

## COMPARISON OF THE 2003 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

The annual fluctuations of nutrient and SS loads and water discharge make it difficult to determine whether the changes were related to land use, nutrient availability, or simply annual water discharge. Ott and others (1991) used the functional 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 loads or 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 5-year study (1985-89) were used to provide a best-fit linear regression line to be used as the baseline relationship between annual loads and water discharge. It was hypothesized that, as future loads and water-discharge ratios were plotted against the baseline, any significant deviation from the baseline would indicate that some change in the annual load had occurred, and that further evaluations to determine the reason for the change were warranted. The data collected in 2003 were compared with the 1985-89 baseline, 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. 2003 yields values also were plotted against a baseline developed with data from the beginning of each dataset (usually 1985) through 2002. Figures 17-28 display the baseline graphs and the 2003 yields.

### Susquehanna River at Towanda, Pa.

The baselines for TN, TP, and SS for the Susquehanna River at Towanda are shown in Figures 17 and 18 with the 2003 annual yield. Actual 2003 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:

Initial 5-year Baseline;

Total Nitrogen (TN)

$$\text{TN Yield} = .0642 + 6.0358x \quad R^2 = 0.86$$

Total Phosphorus (TP)

$$\text{TP Yield} = -0.1375 + 0.4909x \quad R^2 = 0.53$$

Suspended Sediment (SS)

$$\text{SS Yield} = -620.42 + 914.21x \quad R^2 = 0.43$$

Where x = water-discharge ratio and R2 = correlation coefficient

2002 Baselines;

Total Nitrogen (TN)

$$\text{TN Yield} = 0.3397 + 5.8545x \quad R^2 = 0.87$$

Total Phosphorus (TP)

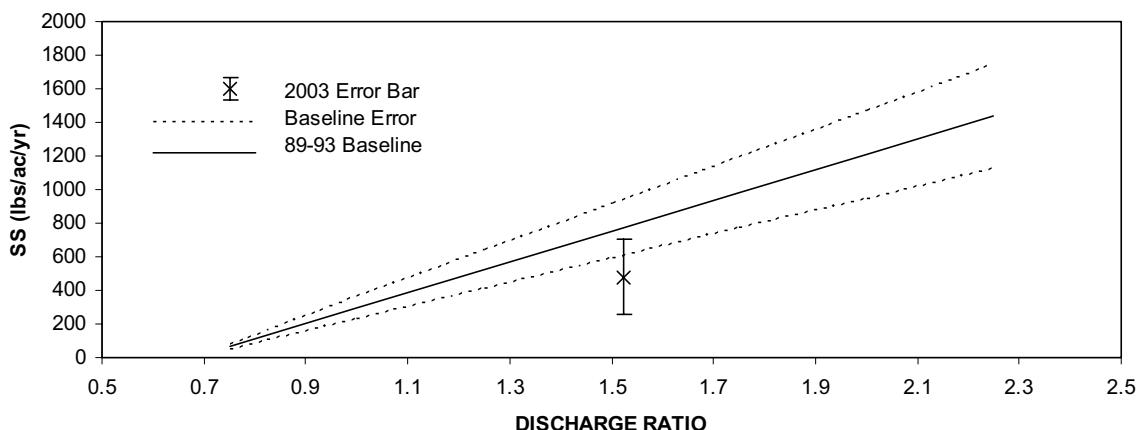
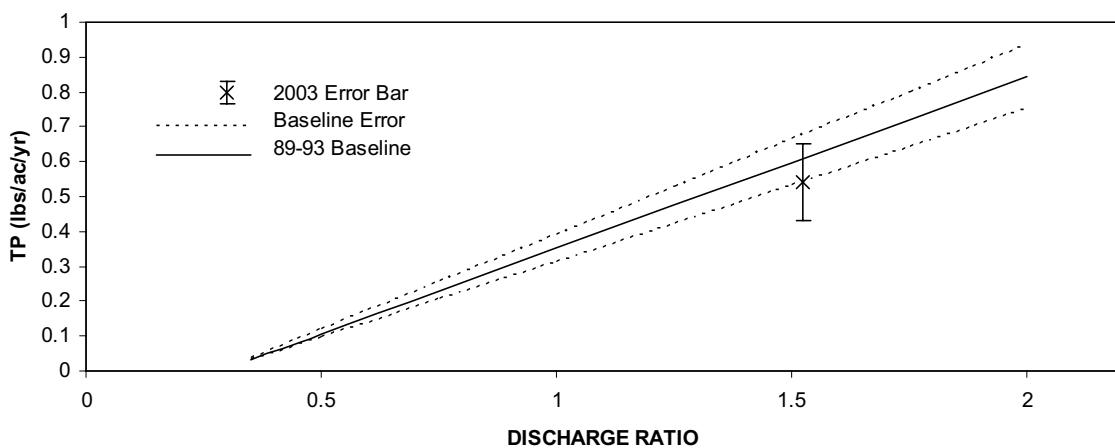
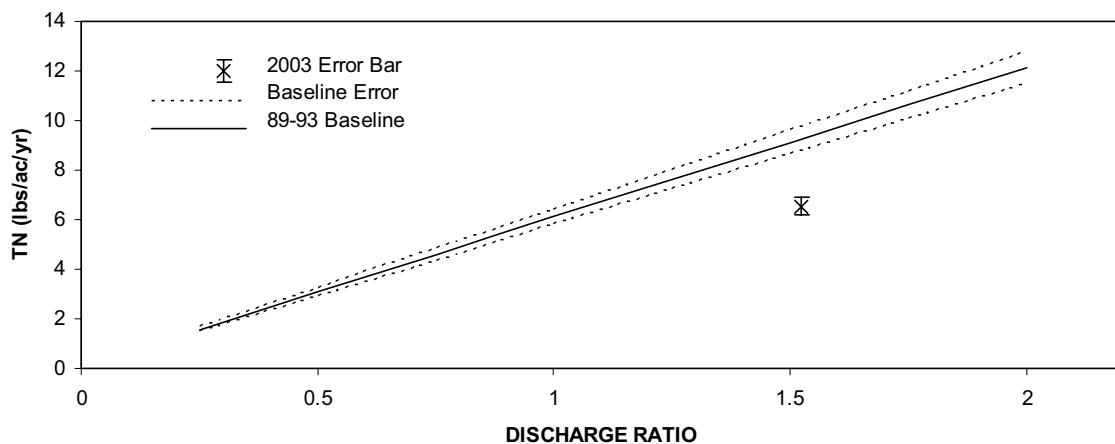
$$\text{TP Yield} = -0.2163 + 0.6148x \quad R^2 = 0.71$$

Suspended Sediment (SS)

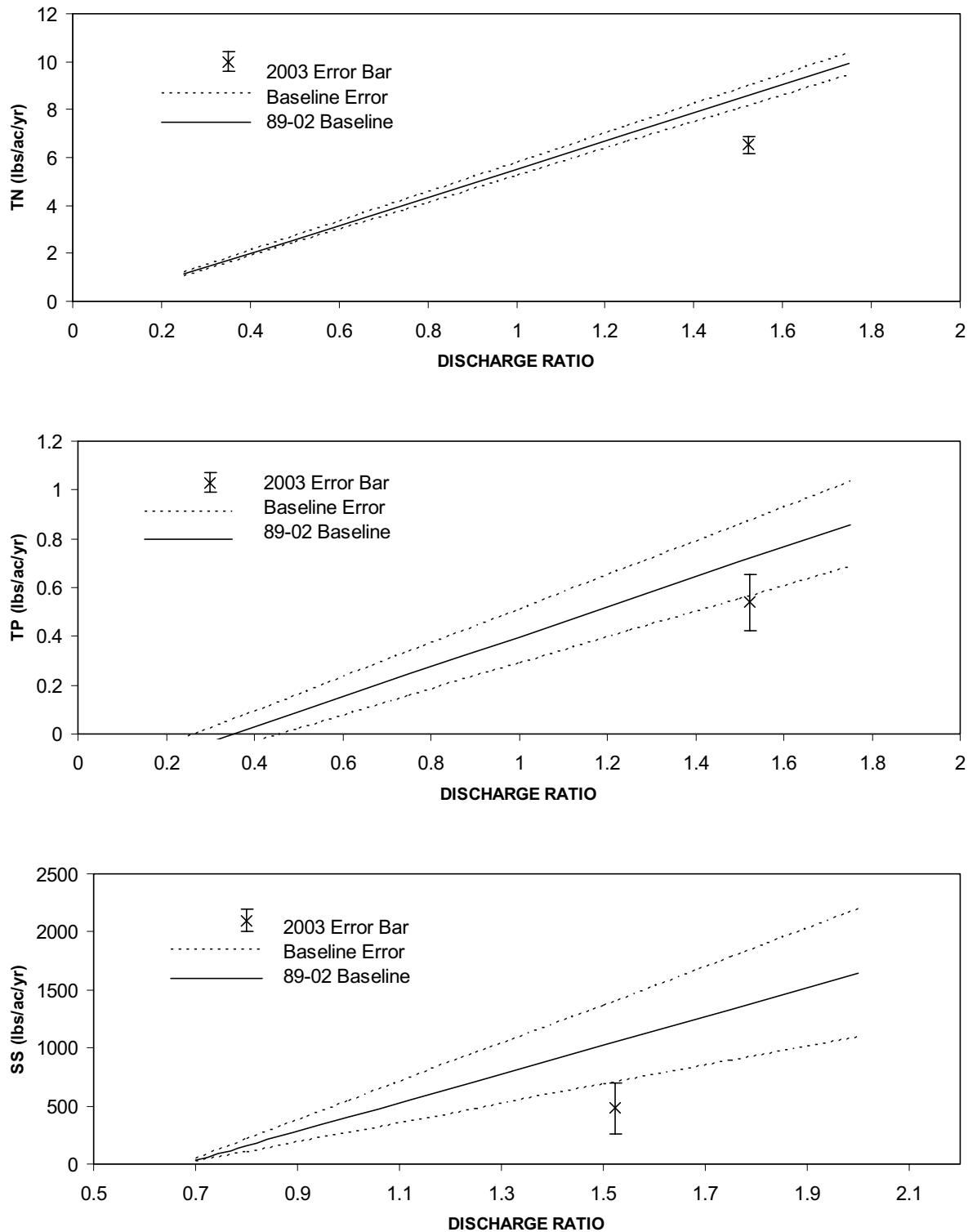
$$\text{SS Yield} = -833.1 + 1238.3x \quad R^2 = 0.67$$

**Table 27. Comparison of 2003 TN, TP, and SS Yields with Baseline Yields at Towanda, Pa.**

| Parameter | Discharge Ratio | 1989 – 1993 Baseline<br>lb/ac/yr | 1989 - 2002 Baseline<br>lb/ac/yr | 2003<br>lb/ac/yr |
|-----------|-----------------|----------------------------------|----------------------------------|------------------|
| TN        | 1.522           | 9.25                             | 9.25                             | 6.54             |
| TP        | 1.522           | 0.6096                           | 0.7194                           | 0.54             |
| SS        | 1.522           | 771.008                          | 1051.59                          | 480.91           |



**Figure 17.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 1989-1993 and 2003



**Figure 18.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 1989-2002 and 2003

## Susquehanna River at Danville, Pa.

Figures 19-20 shows the baselines for TN, TP, and SS and the 2003 yields for the Susquehanna River at Danville. Actual 2003 and baseline yields are listed in Table 28 along with the discharge ratio. The regression equations used to establish the baselines were:

Initial 5-year baseline;

### Total Nitrogen (TN)

$$\text{TN Yield} = -0.2303 + 7.3419x \quad R^2 = 0.85$$

### Total Phosphorus (TP)

$$\text{TP Yield} = -0.1583 + 0.6657x \quad R^2 = 0.95$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -480.64 + 870.684x \quad R^2 = 0.99$$

2002 Baselines;

### Total Nitrogen (TN)

$$\text{TN Yield} = 0.3994 + 5.7997x \quad R^2 = 0.78$$

### Total Phosphorus (TP)

$$\text{TP Yield} = -0.1748 + 0.5993x \quad R^2 = 0.73$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -557.19 + 887.57x \quad R^2 = 0.7446$$

## West Branch Susquehanna River at Lewisburg, Pa.

The baselines and the 2003 yields for TN, TP, and SS are shown in Figures 21-22. Actual 2003 and baseline yields are listed in Table 29 along with the discharge ratio. The baselines were defined by the following equations:

Initial 5-year baseline;

### Total Nitrogen (TN)

$$\text{TN Yield} = -1.4234 + 7.8108x \quad R^2 = 0.73$$

### Total Phosphorus (TP)

$$\text{TP Yield} = 0.0255 + 0.2728x \quad R^2 = 0.53$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -157.34 + 345.33x \quad R^2 = 0.67$$

2002 Baselines;

### Total Nitrogen (TN)

$$\text{TN Yield} = -0.5775 + 6.1956x \quad R^2 = 0.88$$

### Total Phosphorus (TP)

$$\text{TP Yield} = -0.1392 + 0.424x \quad R^2 = 0.72$$

### Suspended Sediment (SS)

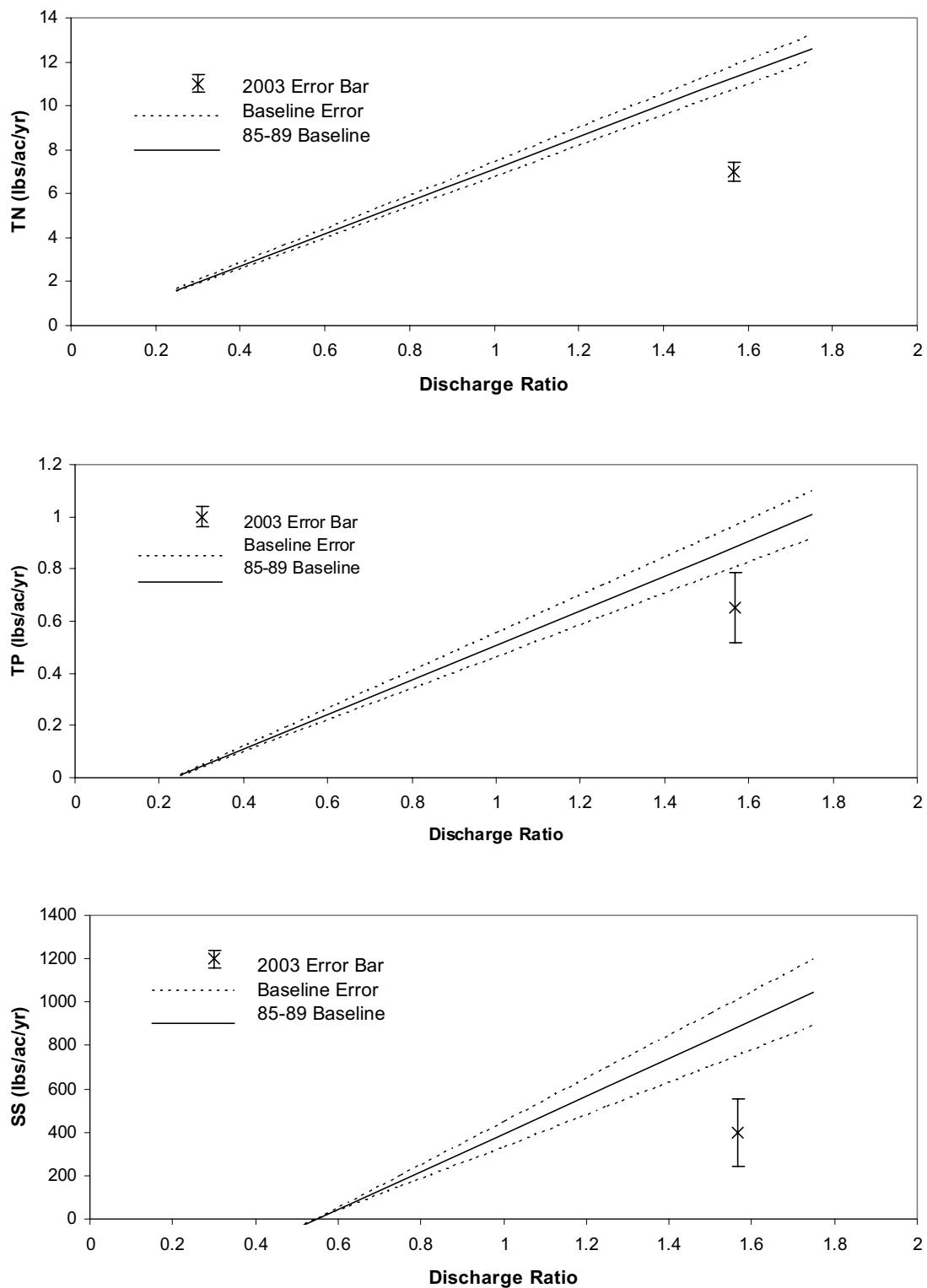
$$\text{SS Yield} = -507.09 + 768.37x \quad R^2 = 0.72$$

**Table 28. Comparison of 2003 TN, TP, and SS Yields with Baseline Yields at Danville, Pa.**

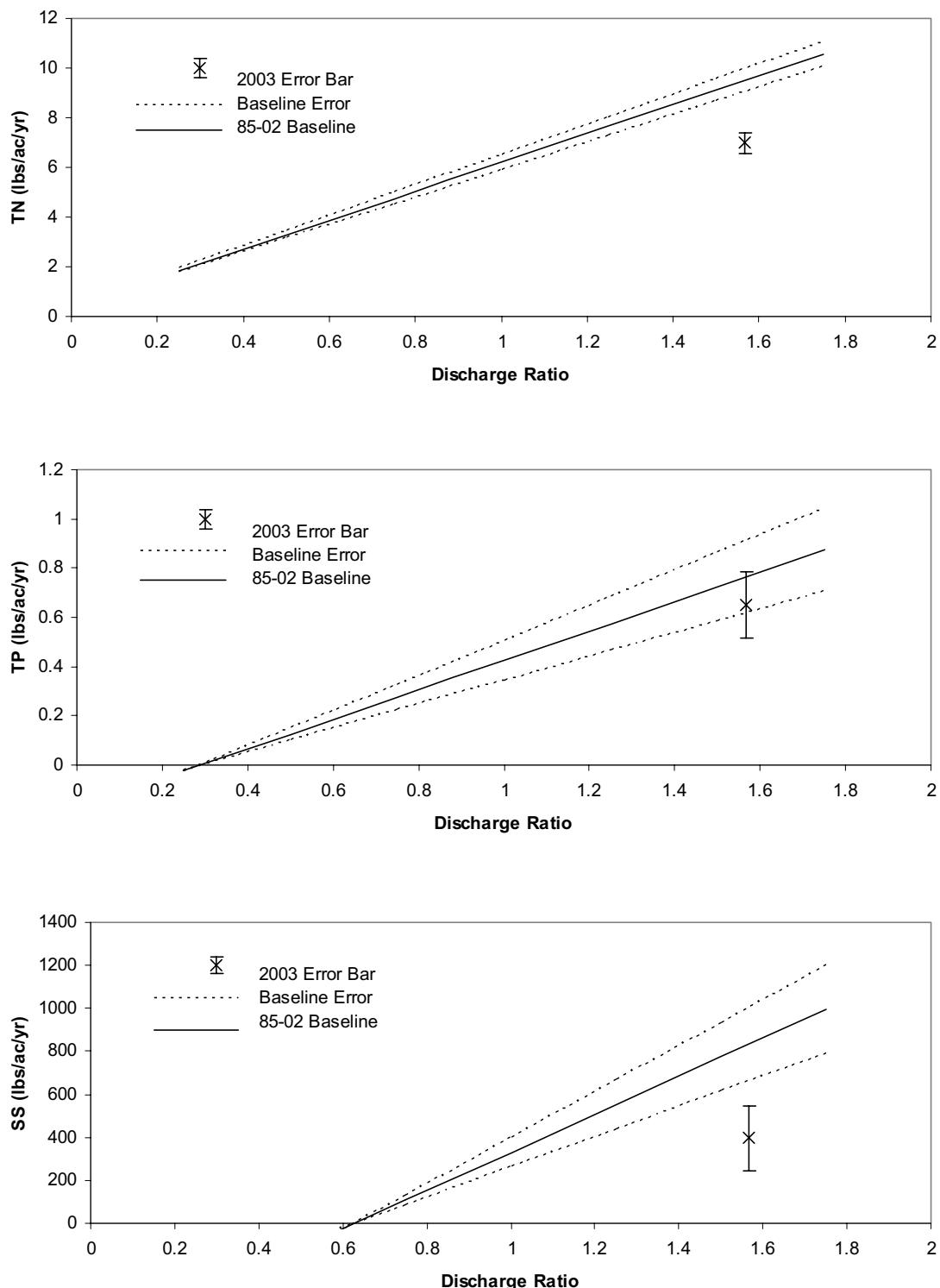
| Parameter | Discharge Ratio | 1985 – 1989 Baseline<br>lb/ac/yr | 1985 - 2002 Baseline<br>lb/ac/yr | 2003<br>lb/ac/yr |
|-----------|-----------------|----------------------------------|----------------------------------|------------------|
| TN        | 1.566           | 11.27                            | 9.482                            | 6.99             |
| TP        | 1.566           | 0.8842                           | 0.7637                           | 0.65             |
| SS        | 1.566           | 882.851                          | 832.745                          | 397.68           |

**Table 29. Comparison of 2003 Total Nitrogen, Total Phosphorus, and Suspended-Sediment Yields With Baseline Yields at Lewisburg, Pa.**

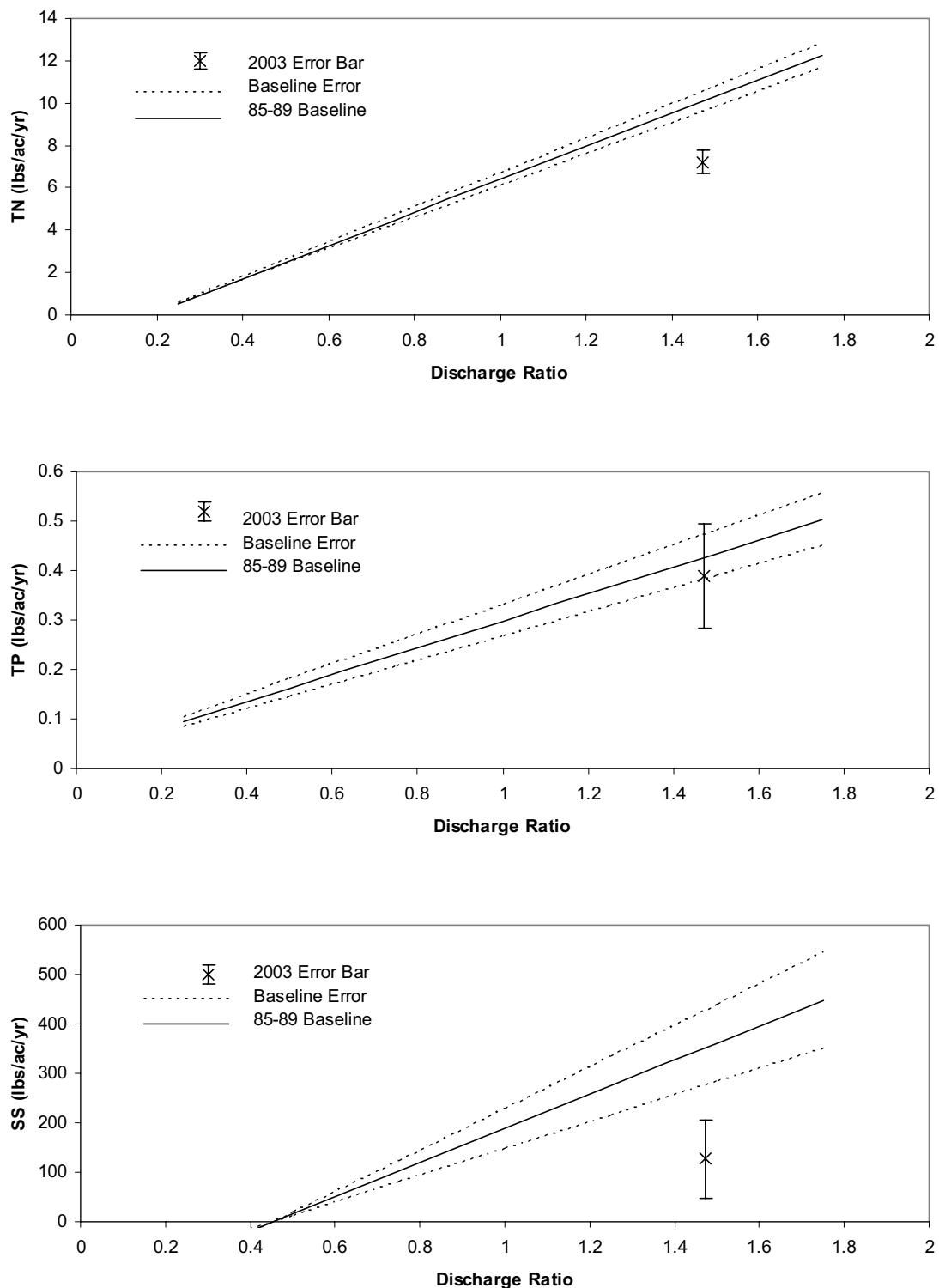
| Parameter | Discharge Ratio | 1985 – 1989 Baseline<br>lb/ac/yr | 1985 - 2002 Baseline<br>lb/ac/yr | 2003<br>lb/ac/yr |
|-----------|-----------------|----------------------------------|----------------------------------|------------------|
| TN        | 1.473           | 10.082                           | 8.549                            | 7.22             |
| TP        | 1.473           | 0.4273                           | 0.4854                           | 0.39             |
| SS        | 1.473           | 351.331                          | 624.719                          | 126.76           |



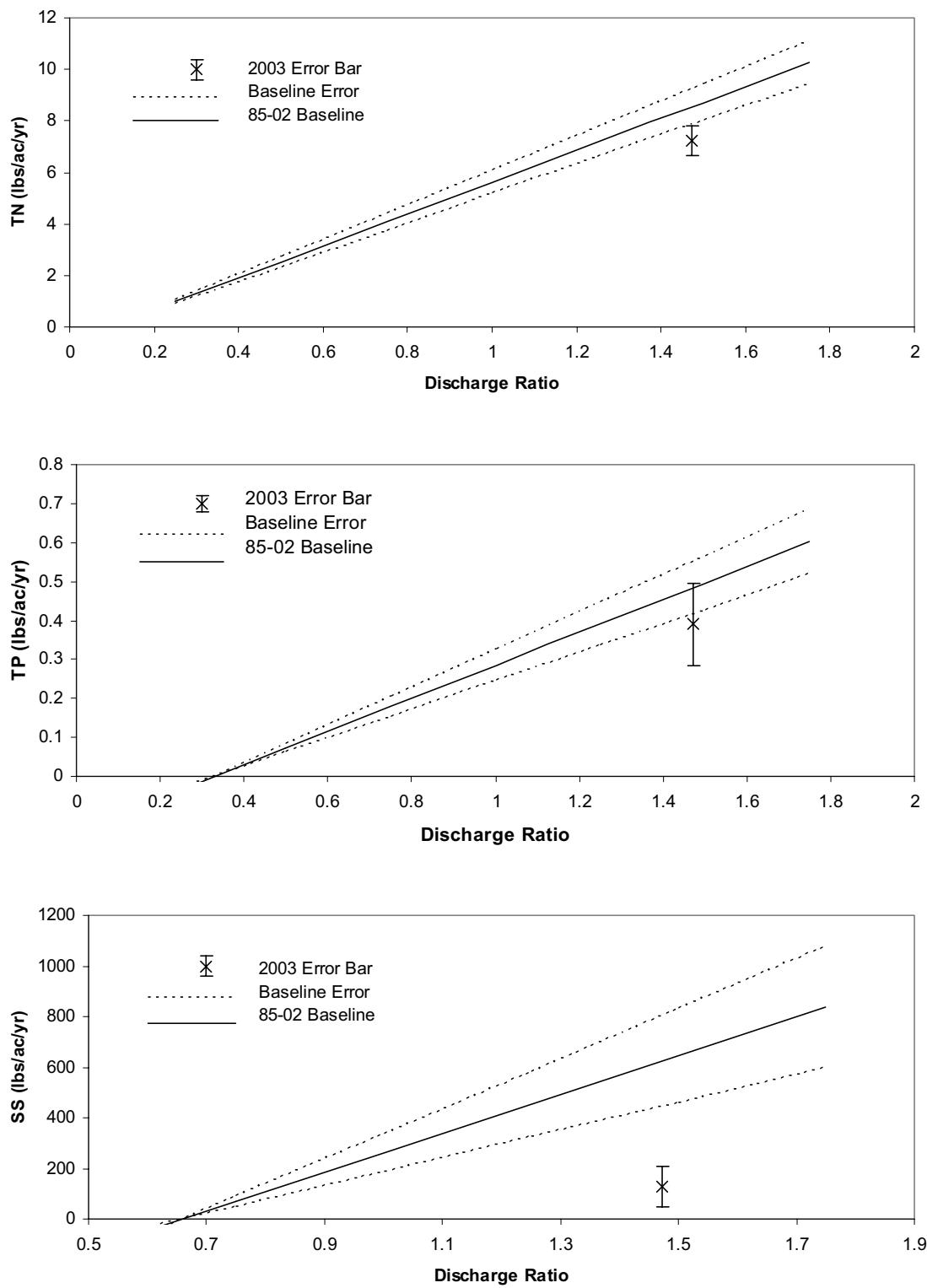
**Figure 19.** *Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 1985-1989 and 2003*



**Figure 20.** *Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 1985-2002 and 2003*



**Figure 21.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 1985-1989 and 2003



**Figure 22.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 1985-2002 and 2003

## Juniata River at Newport, Pa.

The baselines and 2003 yields for TN, TP, and SS at Newport, are shown in Figures 23-24. Actual 2003 and baseline yields are listed in Table 30 along with the discharge ratio. The baselines were defined by the following equations:

Initial 5-year baseline;

### Total Nitrogen (TN)

$$\text{TN Yield} = -0.2997 + 8.3964x R^2 = 0.80$$

### Total Phosphorus (TP)

$$\text{TP Yield} = -0.0762 + 0.4844x R^2 = 0.96$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -294.17 + 532.33x R^2 = 0.89$$

2002 Baselines;

### Total Nitrogen (TN)

$$\text{TN Yield} = 0.0697 + 7.4075x R^2 = 0.93$$

### Total Phosphorus (TP)

$$\text{TP Yield} = 0.1038 + 0.2498x R^2 = 0.54$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -131.86 + 355.03x R^2 = 0.80$$

## Susquehanna River at Marietta, Pa.

The Figure 25-26 shows the TN, TP, and SS baselines and 2003 yield. Actual 2003 and baseline yields are listed in Table 31 along with the discharge ratio. The baselines were defined by the following equations:

Initial 5-year baseline;

### Total Nitrogen (TN)

$$\text{TN Yield} = -0.8251 + 9.1855x R^2 = 0.99$$

### Total Phosphorus (TP)

$$\text{TP Yield} = 0.1393 + 0.2321x R^2 = 0.27$$

### Suspended Sediment (SS)

$$\text{SS Yield} = -97.695 + 380.81x R^2 = 0.48$$

2002 Baselines;

### Total Nitrogen (TN)

$$\text{TN Yield} = -0.8488 + 8.449x R^2 = 0.92$$

### Total Phosphorus (TP)

$$\text{TP Yield} = -0.1479 + 0.5872x R^2 = 0.69$$

### Suspended Sediment (SS)

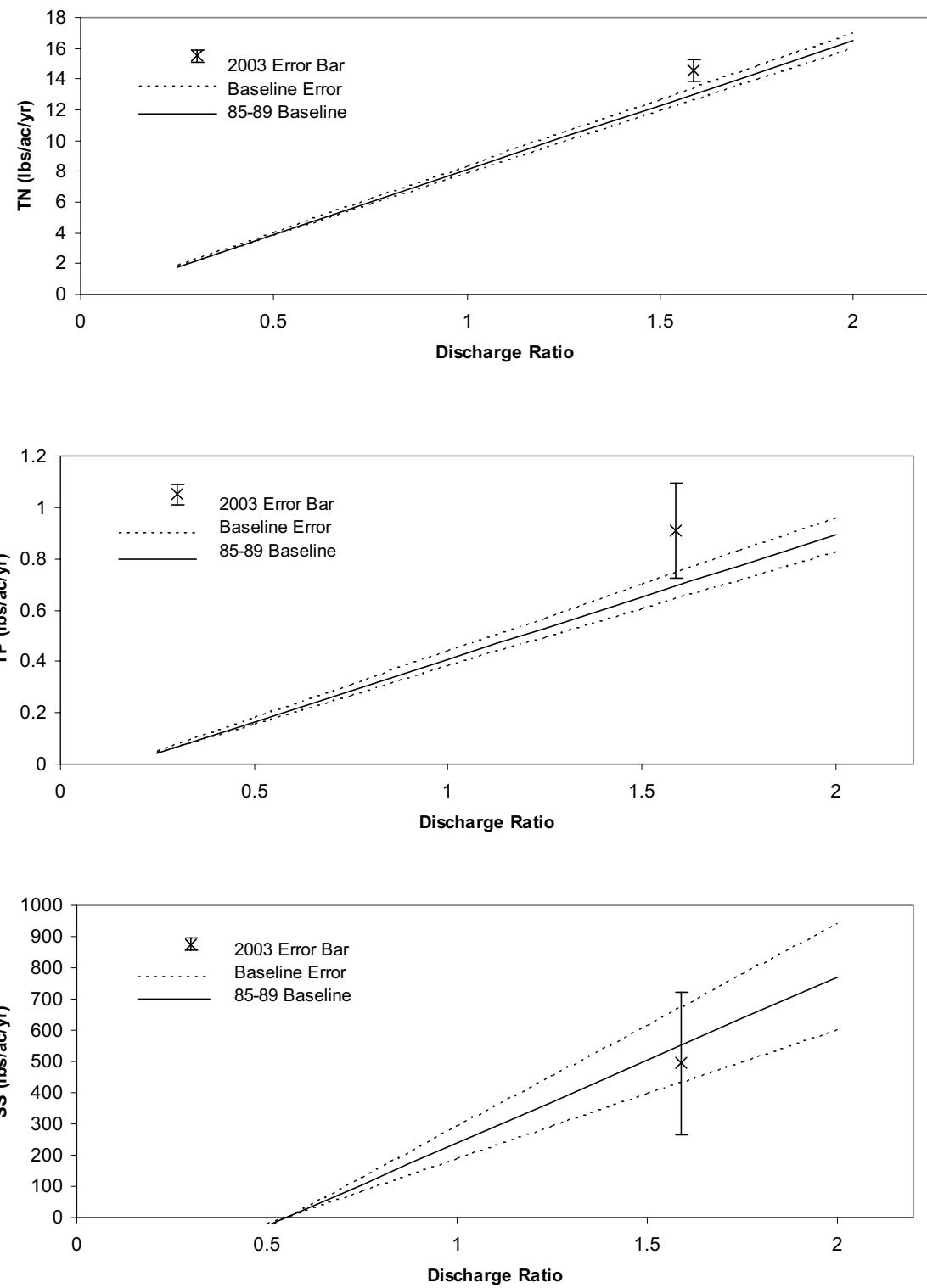
$$\text{SS Yield} = -320.71 + 637.48x R^2 = 0.83$$

**Table 30. Comparison of 2003 TN, TP, and SS Yields with Baseline Yields at Newport, Pa.**

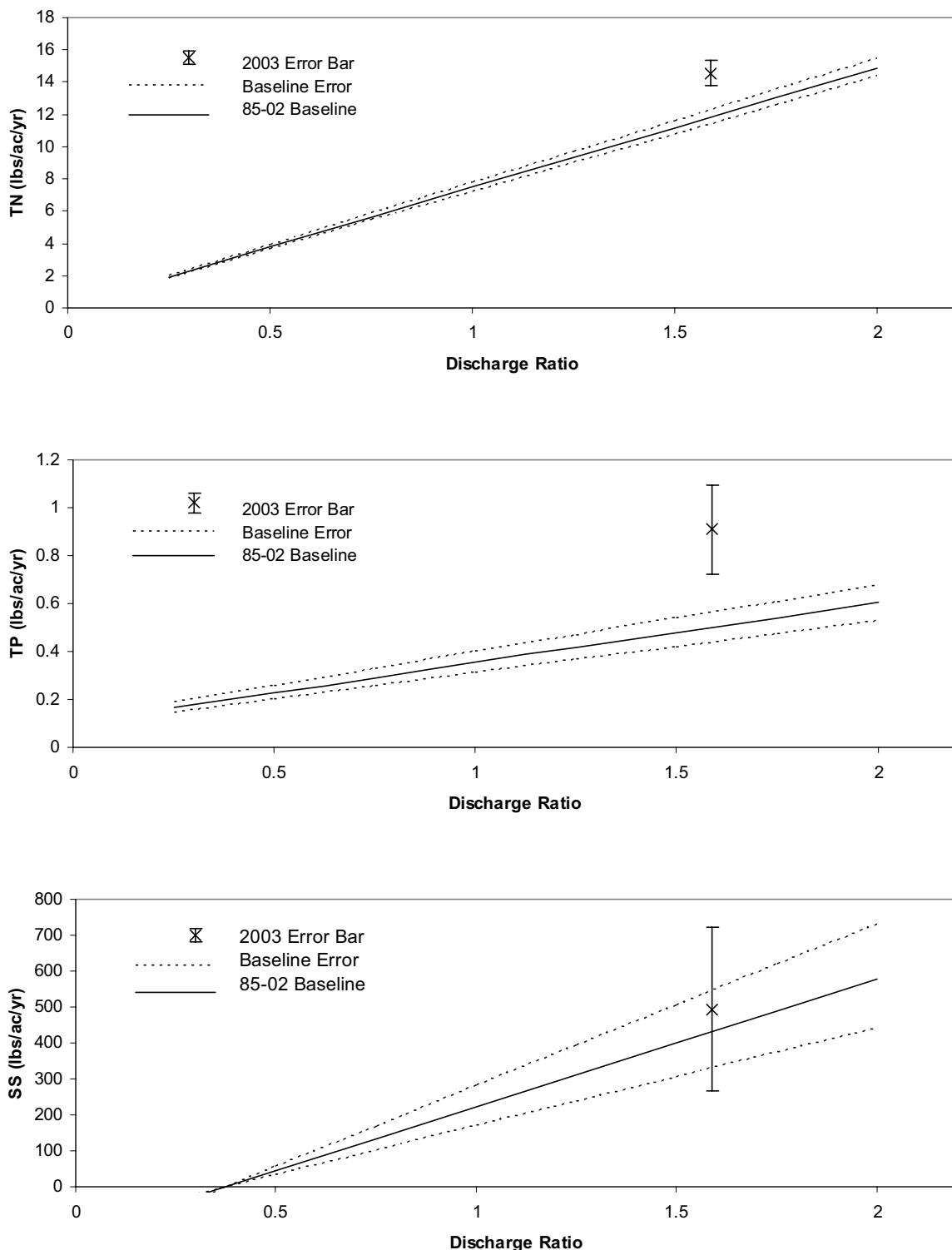
| Parameter | Discharge Ratio | 1985 – 1989 Baseline lb/ac/yr | 1985 - 2002 Baseline lb/ac/yr | 2003 lb/ac/yr |
|-----------|-----------------|-------------------------------|-------------------------------|---------------|
| TN        | 1.59            | 13.051                        | 11.848                        | 14.57         |
| TP        | 1.59            | 0.6939                        | 0.501                         | 0.91          |
| SS        | 1.59            | 552.235                       | 432.637                       | 493.63        |

**Table 31. Comparison of 2003 TN, TP, and SS Yields with Baseline Yields at Marietta, Pa.**

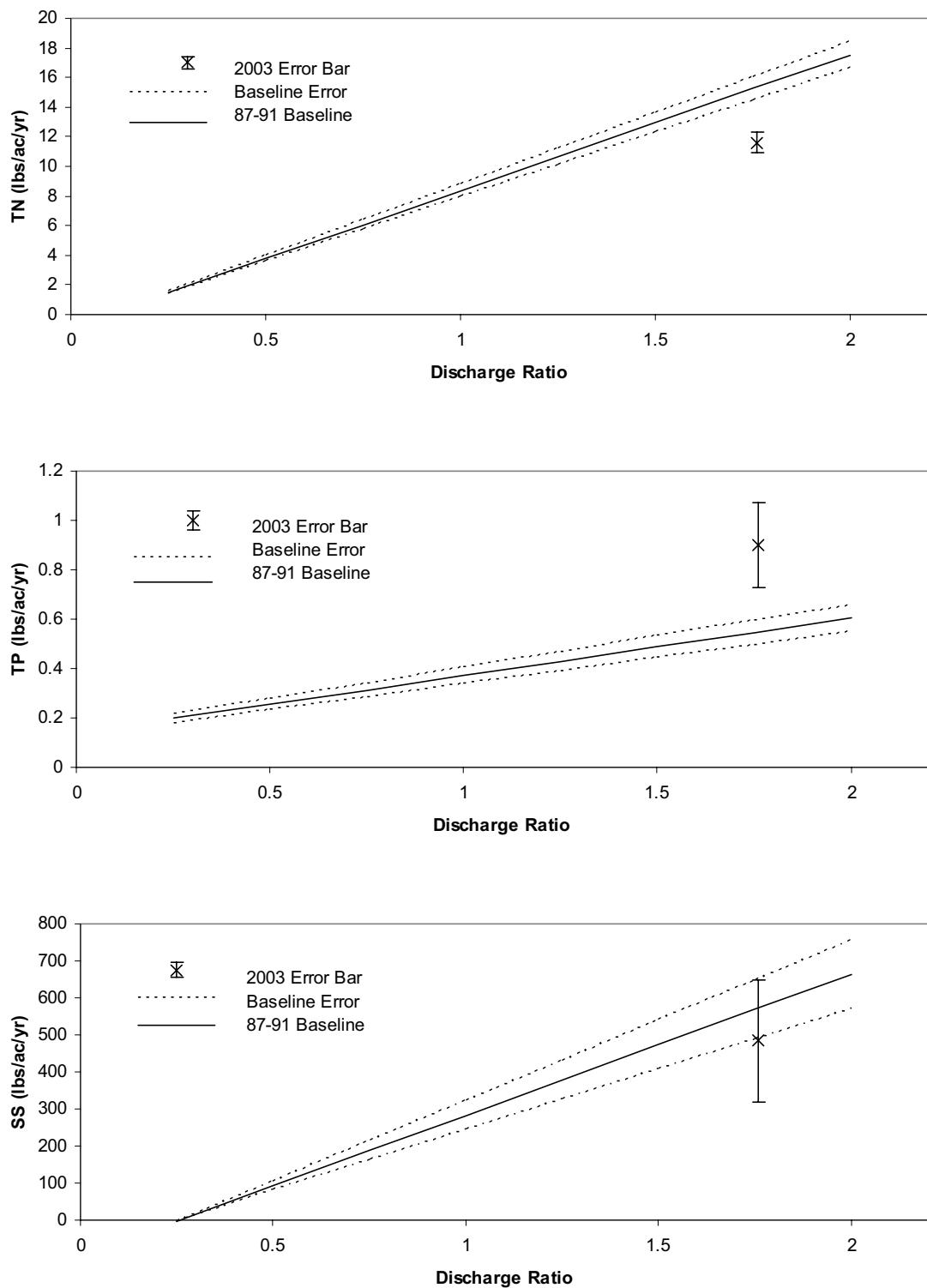
| Parameter | Discharge Ratio | 1987 – 1991 Baseline lb/ac/yr | 1987 - 2002 Baseline lb/ac/yr | 2003 lb/ac/yr |
|-----------|-----------------|-------------------------------|-------------------------------|---------------|
| TN        | 1.759           | 15.332                        | 14.013                        | 11.61         |
| TP        | 1.759           | 0.5476                        | 0.885                         | 0.9           |
| SS        | 1.759           | 572.15                        | 800.617                       | 483.47        |



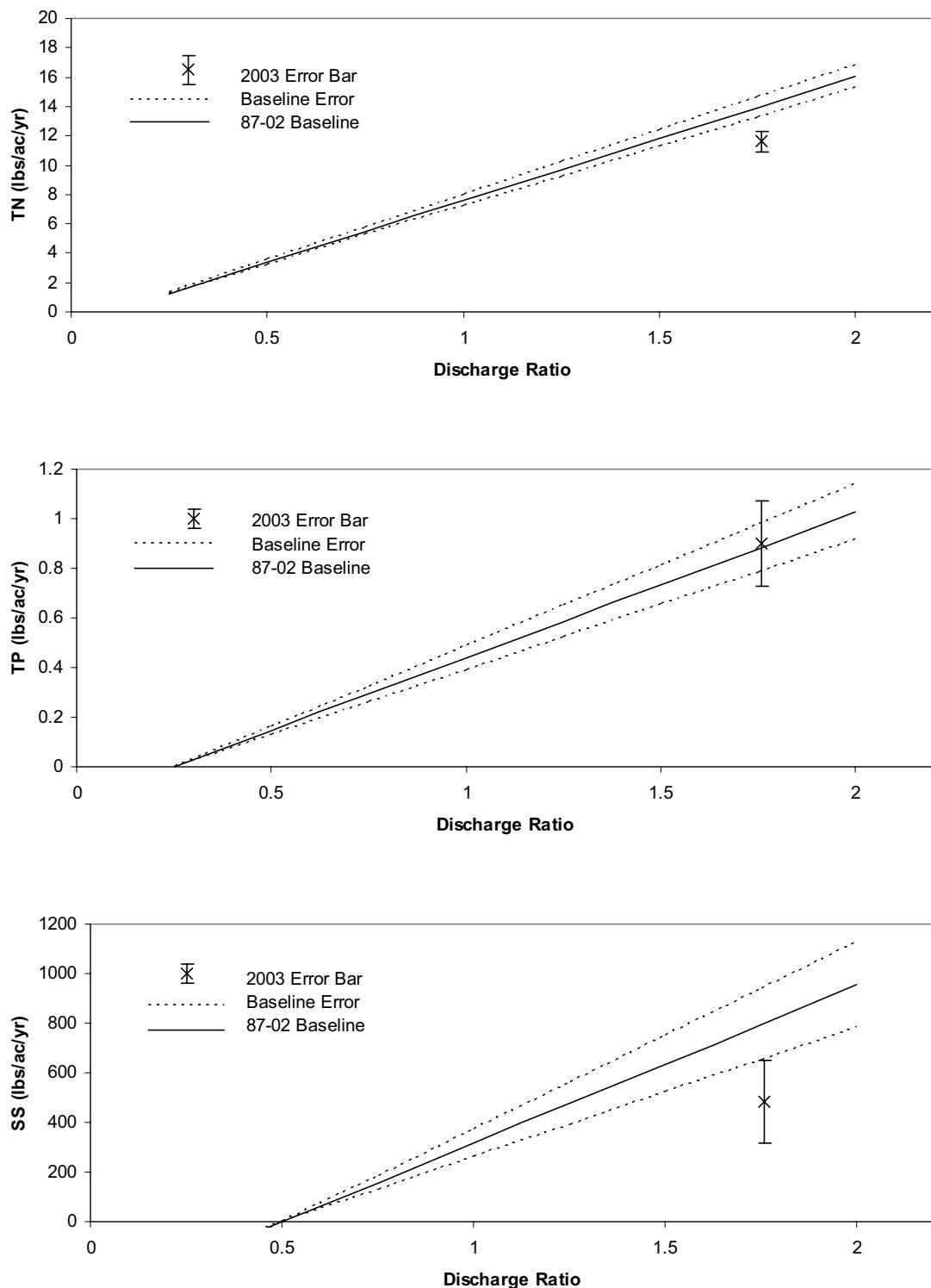
**Figure 23.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 1985-1989 and 2003



**Figure 24.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 1985-2002 and 2003



**Figure 25.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 1987-1991 and 2003



**Figure 26.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 1987-2002 and 2003

### **Conestoga River at Conestoga, Pa.**

Figure 27-28 shows the TN, TP, and SS baselines and 2003 yields. Actual 2003 and baseline yields are listed in Table 32 along with the discharge ratio. The baselines were defined by the following equations:

Initial 5-year baseline;

#### Total Nitrogen (TN)

$$\text{TN Yield} = 2.1988 + 31.264x R^2 = 0.97$$

#### Total Phosphorus (TP)

$$\text{TP Yield} = 0.4272 + 1.8654x R^2 = 0.67$$

#### Suspended Sediment (SS)

$$\text{SS Yield} = -614.08 + 1740.7x R^2 = 0.72$$

2002 Baselines;

#### Total Nitrogen (TN)

$$\text{TN Yield} = 2.347 + 32.262x R^2 = 0.95$$

#### Total Phosphorus (TP)

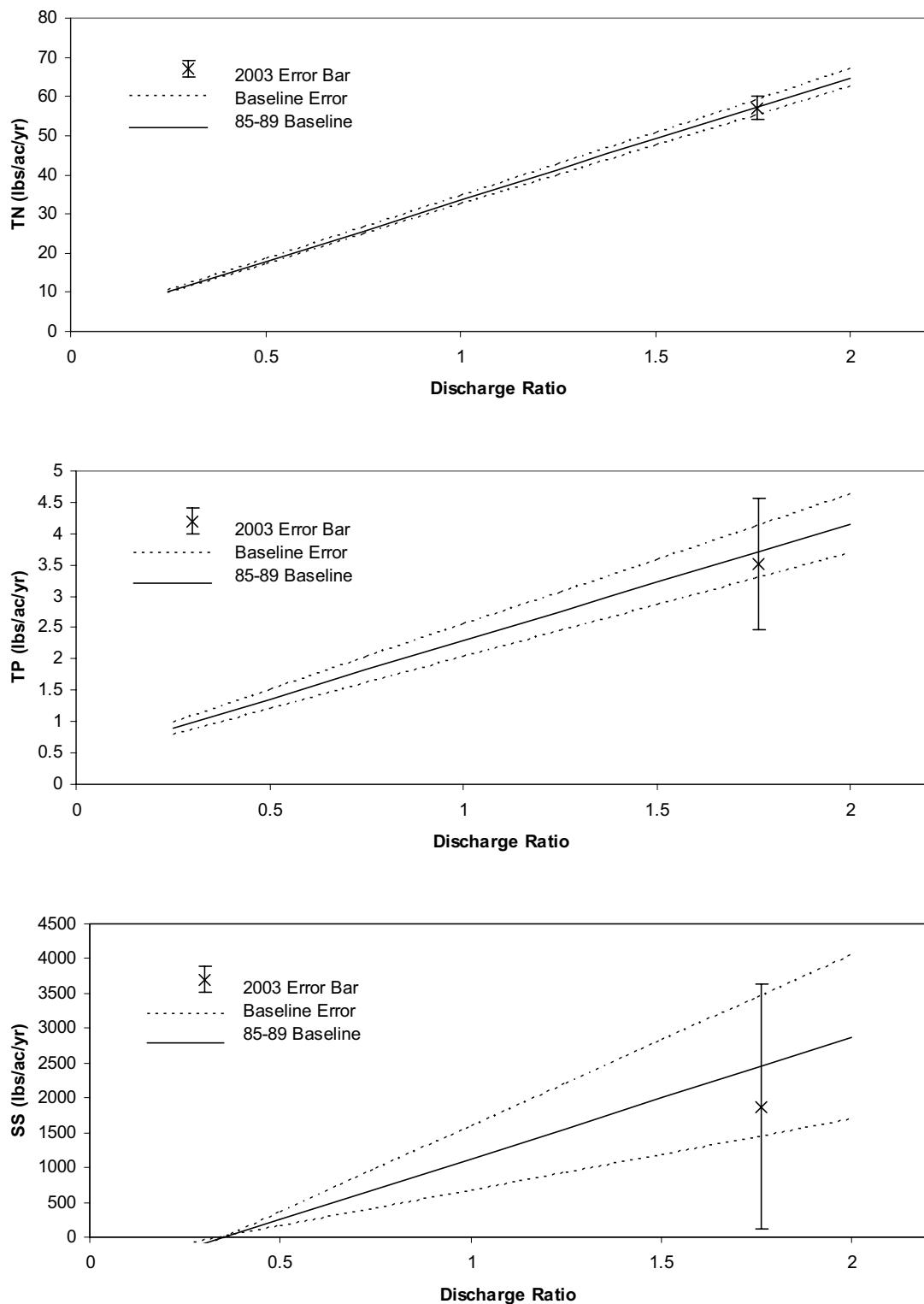
$$\text{TP Yield} = -1.1218 + 3.4263x R^2 = 0.82$$

#### Suspended Sediment (SS)

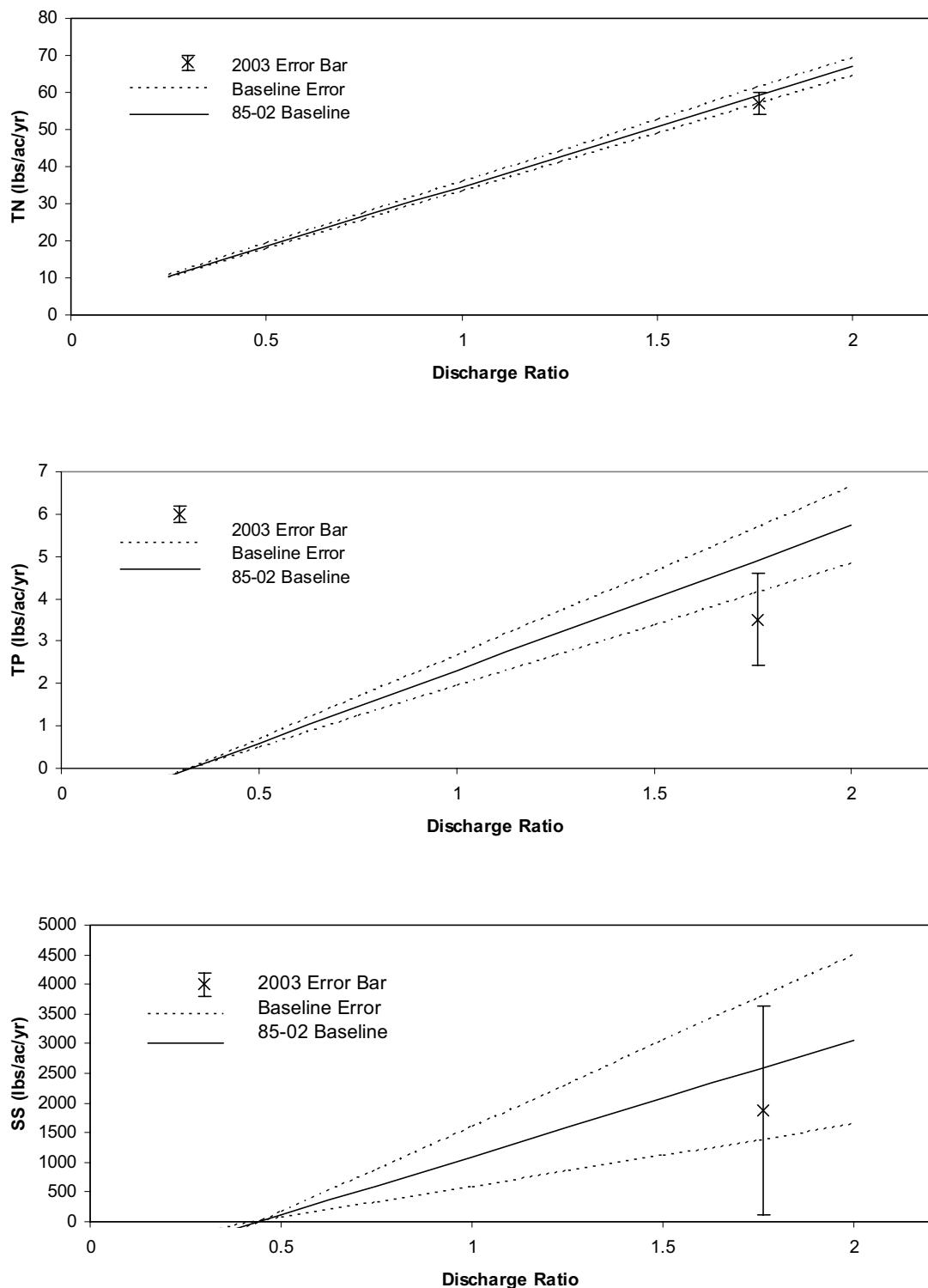
$$\text{SS Yield} = -871.82 + 1966.6x R^2 = 0.77$$

**Table 32. Comparison of 2003 TN, TP, and SS Yields with Baseline Yields at Conestoga, Pa.**

| Parameter | Discharge Ratio | 1985 – 1989 Baseline<br>lb/ac/yr | 1985 - 2002 Baseline<br>lb/ac/yr | 2003<br>lb/ac/yr |
|-----------|-----------------|----------------------------------|----------------------------------|------------------|
| TN        | 1.761           | 57.255                           | 59.16                            | 56.98            |
| TP        | 1.761           | 3.712                            | 6.034                            | 3.51             |
| SS        | 1.761           | 2,451.29                         | 2,591.36                         | 1868.2           |



**Figure 27. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Conestoga River at Conestoga, Pa., 1985-1989 and 2003**



**Figure 28.** Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Conestoga River at Conestoga, Pa., 1985-2002 and 2003