COMPARISON OF THE 2005 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. The water-discharge ratio is the ratio of the annual mean discharge to the LTM discharge. Data from the initial 5-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. The data collected in 2005 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 5-year period following the start of monitoring. 2005 yield values also were plotted against two other baselines, one created from the first half of each dataset and one created from the second half of each dataset. Figures 10 - 21 display the baseline graphs and the 2005 yields.

Susquehanna River at Towanda, Pa.

The baselines for TN, TP, and SS for the Susquehanna River at Towanda are shown in Figures 10 and 11 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 26 along with the discharge ratio. Best-fit lines were drawn through the data sets using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1989-1993 Baselines;
Total Nitrogen (TN)
TN Yield = 6.2113x + 0.6168 $R^2 = 0.7868$
Total Phosphorus (TP)
TP Yield = 0.7947x - 0.3135 $R^2 = 0.7178$
Suspended Sediment (SS)
SS Yield = 2079.2x - 1312.7 $R^2 = 0.4125$

1989-1996 Baselines;
Total Nitrogen (TN)
TN Yield = 5.5766x + 0.8554 $R^2 = 0.8212$
Total Phosphorus (TP)
TP Yield = 0.844x - 0.3493 $R^2 = 0.8592$
Suspended Sediment (SS)
SS Yield = 2297.4x - 1464.5 $R^2 = 0.6701$

1997-2004 Baselines;
Total Nitrogen (TN)
TN Yield = 4.1303x + 1.0532 $R^2 = 0.9310$
Total Phosphorus (TP)
TP Yield = 0.4964x - 0.052 $R^2 = 0.7755$
Suspended Sediment (SS)
SS Yield = 832.17x - 373.88 $R^2 = 0.5834$

Table 26. Comparison of 2005 Total Nitrogen, Total Phosphorous, and Suspended Sediment Yields with Baseline Yields at Towanda, Pa.

Parameter	Discharge Ratio	1989 – 1993 Baseline lb/ac/yr	1989 – 1996 Baseline lb/ac/yr	1997 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	1.129	7.63	7.15	5.72	5.59
TP	1.129	0.584	0.604	0.509	0.633
SS	1.129	1035	1130	566	1037

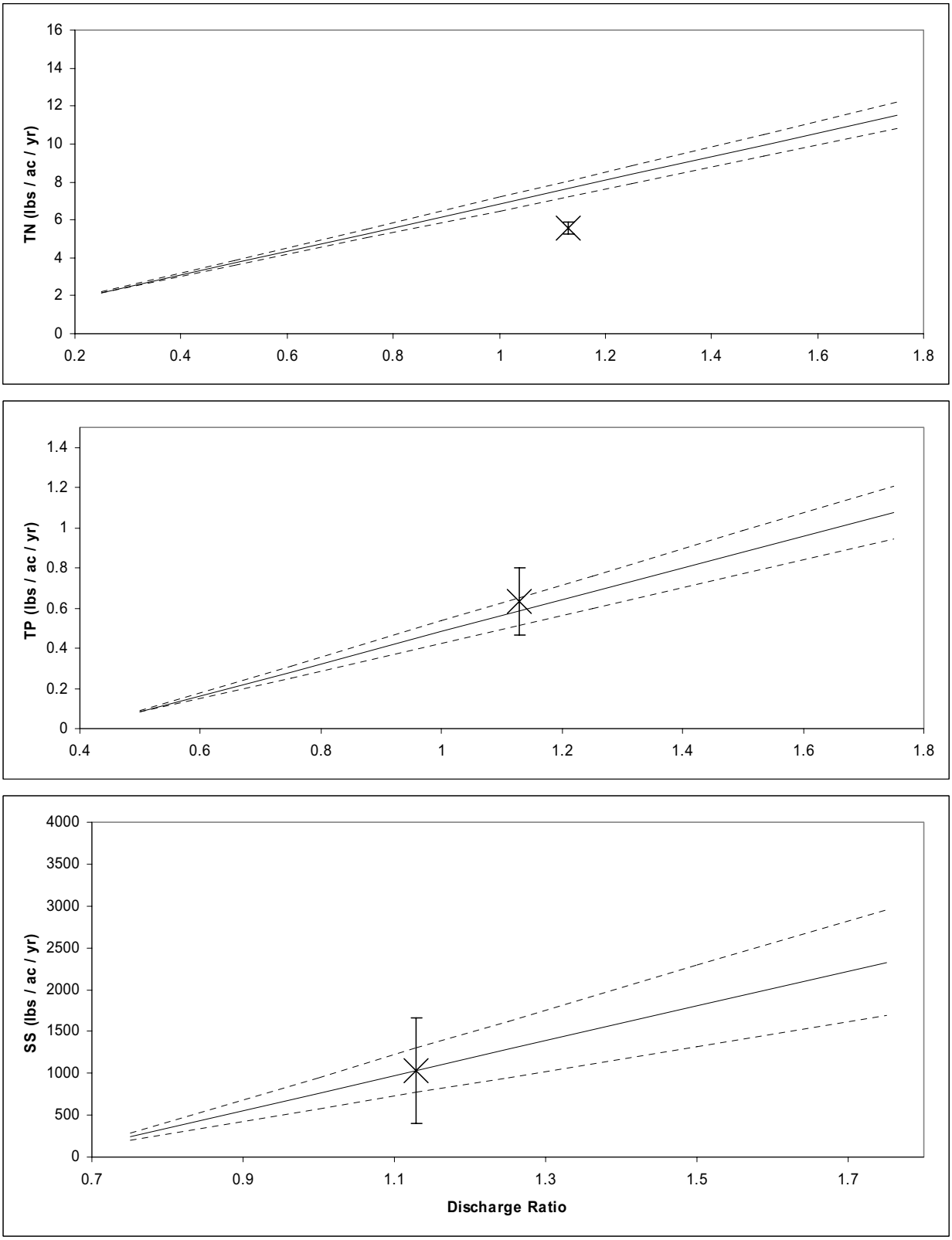

Figure 10. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 2005 Yield Compared to 1989-1993 Baseline

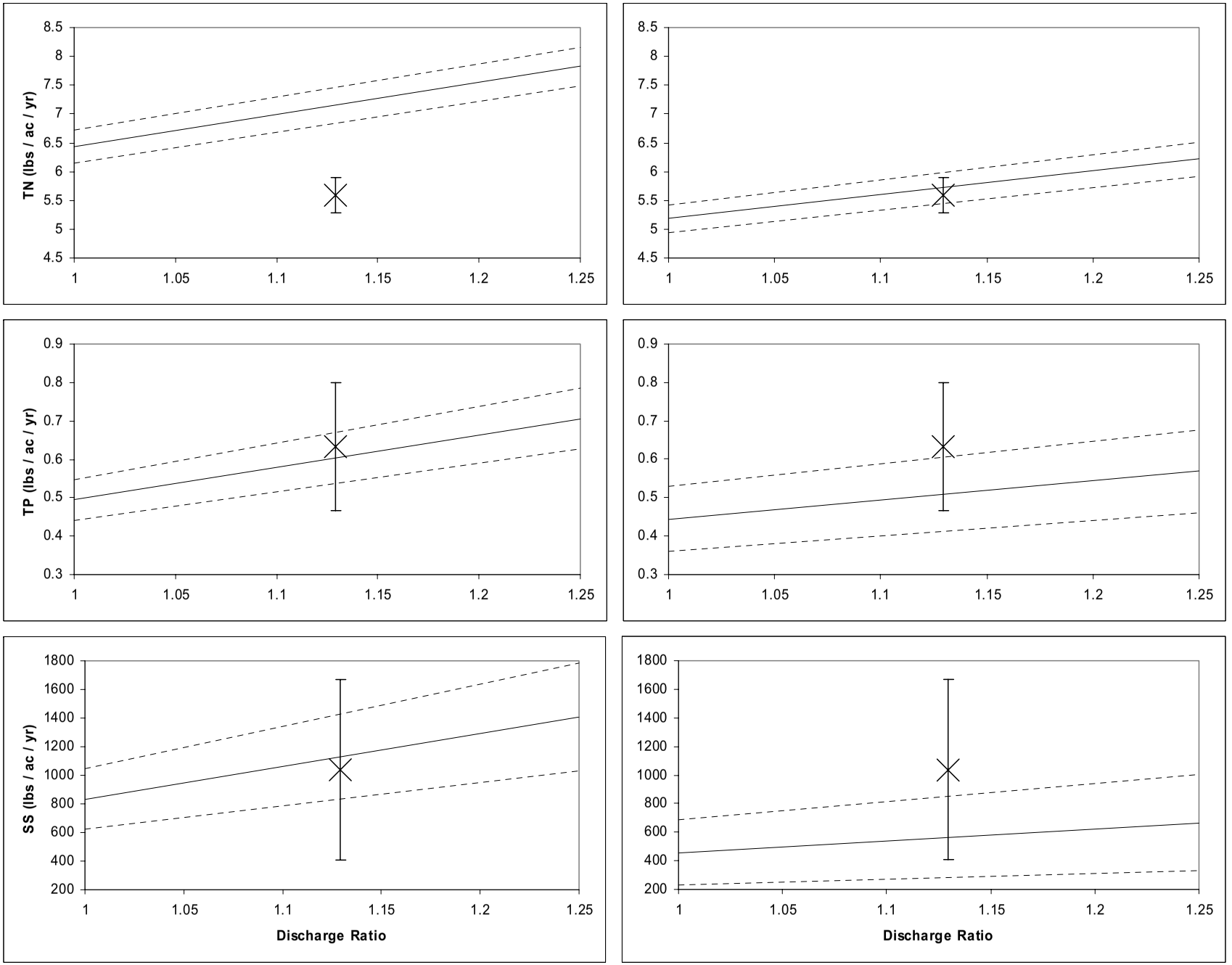

Figure 11. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 2005 Yield Compared to 1989-1996 Baseline (left) and Compared to 1997-2004 (right)

Susquehanna River at Danville, Pa.

The baselines for TN, TP, and SS for the Susquehanna River at Danville are shown in Figures 12 and 13 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 27 along with the discharge ratio. Best-fit lines were drawn through the data sets using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1985-1989 Baselines;
Total Nitrogen (TN)
TN Yield = 7.8576x - 0.2294 $R^2 = 0.8499$
Total Phosphorus (TP)
TP Yield = 0.7126x - 0.1582 $R^2 = 0.9504$
Suspended Sediment (SS)
SS Yield = 750.23x - 353.67 $R^2 = 0.9503$

1985-1994 Baselines;
Total Nitrogen (TN)
TN Yield = 6.3883x + 0.8479 $R^2 = 0.8478$
Total Phosphorus (TP)
TP Yield = 0.5451x - 0.0669 $R^2 = 0.6798$
Suspended Sediment (SS)
SS Yield = 944.86x - 536.86 $R^2 = 0.6518$

1995-2004 Baselines;
Total Nitrogen (TN)
TN Yield = 4.7736x + 0.8011 $R^2 = 0.8800$
Total Phosphorus (TP)
TP Yield = 0.6863x - 0.2359 $R^2 = 0.7991$
Suspended Sediment (SS)
SS Yield = 805.91x - 451.21 $R^2 = 0.6930$

Table 27. Comparison of 2005 Total Nitrogen, Total Phosphorous, and Suspended Sediment Yields with Baseline Yields at Danville, Pa.

Parameter	Discharge Ratio	1985 – 1989 Baseline lb/ac/yr	1985 - 1994 Baseline lb/ac/yr	1995 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	1.15	8.81	8.19	6.29	5.64
TP	1.15	0.661	0.560	0.553	0.723
SS	1.15	400	550	476	617

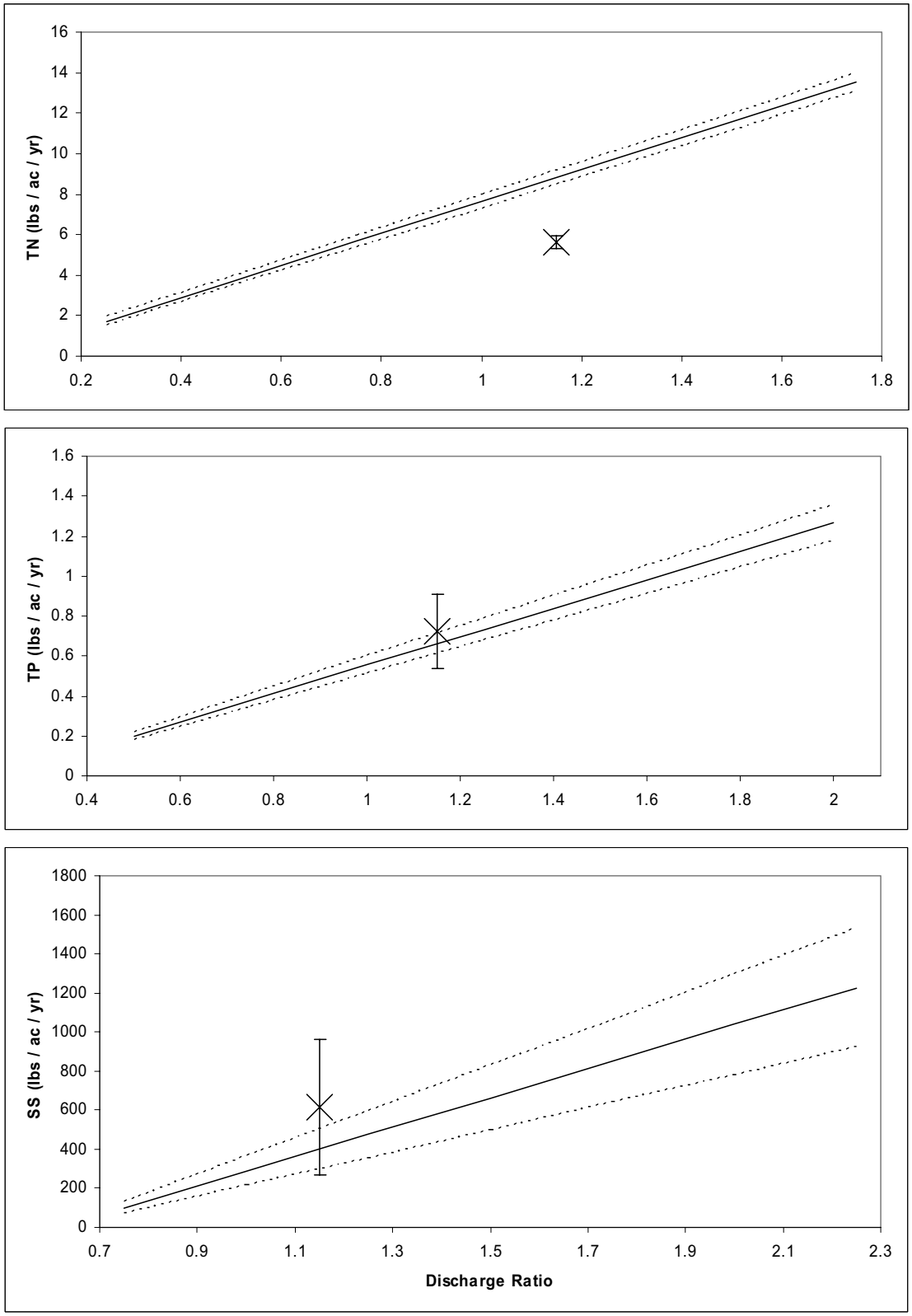

Figure 12. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 2005 Yield Compared to 1985-1989 Baseline

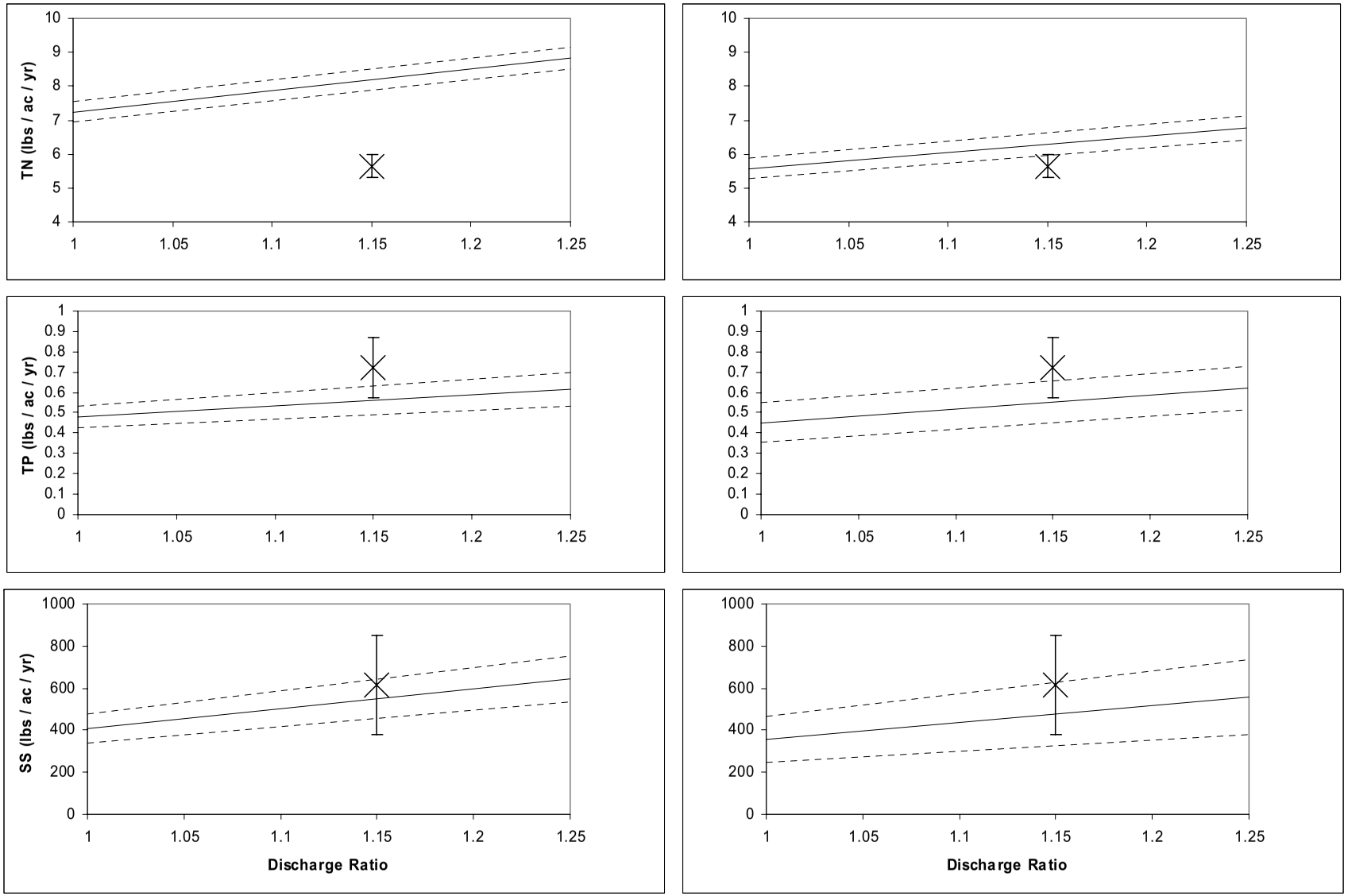

Figure 13. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 2005 Yield Compared to 1985-1994 Baseline (left) and Compared to 1995-2004 (right)

West Branch Susquehanna River at Lewisburg, Pa.

The baselines for TN, TP, and SS for the West Branch Susquehanna River at Lewisburg are shown in Figures 14 and 15 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 28 along with the discharge ratio. Best-fit lines were drawn using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1985-1989 Baselines;

Total Nitrogen (TN)
TN Yield = 7.9538x - 1.436 $R^2 = 0.7274$
Total Phosphorus (TP)
TP Yield = 0.2774x + 0.0253 $R^2 = 0.5306$
Suspended Sediment (SS)
SS Yield = 438x - 243.12 $R^2 = 0.8084$

1985-1994 Baselines;

Total Nitrogen (TN)
TN Yield = 5.3007x + 0.6364 $R^2 = 0.7767$
Total Phosphorus (TP)
TP Yield = 0.3379x - 0.0554 $R^2 = 0.6224$
Suspended Sediment (SS)
SS Yield = 612.83x - 404.09 $R^2 = 0.7005$

1995-2004 Baselines;

Total Nitrogen (TN)
TN Yield = 5.6034x - 0.4074 $R^2 = 0.9498$
Total Phosphorus (TP)
TP Yield = 0.426x - 0.1387 $R^2 = 0.7968$
Suspended Sediment (SS)
SS Yield = 462.12x - 227.23 $R^2 = 0.3436$

Table 28. Comparison of 2005 Total Nitrogen, Total Phosphorus, and Suspended-Sediment Yields With Baseline Yields at Lewisburg, Pa.

Parameter	Discharge Ratio	1985 – 1989 Baseline lb/ac/yr	1985 - 1994 Baseline lb/ac/yr	1995 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	0.95	6.09	5.65	4.90	4.83
TP	0.95	0.288	0.264	0.264	0.285
SS	0.95	171	175	210	122

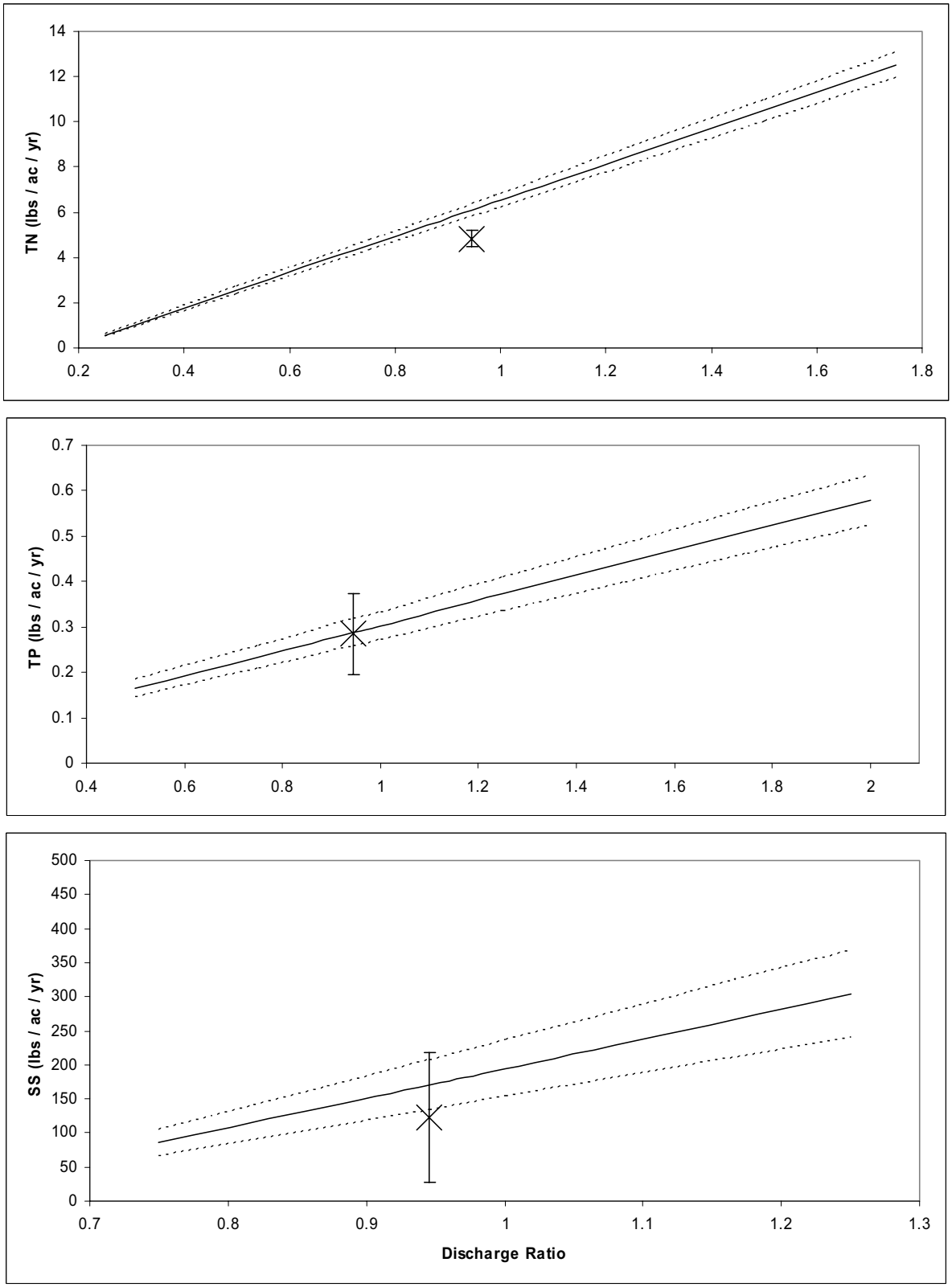

Figure 14. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 2005 Yield Compared to 1985-1989 Baseline

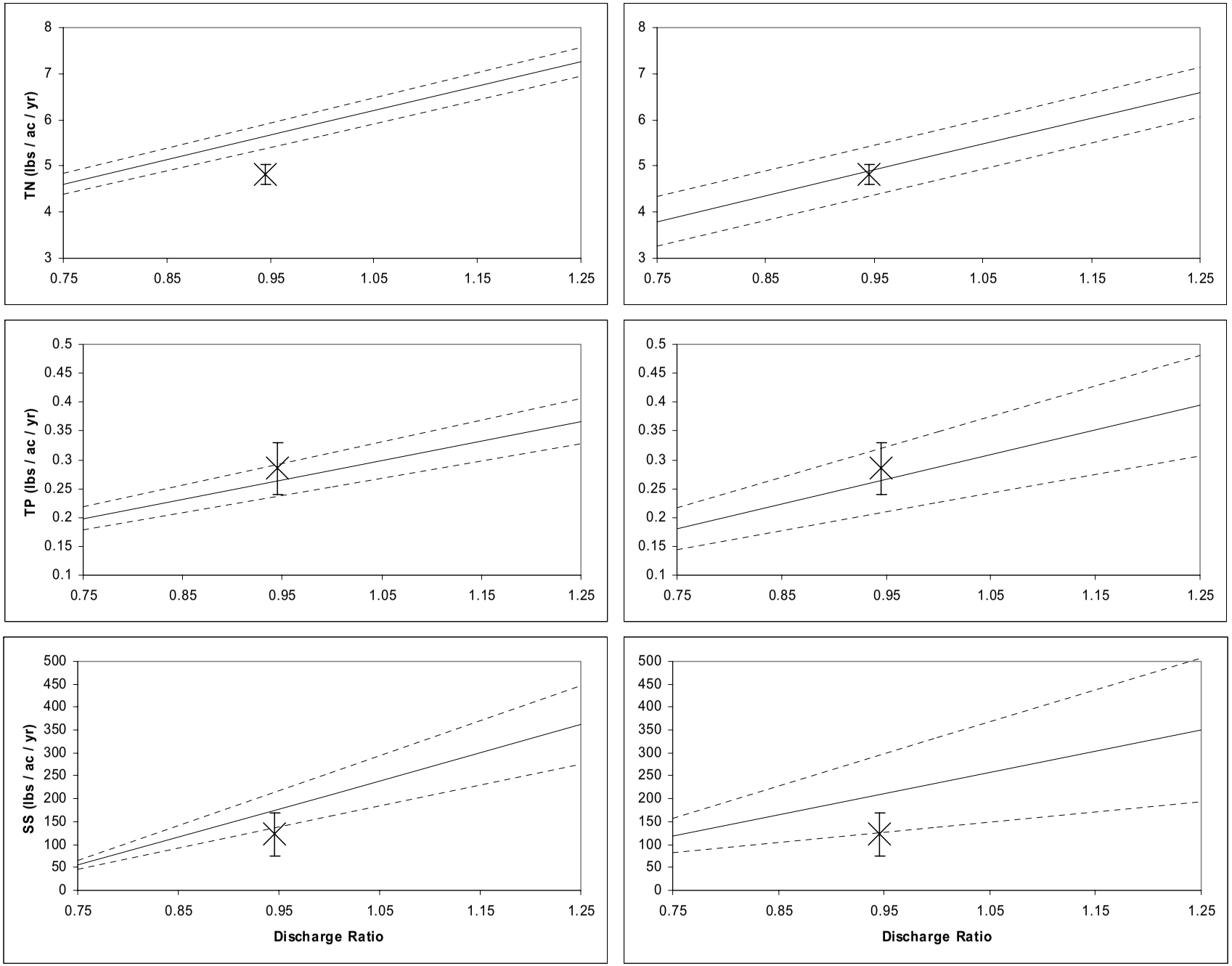

Figure 15. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 2005 Yield Compared to 1985-1994 Baseline (left) and Compared to 1995-2004 (right)

Juniata River at Newport, Pa.

The baselines for TN, TP, and SS for the Juniata River at Newport are shown in Figures 16 and 17 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 29 along with the discharge ratio. Best-fit lines were drawn through the data sets using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1985-1989 Baselines;
Total Nitrogen (TN)
TN Yield = 8.8923x - 0.3266 $R^2 = 0.7968$
Total Phosphorus (TP)
TP Yield = 0.5069x - 0.0732 $R^2 = 0.9589$
Suspended Sediment (SS)
SS Yield = 561.06x - 293.83 $R^2 = 0.8895$

1985-1994 Baselines;
Total Nitrogen (TN)
TN Yield = 7.8925x + 0.1029 $R^2 = 0.8693$
Total Phosphorus (TP)
TP Yield = 0.4219x - 0.0404 $R^2 = 0.8063$
Suspended Sediment (SS)
SS Yield = 396.15x - 186.71 $R^2 = 0.7502$

1995-2004 Baselines;
Total Nitrogen (TN)
TN Yield = 8.9249x - 0.8592 $R^2 = 0.9794$
Total Phosphorus (TP)
TP Yield = 0.3813x + 0.0144 $R^2 = 0.6246$
Suspended Sediment (SS)
SS Yield = 363.42x - 98.515 $R^2 = 0.8376$

Table 29. Comparison of 2005 Total Nitrogen, Total Phosphorous, and Suspended Sediment Yields With Baseline Yields at Newport, Pa.

Parameter	Discharge Ratio	1985 – 1989 Baseline lb/ac/yr	1985 - 1994 Baseline lb/ac/yr	1995 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	0.91	7.76	7.28	7.26	7.45
TP	0.91	0.388	0.343	0.361	0.228
SS	0.91	217	174	232	126

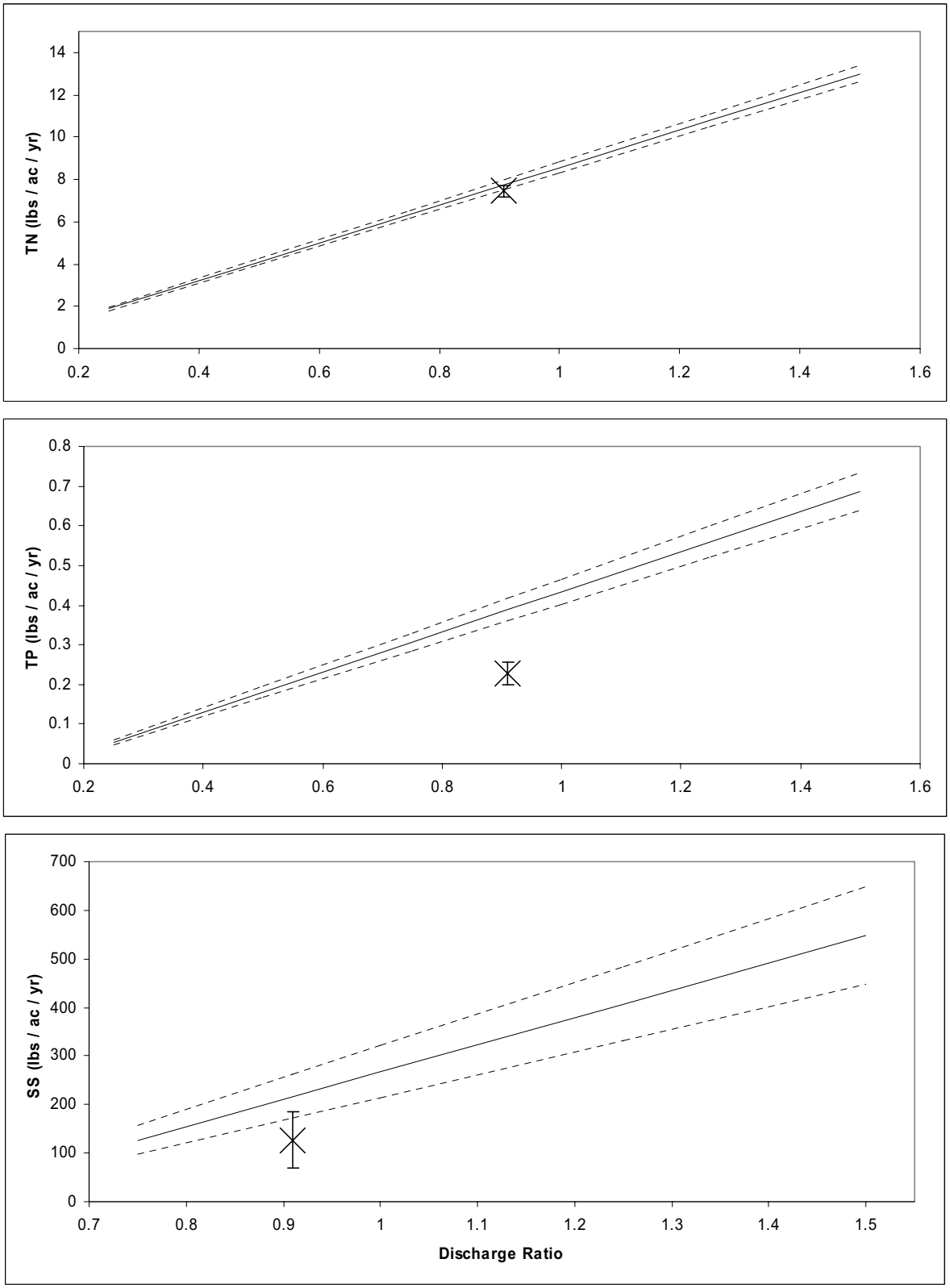

Figure 16. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 2005 Yield Compared to 1985-1989 Baseline

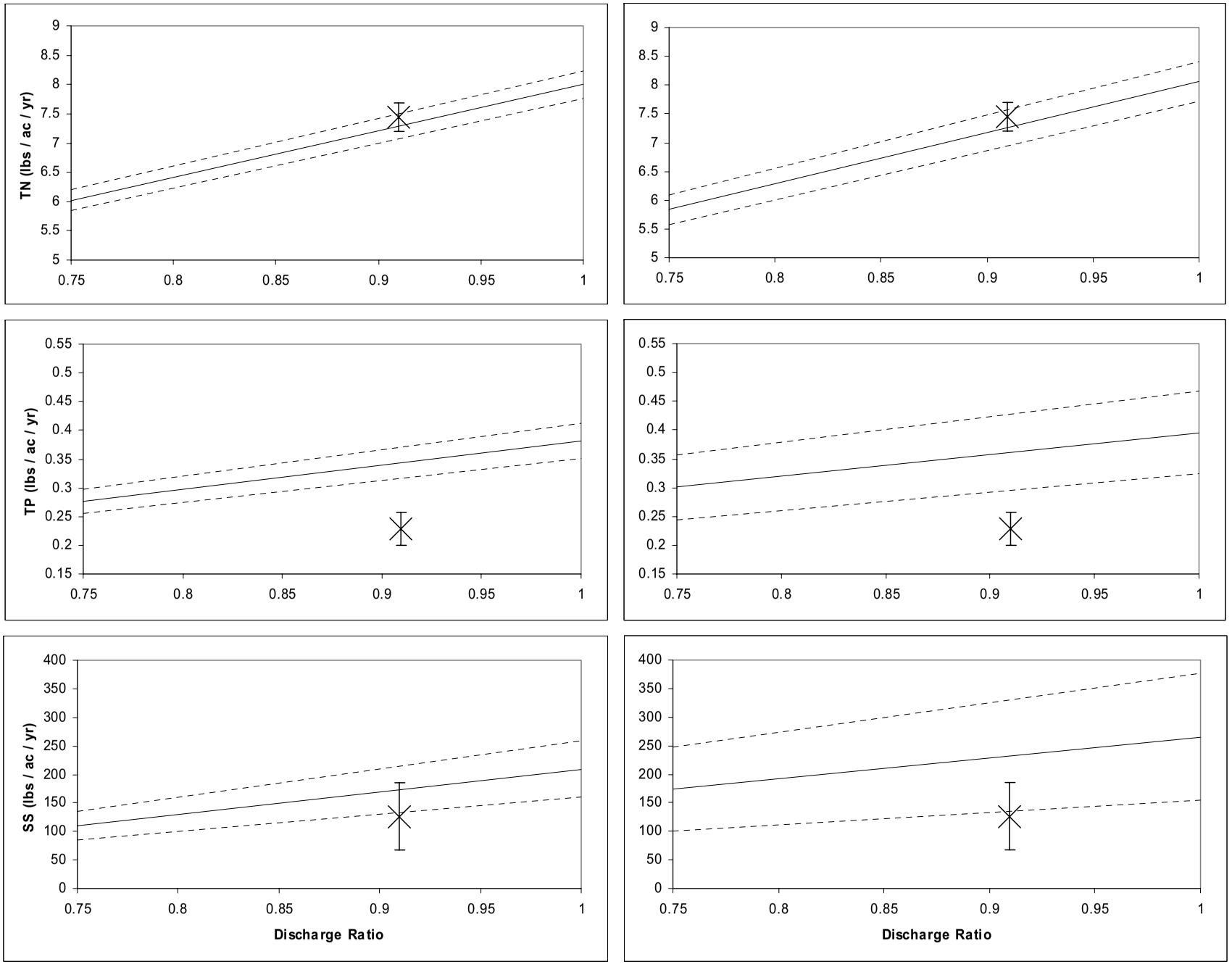

Figure 17. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 2005 Yield Compared to 1985-1994 Baseline (left) and Compared to 1995-2004 (right)

Susquehanna River at Marietta, Pa.

The baselines for TN, TP, and SS for the Susquehanna River at Marietta are shown in Figures 18 and 19 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 30 along with the discharge ratio. Best-fit lines were drawn through the data sets using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1987-1991 Baselines;
Total Nitrogen (TN)
TN Yield = 9.4692x - 0.6063 $R^2 = 0.9897$
Total Phosphorus (TP)
TP Yield = 0.5386x - 0.0693 $R^2 = 0.9159$
Suspended Sediment (SS)
SS Yield = 488.92x - 143.49 $R^2 = 0.6409$

1987-1995 Baselines;
Total Nitrogen (TN)
TN Yield = 8.6008x - 0.1443 $R^2 = 0.9631$
Total Phosphorus (TP)
TP Yield = 0.6978x - 0.2208 $R^2 = 0.8983$
Suspended Sediment (SS)
SS Yield = 704.31x - 340.17 $R^2 = 0.8186$

1996-2004 Baselines;
Total Nitrogen (TN)
TN Yield = 7.941x - 0.3542 $R^2 = 0.9944$
Total Phosphorus (TP)
TP Yield = 0.7679x - 0.1963 $R^2 = 0.9412$
Suspended Sediment (SS)
SS Yield = 979.39x - 511.23 $R^2 = 0.7255$

Table 30. Comparison of 2005 Total Nitrogen, Total Phosphorous, and Suspended Sediment Yields With Baseline Yields at Marietta, Pa.

Parameter	Discharge Ratio	1987 – 1991 Baseline lb/ac/yr	1987 - 1995 Baseline lb/ac/yr	1996 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	1.05	9.36	8.90	8.00	8.34
TP	1.05	0.498	0.514	0.612	0.470
SS	1.05	371	401	520	333

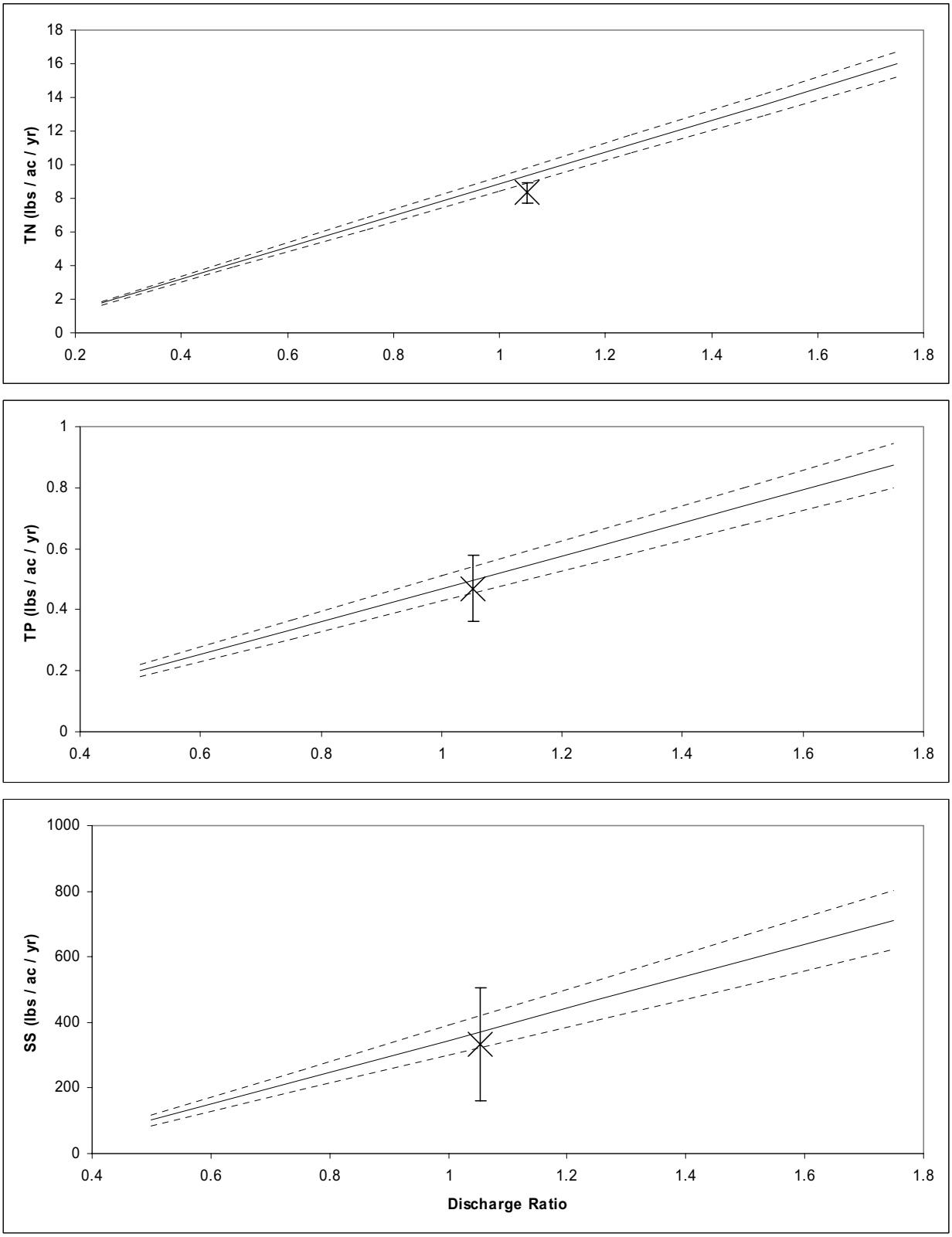

Figure 18. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 2005 Yield Compared to 1987-1991 Baseline

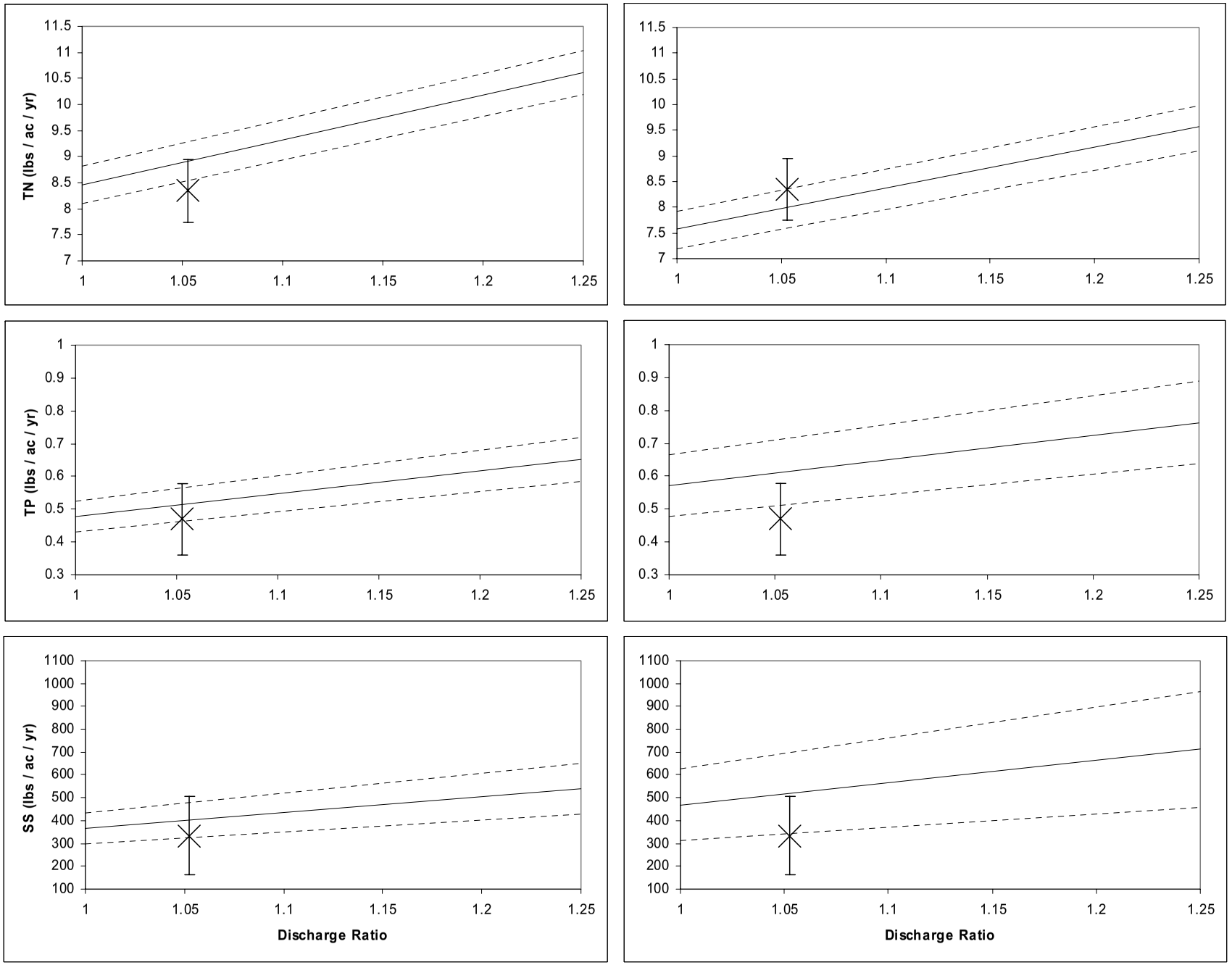

Figure 19. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 2005 Yield Compared to 1987-1995 Baseline (left) and Compared to 1996-2004 (right)

Conestoga River at Conestoga, Pa.

The baselines for TN, TP, and SS for the Conestoga River at Conestoga are shown in Figures 20 and 21 with the 2005 annual yield. Actual 2005 and baseline yields are listed in Table 31 along with the discharge ratio. Best-fit lines were drawn through the data sets using the following equations:

Where x = water-discharge ratio and R^2 = correlation coefficient

1985-1989 Baseline;
Total Nitrogen (TN)
TN Yield = 29.91x + 7.087 $R^2 = 0.9752$
Total Phosphorus (TP)
TP Yield = 2.6126x + 0.0672 $R^2 = 0.8461$
Suspended Sediment (SS)
SS Yield = 2976.9x - 1309.3 $R^2 = 0.6957$

1985-1994 Baselines;
Total Nitrogen (TN)
TN Yield = 32.879x + 3.3409 $R^2 = 0.9763$
Total Phosphorus (TP)
TP Yield = 3.3094x - 0.9592 $R^2 = 0.7652$
Suspended Sediment (SS)
SS Yield = 2908.8x - 1522.2 $R^2 = 0.7499$

1995-2004 Baselines;
Total Nitrogen (TN)
TN Yield = 33.045x + 0.8061 $R^2 = 0.9920$
Total Phosphorus (TP)
TP Yield = 3.0592x - 0.5039 $R^2 = 0.7332$
Suspended Sediment (SS)
SS Yield = 2037.9x - 721.39 $R^2 = 0.5469$

Table 31. Comparison of 2005 Total Nitrogen, Total Phosphorous, and Suspended Sediment Yields With Baseline Yields at Conestoga, Pa.

Parameter	Discharge Ratio	1985 – 1989 Baseline lb/ac/yr	1985 - 1994 Baseline lb/ac/yr	1995 - 2004 Baseline lb/ac/yr	2005 lb/ac/yr
TN	1.15	41.39	41.05	38.71	39.28
TP	1.15	3.064	2.837	3.005	1.840
SS	1.15	2,105	1,814	1,616	949

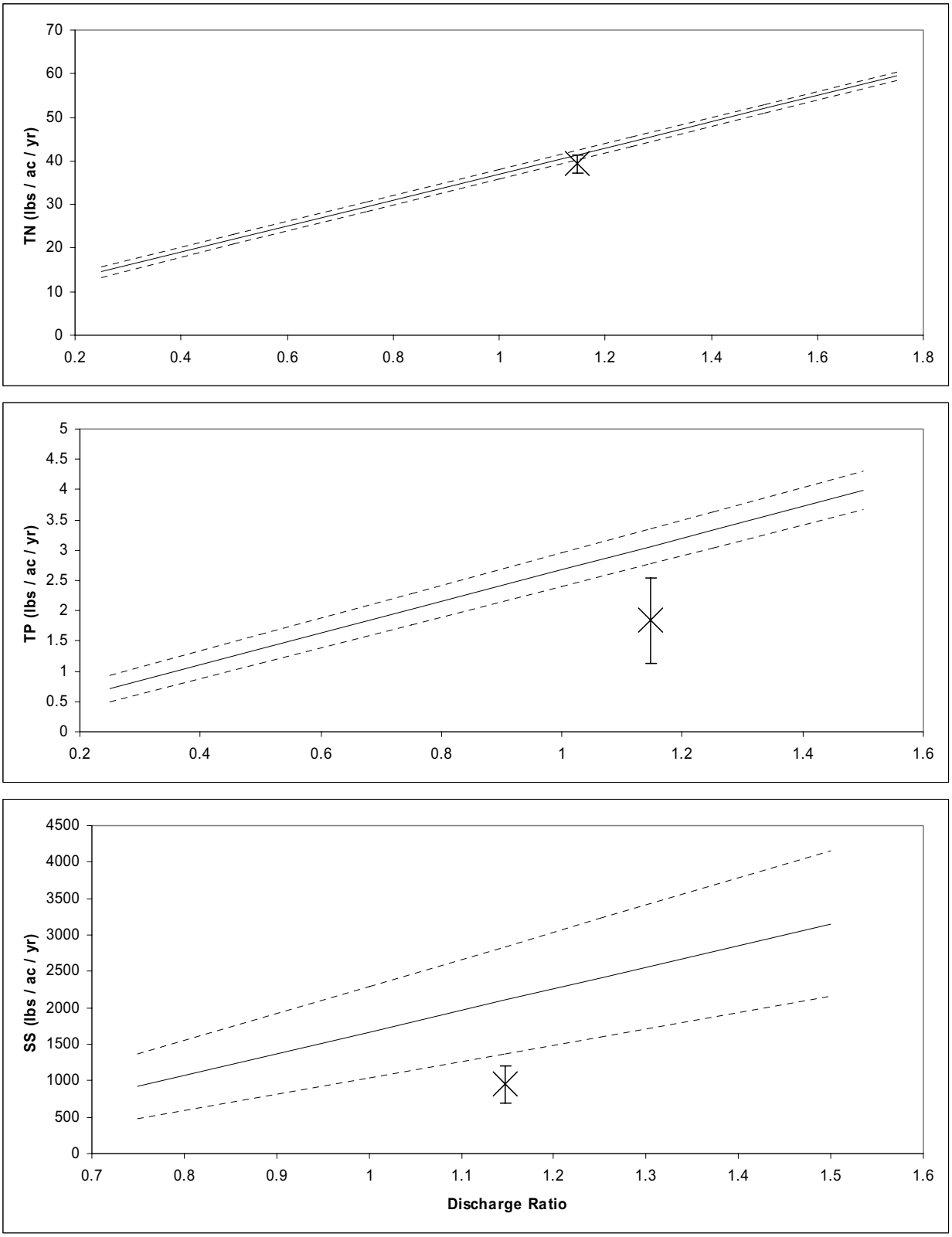

Figure 20. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Conestoga River at Conestoga, Pa., 2005 Yield Compared to 1985-1989 Baseline

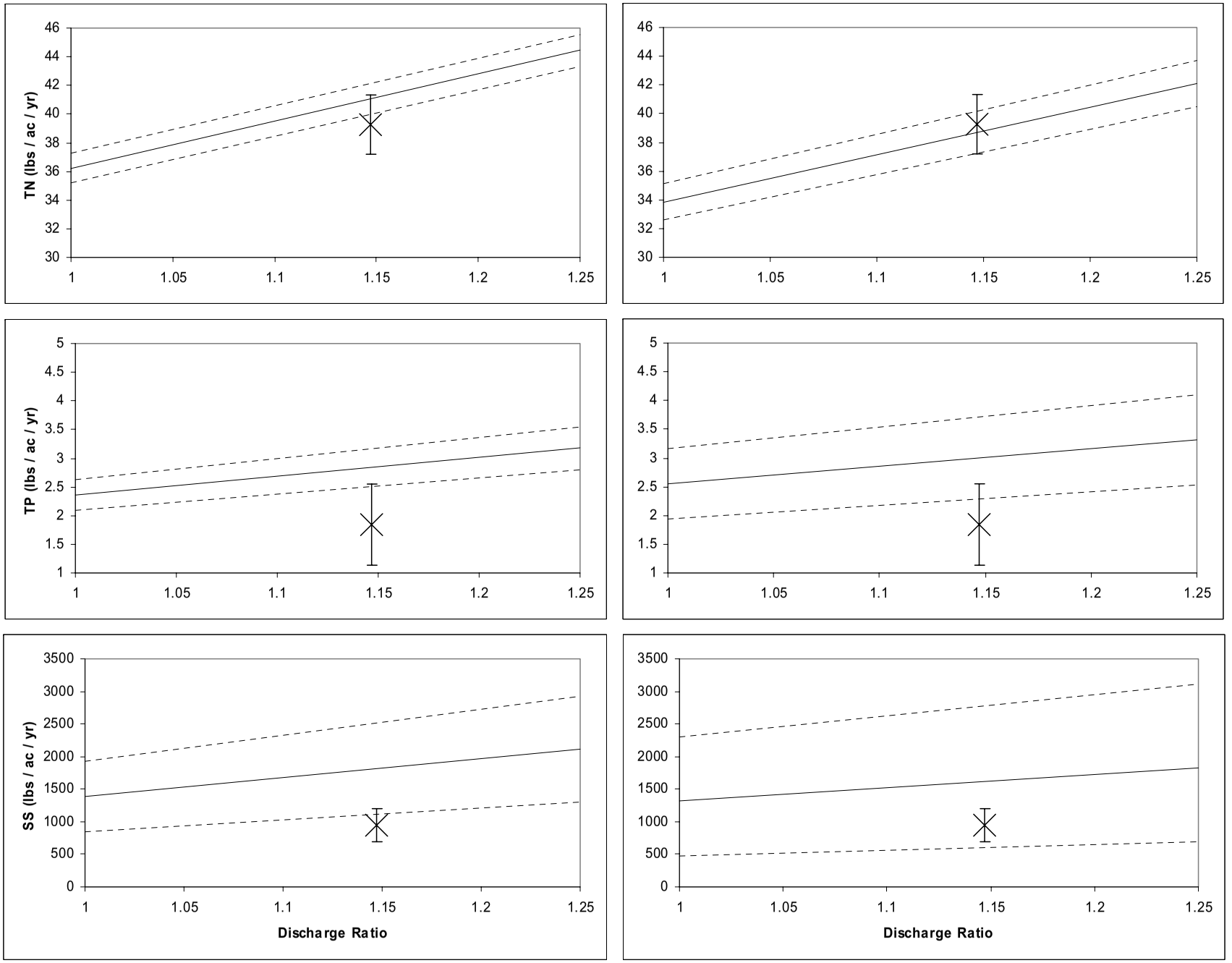

Figure 21. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Conestoga River at Conestoga, Pa., 2005 Yield Compared to 1985-1994 Baseline (left) and Compared to 1995-2004 (right)