with an asterisk (*) in Tables 31 and 32. Where R^2 value was low for a parameter when using linear regression to explain the relationship, the Y' value is the yield value that the regression line predicts for 2009. The Y corresponds to the actual 2009 yield.

R^2 values for TN tend to be close to one, as the relationship between TN and flow is very consistent through various ranges of flows. R^2 values for TP and SS tend to vary more, especially towards higher flows. Thus, when regression graphs include high flow events, the resulting correlation tends to be less perfect indicated by a low R^2 value. This is an indication that single high flow events, and not necessarily a high flow year, are the highest contributors to high loads in TP and SS. As has been evident in the last few years, the high loads that have occurred at Towanda and Danville can be linked directly to high flow events, specifically Tropical Storm Ernesto in 2006 and Hurricane Ivan in 2004. Due to this variation, baseline comparisons for this report utilized both linear regression and exponential regression. The method yielding the higher R^2 value was reported as it represents the better descriptor of the data. R^2 values listed with an asterisk in Tables 31 and 32 represent baseline comparisons that utilized the exponential regression baseline for comparison. Seasonal baselines also were calculated for the initial five years of data at each site. Table 32 compares these baselines to the 2009 seasonal yields.

Table 31. Comparison of 2009 TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Initial Baseline			First Half Baseline			Second Half Baseline			Full Baseline			2009
		Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Y
Towanda	TN	0.87	0.87*	5.87	0.87	0.87	5.50	0.82	0.92*	4.18	0.85	0.67*	4.61	3.36
	TP		0.82*	0.358		0.91*	0.337		0.89*	0.334		0.88*	0.335	0.367
	SS		0.54*	276.0		0.79*	303.0		0.75*	265.3		0.74*	270.0	137.8
Danville	TN	1.11	0.96*	8.78	0.93	0.87	6.51	0.87	0.79*	4.75	0.90	0.57*	5.38	3.92
	TP		0.97	0.651		0.86	0.479		0.91*	0.335		0.86*	0.386	0.357
	SS		0.99	646.5		0.82*	314.0		0.79*	217.9		0.78*	257.7	138.4
Lewisburg	TN	0.94	0.91	5.77	0.82	0.95	4.84	0.89	0.99	4.31	0.85	0.84	4.59	3.52
	TP		0.93*	0.265		0.90*	0.210		0.95	0.235		0.89*	0.215	0.200
	SS		0.71*	166.4		0.83*	120.3		0.67*	150.9		0.75*	138.0	72.9
Newport	TN	0.94	0.84	7.78	0.83	0.95	6.34	0.86	0.99	6.31	0.84	0.97	6.31	5.67
	TP		0.68	0.442		0.76	0.312		0.85	0.278		0.80	0.293	0.238
	SS		0.94	263.1		0.90	156.8		0.88*	126.7		0.81*	130.4	99.7
Marietta	TN	1.04	1.00	9.41	0.91	0.95	7.52	0.87	0.98	6.39	0.89	0.92	6.88	5.63
	TP		0.79	0.469		0.90	0.401		0.84	0.368		0.87	0.376	0.251
	SS		0.70	385.2		0.90	303.9		0.79*	270.1		0.78*	244.1	145.6
Conestoga	TN	1.02	0.99	37.94	0.95	0.98	34.08	0.95	0.97	31.76	0.95	0.97	32.91	25.57
	TP		0.72*	2.657		0.90	2.403		0.59	1.761		0.65	2.084	0.981
	SS		0.87	1,548.3		0.89	1,200.2		0.32#	996.0		0.57	1,099.6	292.4

Q = discharge ratio
R^2 = correlation coefficient
* indicates where an exponential regression was used instead of a linear regression as it yielded a higher R^2.
# indicates a R^2 that is low and thus is less accurate at predicting Y

Table 32. Comparison of 2009 Seasonal TN, TP, and SS Yields with Initial Baseline Yields

Site/Parameter		Fall				Spring				Summer				Winter			
		Q	R^2	Y'	Y09	Q	R^2	Y'	Y09	Q	R^2	Y'	Y09	Q	R^2	Y'	Y09
Towanda	TN	0.832	0.98	1.31	0.75	0.58	0.97	1.41	0.84	1.9	0.99	0.66	0.40	1.04	0.99*	2.17	1.37
	TP		0.97*	0.076	0.081		1.00*	0.073	0.091		0.99	0.049	0.059		0.69*	0.119	0.136
	SS		0.92*	31.8	21.2		1.00*	44.2	29.9		0.94*	20.7	15.0		0.20*#	89.6	71.7
Danville	TN	1.09	1.00	1.74	0.96	0.85	1.00	1.71	0.96	1.77	0.99	0.942	0.50	1.21	1.00	2.52	1.50
	TP		0.98	0.116	0.088		1.00	0.126	0.089		0.93	0.080	0.059		0.97	0.166	0.122
	SS		0.96*	48.1	31.9		0.98	105.7	32.6		0.79	35.8	21.6		0.98*	109.4	52.3
Lewisburg	TN	1.14	1.00	1.56	1.01	0.69	1.00	1.29	0.82	1.25	0.99	0.65	0.43	0.95	0.99	1.81	1.27
	TP		0.99	0.067	0.060		0.99	0.059	0.046		0.97	0.038	0.027		0.99*	0.067	0.067
	SS		0.97*	26.4	22.5		0.96	27.5	13.0		0.41#	10.3	7.5		0.95*	40.0	29.9
Newport	TN	1.556	1.00	2.839	2.05	1.02	0.98	2.511	2.04	0.66	1	0.514	0.39	0.6	0.96	1.278	1.19
	TP		1.00*	0.169	0.10		0.89	0.16	0.09		0.997	0.037	0.02		0.84	0.029	0.03
	SS		0.99*	88.85	45.3		0.98	109.79	44.5		0.995	13.02	3.3		0.83*	13.08	6.5
Marietta	TN	1.3	1.00	2.403	1.73	0.87	1.00	2.152	1.44	1.37	1.00	1.021	0.70	0.94	0.999	2.366	1.76
	TP		1.00	0.122	0.08		0.91	0.119	0.07		0.89*	0.061	0.04		0.872	0.095	0.06
	SS		0.98	99.9	51.1		0.92	101.96	37.7		0.91*	34.99	16.9		0.966	53.75	39.9
Conestoga	TN	1.778	0.98	12.37	8.89	0.99	1.00	9.81	6.79	0.91	0.999	6.179	4.61	0.62	1.00*	6.986	5.27
	TP		0.85	1.034	0.44		0.99	0.666	0.22		0.21#	0.682	0.23		0.45*#	0.414	0.10
	SS		0.95	300.58	158.0		0.98	412.57	68.2		0.16#	548.4	50.4		0.25*#	129.2	15.8

Q = discharge ratio
R^2 = correlation coefficient
* indicates where an exponential regression was used instead of a linear regression as it yielded a higher R^2.
# indicates a R^2 that is low and thus is less accurate at predicting Y

DISCHARGE, NUTRIENT, AND SUSPENDED-SEDIMENT TRENDS

Flow-Adjusted Concentration (FAC) trend analyses of water quality and flow data collected at the six Group A monitoring sites were completed for the period January 1985 through December 2009. Trends were estimated based on the USGS water year, October 1 to September 30, using the USGS 7-parameter, log-linear regression model (ESTIMATOR) developed by Cohn and others (1989) and described in Langland and others (1999). This estimator relates the constituent concentration to water discharge, seasonal effects, and long-term trends, and computes the best-fit regression equation. These tests were used to estimate the direction and magnitude of trends for discharge, SS, TOC, and several forms of nitrogen and phosphorus. Slope, p-value, and sigma (error) values are taken directly from ESTIMATOR output. These values are then used to calculate flow-adjusted trends using the following equations:

Trend =
100*(exp(Slope * (end yr – begin yr)) – 1)

Trend minimum =
100*(exp((Slope – (1.96*sigma))
* (end yr – begin yr)) – 1)

Trend maximum =
100*(exp((Slope + (1.96*sigma))
*(end yr – begin yr)) – 1)

The computer application S-Plus with the USGS ESTREND library addition was used to conduct Seasonal Kendall trend analysis on flows (Schertz and others, 1991). Trend results were reported for monthly mean discharge (FLOW) and FAC. Trends in FLOW indicate the natural changes in hydrology. Changes in flow and the cumulative sources of flow (base flow and overland runoff) affect the observed concentrations and the estimated loads of nutrients and SS. The FAC is the concentration after the effects of flow are removed from the concentration time series. Trends in FAC indicate that changes have occurred in the processes that deliver constituents to the stream system. After the effects of flow are removed, this is the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed. A description of the methodology is included in Langland and others (1999).

Trend results for each monitoring site are presented in Tables 33 through 38. Each table lists the results for flow, the various nitrogen and phosphorus species, TOC, and SS. The level of significance was set by a p-value of 0.05 for FAC (Langland and others, 1999). The magnitude of the slope incorporates a confidence interval and was reported as a range (minimum and maximum). The trend percent change was the magnitude of change in flow-adjusted concentration estimated to have occurred over the trend period. The values were recorded as a range with the actual value located within the range. The slope direction indicated the direction of the trend percent change and was reported as not significant (NS) or, when significant, as down to indicate decreasing FACs and improving trends or up to indicate increasing FACs and degrading trends. When a time series for a particular parameter had greater than 20 percent of its observations BMDL, a trend analysis could not be completed and it was listed as BMDL.

Table 33. Trend Statistics for the Susquehanna River at Towanda, Pa., October 1988 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	52.63	0.3930	-	-	-	-	NS
TN	600	FAC	-0.03	<0.0001	-43.2	-40.0	-36.6	37-43	Down
DN	602	FAC	-0.02	<0.0001	-39.8	-36.1	-32.2	32-40	Down
TON	605	FAC	-0.03	<0.0001	-51.3	-45.2	-38.4	38-51	Down
DON	607	FAC	-0.02	<0.0001	-43.1	-35.5	-26.8	27-43	Down
DNH_3	608	FAC	-0.02	<0.0001	-41.8	-31.3	-19.1	N/A	BMDL
TNH_3	610	FAC	-0.03	<0.0001	-51.4	-42.4	-31.9	32-51	Down
DKN	623	FAC	-0.02	<0.0001	-41.2	-34.2	-26.2	26-41	Down
TKN	625	FAC	-0.03	<0.0001	-50.8	-45.1	-38.8	39-51	Down
TNOx	630	FAC	-0.02	<0.0001	-40.4	-36.2	-31.8	32-40	Down
DNOx	631	FAC	-0.02	<0.0001	-40.2	-35.9	-31.2	31-40	Down
TP	665	FAC	0.00	0.8120	-11.1	1.6	16.1	N/A	NS
DP	666	FAC	0.00	0.7570	-11.2	2.2	17.7	N/A	NS
DOP	671	FAC	0.10	<0.0001	486.2	633.0	816.5	486-817	Up
TOC	680	FAC	0.00	0.0043	-12.4	-7.5	-2.3	2-12	Down
SS	80154	FAC	-0.02	0.0012	-41.8	-28.6	-12.3	12-42	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 34. Trend Statistics for the Susquehanna River at Danville, Pa., October 1984 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	111.3	0.1259	-	-	-	-	NS
TN	600	FAC	-0.03	<0.0001	-48.4	-45.4	-42.2	42-48	Down
DN	602	FAC	-0.02	<0.0001	-42.6	-39.0	-35.2	35-43	Down
TON	605	FAC	-0.03	<0.0001	-59.9	-54.9	-49.3	49-60	Down
DON	607	FAC	-0.02	<0.0001	-48.9	-42.8	-36.0	36-49	Down
DNH_3	608	FAC	-0.02	<0.0001	-53.3	-44.7	-34.5	N/A	BMDL
TNH_3	610	FAC	-0.03	<0.0001	-58.0	-50.7	-42.2	42-58	Down
DKN	623	FAC	-0.02	<0.0001	-48.2	-42.6	-36.3	36-48	Down
TKN	625	FAC	-0.03	<0.0001	-60.0	-55.5	-50.4	50-60	Down
TNOx	630	FAC	-0.02	<0.0001	-40.4	-36.3	-32.0	32-40	Down
DNOx	631	FAC	-0.02	<0.0001	-40.8	-36.5	-31.8	32-41	Down
TP	665	FAC	-0.01	<0.0001	-34.7	-25.2	-14.3	14-35	Down
DP	666	FAC	0.00	0.6024	-17.8	-4.0	12.1	N/A	NS
DOP	671	FAC	0.09	<0.0001	518.4	693.4	918.1	N/A	BMDL
TOC	680	FAC	-0.01	<0.0001	-23.9	-19.4	-14.8	15-24	Down
SS	80154	FAC	-0.03	<0.0001	-59.0	-51.2	-41.9	42-59	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 35. Trend Statistics for the West Branch Susquehanna River at Lewisburg, Pa., October 1984 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	-12.50	0.8109	-	-	-	-	NS
TN	600	FAC	-0.02	<0.0001	-36.5	-31.9	-26.9	27-37	Down
DN	602	FAC	-0.01	<0.0001	-31.3	-27.0	-22.4	22-31	Down
TON	605	FAC	-0.04	<0.0001	-65.7	-59.5	-52.3	52-66	Down
DON	607	FAC	-0.03	<0.0001	-58.3	-51.8	-44.2	44-58	Down
DNH_3	608	FAC	-0.01	0.0007	-37.3	-25.4	-11.2	N/A	BMDL
TNH_3	610	FAC	-0.02	<0.0001	-44.4	-33.8	-21.2	21-44	Down
DKN	623	FAC	-0.02	<0.0001	-47.3	-39.9	-31.4	31-47	Down
TKN	625	FAC	-0.03	<0.0001	-59.1	-52.7	-45.3	45-59	Down
TNOx	630	FAC	-0.01	0.0001	-17.4	-12.2	-6.6	7-17	Down
DNOx	631	FAC	-0.01	0.0001	-18.0	-12.4	-6.4	6-18	Down
TP	665	FAC	-0.02	<0.0001	-41.8	-30.7	-17.6	18-42	Down
DP	666	FAC	-0.03	<0.0001	-54.9	-45.5	-34.2	N/A	BMDL
DOP	671	FAC	0.07	<0.0001	312.5	449.6	632.2	N/A	BMDL
TOC	680	FAC	0.00	0.1602	-2.2	5.4	13.7	N/A	NS
SS	80154	FAC	-0.02	0.0014	-45.4	-31.2	-13.4	13-45	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 36. Trend Statistics for the Juniata River at Newport, Pa., October 1984 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	8.174	0.6437	-	-	-	-	NS
TN	600	FAC	-0.01	<0.0001	-17.0	-12.6	-7.9	8-17	Down
DN	602	FAC	0.00	0.0009	-11.9	-7.6	-3.2	3-12	Down
TON	605	FAC	-0.03	<0.0001	-59.3	-52.5	-44.5	45-59	Down
DON	607	FAC	-0.03	<0.0001	-51.9	-45.1	-37.4	37-52	Down
DNH_3	608	FAC	-0.02	<0.0001	-45.2	-34.5	-21.6	N/A	BMDL
TNH_3	610	FAC	-0.02	<0.0001	-44.1	-33.5	-20.9	N/A	BMDL
DKN	623	FAC	-0.03	<0.0001	-53.0	-45.9	-37.7	38-53	Down
TKN	625	FAC	-0.03	<0.0001	-55.4	-48.4	-40.3	40-55	Down
TNOx	630	FAC	0.00	0.4986	-3.4	1.7	7.1	N/A	NS
DNOx	631	FAC	0.00	0.0970	-0.9	4.4	10.0	N/A	NS
TP	665	FAC	-0.02	<0.0001	-45.7	-36.9	-26.7	27-46	Down
DP	666	FAC	-0.02	<0.0001	-45.5	-36.9	-27.0	27-45	Down
DOP	671	FAC	0.04	<0.0001	126.8	192.4	276.9	127-277	Up
TOC	680	FAC	-0.01	<0.0001	-23.6	-17.3	-10.4	10-24	Down
SS	80154	FAC	-0.02	0.0001	-50.3	-37.4	-21.1	21-50	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 37. Trend Statistics for the Susquehanna River at Marietta, Pa., October 1986 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	-25.94	0.8924	-	-	-	-	NS
TN	600	FAC	-0.01	<0.0001	-32.2	-28.0	-23.5	23-32	Down
DN	602	FAC	-0.02	<0.0001	-42.9	-39.0	-35.0	35-43	Down
TON	605	FAC	-0.03	<0.0001	-55.0	-48.3	-40.7	41-55	Down
DON	607	FAC	-0.03	<0.0001	-50.5	-42.7	-33.6	34-51	Down
DNH_3	608	FAC	-0.01	0.0014	-34.1	-22.7	-9.3	9-34	Down
TNH_3	610	FAC	-0.01	0.0002	-37.5	-26.4	-13.2	13-37	Down
DKN	623	FAC	-0.02	<0.0001	-46.9	-39.3	-30.6	31-47	Down
TKN	625	FAC	-0.03	<0.0001	-52.4	-46.1	-38.9	39-52	Down
TNOx	630	FAC	-0.01	<0.0001	-19.6	-14.3	-8.5	9-20	Down
DNOx	631	FAC	-0.01	<0.0001	-19.5	-14.1	-8.3	8-19	Down
TP	665	FAC	-0.01	<0.0001	-33.1	-24.2	-14.1	14-33	Down
DP	666	FAC	-0.02	<0.0001	-42.0	-33.4	-23.6	24-42	Down
DOP	671	FAC	0.09	<0.0001	493.2	658.5	869.9	N/A	BMDL
TOC	680	FAC	-0.01	<0.0001	-18.4	-13.3	-7.9	8-18	Down
SS	80154	FAC	-0.02	<0.0001	-48.5	-37.4	-24.0	24-48	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 38. Trend Statistics for the Conestoga River at Conestoga, Pa., October 1984 Through September 2009

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	3.697	0.3811	-	-	-	-	NS
TN	600	FAC	-0.01	<0.0001	-24.1	-20.8	-17.3	17-24	Down
DN	602	FAC	0.00	0.0601	-8.6	-4.2	0.4	N/A	NS
TON	605	FAC	-0.03	<0.0001	-59.0	-53.3	-46.7	47-59	Down
DON	607	FAC	-0.01	0.0396	-22.3	-12.2	-0.7	1-22	Down
DNH_3	608	FAC	-0.06	<0.0001	-78.1	-74.4	-69.9	70-78	Down
TNH_3	610	FAC	-0.06	<0.0001	-79.0	-75.4	-71.1	71-79	Down
DKN	623	FAC	-0.01	<0.0001	-35.4	-27.7	-19.0	19-35	Down
TKN	625	FAC	-0.04	<0.0001	-63.5	-58.8	-53.4	53-64	Down
TNOx	630	FAC	0.00	0.9417	-5.7	-0.2	5.6	N/A	NS
DNOx	631	FAC	0.00	0.6812	-4.4	1.2	7.1	N/A	NS
TP	665	FAC	-0.03	<0.0001	-57.5	-51.8	-45.3	45-58	Down
DP	666	FAC	-0.02	<0.0001	-49.3	-44.9	-40.0	40-49	Down
DOP	671	FAC	-0.01	0.0004	-31.7	-21.7	-10.3	10-32	Down
TOC	680	FAC	-0.03	<0.0001	-50.8	-46.4	-41.7	42-51	Down
SS	80154	FAC	-0.05	<0.0001	-76.0	-70.7	-64.1	64-76	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

DISCUSSION

2009 monthly flows were compared with historical monthly flows to find similar months for comparison. For months chosen, individual loads from both the historical month and the 2009 month were compared to see where loads had substantially deviated from the accepted premise that higher flows tend to yield higher loads.

For example, 2009 flow at Towanda was 10,244 cubic feet per second (cfs) for June 2009 and 10,638 CFS for June 1994. By looking closer at the daily flows of each month, the peak daily flow for June 1994 was 52,700 cfs and for June 2009 was 34,000 cfs. With June 2009 having both a 4 percent lower average monthly flow and a 35 percent lower average daily flow as compared to 1994, it would be expected that June 1994 would have higher loads if there had been no improvements or degradations during the time period. Further comparison of the two months showed that 2009 had 34 and 68 percent lower loads of TN and SS, respectively, which was expected.

In contradiction to what was expected, DP and DOP had 97 and 1,045 percent higher loads during June 2009, respectively. This shows a dramatic difference from what would be expected given the difference in flows. It could be inferred that TN and SS loads have been reduced from 1994 to 2009 and DP and DOP loads have increased over the time period at Towanda. Similarly, May 1994 was comparable to May 2009 with the flow difference being 1 percent more during 1994. TN and SS loads were 40 and 20 percent lower, respectively, during May 2009 while TP, DP, and DOP were 31, 53, and 93 percent higher, respectively, during May 2009 as compared to May 1994. Closer inspection of the flows indicate that the May 2009 peak daily average was 25 percent higher than the May 1994 peak daily average so the comparison may not be as strong.

Table 39 shows a condensation of monthly loads at all sites down to a percent variation that can be compared to the variation in monthly flow. To calculate these values, the percent difference between each monthly comparison was averaged together to get one value for each parameter and site and may be useful for identifying parameters for future in-depth study. The flow value corresponds to the percent difference between the comparison period and the 2009 period and does not specifically designate the 2009 flow as higher or lower than the comparison flow. Parameter percent values do indicate whether the values were lower or higher during 2009 as compared to other years. For example, the average flow difference for 2009 comparisons at Towanda was 5 percent while the average TN values for 2009 were 30 percent less, and the TP values were 20 percent greater than the comparison periods.

Towanda

2009 annual flow at Towanda was 85 percent of the LTM with June, August, and October rising above LTM values. This resulted in loads for all parameters, except DP and DOP, being largely below the LTM. These included TN, TP, and SS at 61, 78, and 24 percent of LTM, respectively. In contrast, DP and DOP both were above LTM at 126 and 184 percent, respectively, including the DOP average concentration being 215 percent of the LTM. Highest season flows and loads of all parameters were recorded during winter. Although spring had the next highest flow, fall had higher load values for TNH_3, DP, and DOP. Summer recorded the lowest flows and loads for all parameters.

March 2009 accounted for a high percentage of the nutrient load including 23, 25, and 45 percent of the TN, TP, and SS loads, respectively. A closer comparison of January and August at Towanda shows that although the flow was comparable at 8,315 and 8,437 cfs, respectively, there was a dramatic difference in SS, with 16 million pounds transported during January and 48 million pounds during August. This may indicate a difference in the amount of new erosion that was transported, as the ground was likely frozen during January, and may account for the dramatic decrease in SS load.

Also noteworthy is that although TP load increased 78 percent from January to August, DP and DOP only increased by 37 and 26 percent, respectively. During the same period, there was a 28 percent drop in TN loads. This may be due to higher volatilization and/or plant uptake increases during the summer versus winter. Drops were also found when comparing January and August in TNOx and TNH_3 with 55 percent and 43 percent, respectively.

Comparisons with baselines at Towanda showed that TP was higher than predicted by each method. Looking closer at seasonal baselines, all seasons showed that TP was higher than predicted by baseline comparisons. All other annual and seasonal baseline comparisons were below predicted values for 2009.

Trends for 1989 through 2009 at Towanda were decreasing for all parameters except flow, TP, DP, DOP, and DNH_3. DNH_3 had no significant trend due to 20 percent of the values BMDL, resulting in no significant trends. Flow, TP, and DP had no significant trends while DOP had an upward trend. This trend indicates that DOP flow-adjusted concentrations have increased by between 486 and 817 percent over the 20-year time period. Starting at the detection limit for DOP (0.01mg/L), this increase would result in values of about 0.06 mg/L today.

Danville

2009 flow at Danville was similar to Towanda including above LTM values during June, August, and October with annual flow at 90 percent of the LTM. Annual loads for all parameters were below LTM values except DP and DOP, with 119 and 165 percent of the LTM, respectively. DP and DOP average concentration values for 2009 were above the LTM by 131 and 183 percent, respectively. Seasonal load and flow values were highest during the winter and lowest during summer.

Comparable monthly flows at Danville were February to December and May to November but there were no large differences between TN, TP, and SS loads. As with Towanda, March had the highest flows and highest loads for these parameters. Interestingly, October had the third lowest monthly flow and the second highest SS load. As with Towanda, Danville had lowest flows and lowest loads of TN, TP, and SS during September.

2009 TN, TP, and SS yields at Danville were lower than all baseline values except for TP, when compared to the second half of the dataset. The predicted yield was 0.335 lbs/acre, and the actual 2009 yield was 0.357 lbs/acre. All seasonal yields for 2009 were below the initial five-year baseline yields. 2009 trends at Danville were the same as at Towanda with two exceptions: TP had a downward trend and DOP had no trends, as 20 percent of the values were BMDL.

Marietta

2009 flows at Marietta were 89 percent of the LTM with the same months as Towanda and Danville being above the LTM: June, August, and October. 2009 loads also were well below LTM values, including 73 percent for TN, 55 percent for TP, and 37 percent for SS. High seasonal flows occurred during winter followed by spring. Although winter had 2 percent higher flows for the period, it had 23 percent, 26 percent, and 36 percent higher loads of DN, DNOx, and DNH_3, respectively, and 17 percent less TOC. Comparison of monthly flows and loads for TN, TP, and SS show that January had 9 percent less flow than June, while the TN load during the time period was 23 percent greater than the TN load during June. This could account for the variation in DN, DNOx, and DNH_3 when comparing the winter and spring months. The lower January flow and higher than expected TN loads as compared to June could be a product of lower temperature and less rain during January, causing reductions in volatization and infiltration. The same situation was found when February was compared to May. Additionally, TP, DP, and DOP loads were slightly higher for the lower flow spring period. As with other mainstem sites, Marietta recorded lowest flows and loads of all parameters during the summer season.

Additional monthly comparisons, like those shown in Table 39, show that DP and DOP had large variations from expected conditions. Specific monthly comparisons with similar flow months that occurred prior to 2000 showed that DP and DOP loads have increased. When used to compare a similar flow month during the early to mid-2000s, the same comparison method shows the opposite for DP and DOP as values seem to be lower than expected during 2009. Past reports have also shown that the early to mid-2000s have shown increases in these two parameters at Marietta as well as several other sites. Specifically at Marietta, these increases have begun to somewhat reverse over the past few years while loads at Danville, Towanda, and Lewisburg have continued to show high values of both DP and DOP.

2009 annual and seasonal yields at Marietta were below baseline values for TN, TP, and SS for all comparisons. Apparently, some change had occurred from north to south on the mainstem regarding TP, as yields at Towanda were above all baseline predictions, while yields at Danville were above the baseline prediction using the second half of the dataset.

Changes in trends from Danville to Marietta included the addition of two downward trends for DNH_3 and DP. DOP had no trend due to concentration BMDL and there was no trend for flow. All other parameters had downward trends through 2009. Most dramatic reductions from 1987 to 2009 occurred for TON and DON, with 41-55 percent change in TON and 34-51 percent change in DON.

Lewisburg

2009 annual flow at Lewisburg was 86 percent of the LTM with August, October, and December being above the LTM. Subsequently, loads for all parameters except DP and DOP were well below LTM values. DP loads at Lewisburg were 105 percent of the LTM while the average concentration was 122 percent of the LTM. DOP loads were 178 percent of the LTM and average concentration was 207 percent of the LTM. Compared with DP and DOP values at Towanda, Danville, and Marietta, it seems that both DP and DOP recorded higher values in the middle and northern parts of the basin versus the southern portion. Comparisons with Newport and Conestoga indicated the same pattern as Newport recorded values of DP below the LTM and DOP at the LTM while Conestoga recorded lower than LTM values for both DP and DOP. Lewisburg recorded substantially lower than LTM values of SS at 28 percent of LTM for 2009.

No noticeable patterns were found when comparing seasonal loads at Lewisburg. The highest flow values and load values for all parameters were recorded during winter followed by fall, spring, and summer.

Monthly comparisons similar to those mentioned for Marietta show the same pattern. Specific comparisons of January and June show that June had 4 percent less flow than January, coupled with 34 percent less TN, 6 percent more TP, and 24 percent more SS. Comparison of May to October at Lewisburg shows a variation in flow of less than 1 percent coupled with higher values of both TP and SS during October, with 25 percent and 129 percent more loads of the constituents, respectively. October represents the beginning of the water year and typically consists of substantial rises in flows during the time period. Give that flow was essentially the same for both months, the increases in SS load could be attributed to increases in runoff versus infiltration due to the fall turnover of vegetation and crops. Higher sediment loads during October may have been influenced by low flows during September, which was not an issue during May 2009.

2009 annual baseline comparisons for Lewisburg were below all predicted values for TN, TP, and SS. Seasonal baseline comparisons were also below predicted values, except for TP during winter, which was at the predicted value. Most trends at Lewisburg were downward for 2009. Similar to Marietta, largest trend reductions from 1984 to 2009 were for TON and DON, with 52-66 percent and 45-59 percent reductions, respectively. DNH_3, DP, and DOP all had no trends due to concentrations BMDL. TOC and flow had no significant trends.

Newport

2009 annual flow at Newport was 85 percent of the LTM with monthly rises above the LTM during May, June, October, and December. Annual loads were also below LTM including SS being less than 50 percent of the LTM. Both DOP and TOC were at 100 percent of the LTM although flow values were 85 percent of the annual LTM. Seasonal flows were highest during spring at 5,708 cfs followed by fall at 4,717 cfs. High seasonal loads varied between the two seasons for different parameters with no substantial differences to note.

Relevant monthly comparisons at Newport include February, June, and October, which are evenly split through the year temporally. Moving from those months through the year, there was an increase in flow of 8 percent between February and June, a decrease of 6 percent between June and October, and a 1 percent increase between February and October. Through all of these changes, the differences in values of TN, TP, and SS between the same months increased by a substantial percentage beyond the smaller change in flow, with the exception of TN from February to June, which only changed 1 percent. June values of TP and SS were 152 percent and 230 percent higher, respectively, than February values. October values of TP and SS were 252 percent and 497 percent higher, respectively, than February values, although there was only a 1 percent difference in total monthly flow.

Baseline comparisons at Newport indicate that 2009 yield values were below predictions for TN, TP, and SS for all comparisons. The only exception was the seasonal comparison of TP during winter, which was slightly above the predicted initial baseline value. Trends at Newport were more variable than at the other sites. Both TNH_3 and DNH_3 had no trends due to BMDL, while both TNOx and DNOx had no significant trends. There were significant downward trends in TON and DON including reductions of 45-59 percent and 37-52 percent for each, respectively, since 1984. Apparently, these large reductions in TON and DON were enough to define a downward trend for both TN and DON, with 8-17 percent and 3-12 percent reductions, respectively, documented from 1984 through 2009. TP and DP had downward trends amounting in 27-46 percent and 27-45 percent reductions, respectively, over the time period. Interestingly, DOP continued a previous upward trend in spite of the downward TP and DP trends, including increases of 127-277 percent over the time period. Whereas the trend results indicate one direction over the entire time period, several monthly comparisons indicate a situation similar to Marietta in that comparisons of 2009 to the early and mid-2000s indicate less difference than comparisons with the 1980s and 1990s. Thus, the increases in DOP seem to have leveled off since the early to mid-2000s but still represent substantial increases since the beginning of the monitoring period in 1984.

Conestoga

2009 annual flows at Conestoga were 95 percent of the LTM representing the highest LTM flow percentage of all sites. Monthly flow values surpassed the LTM during seven of the 12 months including August through December. Conestoga continued to be the site with the highest yields and average concentrations for all parameters. However, when compared to previous years, 2009 values implied substantial reductions in several parameters. When comparing LTM load and concentration values, Conestoga had the lowest percentage of LTM values for TP, TON, DOP, DON, and TOC. Additionally, the 2009 SS average concentration was the lowest percentage of LTM average concentration of all sites at 26.5 percent.

Seasonal flows were highest during the fall followed by spring, summer, and winter. Due to the uncommon distribution of flows at Conestoga (with winter being the lowest flow period and summer having substantial flow), a few comparisons can be made. Comparison of spring and summer shows that summer had 40 percent less flow, which resulted in lower loads of most parameters ranging from 24 percent for TOC to 80 percent for DON, with TN and DN at 47 and 46 percent, respectively. The interesting comparison is that TP, DP, and DOP all increased from spring to summer with increases of 4, 23, and 27 percent, respectively. Although trends analysis for DOP showed decreasing trends, this monthly comparison implied that DOP values were higher than expected. The cause of this observation may be similar to the cause of the increases in DOP found at other sites including Towanda, Danville, and Lewisburg.

Monthly comparisons similar to those shown in Table 39 indicate dramatic differences when March 2009 is compared to March 1985. Flow during 2009 was 8 percent lower than March 1985 flow while TN, DN, TON, DON, TNOx, and DNOx monthly loads during 2009 ranged from 45 to 67 percent lower than 1985 values. Other substantial reductions taken from this comparison include TP, DP, DOP, TOC, and SS at 365, 222, 189, 261, and 183 percent lower than March 1985 values, respectively. By far, the biggest change was for TNH_3 and DNH_3 at 1,293 and 1,192 percent, respectively, below the 1985 March values.

2009 annual and seasonal yields were below all baseline comparisons for TN, TP, and SS. The most substantial comparison involved SS with the 2009 yield being 292 and the baseline predictions ranging from 996 to 1,548 lbs/acre/year. Seasonal comparisons indicate that the lowest deviation from the baseline prediction occurred during fall for SS where the value for 2009 was 50 percent less that the baseline prediction.

Trends for 2009 at Conestoga were downward for all parameters except DN, TNOx, and DNOx, which had no significant trends. These downward trends included DOP which had been trending upward at most sites. As previously mentioned, in spite of the downward trend, DOP did show conditions that could be perceived as degrading when comparing the spring and summer seasons.

Table 39. Average of Monthly Changes from Historical Similar Flow Month

Site	Q	TN	DN	TON	DON	DNH3	TNH3	TNOx	DNOx	TP	DP	DIP	TOC	Sed
Towanda	5	-30	-28	-24	-20	-31	-48	-40	-38	20	58	360	-5	-26
Danville	3	-38	-33	-46	-31	-63	-55	-39	-39	-2	33	171	-16	-8
Lewisburg	7	-26	-22	-13	-1	-38	-47	-25	-24	4	37	233	3	-28
Newport	4	-9	-9	-6	-14	-26	-6	-9	-9	-15	-31	44	6	-7
Marietta	7	-19	-21	-21	-36	-16	-12	-17	-16	-27	-57	12	2	-7
Conestoga	4	-24	-23	-71	-65	-87	-100	-18	-19	-74	-38	-48	-31	-87

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