Appendix A. Weather Data

A.1.1 Weather Data Processing

A.1.1.1 Precipitation

Precipitation is a primary forcing for most water resources model applications. The most intensive processing effort of all the weather data parameters was required for precipitation. The following steps were typically used to process precipitation.

1. Reduce the various source formats to a common format
2. Add time of collection for the Summary of the Day (SOD) stations when necessary
3. Assess data quality flags
4. Patch impaired (missing or aggregated) periods
5. Disaggregate daily totals to hourly
6. Summarize for review and QA/QC

Custom FORTRAN and/or MS Excel VBA based tools were developed as needed to reduce the various source formats into a common format which enabled processing. Another custom tool was developed to read the NC SCO SOD data, which was precipitation, maximum air temperature, and minimum air temperature. This tool parses the source information into the required formats for further processing.

The SOD and HPD data include data quality flags. These flags indicate if a given record was deleted (d, D) or missing (m, M). The lower case flag indicates the beginning of an impaired period and the upper case flag indicates the end. These impaired records were addressed by a patching process (Table A- 1 and Figure A- 1). Neighboring index stations were selected to 1) use the normal ratio method to estimate daily totals for the deleted or missing records and then 2) disaggregate the patched file to hourly based on a template. The patched and disaggregated precipitation records were then reviewed for quality. Figures A-2 through A-15 (at the end of this section) show the amounts of missing data and summarize the results of the patching process. Note that 2010 data were developed only through March of that year.

Table A- 1. Precipitation Patching Index Station Assignments

Patched Station	Index Station	Index Station	Index Station	Index Station	Index Station	Index Station
312740 (D)	315890 (D)	316256 (D)	318158 (D)	02113000 (H)	02111391 (H)	NC9675 (H)
314063 (D)	313630 (D)	314970 (D)	317097 (D)	KINT (H)	NLEX (H)	NC3630 (H)
314970 (D)	314063 (D)	317097 (D)	317615 (D)	NLEX (H)	SALI (H)	NC9675 (H)
315890 (D)	312238 (D)	312740 (D)	318158 (D)	02113850 (H)	02113000 (H)	NC9675 (H)
316256 (D)	312740 (D)	318519 (D)	319555 (D)	02111391 (H)	LAUR (H)	NC9675 (H)
317615 (D)	311975 (D)	314970 (D)	317618 (D)	NLEX (H)	SALI (H)	NC9675 (H)
317618 (D)	311975 (D)	314970 (D)	317615 (D)	NLEX (H)	SALI (H)	NC9675 (H)
318158 (D)	312740 (D)	315890 (D)	318694 (D)	02112120 (H)	LAUR (H)	NC9675 (H)
318292 (D)	311579 (D)	311990 (D)	318778 (D)	02118500 (H)	SALI (H)	NC9675 (H)
318519 (D)	311990 (D)	318292 (D)	318778 (D)	02118500 (H)	SALI (H)	NC9675 (H)
318694 (D)	316256 (D)	318158 (D)	319555 (D)	02111391 (H)	LAUR (H)	NC9675 (H)
318778 (D)	318292 (D)	318519 (D)	319675 (D)	NLEX (H)	SALI (H)	NC9675 (H)
319555 (D)	312740 (D)	316256 (D)	318694 (D)	KINT (H)	LAUR (H)	NC9675 (H)
319675 (D)	312238 (D)	314970 (D)	318778 (D)	KINT (H)	NC9675 (H)	NLEX (H)
93807 = KINT	313630 (D)	314970 (D)	319675 (D)	NC3630 (H)	NC3630 (H)	NC9675 (H)

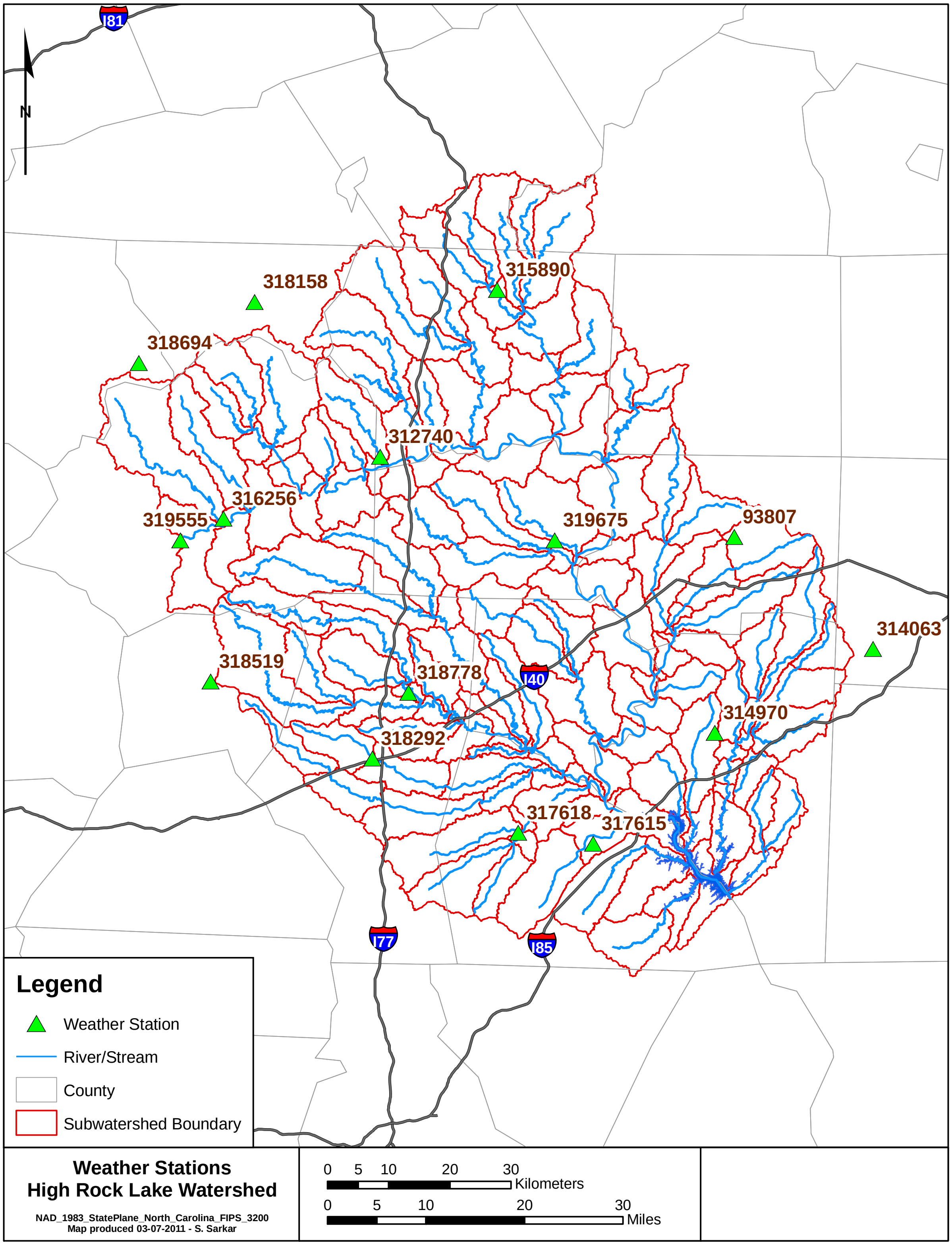

Figure A- 1. Watershed Model Weather Stations

A.1.1.2 Air Temperature

The study area was represented by four hourly air temperature records. The hourly air temperature records were developed from four SOD stations: 319555, 315890, 318292, and 319675. The first step was to patch missing days for the maximum and minimum air temperatures. This was done by using the neighboring stations. Then the hourly index station was used to develop 12 hourly templates, one per month. These template series were used to convert the patched daily maximum and minimum air temperatures into an hourly distribution. Table A- 2 indicates the assignment of index stations to patch a daily record and create an hourly time series. The hourly record (93807) was used only to obtain an hourly distribution for the air temperature at the respective patched station.

Table A- 2. Air Temperature Index Station Assignments

Patched Station	Index Station	Index Station	Index Station
315890 (D)	319555 (D)	318292 (D)	93807 (H)
318292 (D)	319555 (D)	315890 (D)	93807 (H)
319555 (D)	315890 (D)	318292 (D)	93807 (H)
319675 (D)	318292 (D)	315890 (D)	93807 (H)

A.1.1.3 Cloud Cover

Cloud cover was estimated from sky condition observations at the NCDC Surface Airways (SA) station, 93807. Table A- 3 presents the assumptions used to estimate numerical cloud cover for model input from sky condition observations. The cloud cover parameter is used as input forcing to both the watershed and lake models; furthermore it is used in the calculation of incident solar radiation.

Table A- 3. Numerical Interpretation of Sky Condition Observation

Description	Abbreviation	NWS Suggested Numerical Range (Eighths)	Numerical Assignment for Model Input (Tenths)
Clear Sky	CLR	0	0
Few	FEW	1 – 2	1.25
Scattered	SCT	3 – 4	4.38
Broken	BKN	5 – 7	7.5
Variable	VV	8	10
Overcast	OVC	8	10

A.1.1.4 Solar Radiation

An hourly solar radiation time series was estimated at station 93807. The incident (land surface) solar radiation calculation routine from CE-QUAL-W2 (Cole et al., 1995) was used to develop the time series. The routine uses cloud cover, latitude, elevation, and date-time to perform the computations.

A.1.1.5 Potential Evapotranspiration

Similar to precipitation, potential evapotranspiration is a primary weather forcing parameter in the watershed model. The reported and calculated hourly time series were used to create four potential evapotranspiration time series, one at each of the four processed air temperature record locations. The potential evapotranspiration calculations were based on the Penman Pan energy balance method (Hummel et al., 2001). Table A- 4 indicates which time series were used for each of the four calculations of potential evapotranspiration.

Table A- 4. Weather Time Series Used to Calculate Potential Evapotranspiration

Potential Evapotranspiration (PEVT)	Air Temperature (ATEM)	Dewpoint Temperature (DEWP)	Wind (WIND)	Solar Radiation (SOLR)
315890	315890	93807	93807	93807
318292	318292	93807	93807	93807
319555	319555	93807	93807	93807
319675	319675	93807	93807	93807

A.1.1.6 Dewpoint Temperature, Relative Humidity, Wind, and Atmosphere Pressure

Hourly dewpoint temperature, relative humidity, wind observations, and atmosphere pressure were obtained from the NCDC SA station 93807. The data were reviewed for outliers, missing, or impaired data and repaired. The repairs were performed by either averaging a before and after value if a missing period were short, or by inserting a long-term average value.

A.1.1.7 Appendix A References

Cole, T.M. and E.M. Buchak. 1995. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 2.0 User Manual. United States Army Corps of Engineers. Instruction Report EL-95-1, June, 1995. Washington, DC.

Hummel, P., J. Kittle, Jr., and M. Gray. 2001. WDMUtil Version 2.0, A Tool for Managing Watershed Modeling Time Series Data, User’s Manual. Office of Science and technology, Office of Water, U.S. Environmental Protection Agency, Washington, DC.

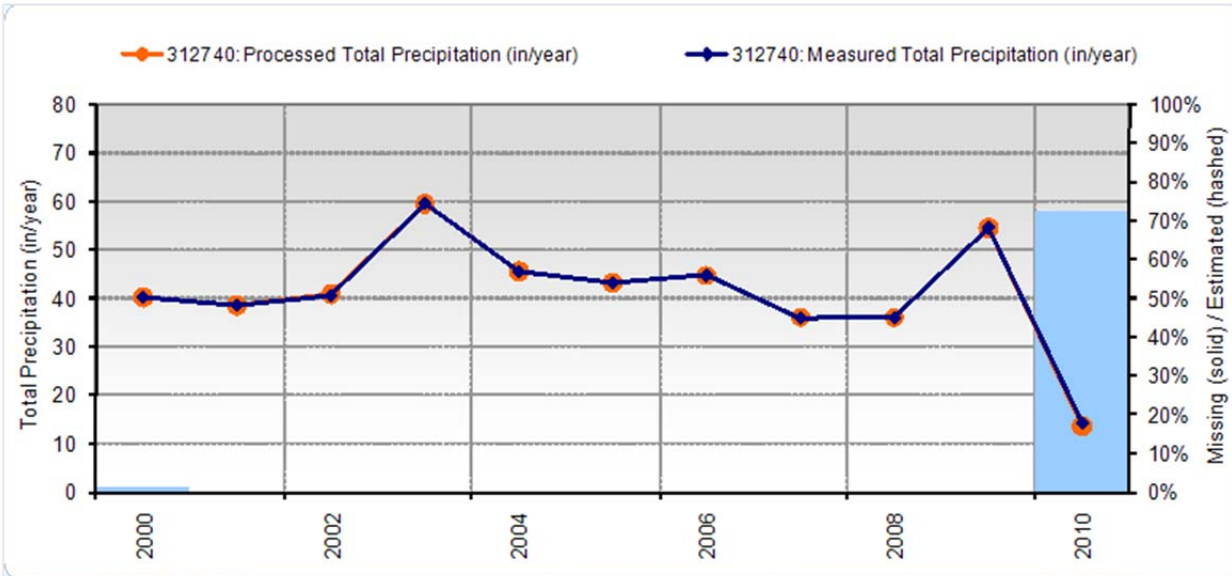

Figure A- 2. Total Precipitation at ELKIN (312740), 2000-2010

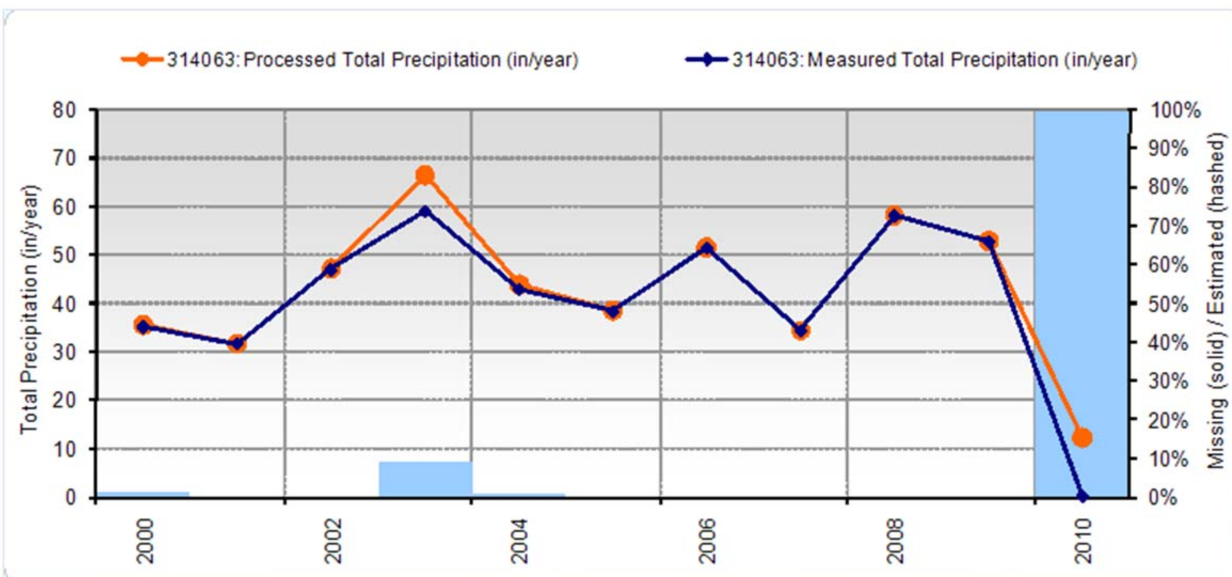

Figure A- 3. Total Precipitation at HIGH POINT (314063), 2000-2010

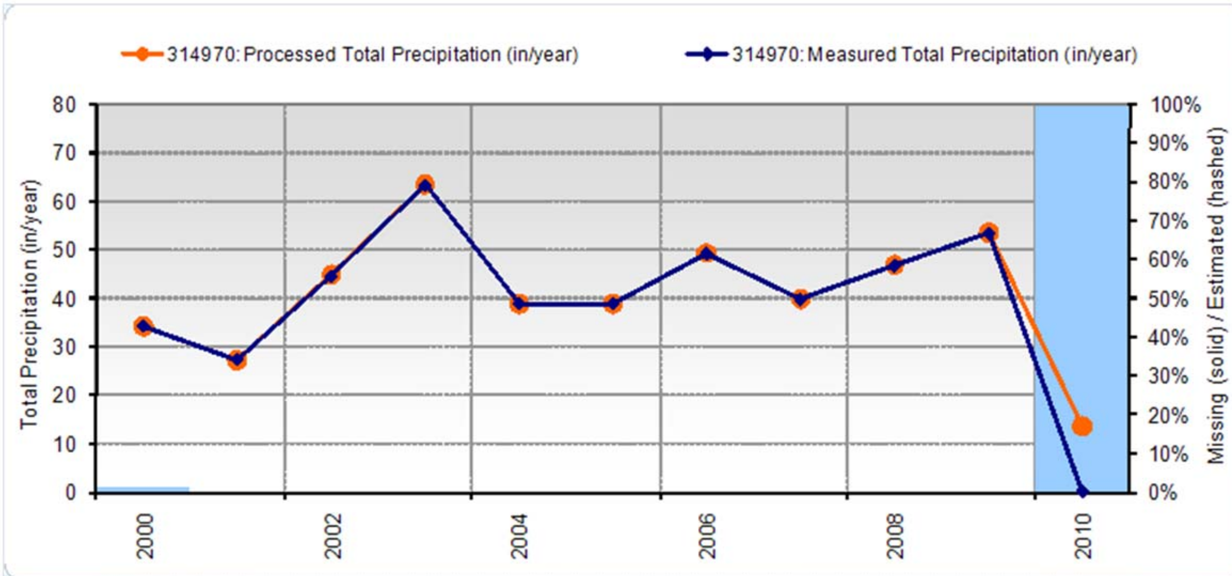

Figure A- 4. Total Precipitation at LEXINGTON (314970), 2000-2010

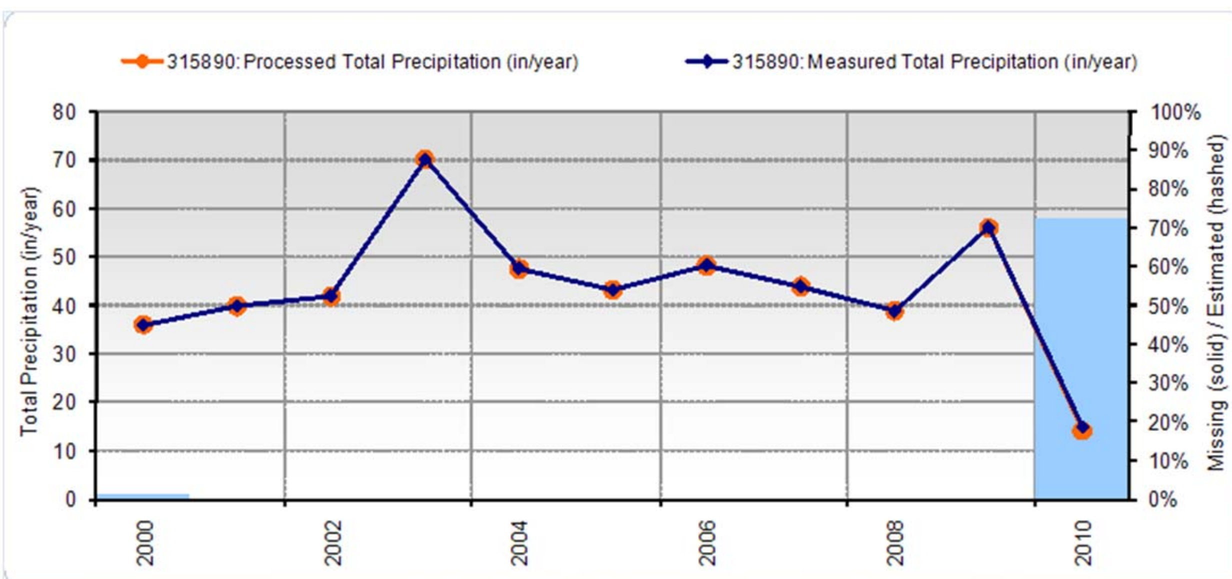

Figure A- 5. Total Precipitation at MOUNT AIRY 2 W (315890), 2000-2010

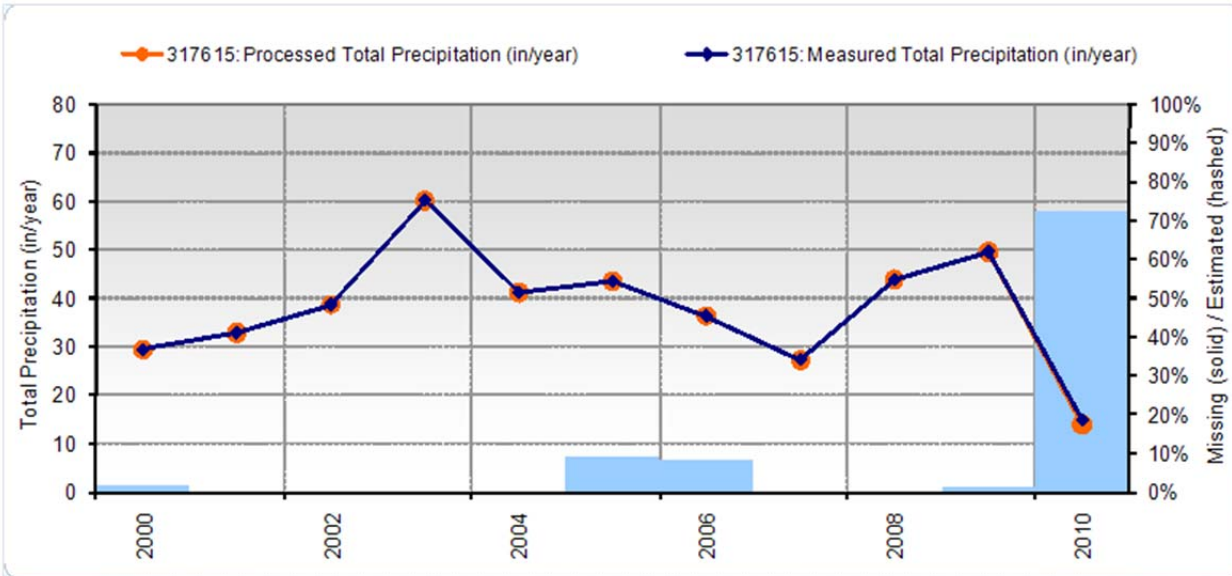

Figure A- 6. Total Precipitation at SALISBURY (317615), 2000-2010

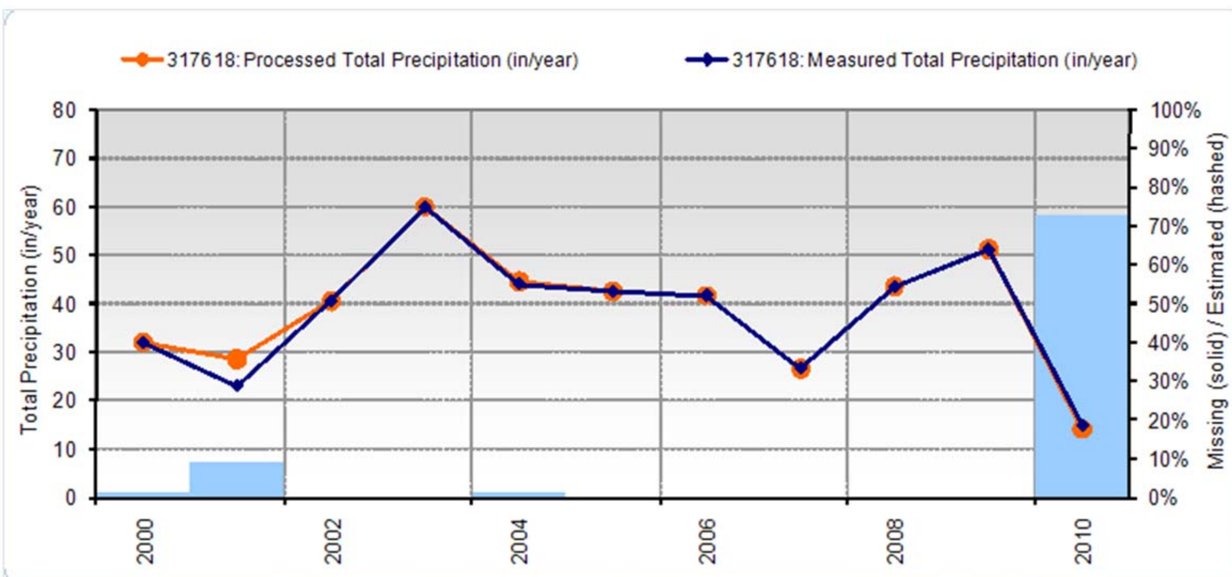

Figure A- 7. Total Precipitation at SALISBURY 9 WNW (317618), 2000-2010

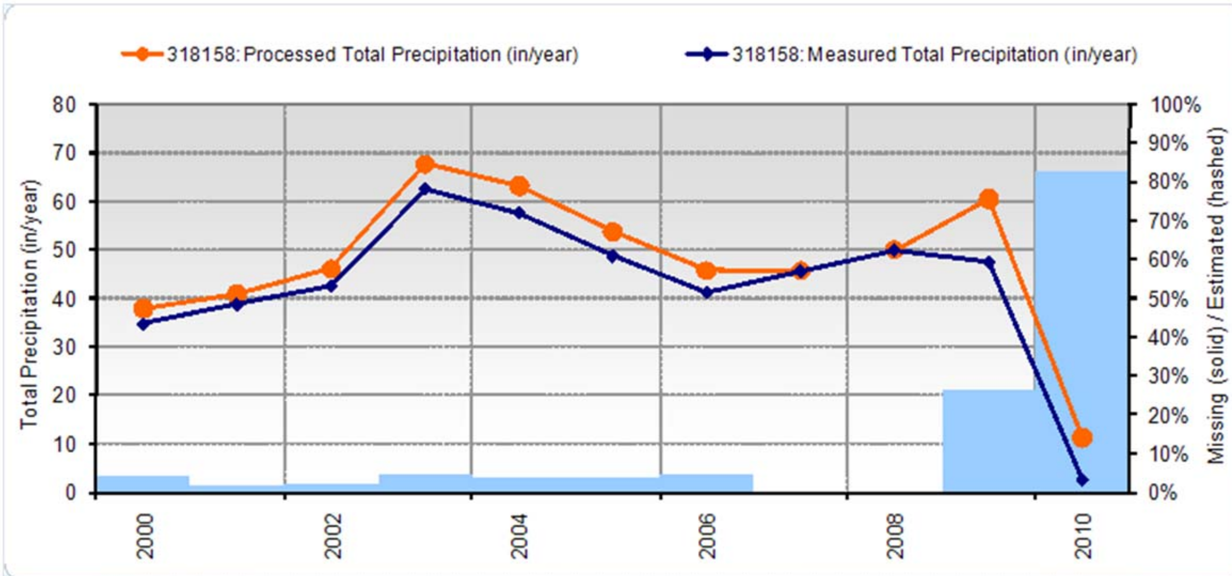

Figure A- 8. Total Precipitation at SPARTA 2 SE (318158), 2000-2010

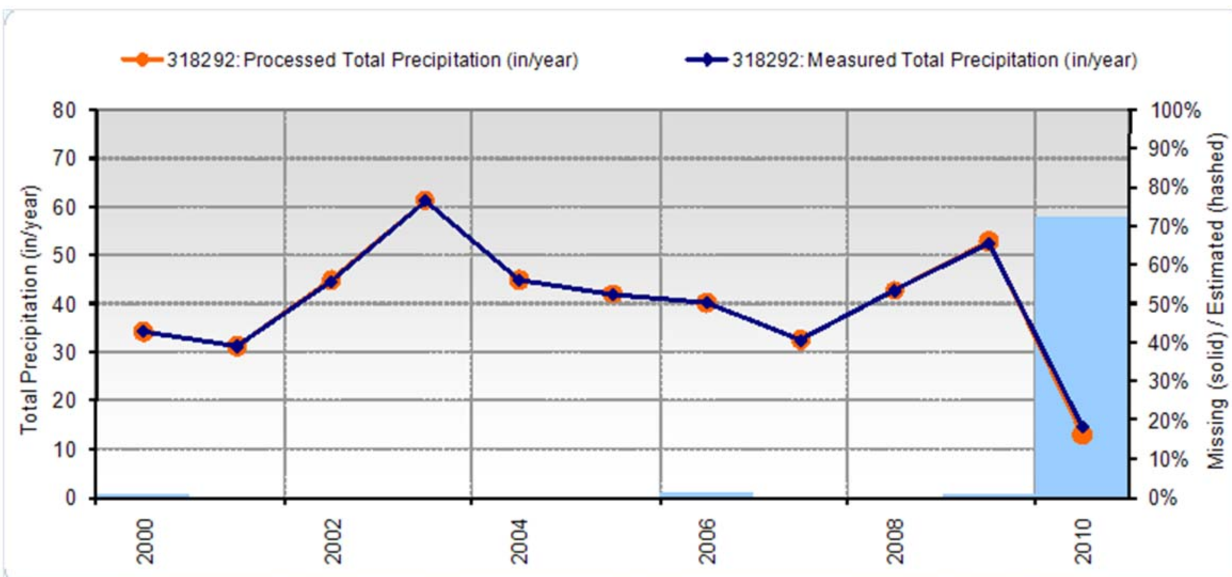

Figure A- 9. Total Precipitation at STATESVILLE 2 NNE (318292), 2000-2010

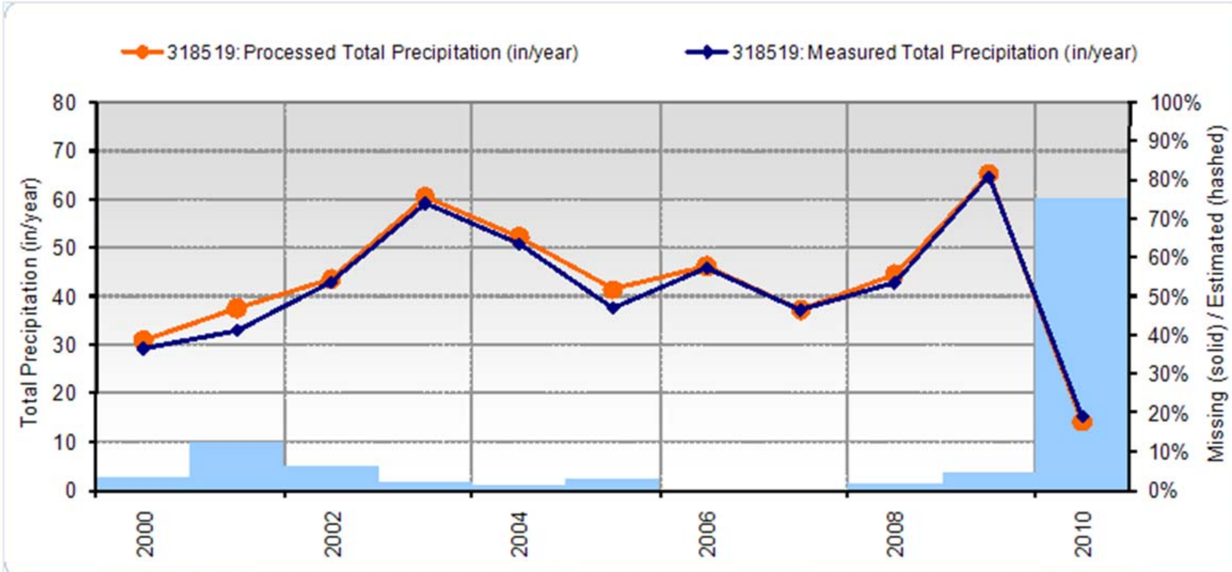

Figure A- 10. Total Precipitation at TAYLORSVILLE (318519), 2000-2010

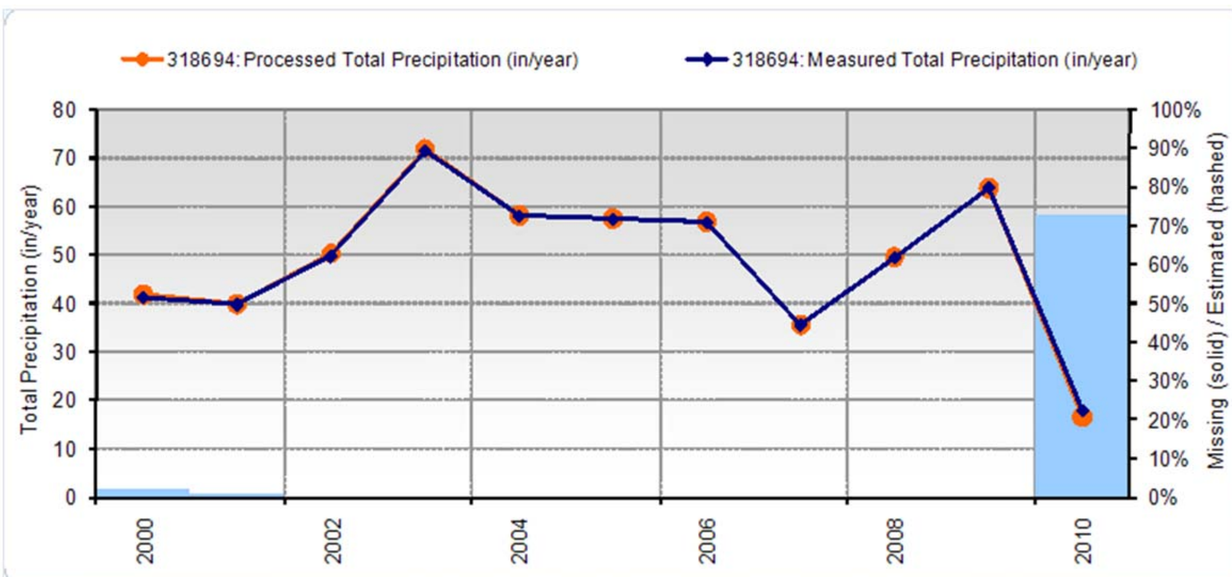

Figure A- 11. Total Precipitation at TRANSOU (318694), 2000-2010

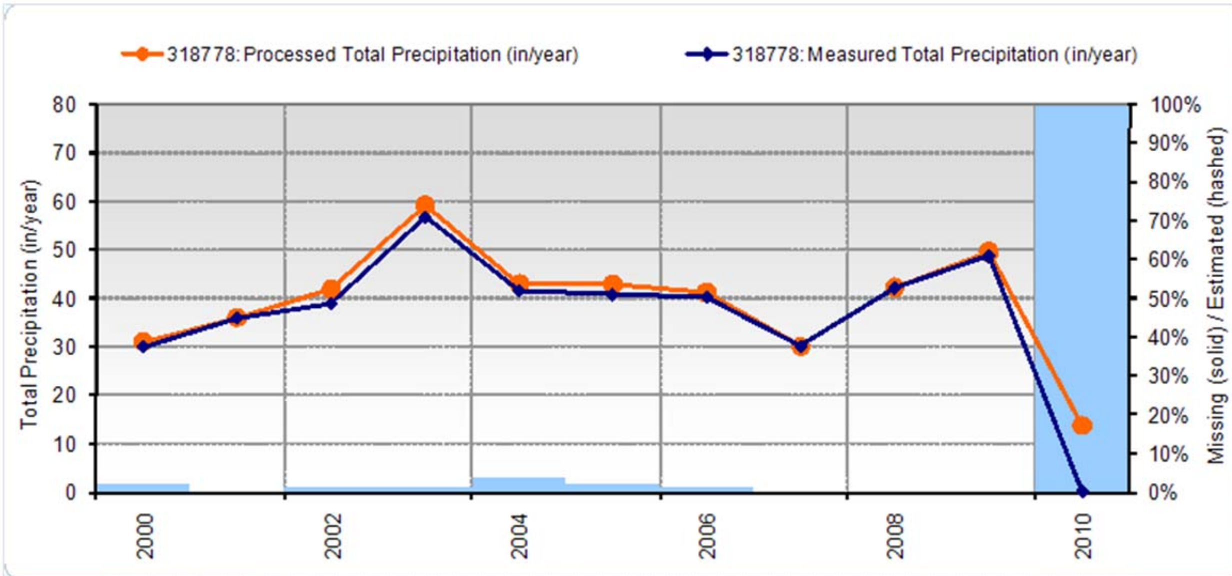

Figure A- 12. Total Precipitation at TURNERSBURG (318778), 2000-2010

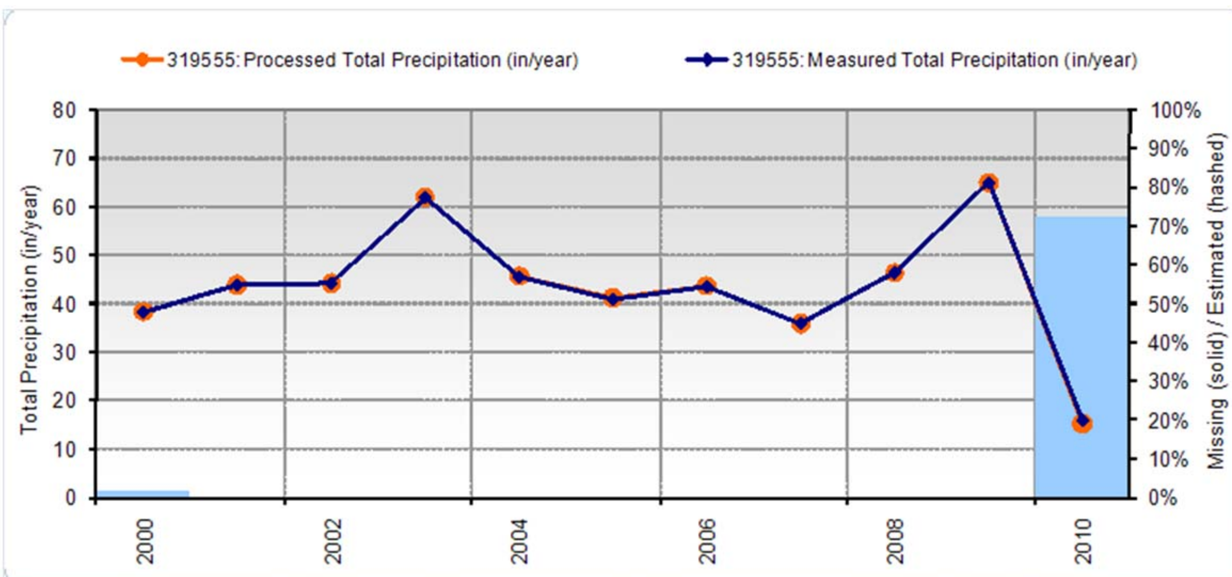

Figure A- 13. Total Precipitation at W KERR SCOTT RESERVOIR (319555), 2000-2010

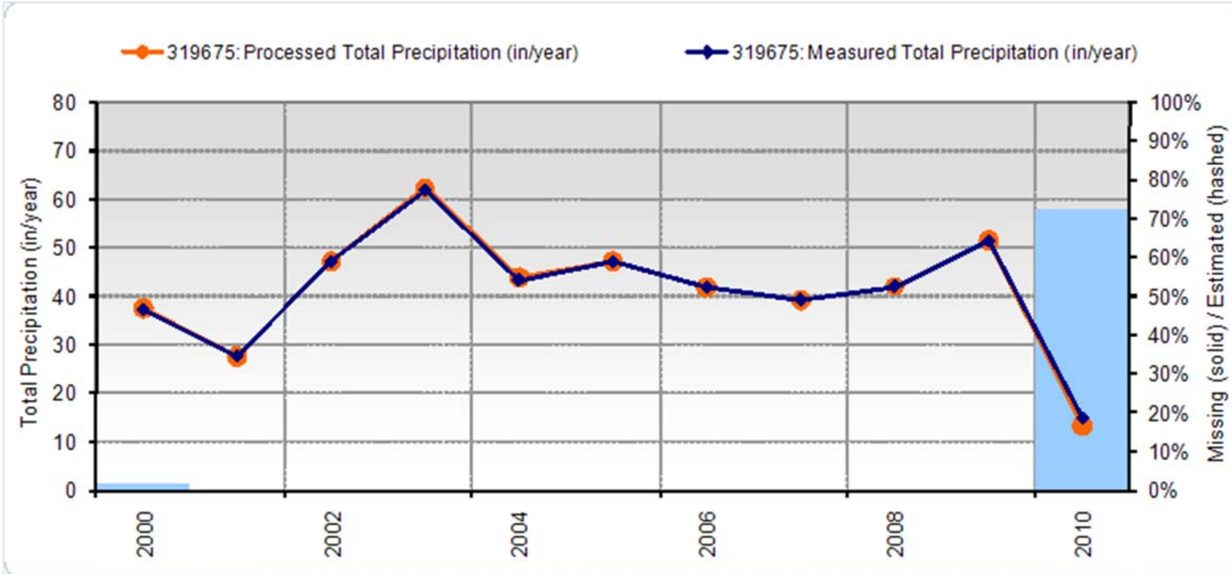

Figure A- 14. Total Precipitation at YADKINVILLE 6 E (319675), 2000-2010

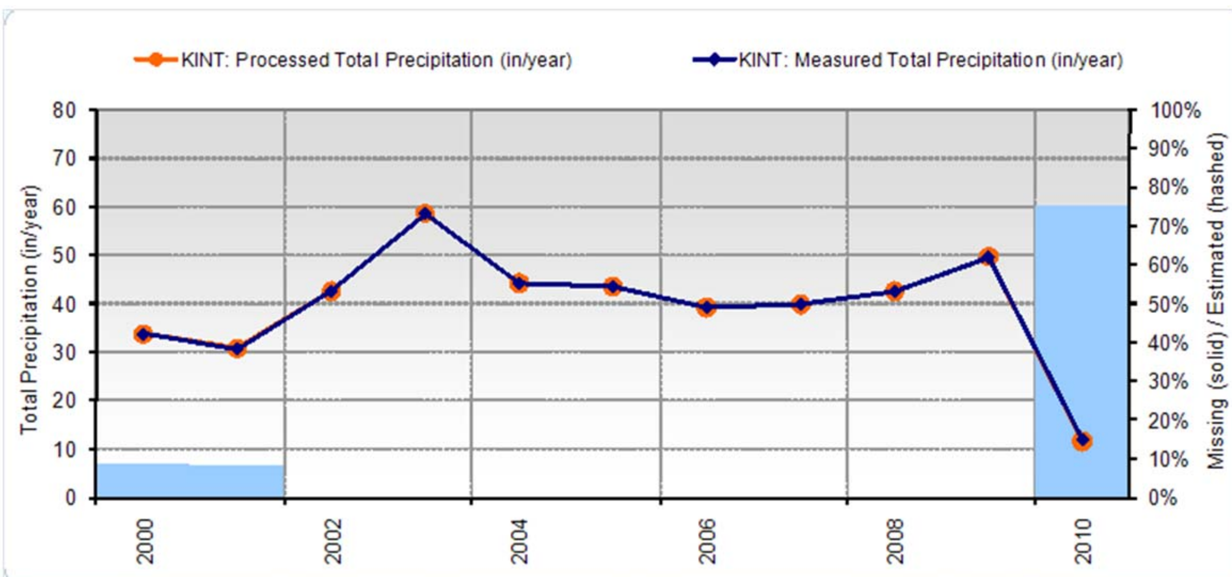

Figure A- 15. Total Precipitation at Winston-Salem Airport (93807, KINT), 2000-2010

Appendix B. Point Source Nitrogen and Phosphorus Loads

Table B- 1. Major Point Source Nitrite+Nitrate-N (lb-N/d) Summary

Station	Station Name	Mean	Min	Max
NC0005266	Louisiana Pacific ABT Co. Mill	144.9	0.0	1471.7
NC0005312	Interface Fabric Elkin, Inc. WWTP	17.3	0.0	100.0
NC0005487	Color-Tex Finishing Corp	3.8	0.0	450.3
NC0020338	Town of Yadkinville WWTP	65.7	12.9	204.5
NC0020567	Town of Elkin WWTP	23.9	0.0	191.1
NC0020591	City of Statesville Third Creek WWTP	156.3	18.9	708.1
NC0020761	Town of North Wilkesboro Thurman St WWTP	42.0	0.0	414.5
NC0021121	City of Mount Airy WWTP	182.2	8.0	929.5
NC0021717	Town of Wilkesboro Cub Creek WWTP	576.9	36.1	1642.5
NC0023884	Salisbury Rowan WWTP	771.4	75.0	3,223.7
NC0023892	Salisbury Town Creek WWTP	21.1	0.0	668.6
NC0024112	City of Thomasville Hamby Creek WWTP	263.3	0.0	1,070.4
NC0024228	City of High Point Westside WWTP	319.4	75.2	1,130.9
NC0024872	Davie County Cooleemee WWTP	35.8	0.0	787.4
NC0026646	Town of Pilot Mountain WWTP	26.7	0.0	200.4
NC0031836	City of Statesville Fourth Creek WWTP	107.9	0.0	773.3
NC0037834	City of Winston-Salem Archie Elledge WWTP	1,506.8	426.5	5,660.5
NC0050342-001	City of Winston-Salem Muddy Creek WWTP (001)	1,665.0	205.2	6,428.2
NC0050342-002	City of Winston-Salem Muddy Creek WWTP (002)	2.0	0.0	901.1
NC0055786	City of Lexington WWTP	123.4	7.8	1,288.9

Table B- 2. Major Point Source Organic Nitrogen (lb-N/d) Summary

Station	Station Name	Mean	Min	Max
NC0005266	Louisiana Pacific ABT Co. Mill	0.0	0.0	0.0
NC0005312	Interface Fabric Elkin, Inc. WWTP	0.0	0.0	0.0
NC0005487	Color-Tex Finishing Corp	0.0	0.0	0.0
NC0020338	Town of Yadkinville WWTP	13.4	2.6	41.9
NC0020567	Town of Elkin WWTP	4.9	0.0	39.1
NC0020591	City of Statesville Third Creek WWTP	32.0	3.9	145.0
NC0020761	Town of North Wilkesboro Thurman St WWTP	8.6	0.0	84.9
NC0021121	City of Mount Airy WWTP	37.3	1.6	190.4
NC0021717	Town of Wilkesboro Cub Creek WWTP	118.2	7.4	336.4
NC0023884	Salisbury Rowan WWTP	271.0	26.3	1,132.7
NC0023892	Salisbury Town Creek WWTP	4.3	0.0	136.9
NC0024112	City of Thomasville Hamby Creek WWTP	53.9	0.0	219.2
NC0024228	City of High Point Westside WWTP	79.6	17.4	270.6
NC0024872	Davie County Cooleemee WWTP	7.3	0.0	161.3
NC0026646	Town of Pilot Mountain WWTP	5.5	0.0	41.1
NC0031836	City of Statesville Fourth Creek WWTP	22.1	0.0	158.4
NC0037834	City of Winston-Salem Archie Elledge WWTP	308.6	87.4	1,159.4
NC0050342-001	City of Winston-Salem Muddy Creek WWTP (001)	341.0	42.0	1,316.6
NC0050342-002	City of Winston-Salem Muddy Creek WWTP (002)	0.4	0.0	184.6
NC0055786	City of Lexington WWTP	25.3	1.6	264.0

Table B- 3. Major Point Source Ammonia-N (lb-N/d) Summary

Station	Station Name	Mean	Min	Max
NC0005266	Louisiana Pacific ABT Co. Mill	144.9	0.0	1,471.7
NC0005312	Interface Fabric Elkin, Inc. WWTP	17.3	0.0	100.0
NC0005487	Color-Tex Finishing Corp	3.8	0.0	450.3
NC0020338	Town of Yadkinville WWTP	0.9	0.2	5.1
NC0020567	Town of Elkin WWTP	4.7	0.0	93.5
NC0020591	City of Statesville Third Creek WWTP	12.0	0.7	187.7
NC0020761	Town of North Wilkesboro Thurman St WWTP	10.9	0.5	155.7
NC0021121	City of Mount Airy WWTP	19.5	0.7	165.7
NC0021717	Town of Wilkesboro Cub Creek WWTP	26.0	1.3	486.6
NC0023884	Salisbury Rowan WWTP	22.5	5.6	177.8
NC0023892	Salisbury Town Creek WWTP	0.6	0.0	65.3
NC0024112	City of Thomasville Hamby Creek WWTP	37.5	0.0	615.8
NC0024228	City of High Point Westside WWTP	17.4	0.3	207.5
NC0024872	Davie County Cooleemee WWTP	4.4	0.0	57.8
NC0026646	Town of Pilot Mountain WWTP	2.7	0.1	78.1
NC0031836	City of Statesville Fourth Creek WWTP	45.9	2.1	491.4
NC0037834	City of Winston-Salem Archie Elledge WWTP	84.4	12.2	293.2
NC0050342-001	City of Winston-Salem Muddy Creek WWTP (001)	376.0	44.6	3,146.8
NC0050342-002	City of Winston-Salem Muddy Creek WWTP (002)	1.6	0.0	976.3
NC0055786	City of Lexington WWTP	11.0	1.1	180.5

Table B- 4. Major Point Source Total Phosphorus (lb-P/d) Summary

Station	Station Name	Mean	Min	Max
NC0005266	Louisiana Pacific ABT Co. Mill	27.2	0.0	475.1
NC0005312	Interface Fabric Elkin, Inc. WWTP	7.7	0.0	261.5
NC0005487	Color-Tex Finishing Corp	2.2	0.0	135.0
NC0020338	Town of Yadkinville WWTP	24.3	7.9	80.2
NC0020567	Town of Elkin WWTP	7.1	0.6	40.6
NC0020591	City of Statesville Third Creek WWTP	51.7	4.7	198.3
NC0020761	Town of North Wilkesboro Thurman St WWTP	12.0	0.2	89.8
NC0021121	City of Mount Airy WWTP	66.4	2.7	747.0
NC0021717	Town of Wilkesboro Cub Creek WWTP	347.7	9.4	1,133.1
NC0023884	Salisbury Rowan WWTP	138.6	35.6	700.2
NC0023892	Salisbury Town Creek WWTP	2.4	0.0	88.9
NC0024112	City of Thomasville Hamby Creek WWTP	51.0	0.0	181.3
NC0024228	City of High Point Westside WWTP	33.9	3.8	132.1
NC0024872	Davie County Cooleemee WWTP	9.6	0.2	189.1
NC0026646	Town of Pilot Mountain WWTP	9.4	0.9	45.6
NC0031836	City of Statesville Fourth Creek WWTP	53.8	5.1	321.9
NC0037834	City of Winston-Salem Archie Elledge WWTP	557.6	59.4	2,666.1
NC0050342-001	City of Winston-Salem Muddy Creek WWTP (001)	408.8	219.8	969.7
NC0050342-002	City of Winston-Salem Muddy Creek WWTP (002)	0.7	0.0	185.9
NC0055786	City of Lexington WWTP	45.3	1.8	222.8

Appendix C. County Septic Systems Information

Summary of Septic Tank Information Provided to NCDWQ by NCDPH
Received by Tetra Tech from NCDWQ on Sep. 28, 2010 and Oct. 05, 2010
High Rock Lake Study

Forsyth County

- Forsyth County has no information on total septic systems in the county or how many are still in use.

Iredell County

- Iredell estimates there are between 65,000 and 90,000 septic systems in the county. Fewer than 100 permits are issued annually. A system is considered to be failing if there is a damp spot in the yard or surfacing effluent. The oldest systems in this county date from the 1940s. In the 1960s and 1970s many lots were permitted, and then dropped off in the 1980s. Permitted systems increased in the 1990s and early 2000s and dropped off sharply with the current recession creating a curve like a sine wave.

Davidson County

- The total number of properties that are served by a septic tank system in Davidson County is approximately 47,287. The median number of systems installed in Davidson County is 883 per year of which around 100 are repairs.

Davie County

- Davie County has limited records until they switched to computer in the late 1980s. Oldest records date back to 1963, therefore 47-year range for systems. Number of systems in county –75 percent of county is on OSWW, the rest on municipal sewer. On an annual basis, it is estimated that 1-5 percent of permits are for repairs.

Surry County

- No information is available on how many septic systems are in the county. County population estimated to be about 72,000 people. There are three municipal sewer systems in Surry County: Mt Airy, Elkin, and Pilot Mtn. These have populations of 8,583 (2007 data), 4,121 (2009 data), and 1,261 (2009 data), respectively [data from city-data.com], which implies about 19 percent of the total population in a city with access to city sewer. Therefore, potential population on septic would be about 80-81 percent of total population.
- Over the last three years, Surry County has issued an average of 339 septic permits (data not including 2010). Over that same time, there has been an average of 53 repair permits per year.
- Surry County keeps no records on ages of systems.

Wilkes County

- Wilkes County submitted a spreadsheet showing total permits issued for completion, expansion, or repair since 1994, but did not have information on total number of septic systems in the county. It is estimated that about 2 percent of septic systems per year are failing, with a distribution from 1973 to present.

Yadkin County

- The estimated number of systems in the county is about 18,000. They have no estimates for percent of systems failing or distribution of ages of systems. Permits for septic systems started in the mid-1970s, but there are many homes built prior to permits.

The total population on septic systems is assumed to be equal to the Census population outside of sewer service areas. 2000 Census block population totals were intersected with model subbasins and area weighted. The estimated totals are shown below.

Model Subbasin	Population on Septic	Model Subbasin	Population on Septic	Model Subbasin	Population on Septic
1	2175	50	2792	99	2304
2	2442	51	3878	100	1726
3	6993	52	2497	101	6004
4	6954	53	2406	102	4889
5	8201	54	2090	103	3269
6	2743	55	2350	104	3734
7	329	56	3235	105	21
8	2388	57	566	106	5746
9	13363	58	9196	107	4539
10	2269	59	5366	108	1193
11	285	60	328	109	2626
12	3187	61	4335	110	3687
13	269	62	3008	111	4998
14	1047	63	4318	112	2133
15	2076	64	119	113	1937
16	3092	65	5092	114	121
17	4516	66	4047	115	2039
18	524	67	6524	116	8351
19	797	68	3175	117	87
20	578	69	3665	118	739
21	5560	70	628	119	3257
22	4186	71	1171	120	7294
23	4674	72	1527	121	5964
24	1867	73	751	122	476

Model Subbasin	Population on Septic	Model Subbasin	Population on Septic	Model Subbasin	Population on Septic
25	2807	74	1577	123	133
26	5203	75	1039	124	6101
27	2264	76	5297	125	10063
28	65	77	4005	126	5522
29	501	78	7840	127	6064
30	776	79	8339	128	2387
31	708	80	7394	129	7488
32	5272	81	1507	130	4954
33	262	82	462	131	348
34	606	83	1362	132	861
35	1698	84	580	133	438
36	7138	85	495	134	4027
37	2148	86	1999	135	624
38	228	87	1072	136	552
39	1866	88	1566	137	6652
40	1664	89	4087	138	7568
41	731	90	37	139	4169
42	2090	91	1593	140	2412
43	1281	92	1745	141	6238
44	2187	93	884	142	3419
45	310	94	1519	143	799
46	1793	95	3642	144	1661
47	1651	96	3458	145	1560
48	3771	97	3429		
49	2691	98	2895		

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Appendix D. Animal Operations

Commercial livestock and fowl operations produce large amounts of waste that can have significant impacts on watershed nutrient balances. Much of the feed for these animals is imported from elsewhere (e.g., from the mid-west) and thus represents a net import of nutrients into the watershed. The fate of nutrients in animal waste depends on disposal methods. Manure from confined animals can be effectively used as fertilizer, but may also result in excess nutrient washoff to waterbodies if application exceeds agronomic rates or manure is not incorporated into the soil. Cattle on pasture can contribute nutrient and bacterial loads directly to the stream network if they are not excluded from watercourses.

Any impacts due to animal operations are implicit in the setup of pollutant buildup and washoff rates for individual land uses in the HSPF application. However, since animal operations are an important consideration an effort was made to characterize their potential impacts. An exercise was conducted to estimate animal counts by model subbasin and convert them to estimates of nitrogen and phosphorus production. Specifically, the distribution of cattle and chicken was examined as an index to total livestock populations. Cattle are of particular interest as they have high numbers are likely to be on pasture, while chickens are a major source of manure in most of the watershed. The nutrient production estimates are not intended to represent the total production from all types of animals or the loading delivered to the streams from animal operations. Rather, the data were developed to provide some insight into the potential magnitude of this source and potentially explain why, for example South Yadkin River, reported relatively high observed values.

D.1.1 Cattle and Chicken Counts by County – Decade Comparison

Counts of cattle (beef and dairy by head), chicken (by head, excluding broilers), and broilers (production by head) generally declined throughout the past decade for counties in which High Rock Lake watershed is located (USDA-National Agricultural Statistical Service [NASS]). These counties experienced cattle declines from 2001 to 2010 ranging from 0 percent to 51 percent, with an average decline of 22 percent. The greatest percent decline in cattle was reported for Forsyth County. Stokes County was the only county that did not experience a decline in cattle during this time period (Table D- 1). From 2001 to 2009, Wilkes, Alexander, and Iredell counties experienced chicken declines of 50, 28, and 39 percent, respectively. During this same time period, Surry and Yadkin counties experienced an increase in chickens; Surry County’s chicken count increased by 33 percent while Yadkin County experienced a 60 percent increase in chickens (Table D- 2). Alexander County was the only county to experience an increase in broilers from 2002 to 2009; the reported increase was 24 percent. Wilkes, Davidson, Surry, and Yadkin counties all experienced declines in broilers from 2002 to 2009 with a minimum decline of 2 percent, a maximum decline of 45 percent, and an average decline of 19 percent (Table D- 3).

Table D- 1. Cattle (Beef and Dairy) Counts from 2001 and 2010

County	All Cattle (beef, dairy)		Difference (2001 to 2010)	Percent Difference (2001 to 2010)
	2001	2010		
Wilkes	18,100	14,600	-3,500	-19%
Alexander	12,200	8,500	-3,700	-30%
Iredell	27,700	23,500	-4,200	-15%
Davie	10,700	7,200	-3,500	-33%
Davidson	10,200	7,700	-2,500	-25%
Forsyth	4,500	2,200	-2,300	-51%
Rowan	13,800	9,800	-4,000	-29%
Surry	12,100	11,800	-300	-2%
Yadkin	12,800	11,400	-1,400	-11%
Stokes	4,400	4,400	0	0%

Table D- 2. Chicken Counts (excluding broilers) from 2001 and 2009

County	Chickens (excluding broilers)		Difference (2001 to 2009)	Percent Difference (2001 to 2009)
	2001	2009		
Wilkes	1,200,000	600,000	-600,000	-50%
Alexander	1,800,000	1,300,000	-500,000	-28%
Iredell	1,800,000	1,100,000	-700,000	-39%
Davie	240,000	<500,000	-	-
Davidson	-	-	-	-
Forsyth	-	-	-	-
Rowan	-	-	-	-
Surry	450,000	600,000	150,000	33%
Yadkin	1,008,000	1,608,000	600,000	60%
Stokes	-	-	-	-

Table D- 3. Broiler Counts from 2002 and 2009

County	Broilers (production by head)		Difference (2001 to 2010)	Percent Difference (2002 to 2009)
	2002	2009		
Wilkes	18,496,773	14,000,000	-4,496,773	-24%
Alexander	3,319,221	4,100,000	780,779	24%
Iredell	-	400,000	-	-
Davie	-	-	-	-
Davidson	1,066,617	1,040,000	-26,617	-2%
Forsyth	-	-	-	-
Rowan	-	-	-	-
Surry	4,057,990	3,800,000	-257,990	-6%
Yadkin	1,554,264	860,000	-694,264	-45%
Stokes	-	-	-	-

D.1.2 Cattle and Chicken Counts by Model Subbasin

Cattle (beef and dairy), chicken, and broiler counts from 2009 or 2010 were used to determine animal counts by model subbasin within the High Rock Lake watershed. An area weighting calculation was performed using animal densities (count/hectare) for pasture land within each of the 10 counties listed in Table D- 1 through Table D- 3. Animal densities for each county were used to calculate animal counts per subbasin based on the percentage of pastureland for each subbasin that was located within each of the 10 counties. Subbasin animal counts are displayed in Figure D- 1 through Figure D- 4.

Beef cattle counts for model subbasins ranged from 3 to approximately 1,900, with an average subbasin count of 450 beef cattle. Beef cattle counts were the highest (1,300 to 1,900 head) in the North Little Hunting Creek subbasin (drains to Hunting Creek and then to South Yadkin River), tributaries to Deep Creek (drain to Yadkin River), the headwater subbasin to the South Yadkin River, and one subbasin along the mainstem of the Yadkin River (Figure D- 1).

Dairy cattle counts for model subbasins were lower, on average, than beef counts and ranged from 0 to approximately 900, with an average subbasin count of approximately 100 dairy cattle. Dairy cattle counts were highest (520 to 900 head) in several of the subbasins draining tributaries to the South Yadkin River, including Rocky Creek, Hunting Creek, Fifth Creek, Third Creek, two unnamed tributaries, and the headwaters of the South Yadkin River (Figure D- 2). Eleven subbasins had no dairy cattle.

Chicken counts for model subbasins ranged from 0 to approximately 330,000, with an average subbasin count of approximately 28,000 chickens. Sixty-three subbasins had no chickens. Chicken counts were highest (190 to 330 thousand head) in the headwater subbasin to the South Yadkin River, the North Little Hunting Creek subbasin (drains to Hunting Creek and then to South Yadkin River), North Deep Creek (drains to Deep Creek and then Yadkin River), and a subbasin for an unnamed tributary east of North Deep Creek that drains to the Yadkin River (Figure D- 3).

Broiler counts were the highest of all animals considered in this analysis. For model subbasins, broiler counts ranged from 0 to 1.1 million, with an average of approximately 134,000 broilers. Thirty subbasins had no broilers. Subbasins with the highest broiler counts were the headwater subbasin to the South

Yadkin River, one of the Hunting Creek subbasins (drains to South Yadkin River), two subbasins along the mainstem of the Yadkin River, and several subbasins draining tributaries to the Yadkin River, including Elkin Creek, Big Bugaboo Creek, and three unnamed tributaries to the Yadkin River (Figure D-4).

Subbasins with no recorded animal counts were located in counties where no counts were reported because actual counts were less than the record limit of 500,000 head for chickens and broilers and 500 head for cattle (USDA-NASS).

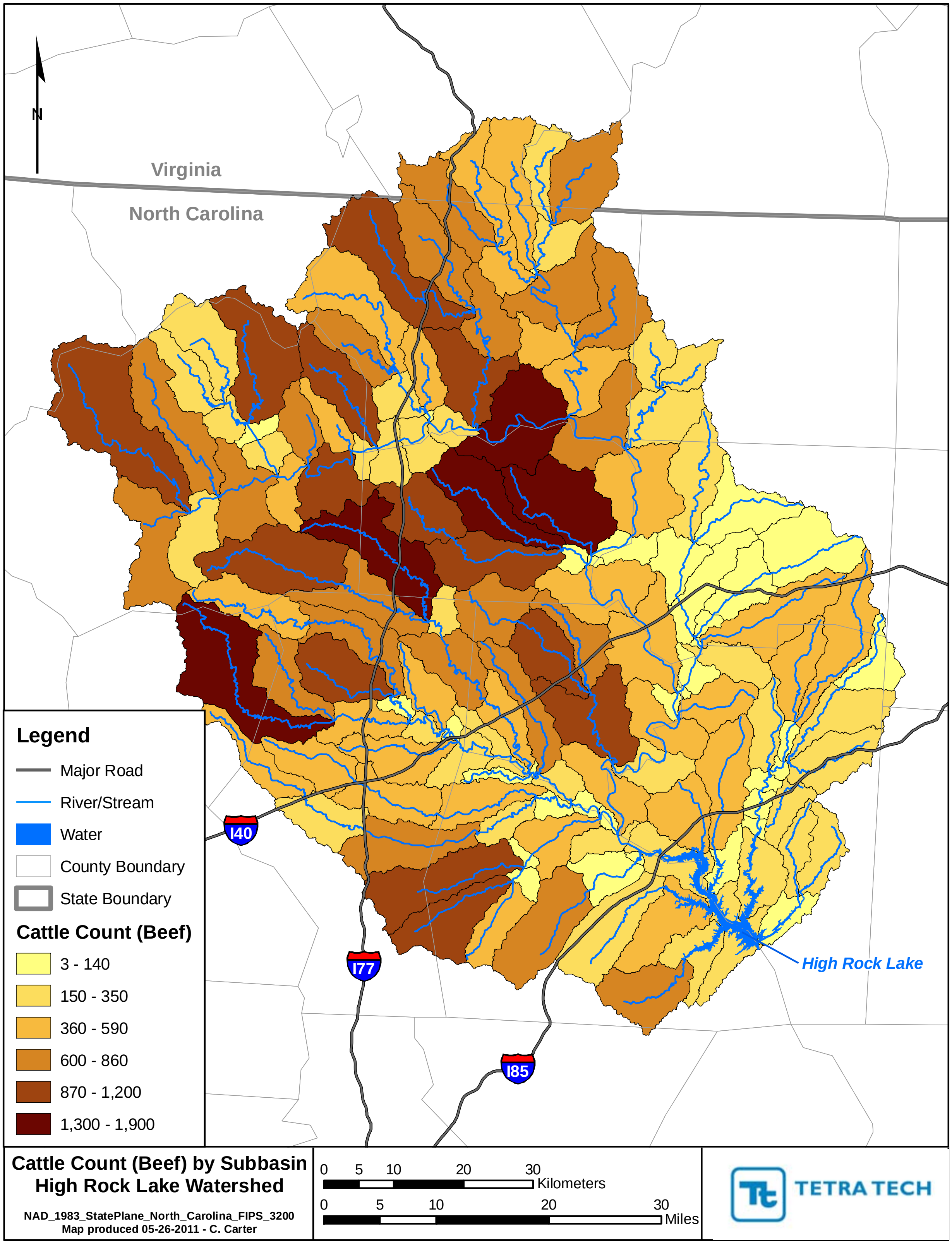

Figure D- 1. Beef Cattle Count by Subbasin

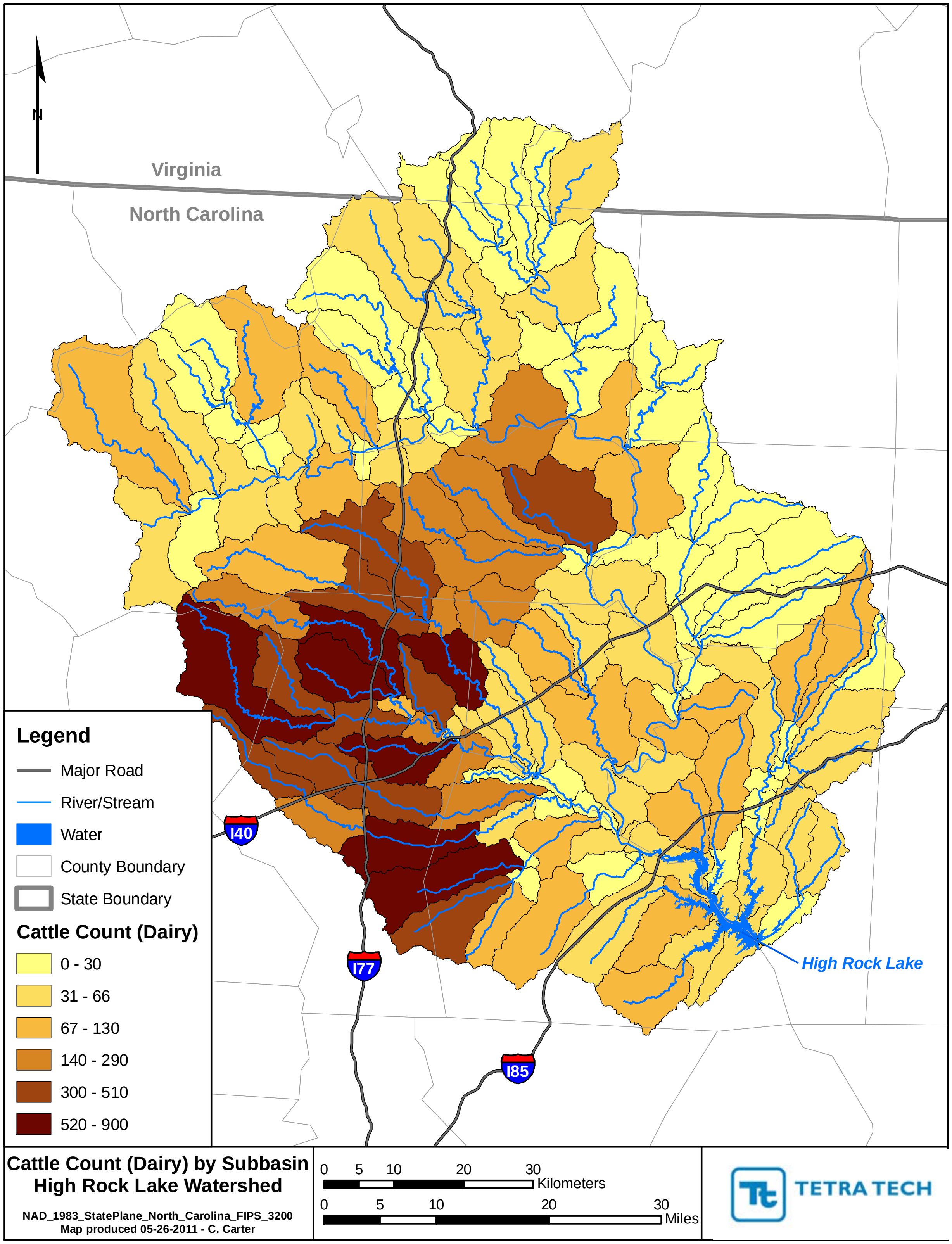

Figure D- 2. Dairy Cattle Count by Subbasin

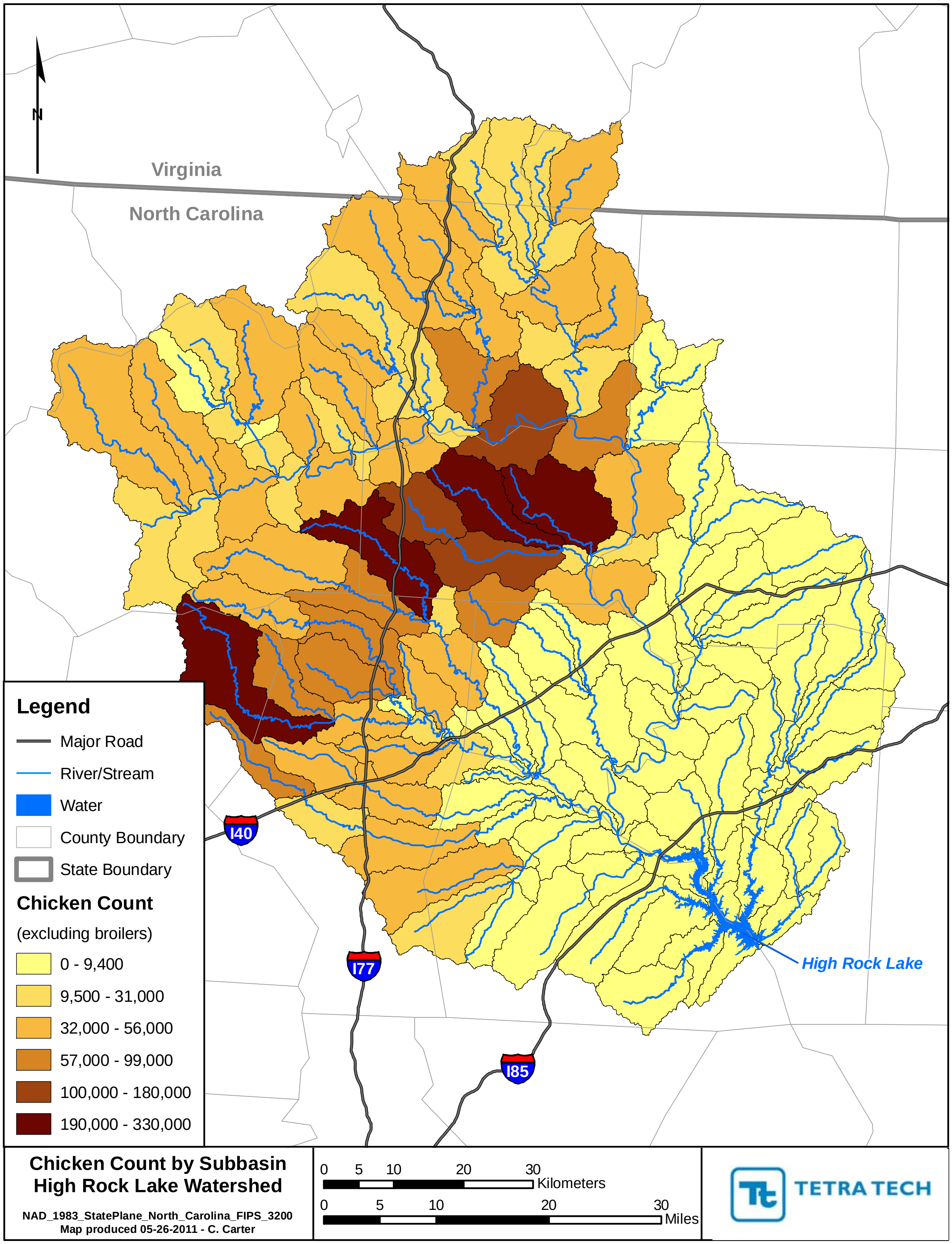

Figure D- 3. Chicken Count by Subbasin

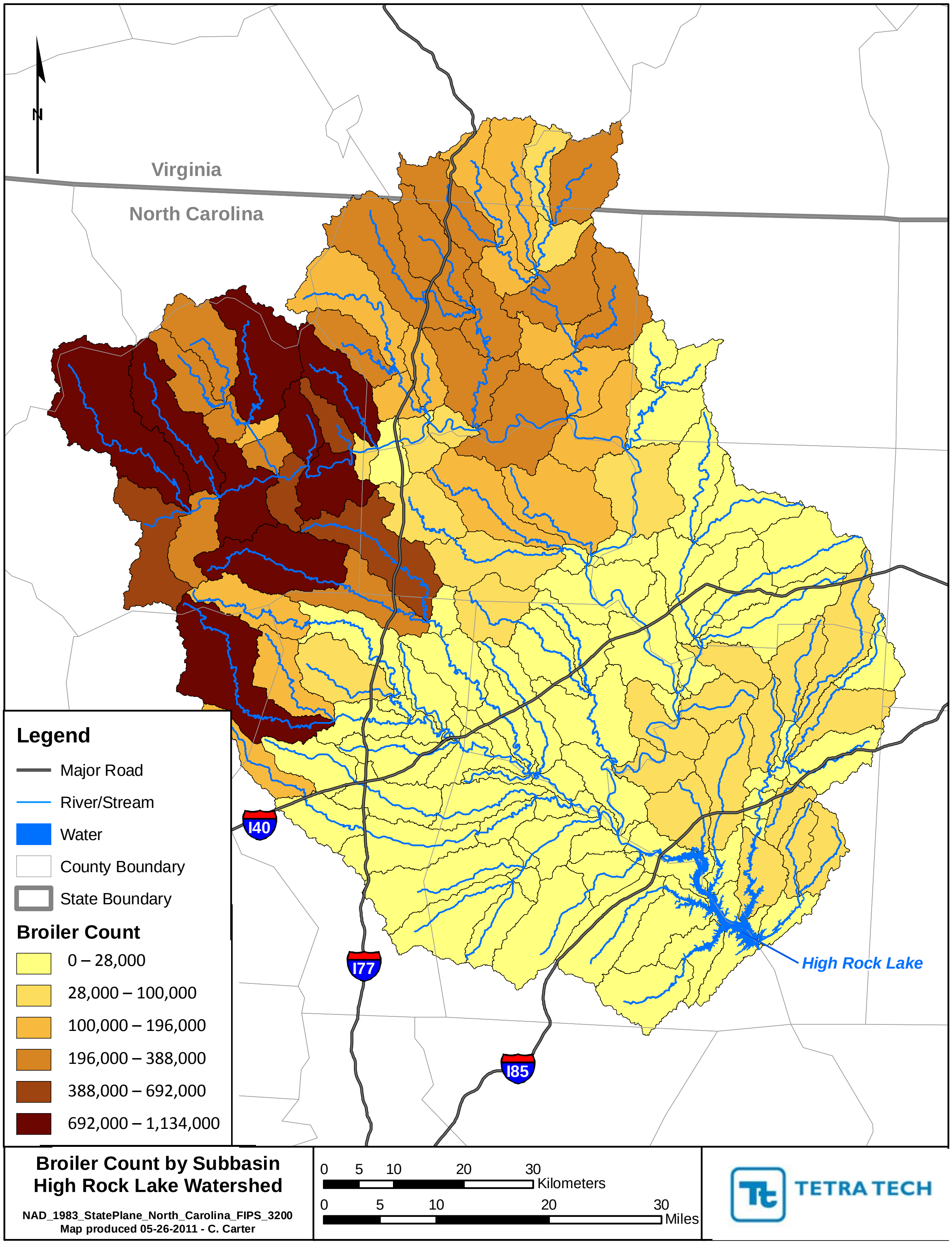

Figure D- 4. Broiler Count by Subbasin

D.1.3 Nutrient Production by Cattle and Chickens

Cattle (beef and dairy), chicken, and broiler counts by subbasin were used to determine the amount of nitrogen (as TN) and phosphorus (as TP) produced by these animals in each subbasin in the High Rock Lake watershed. Animal counts (by head) were multiplied by estimated typical manure characteristic values (Table D- 4) for both nitrogen and phosphorus. Based on these calculations, TN production in modeled subbasins ranged from 3 to 4,000 lb-N/day, with a subbasin average of approximately 600 lb-N/day. TP production in modeled subbasins ranged from 0.6 to 1,000 lb-P/day, with a subbasin average of approximately 145 lb-P/day. In general, subbasins with the highest TN and TP production by animals were those that were also the highest in broiler count. (Figure D- 5 and Figure D- 6).

Animal counts and nutrient production were summed by water quality monitoring station for assessment (Table D- 5). The estimation of nutrient contributions from animals to instream water quality was limited by data availability. Data for waste treatment methods or estimating land application rates practiced by animal operations located in the High Rock Lake watershed would be required. The information contained in this appendix was not used as inputs for the watershed model.

Table D- 4. Estimated Typical Manure (urine and feces combined) Characteristics (ASABE, 2010, MWPS-18, 1993, and Tao and Manci, 2008)

	N	P
Beef Cattle (lb/day-animal)	0.42	0.097
Dairy Cattle (lb/day-animal)	0.99	0.17
	N	**P_2O_5[1]**
Chickens (lb/day)	0.0029	0.0025
Broilers (lb/day)	0.0017	0.0009

[1] The transfer coefficient used to convert P_2O_5 to P was 0.44 (Tao and Mancl, 2008).

Table D- 5. Animal Counts and Nutrient Production by Water Quality Station

Station	Cattle Count (beef)	Cattle Count (dairy)	Chicken Count (excluding broilers)	Broiler Count	Total TN (lb-N/day)	Total TP (lb-P/day)
Yadkin River at Yadkin College (02116500)	34,146	3,248	2,372,213	15,098,819	50,104	12,453
Yadkin River at Enon (02115360)	25,260	1,773	1,447,074	14,431,179	41,094	10,058
Yadkin River at Elkin (02112250)	9,728	807	450,047	9,907,102	23,032	5,499
South Yadkin River (02118000)	6,777	4,858	792,615	1,448,014	12,416	2,929
Abbotts Creek (02121500)	1,756	334	0	248,287	1,490	325
Second Creek (02120780)	2,758	1,046	60,959	22,167	2,408	521

D.1.4 Appendix D References

ASABE. 2010. Manure Production and Characteristics. American Society of Agricultural and Biological Engineers.

MWPS-18. 1993. *Livestock Waste Facilities Handbook*. Midwest Plan Service, Iowa State University.

Tao, J. and K. Manci. 2008. Estimating Manure Production, Storage Size, and Land Application Area. Ohio State University.

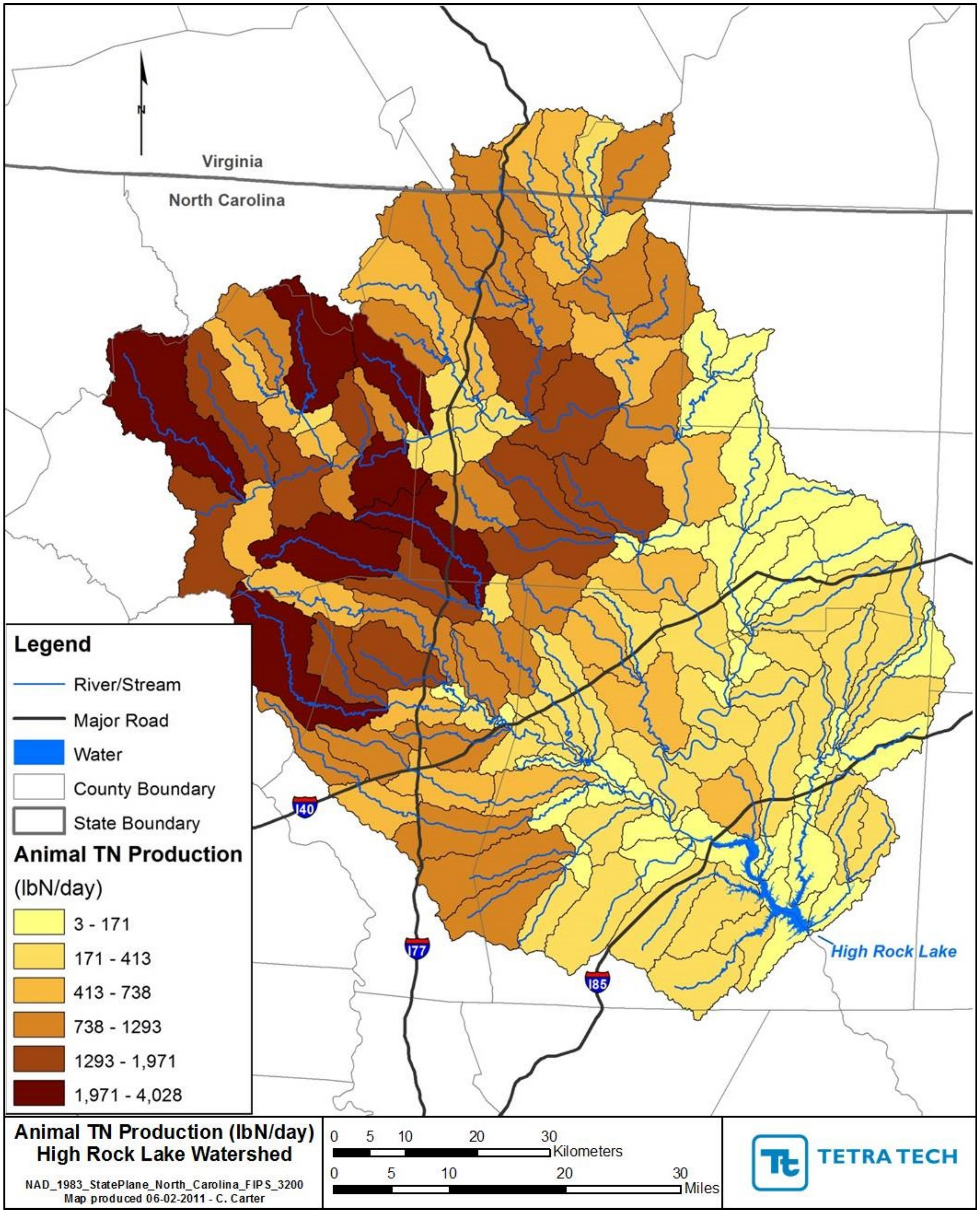

Figure D- 5. Animal TN Production by Subbasin

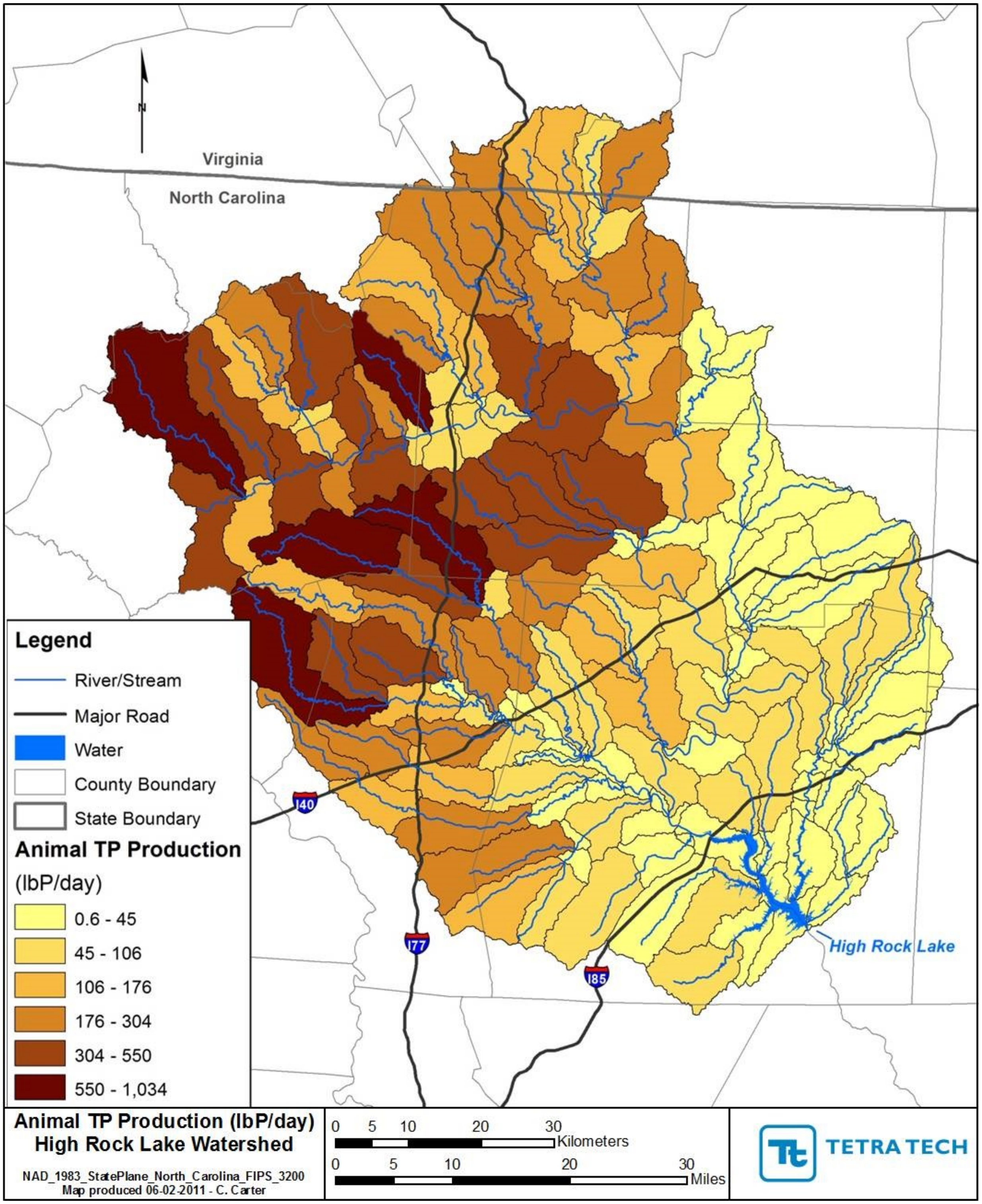

Figure D- 6. Animal TP Production by Subbasin

Appendix E. Hydrology Calibration/Validation

This section provides detailed results for hydrology calibration and validation at each flow gage. Results are presented sequentially for:

- Roaring River near Roaring River (page E-2 to E-6)
- Ararat River at Ararat (pages E-6 to E-10)
- Hunting Creek near Harmony (pages E-11 to E-15)
- South Yadkin River near Mocksville (pages E-15 to E-19)
- Second Creek near Barber (pages E-20 to E-24)
- Abbotts Creek at Lexington (pages E-24 to E-28)
- Yadkin River at Elkin (pages E-29 to E-33)
- Mitchell River near State Road (pages E-33 to E-37)
- Yadkin River at Enon (pages E-38 to E-42)
- Muddy Creek near Muddy Creek (pages E-42 to E-46)
- Yadkin River at Yadkin College (pages E-47 to E-51)

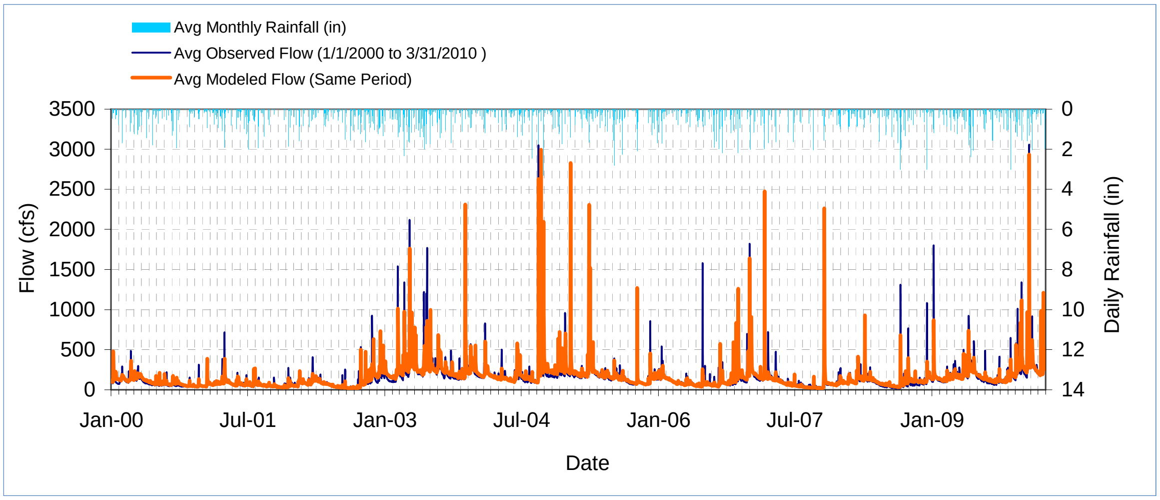

Figure E- 1. Mean Daily Flow: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

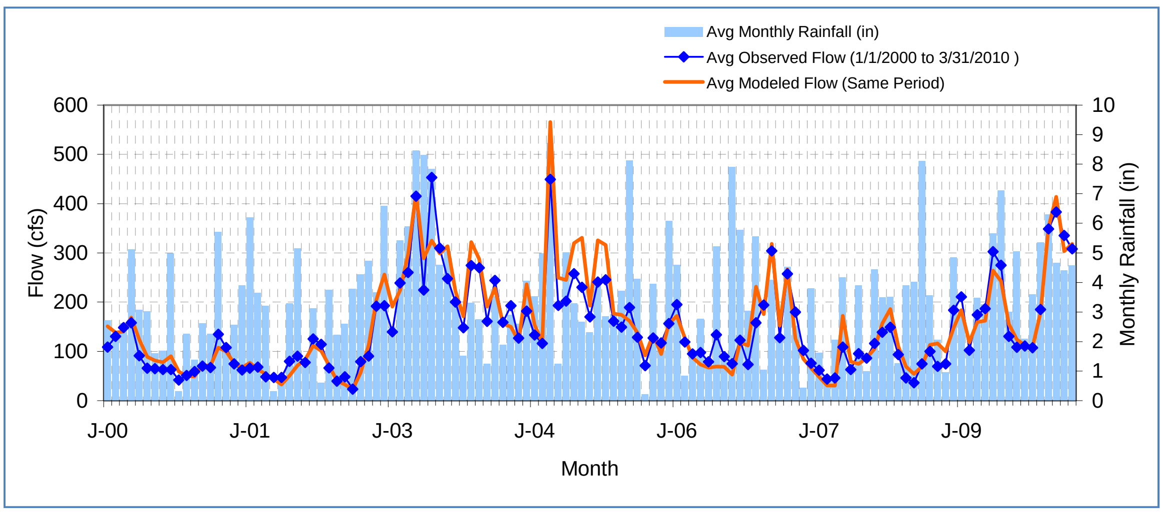

Figure E- 2. Mean Monthly Flow: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

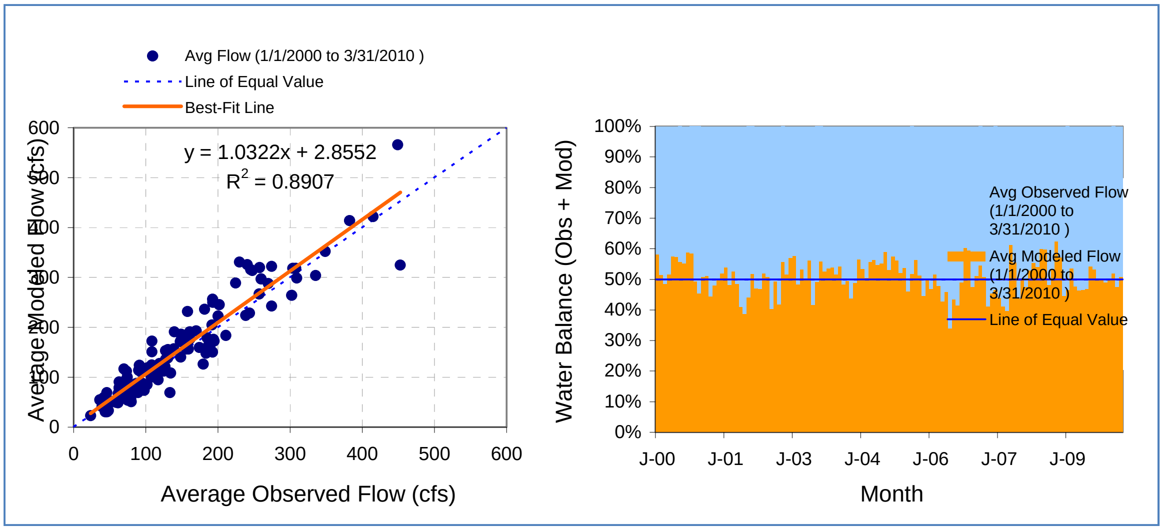

Figure E- 3. Monthly Flow Regression and Temporal Variation: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

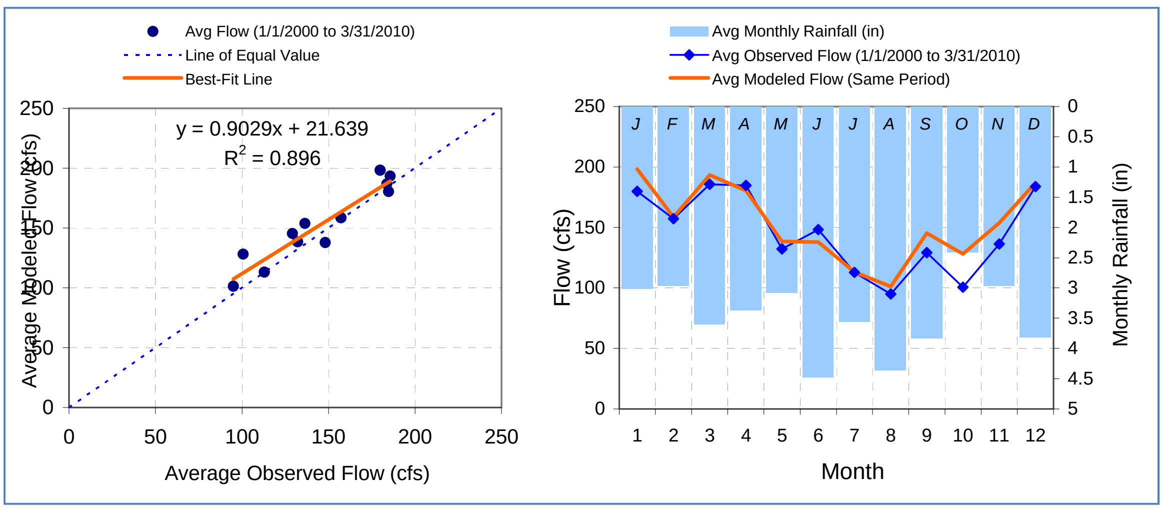

Figure E- 4. Seasonal Regression and Temporal Aggregate: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

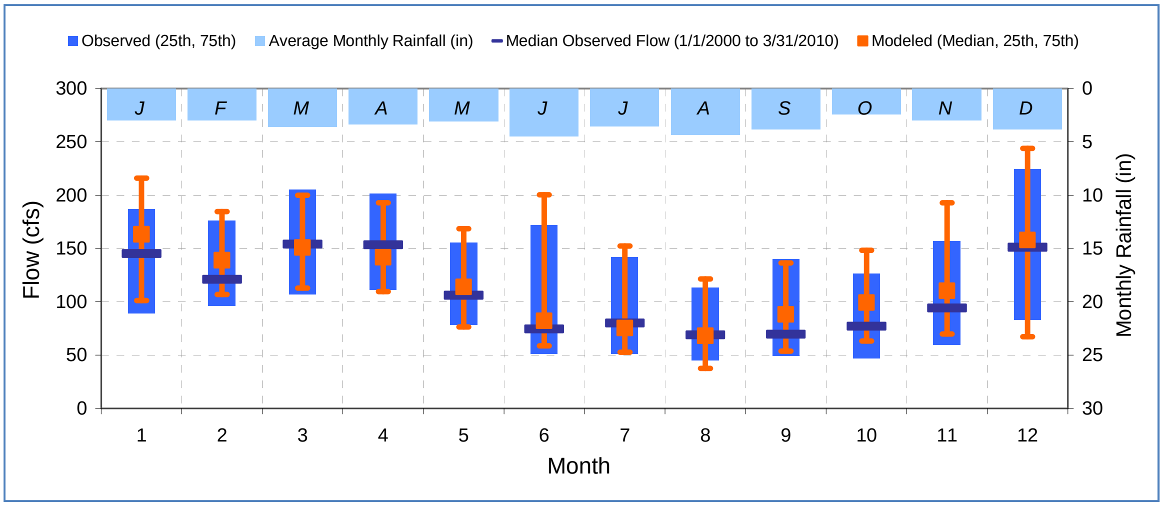

Figure E- 5. Seasonal Medians and Ranges: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

Table E- 1. Seasonal Summary: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	179.86	145.00	89.00	187.00	198.26	163.31	101.10	215.90
Feb	157.26	121.00	96.00	176.00	158.61	138.81	106.97	184.65
Mar	185.65	154.00	107.00	205.00	193.36	150.80	112.91	199.97
Apr	184.73	153.50	111.00	201.50	180.50	141.62	109.51	192.79
May	132.16	106.00	78.00	155.25	138.48	113.85	76.33	168.62
Jun	148.17	74.50	51.00	172.00	137.85	82.10	58.76	200.27
Jul	112.88	80.00	51.00	141.75	113.21	75.28	52.61	152.39
Aug	95.00	69.00	45.00	113.00	101.24	68.12	37.46	121.49
Sep	129.17	69.50	49.00	140.00	145.49	88.23	53.84	136.30
Oct	100.73	77.00	47.00	126.50	128.15	99.24	63.20	148.34
Nov	136.45	94.00	59.75	157.00	153.84	110.40	69.80	192.94
Dec	183.74	151.00	83.25	224.50	186.93	157.87	67.13	243.90

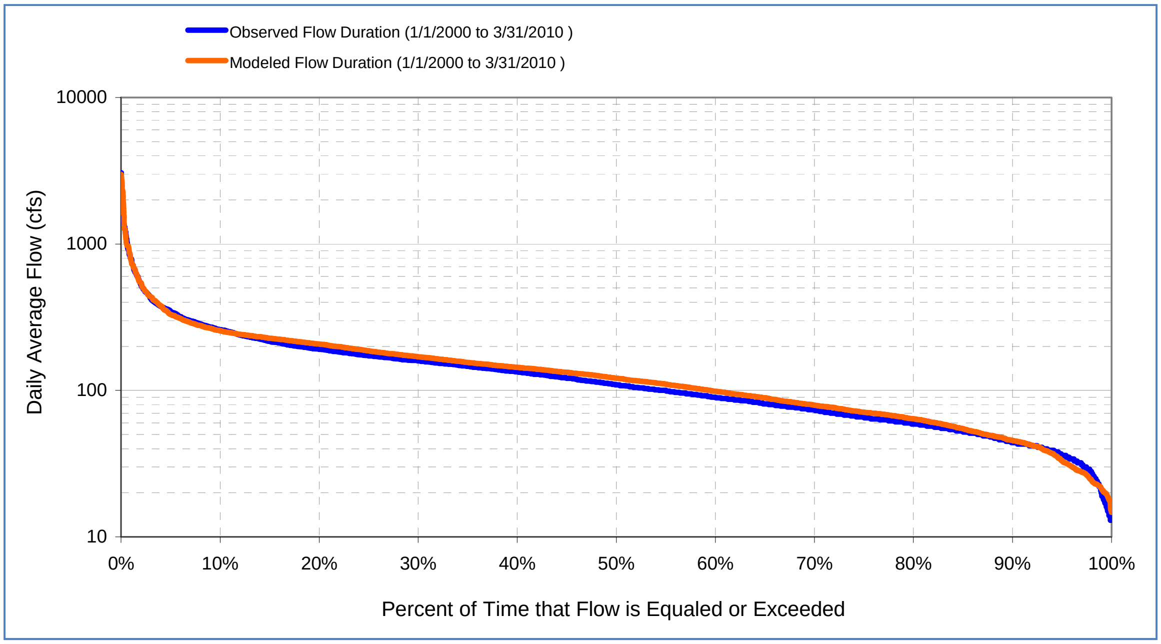

Figure E- 6. Flow Exceedence: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

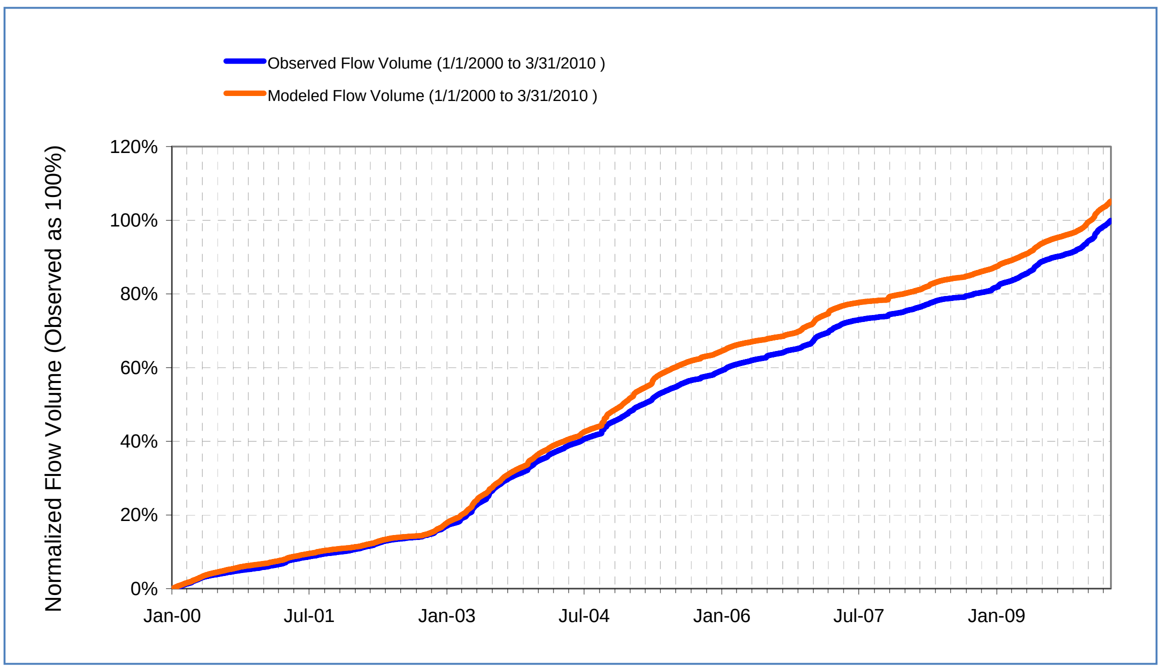

Figure E- 7. Flow Accumulation: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

Table E- 2. Summary Statistics: Model DSN 104 vs. USGS 02112120 Roaring River near Roaring River, NC

HSPF Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM DSN 104 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area At Run 27		USGS 02112120 ROARING RIVER NEAR ROARING RIVER, NC Hydrologic Unit Code: 3040101 Latitude: 36.25027778 Longitude: -81.0444444 Drainage Area (sq-mi): 128	
Total Simulated In-stream Flow:	**16.31**	Total Observed In-stream Flow:	**15.50**
Total of simulated highest 10% flows:	**5.03**	Total of Observed highest 10% flows:	**4.95**
Total of Simulated lowest 50% flows:	**3.81**	Total of Observed Lowest 50% flows:	**3.54**
Simulated Summer Flow Volume (months 7-9):	**3.12**	Observed Summer Flow Volume (7-9):	**2.93**
Simulated Fall Flow Volume (months 10-12):	**4.08**	Observed Fall Flow Volume (10-12):	**3.66**
Simulated Winter Flow Volume (months 1-3):	**5.18**	Observed Winter Flow Volume (1-3):	**4.92**
Simulated Spring Flow Volume (months 4-6):	**3.92**	Observed Spring Flow Volume (4-6):	**3.99**
Total Simulated Storm Volume:	**3.32**	Total Observed Storm Volume:	**3.62**
Simulated Summer Storm Volume (7-9):	**0.69**	Observed Summer Storm Volume (7-9):	**0.80**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	5.22	10	
Error in 50% lowest flows:	7.57	10	
Error in 10% highest flows:	1.67	15	
Seasonal volume error - Summer:	6.71	30	
Seasonal volume error - Fall:	11.39	30	
Seasonal volume error - Winter:	5.37	30	
Seasonal volume error - Spring:	-1.71	30	
Error in storm volumes:	-8.32	20	
Error in summer storm volumes:	-13.75	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.563	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.541	as E or E' approaches 1.0	

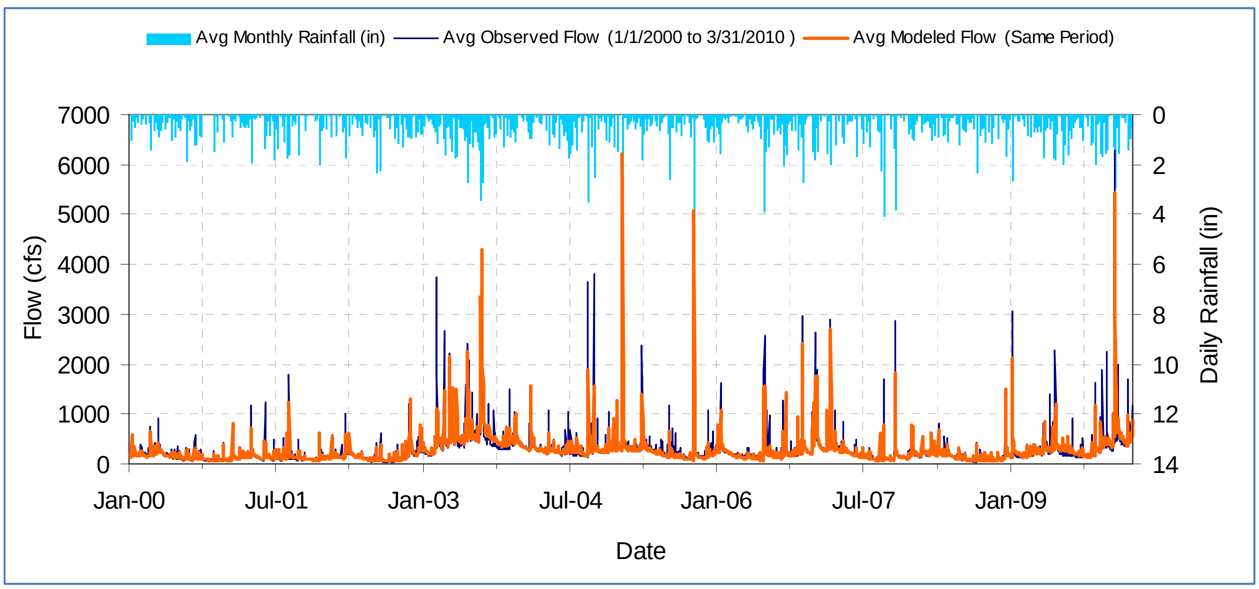

Figure E- 8. Mean Daily Flow: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

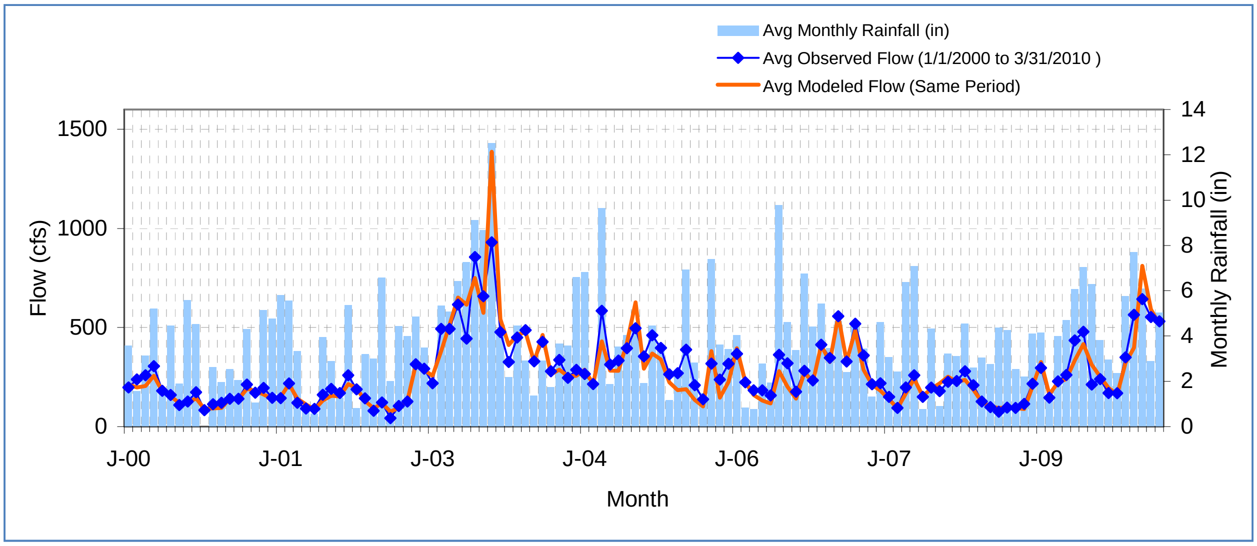

Figure E- 9. Mean Monthly Flow: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

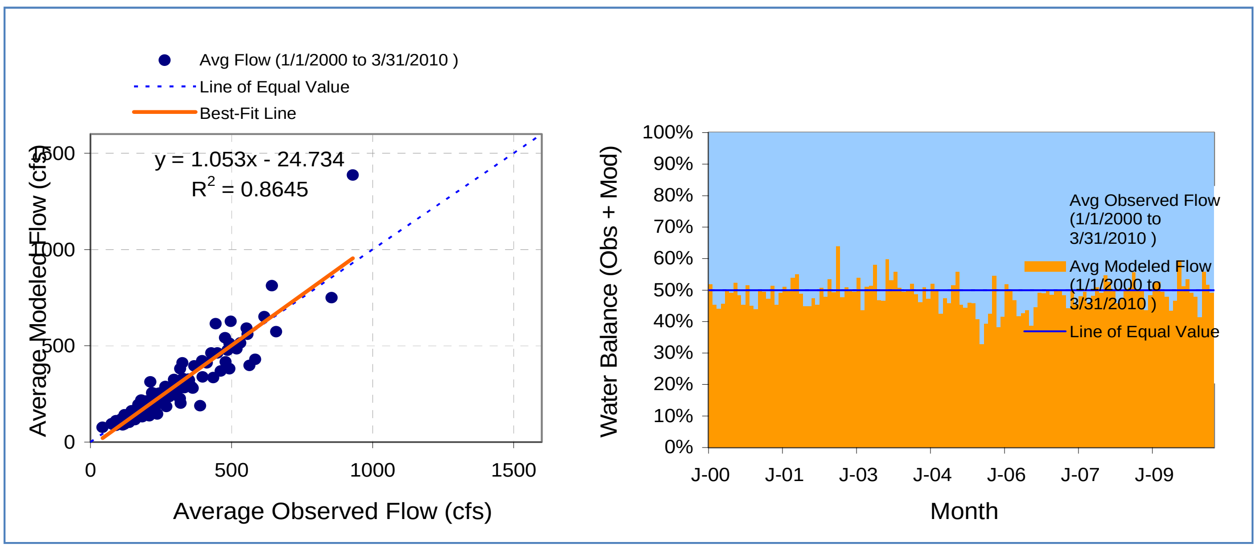

Figure E- 10. Monthly Flow Regression and Temporal Variation: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

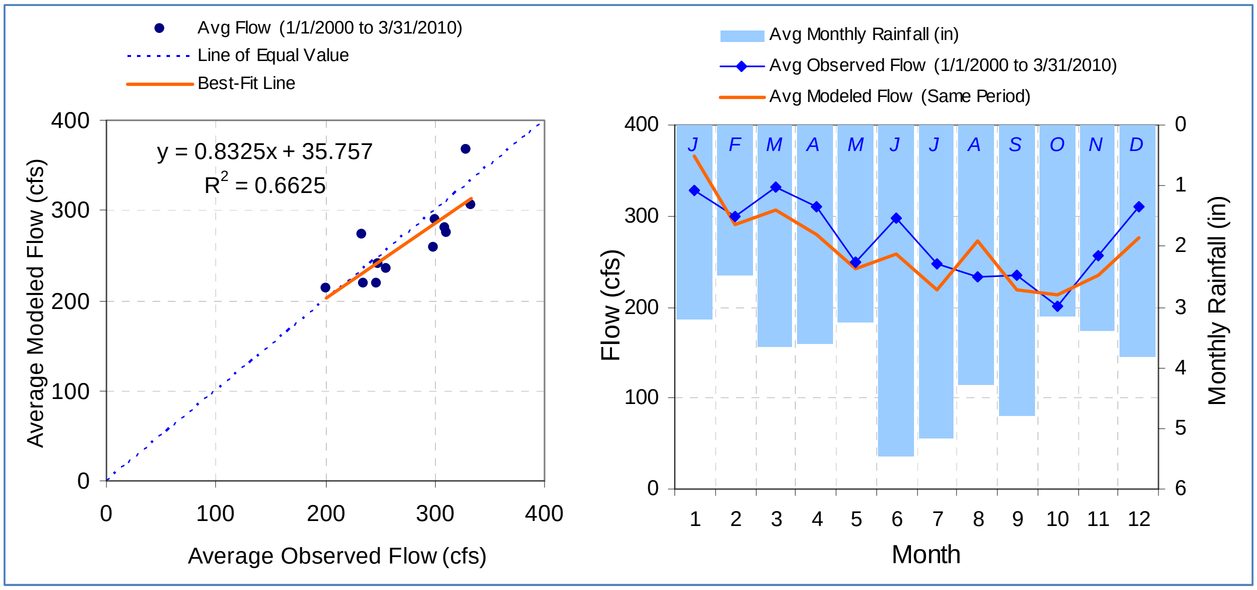

Figure E- 11. Seasonal Regression and Temporal Aggregate: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

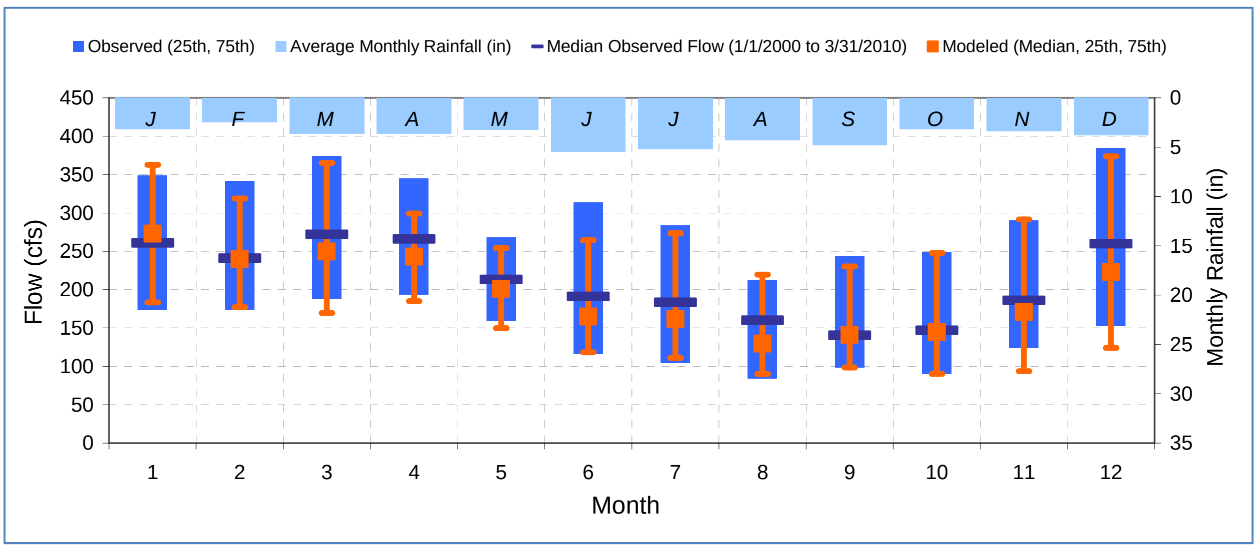

Figure E- 12. Seasonal Medians and Ranges: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

Table E- 3. Seasonal Summary: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	329.01	261.00	173.00	349.00	366.52	272.89	183.24	362.58
Feb	300.25	241.00	174.00	342.00	289.87	240.02	177.36	318.76
Mar	332.47	272.00	188.00	374.00	306.21	249.50	169.68	365.13
Apr	309.93	266.00	193.75	345.00	280.19	242.81	184.84	299.26
May	249.03	213.00	159.00	268.50	241.52	201.14	149.94	254.08
Jun	298.36	191.00	116.00	313.25	258.36	164.67	118.28	264.50
Jul	246.93	183.50	104.25	283.75	219.31	161.75	110.98	273.59
Aug	232.87	160.00	84.00	211.75	272.67	129.61	89.86	219.54
Sep	234.37	140.50	99.00	244.25	218.74	141.17	98.50	230.14
Oct	201.45	147.00	90.00	249.00	212.73	144.51	90.15	247.70
Nov	256.50	186.00	123.50	290.00	235.66	170.79	93.87	291.44
Dec	310.07	260.00	152.25	384.25	275.55	223.09	124.09	373.83

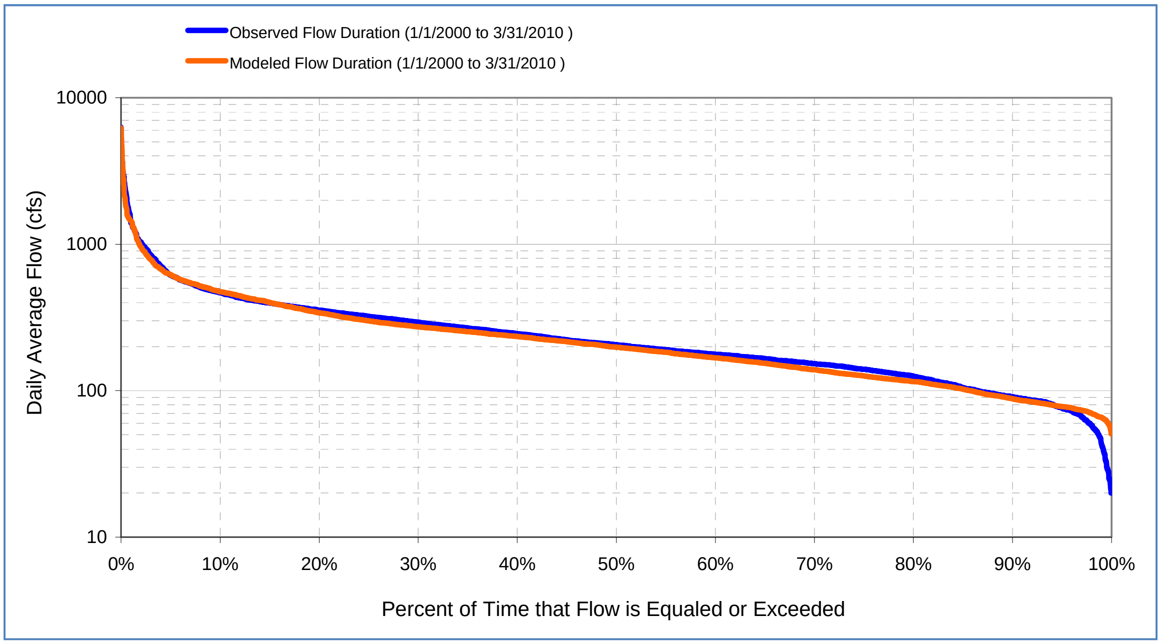

Figure E- 13. Flow Exceedence: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

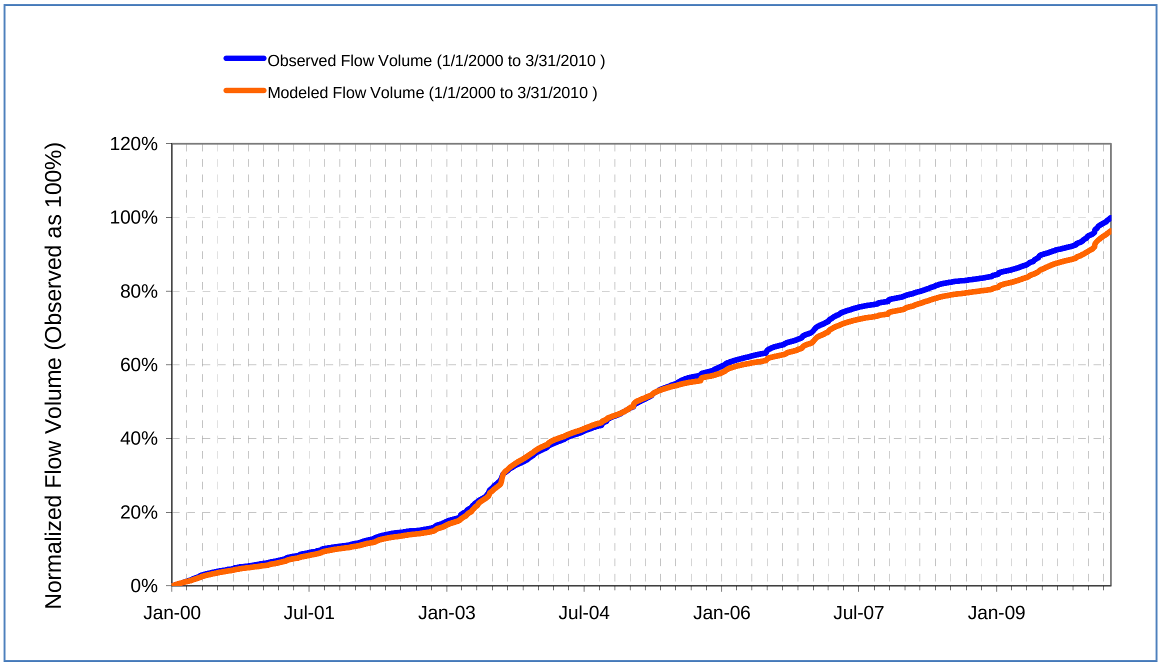

Figure E- 14. Flow Accumulation: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

Table E- 4. Summary Statistics: Model DSN 105 vs. USGS 02113850 Ararat River at Ararat, NC

HSPF Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM DSN 105 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		**USGS 02113850 ARARAT RIVER AT ARARAT, NC** Hydrologic Unit Code: 3040101 Latitude: 36.40444444 Longitude: -80.5616667 Drainage Area (sq-mi): 231		
Total Simulated In-stream Flow:	**15.65**	Total Observed In-stream Flow:		**16.23**
Total of simulated highest 10% flows:	**4.98**	Total of Observed highest 10% flows:		**5.13**
Total of Simulated lowest 50% flows:	**3.77**	Total of Observed Lowest 50% flows:		**3.97**
Simulated Summer Flow Volume (months 7-9):	**3.43**	Observed Summer Flow Volume (7-9):		**3.44**
Simulated Fall Flow Volume (months 10-12):	**3.49**	Observed Fall Flow Volume (10-12):		**3.70**
Simulated Winter Flow Volume (months 1-3):	**5.02**	Observed Winter Flow Volume (1-3):		**5.01**
Simulated Spring Flow Volume (months 4-6):	**3.71**	Observed Spring Flow Volume (4-6):		**4.08**
Total Simulated Storm Volume:	**3.19**	Total Observed Storm Volume:		**3.91**
Simulated Summer Storm Volume (7-9):	**0.76**	Observed Summer Storm Volume (7-9):		**1.01**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-3.58	10		
Error in 50% lowest flows:	-4.83	10		
Error in 10% highest flows:	-2.90	15		
Seasonal volume error - Summer:	-0.42	30		
Seasonal volume error - Fall:	-5.71	30		
Seasonal volume error - Winter:	0.19	30		
Seasonal volume error - Spring:	-8.95	30		
Error in storm volumes:	-18.37	20		
Error in summer storm volumes:	-25.31	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.621	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.540	as E or E' approaches 1.0		

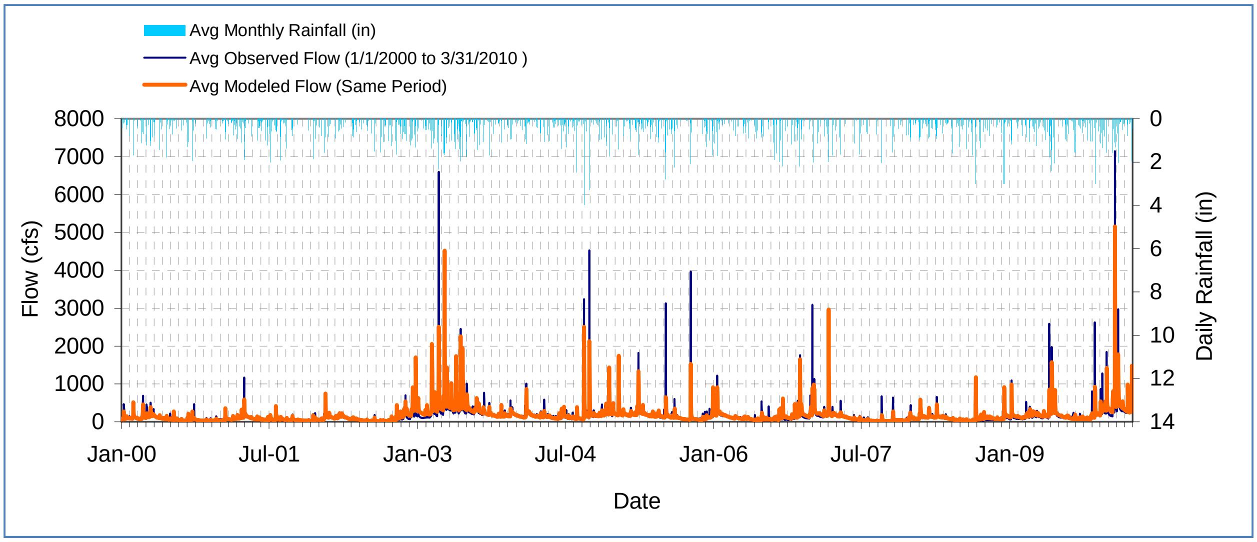

Figure E- 15. Mean Daily Flow: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

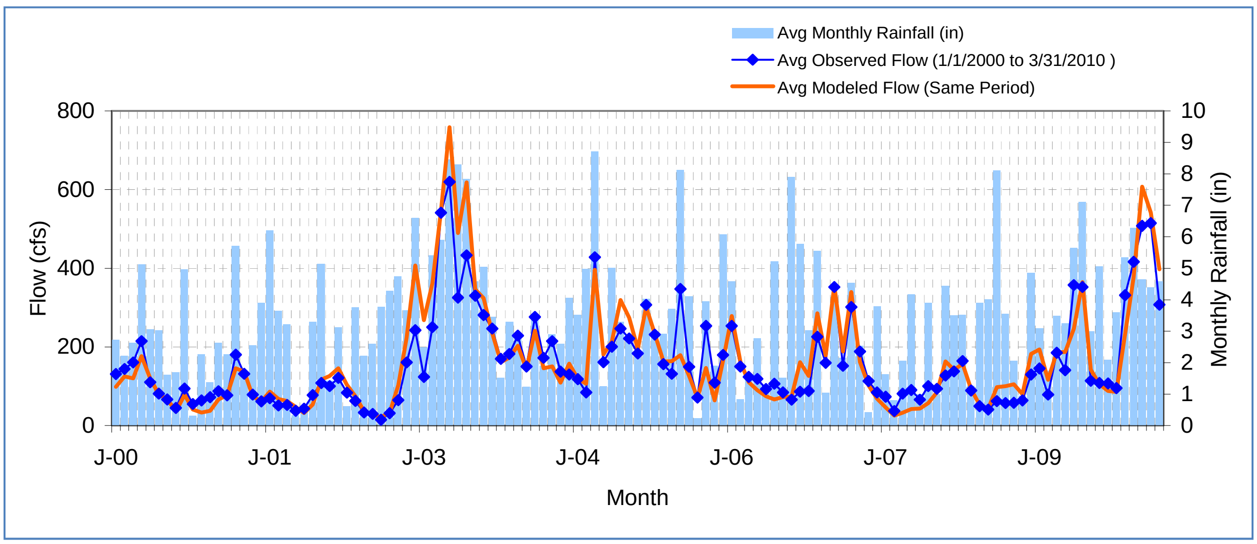

Figure E- 16. Mean Monthly Flow: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

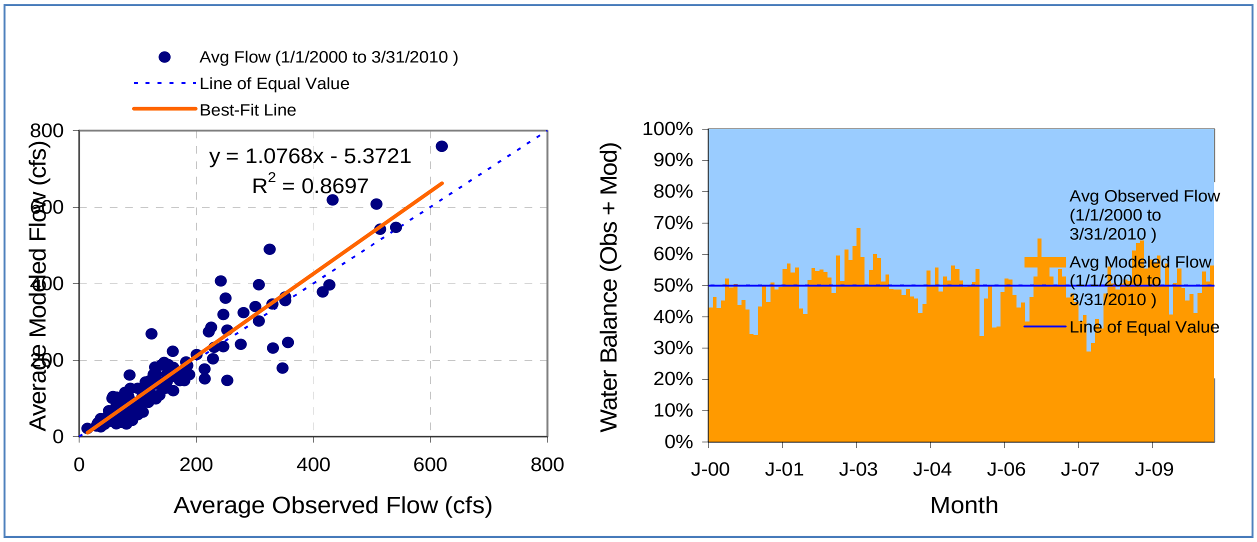

Figure E- 17. Monthly Flow Regression and Temporal Variation: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

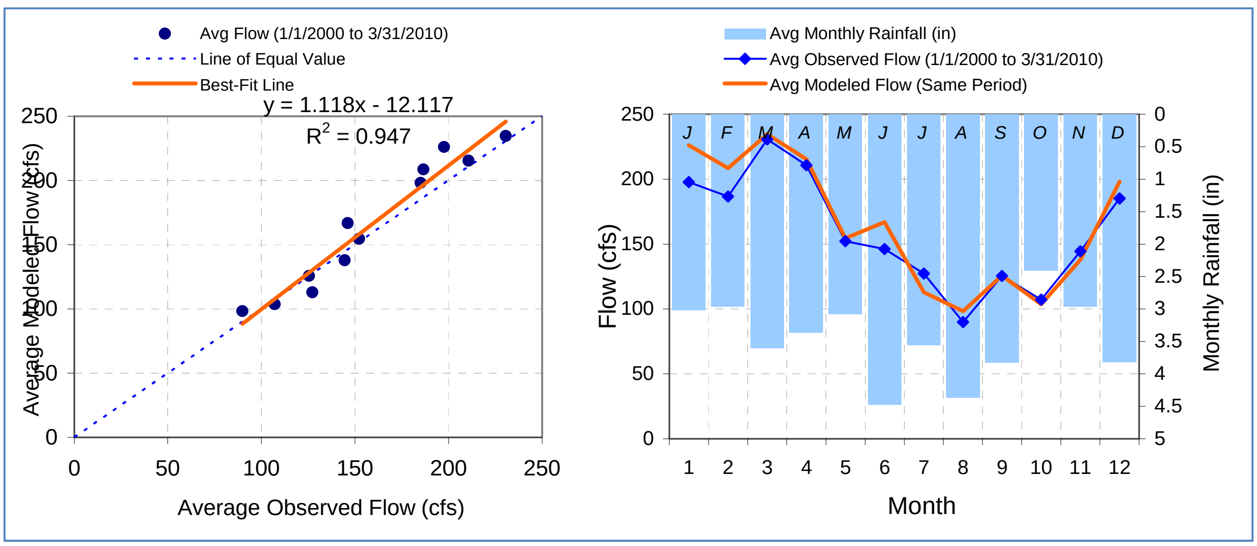

Figure E- 18. Seasonal Regression and Temporal Aggregate: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

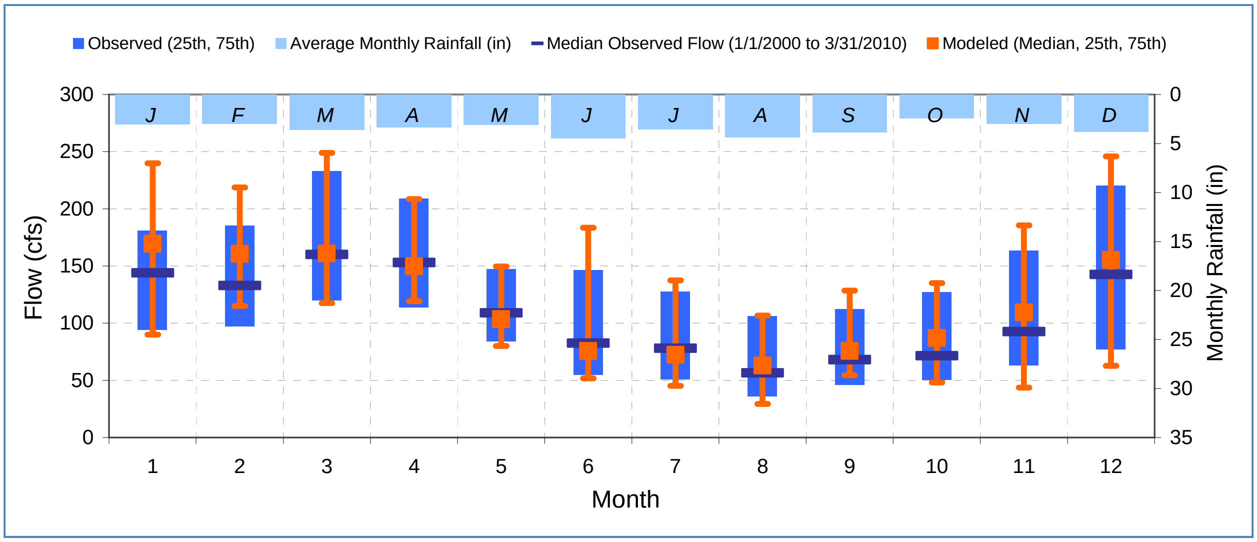

Figure E- 19. Seasonal Medians and Ranges: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

Table E- 5. Seasonal Summary: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	197.69	144.00	94.00	181.00	226.12	169.47	90.15	239.85
Feb	186.59	133.00	97.00	185.50	208.50	160.74	114.98	218.75
Mar	230.67	160.00	120.00	233.00	234.57	160.82	117.52	249.07
Apr	210.77	153.00	114.00	209.00	215.48	149.74	119.21	208.49
May	152.15	109.00	84.00	147.50	154.53	103.54	80.04	149.67
Jun	146.15	82.50	55.00	146.50	166.80	75.69	51.78	183.41
Jul	127.36	78.00	51.00	127.75	112.95	72.25	45.31	137.46
Aug	89.84	56.50	36.00	106.25	98.33	62.84	29.43	106.71
Sep	125.44	68.00	46.00	112.25	125.69	75.64	54.31	128.47
Oct	107.16	71.50	50.25	127.00	103.69	87.05	48.29	135.17
Nov	144.55	92.50	63.00	163.25	137.87	109.38	43.70	185.65
Dec	185.10	142.50	77.00	220.50	198.08	155.24	62.81	245.83

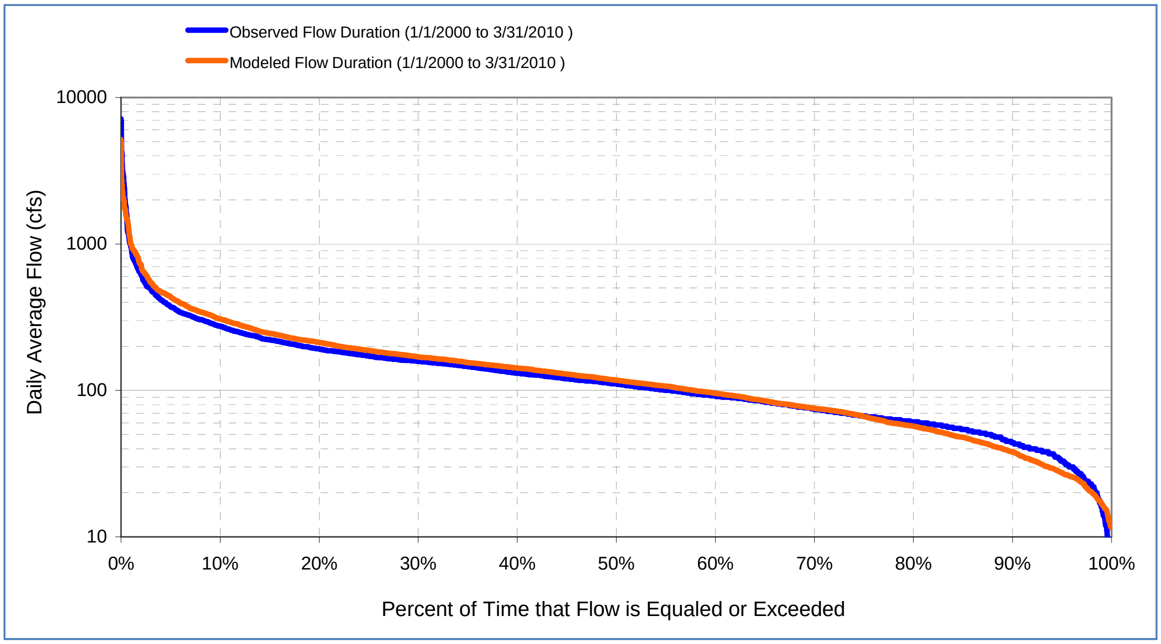

Figure E- 20. Flow Exceedence: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

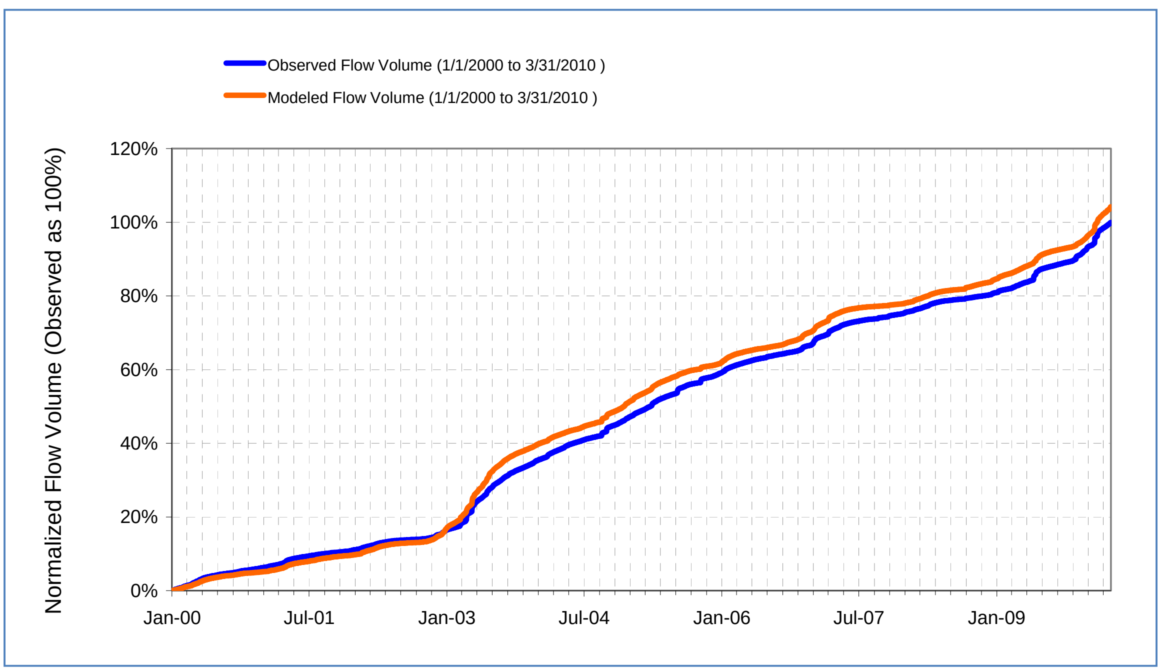

Figure E- 21. Flow Accumulation: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

Table E- 6. Summary Statistics: Model DSN 106 vs. USGS 02118500 Hunting Creek near Harmony, NC

HSPF Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM DSN 106 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 02118500 HUNTING CREEK NEAR HARMONY, NC Hydrologic Unit Code: 3040102 Latitude: 36.00055556 Longitude: -80.7455556 Drainage Area (sq-mi): 155	
Total Simulated In-stream Flow:	**14.58**	Total Observed In-stream Flow:	**13.98**
Total of simulated highest 10% flows:	**5.32**	Total of Observed highest 10% flows:	**5.22**
Total of Simulated lowest 50% flows:	**2.92**	Total of Observed Lowest 50% flows:	**2.95**
Simulated Summer Flow Volume (months 7-9):	**2.42**	Observed Summer Flow Volume (7-9):	**2.46**
Simulated Fall Flow Volume (months 10-12):	**3.16**	Observed Fall Flow Volume (10-12):	**3.14**
Simulated Winter Flow Volume (months 1-3):	**5.20**	Observed Winter Flow Volume (1-3):	**4.78**
Simulated Spring Flow Volume (months 4-6):	**3.81**	Observed Spring Flow Volume (4-6):	**3.61**
Total Simulated Storm Volume:	**3.58**	Total Observed Storm Volume:	**4.03**
Simulated Summer Storm Volume (7-9):	**0.60**	Observed Summer Storm Volume (7-9):	**0.80**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	4.25	10	
Error in 50% lowest flows:	-1.08	10	
Error in 10% highest flows:	1.84	15	
Seasonal volume error - Summer:	-1.68	30	
Seasonal volume error - Fall:	0.71	30	
Seasonal volume error - Winter:	8.74	30	
Seasonal volume error - Spring:	5.41	30	
Error in storm volumes:	-11.19	20	
Error in summer storm volumes:	-25.70	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.626	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.475	as E or E' approaches 1.0	

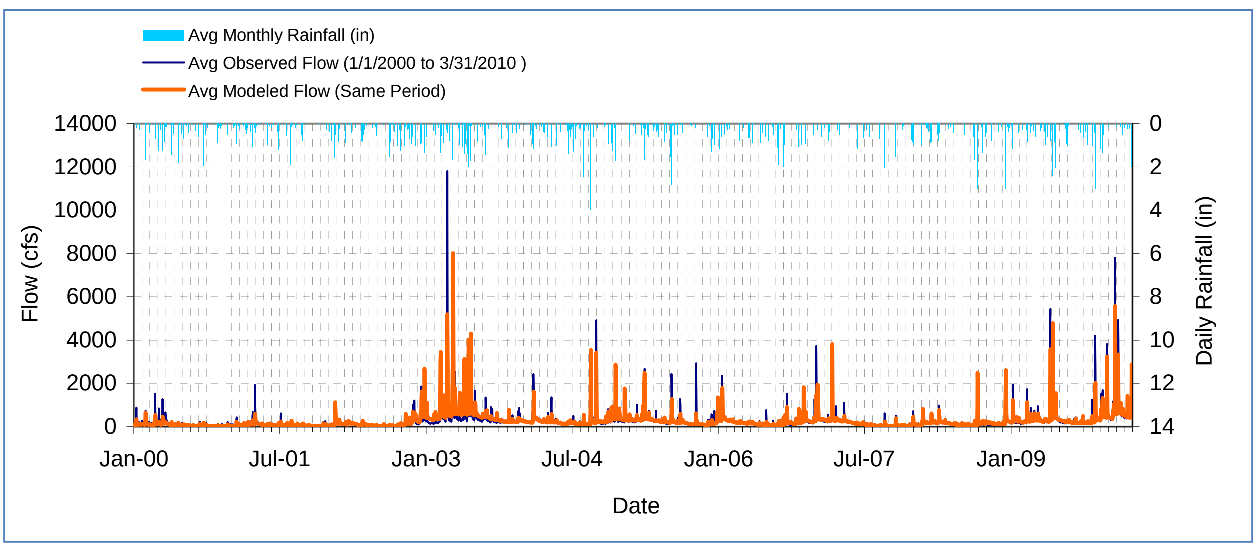

Figure E- 22. Mean Daily Flow: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

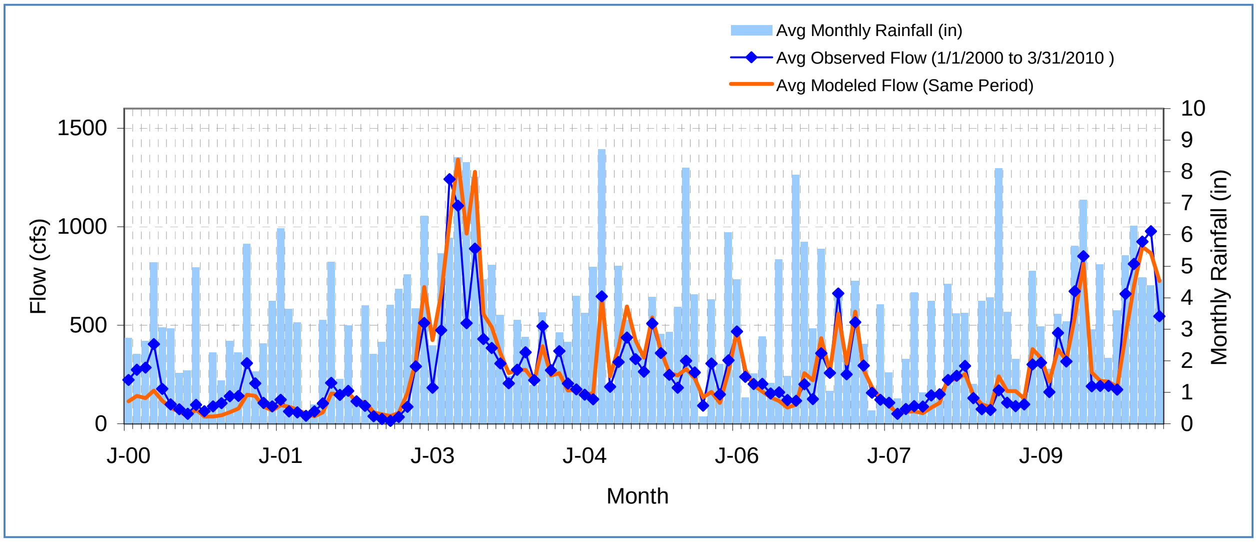

Figure E- 23. Mean Monthly Flow: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

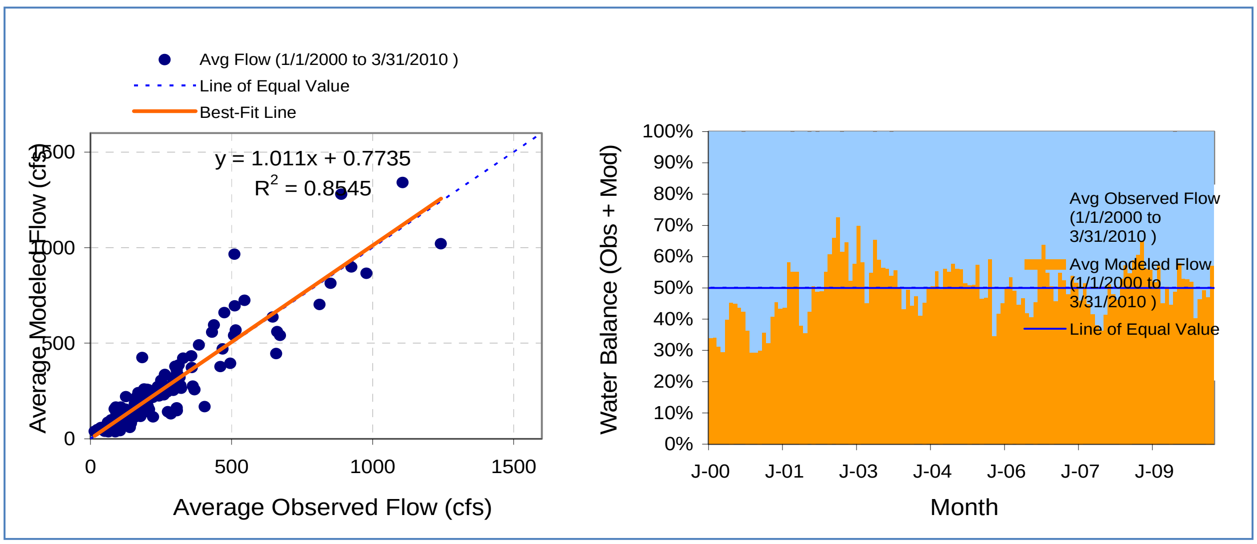

Figure E- 24. Monthly Flow Regression and Temporal Variation: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

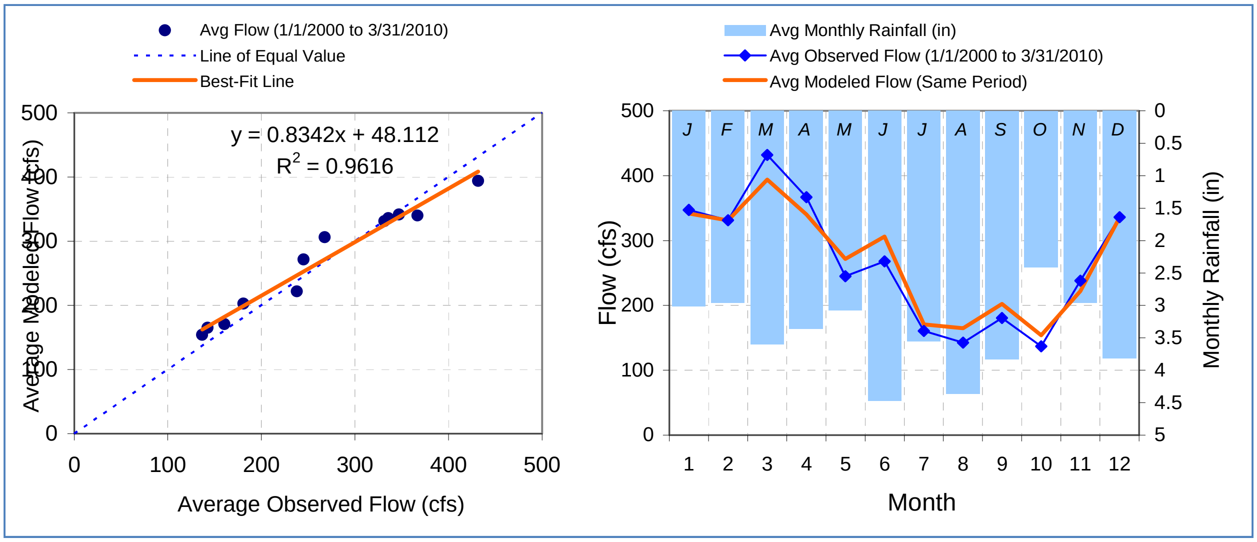

Figure E- 25. Seasonal Regression and Temporal Aggregate: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

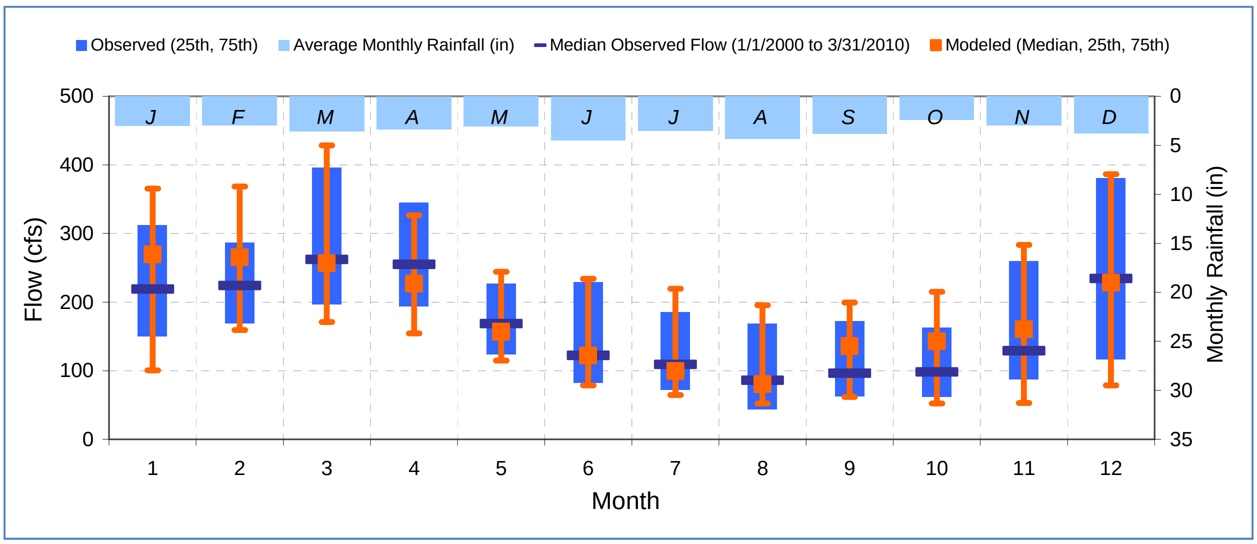

Figure E- 26. Seasonal Medians and Ranges: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

Table E- 7. Seasonal Summary: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	347.17	219.00	150.00	312.00	341.55	269.49	100.56	365.75
Feb	331.54	224.00	168.50	286.50	331.16	265.19	159.39	368.52
Mar	431.84	262.00	197.00	396.00	393.89	256.73	170.97	428.52
Apr	366.90	255.00	193.75	345.00	340.06	226.90	154.34	326.63
May	245.08	168.50	124.00	227.00	271.51	156.80	114.85	244.16
Jun	267.79	122.50	82.00	229.25	306.26	122.05	78.43	234.10
Jul	160.59	109.00	72.25	185.75	170.73	99.57	64.90	219.59
Aug	142.57	86.00	43.25	168.50	164.96	80.50	52.44	195.44
Sep	180.69	96.50	62.75	172.50	202.52	135.75	62.03	199.67
Oct	136.83	98.00	62.00	162.75	153.98	142.91	52.42	215.20
Nov	238.01	129.00	87.00	259.50	221.83	160.29	52.83	283.46
Dec	335.84	234.50	116.50	380.75	335.73	228.42	78.69	386.61

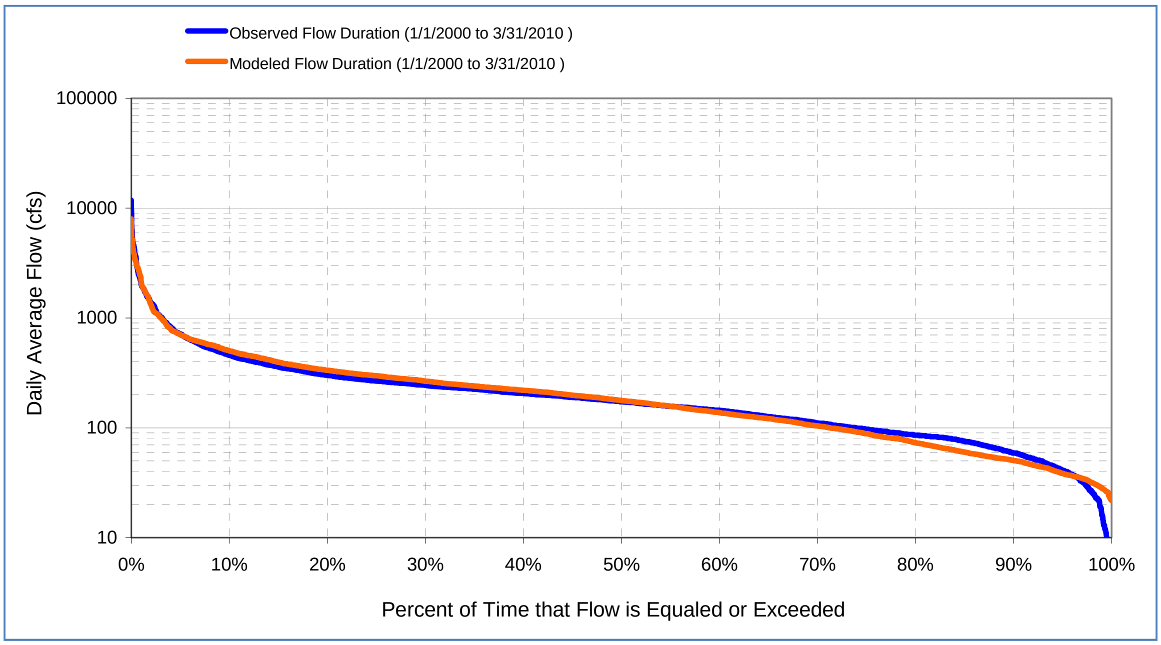

Figure E- 27. Flow Exceedence: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

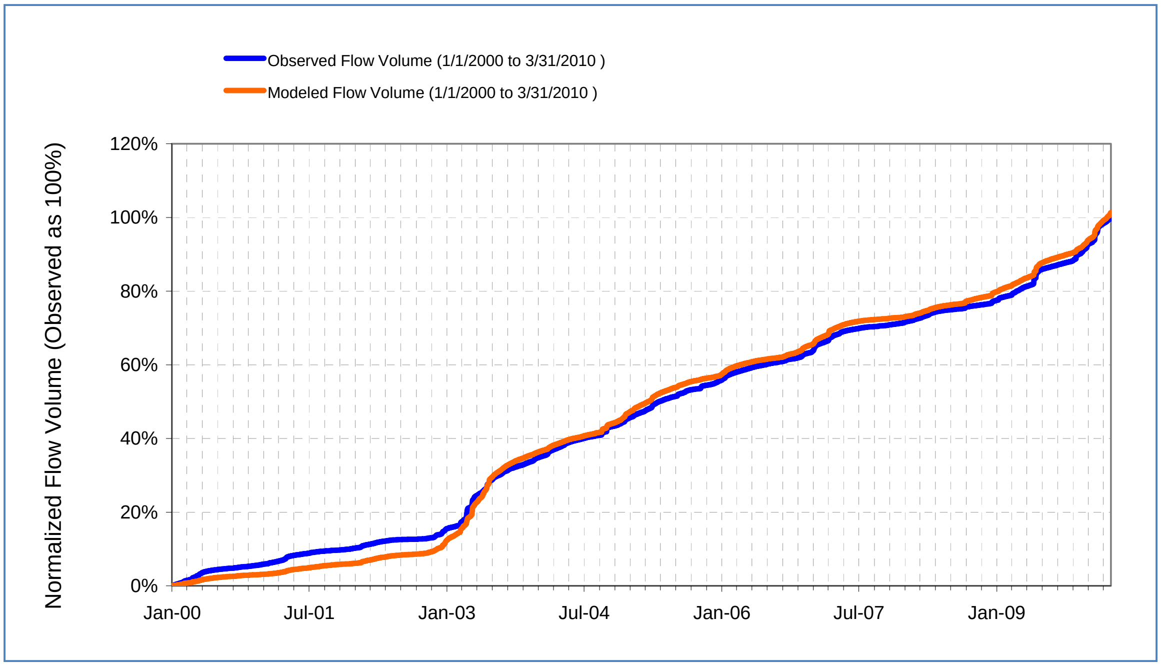

Figure E- 28. Flow Accumulation: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

Table E- 8. Summary Statistics: Model DSN 103 vs. USGS 02118000 South Yadkin River near Mocksville, NC

HSPF Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM DSN 103 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area At run 27		USGS 02118000 SOUTH YADKIN RIVER NEAR MOCKSVILLE, NC Hydrologic Unit Code: 3040102 Latitude: 35.845 Longitude: -80.65888889 Drainage Area (sq-mi): 306		
Total Simulated In-stream Flow:	**12.04**	Total Observed In-stream Flow:		**11.87**
Total of simulated highest 10% flows:	**4.90**	Total of Observed highest 10% flows:		**5.02**
Total of Simulated lowest 50% flows:	**2.07**	Total of Observed Lowest 50% flows:		**2.21**
Simulated Summer Flow Volume (months 7-9):	**1.95**	Observed Summer Flow Volume (7-9):		**1.76**
Simulated Fall Flow Volume (months 10-12):	**2.59**	Observed Fall Flow Volume (10-12):		**2.58**
Simulated Winter Flow Volume (months 1-3):	**4.20**	Observed Winter Flow Volume (1-3):		**4.37**
Simulated Spring Flow Volume (months 4-6):	**3.30**	Observed Spring Flow Volume (4-6):		**3.16**
Total Simulated Storm Volume:	**3.90**	Total Observed Storm Volume:		**4.51**
Simulated Summer Storm Volume (7-9):	**0.56**	Observed Summer Storm Volume (7-9):		**0.67**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	1.38	10		
Error in 50% lowest flows:	-6.07	10		
Error in 10% highest flows:	-2.43	15		
Seasonal volume error - Summer:	11.23	30		
Seasonal volume error - Fall:	0.20	30		
Seasonal volume error - Winter:	-4.06	30		
Seasonal volume error - Spring:	4.39	30		
Error in storm volumes:	-13.41	20		
Error in summer storm volumes:	-15.49	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.716	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.518	as E or E' approaches 1.0		

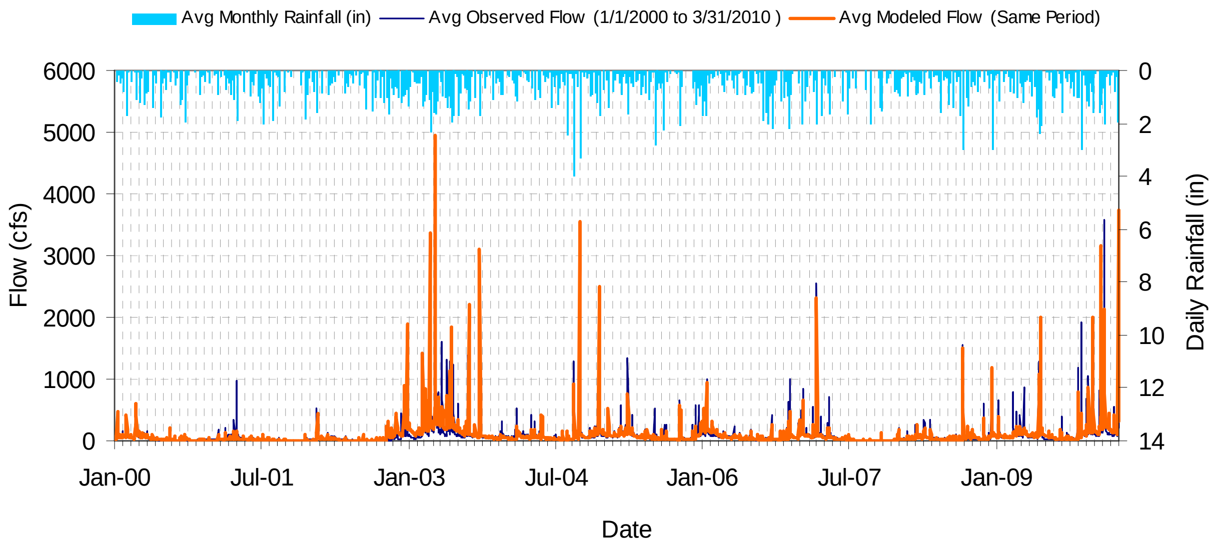

Figure E- 29. Mean Daily Flow: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

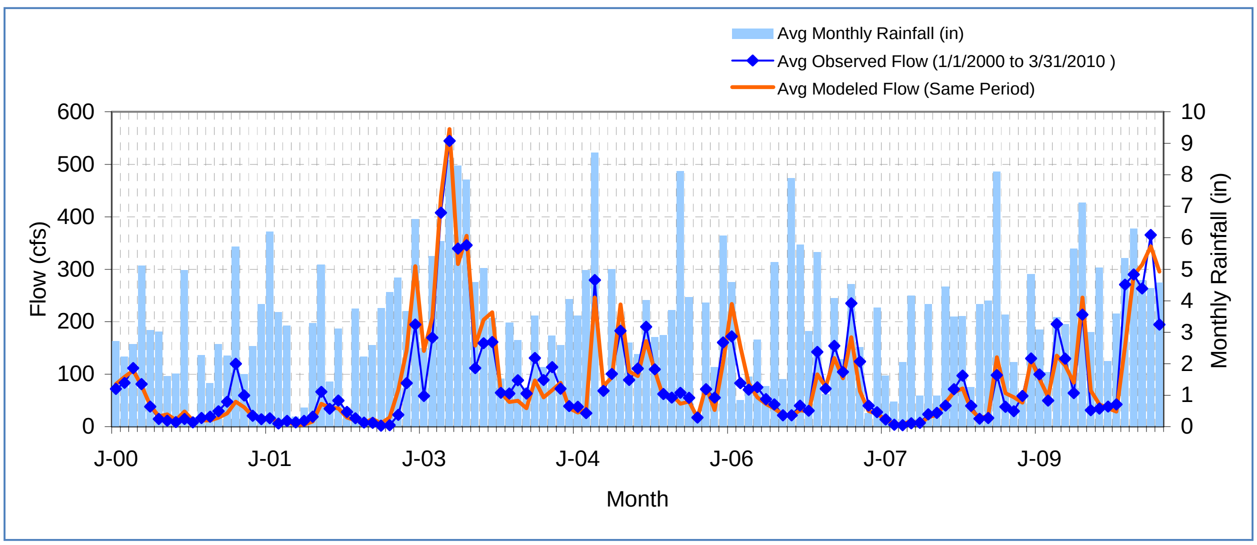

Figure E- 30. Mean Monthly Flow: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

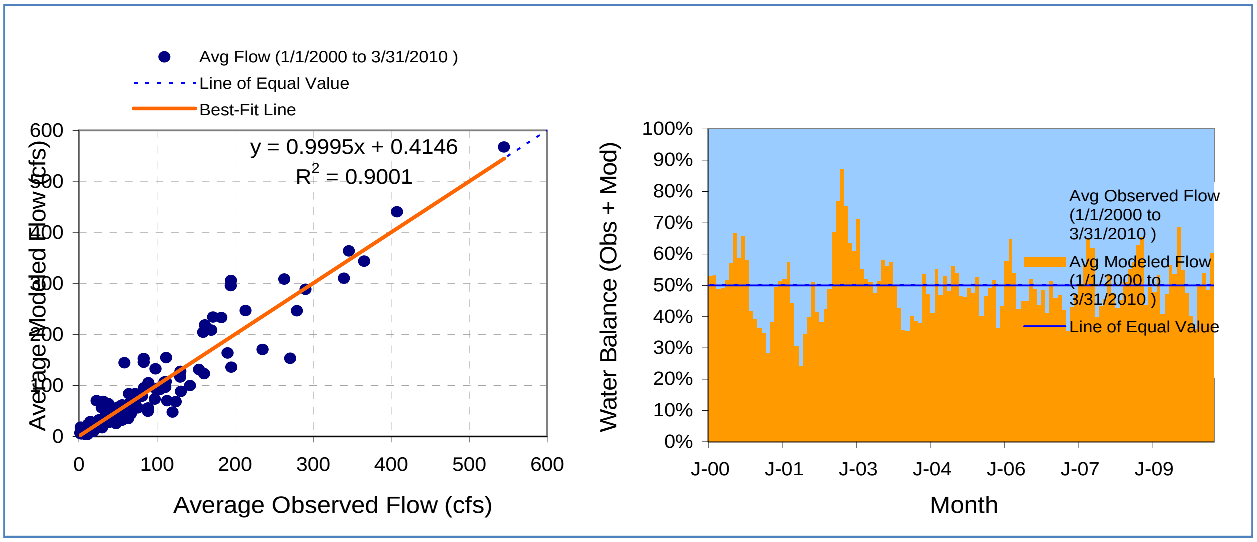

Figure E- 31. Monthly Flow Regression and Temporal Variation: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

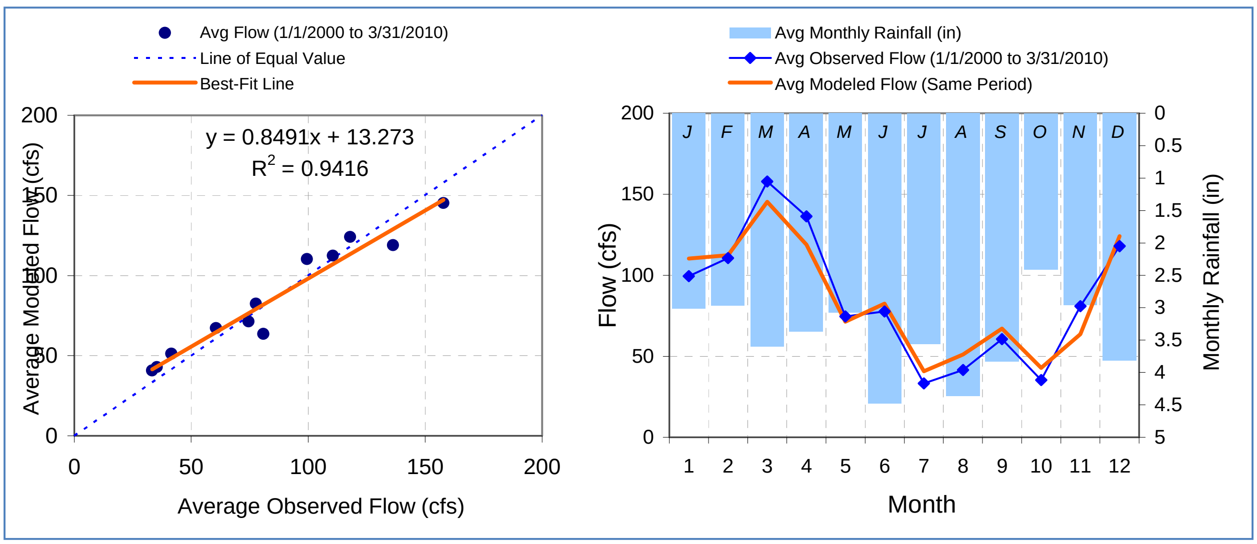

Figure E- 32. Seasonal Regression and Temporal Aggregate: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

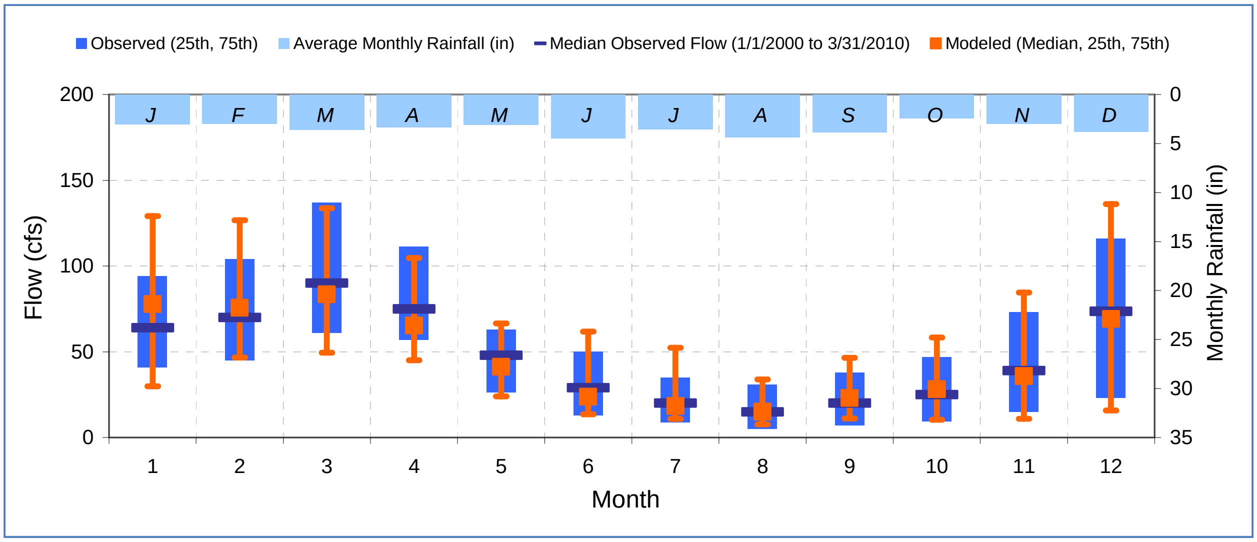

Figure E- 33. Seasonal Medians and Ranges: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

Table E- 9. Seasonal Summary: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	99.48	64.00	41.00	94.00	110.27	77.88	29.88	129.12
Feb	110.61	70.00	45.00	104.00	112.38	75.62	46.67	126.68
Mar	157.81	90.00	61.00	137.00	145.32	83.50	49.47	133.78
Apr	136.27	75.00	57.00	111.50	118.92	65.35	45.15	104.67
May	74.57	48.00	26.25	63.00	71.33	41.21	24.10	66.55
Jun	77.65	29.00	13.00	50.00	82.45	23.79	13.54	61.80
Jul	33.27	20.00	8.83	35.00	40.74	18.29	10.85	52.29
Aug	41.56	15.00	5.10	31.00	51.22	15.07	7.64	33.86
Sep	60.61	20.00	7.08	38.00	67.16	23.09	11.16	46.51
Oct	35.29	25.00	9.45	47.00	42.88	28.16	10.33	58.28
Nov	80.89	39.00	15.00	73.00	63.64	35.87	10.98	84.47
Dec	118.01	73.50	23.00	115.75	124.18	69.14	15.73	136.11

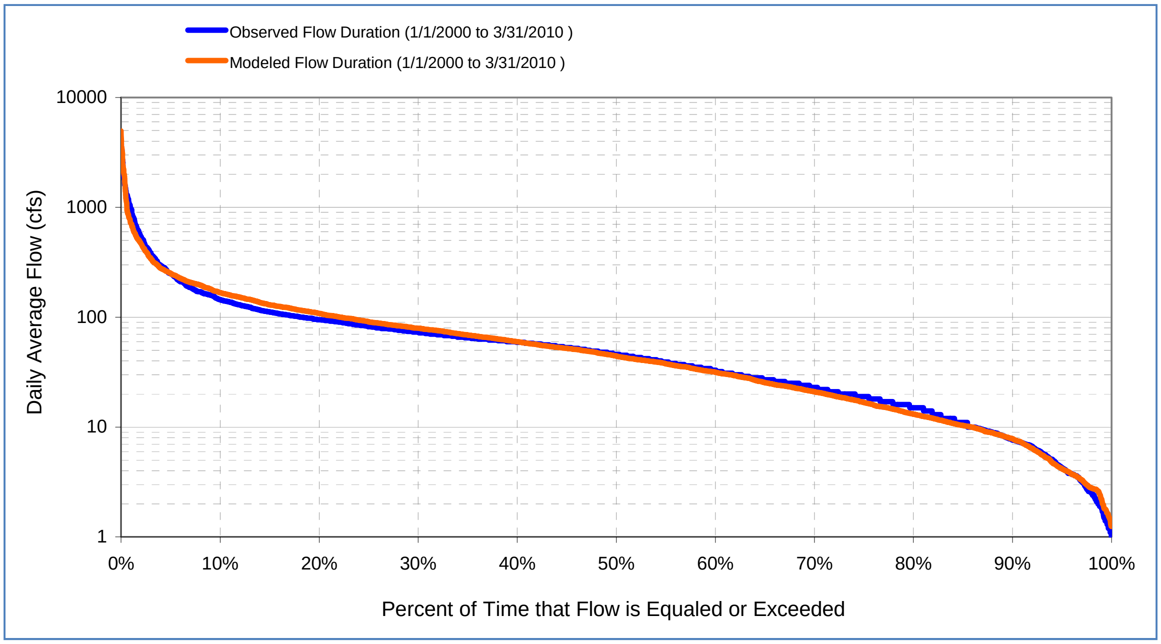

Figure E- 34. Flow Exceedence: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

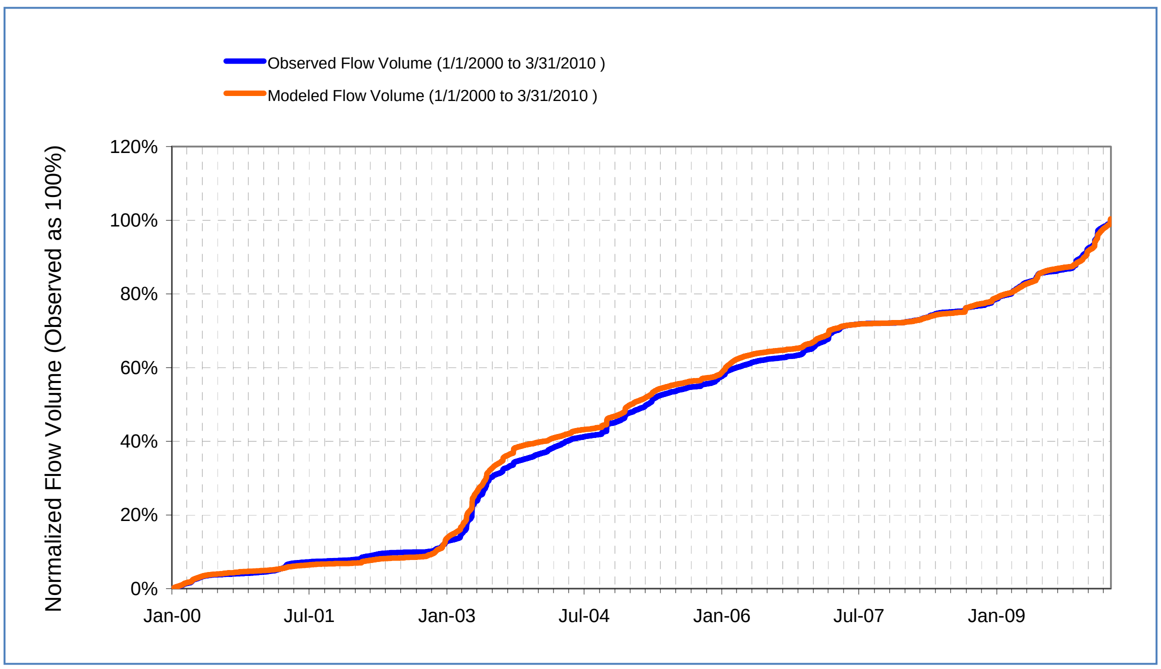

Figure E- 35. Flow Accumulation: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

Table E- 10. Summary Statistics: Model DSN 107 vs. USGS 02120780 Second Creek near Barber, NC

HSPF Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM DSN 107 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 02120780 SECOND CREEK NEAR BARBER, NC Hydrologic Unit Code: 3040102 Latitude: 35.71777778 Longitude: -80.5958333 Drainage Area (sq-mi): 118	
Total Simulated In-stream Flow:	**9.97**	Total Observed In-stream Flow:	**9.92**
Total of simulated highest 10% flows:	**4.89**	Total of Observed highest 10% flows:	**5.12**
Total of Simulated lowest 50% flows:	**1.10**	Total of Observed Lowest 50% flows:	**1.16**
Simulated Summer Flow Volume (months 7-9):	**1.50**	Observed Summer Flow Volume (7-9):	**1.27**
Simulated Fall Flow Volume (months 10-12):	**2.18**	Observed Fall Flow Volume (10-12):	**2.21**
Simulated Winter Flow Volume (months 1-3):	**3.76**	Observed Winter Flow Volume (1-3):	**3.76**
Simulated Spring Flow Volume (months 4-6):	**2.54**	Observed Spring Flow Volume (4-6):	**2.68**
Total Simulated Storm Volume:	**3.73**	Total Observed Storm Volume:	**4.33**
Simulated Summer Storm Volume (7-9):	**0.75**	Observed Summer Storm Volume (7-9):	**0.67**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	0.48	10		
Error in 50% lowest flows:	-5.62	10		
Error in 10% highest flows:	-4.65	15		
Seasonal volume error - Summer:	17.58	30		
Seasonal volume error - Fall:	-1.27	30		
Seasonal volume error - Winter:	-0.02	30		
Seasonal volume error - Spring:	-5.46	30		
Error in storm volumes:	-13.73	20		
Error in summer storm volumes:	11.56	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.722	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.538	as E or E' approaches 1.0		

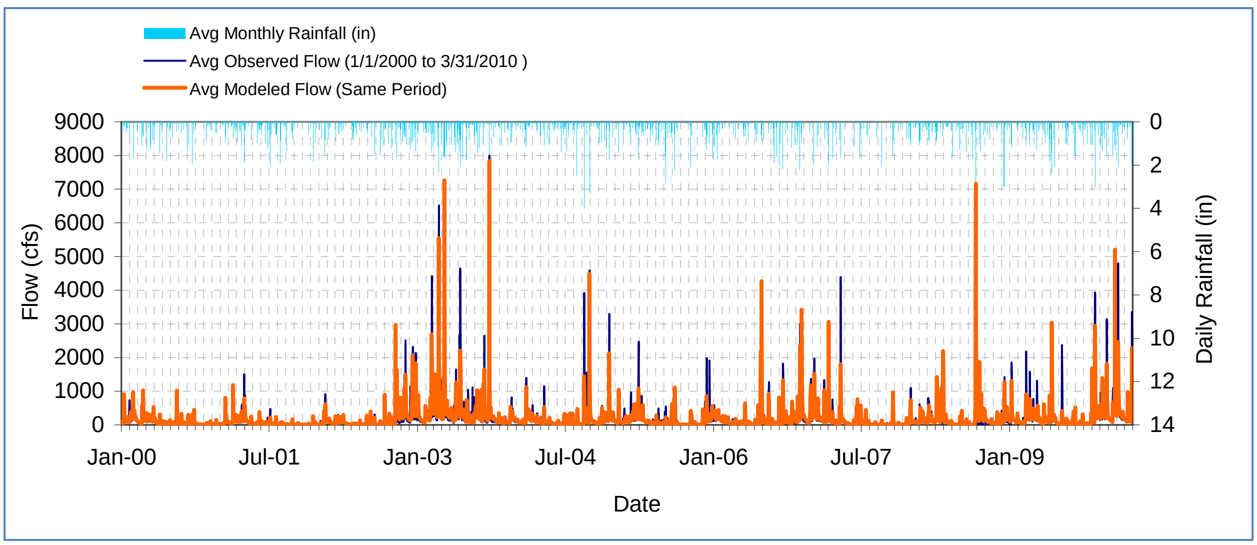

Figure E- 36. Mean Daily Flow: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

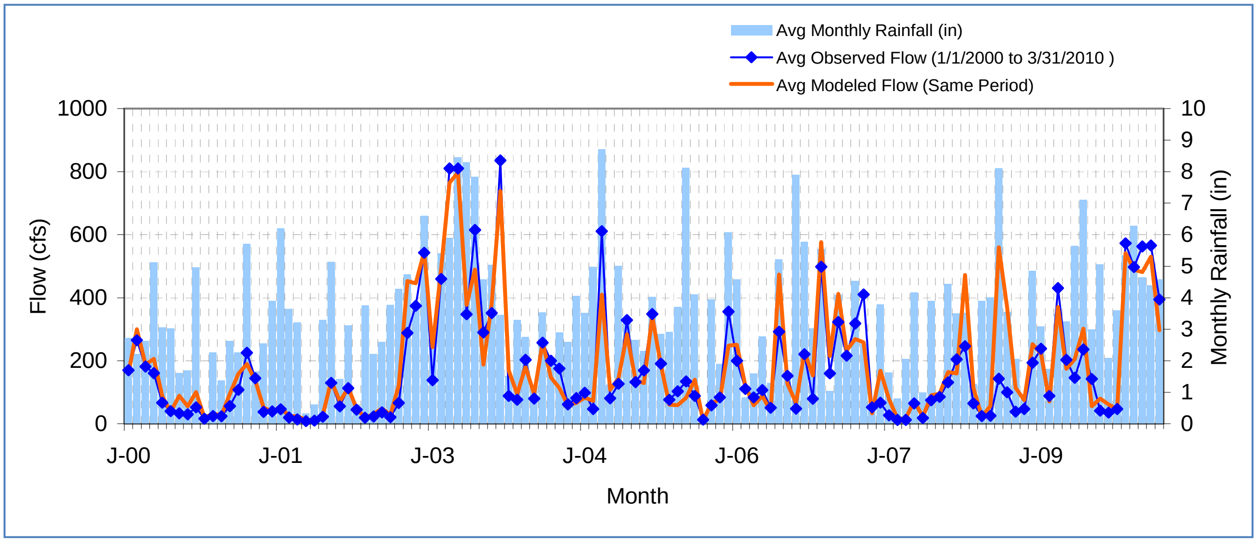

Figure E- 37. Mean Monthly Flow: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

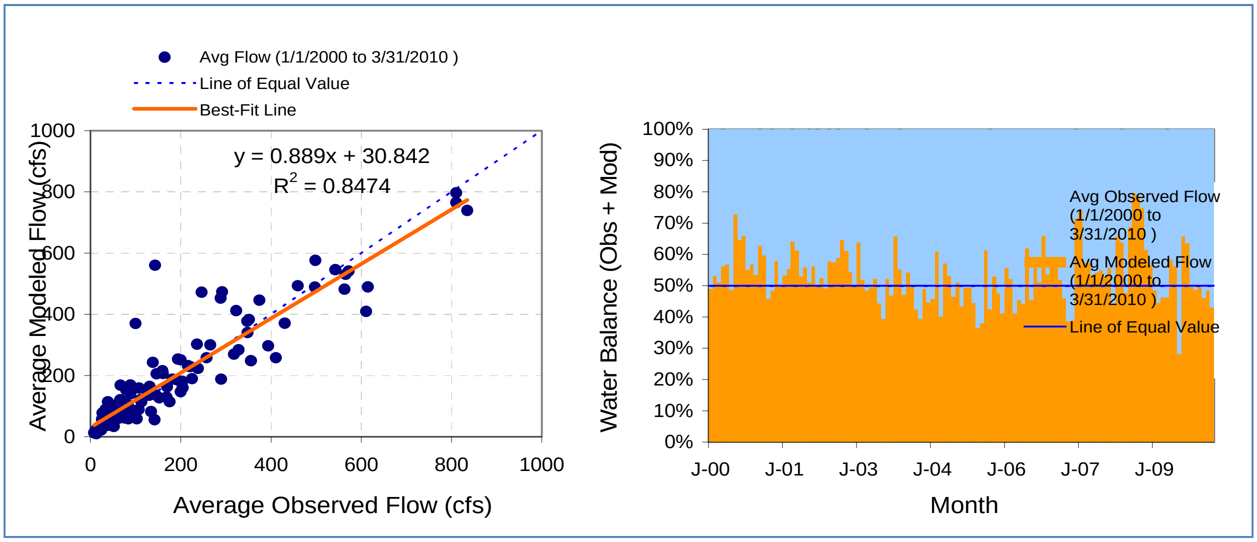

Figure E- 38. Monthly Flow Regression and Temporal Variation: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

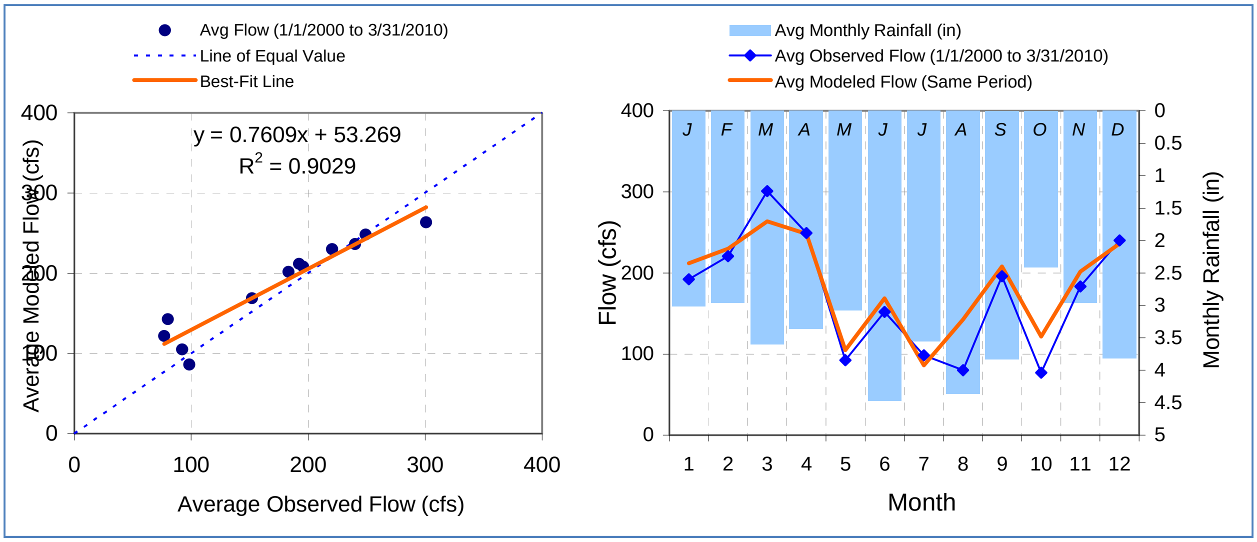

Figure E- 39. Seasonal Regression and Temporal Aggregate: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

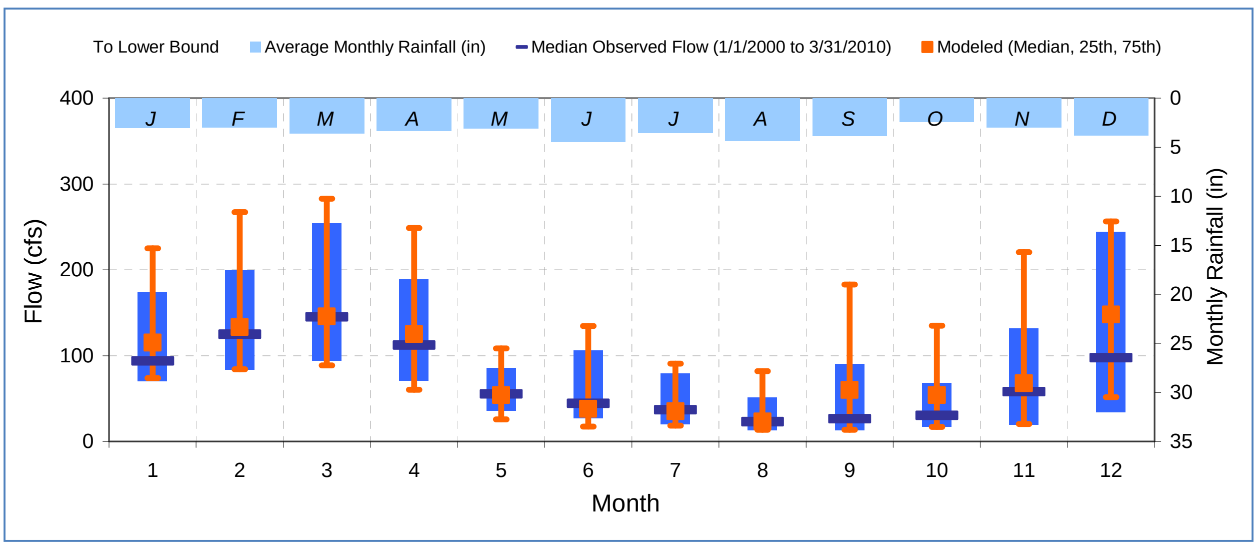

Figure E- 40. Seasonal Medians and Ranges: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

Table E- 11. Seasonal Summary: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	192.24	94.00	70.00	174.00	211.84	115.33	73.93	224.91
Feb	220.50	125.00	83.50	200.00	229.93	133.39	84.13	267.17
Mar	300.90	145.00	94.00	254.00	263.57	145.60	88.80	282.82
Apr	249.33	112.50	70.75	188.50	248.28	125.10	60.29	248.58
May	92.27	55.50	36.25	85.75	104.82	54.07	25.95	108.44
Jun	151.96	44.50	27.00	106.25	168.82	37.99	17.43	134.70
Jul	98.51	37.00	20.00	79.00	85.97	35.27	18.51	90.76
Aug	80.19	23.00	13.00	51.50	142.67	23.24	13.57	81.85
Sep	195.95	26.50	13.00	90.25	208.06	60.04	13.69	183.05
Oct	76.98	30.50	17.00	68.00	121.60	53.92	16.97	134.77
Nov	183.21	58.00	20.00	132.00	201.75	67.90	20.43	220.43
Dec	240.19	97.50	34.25	244.50	236.25	147.90	51.82	256.34

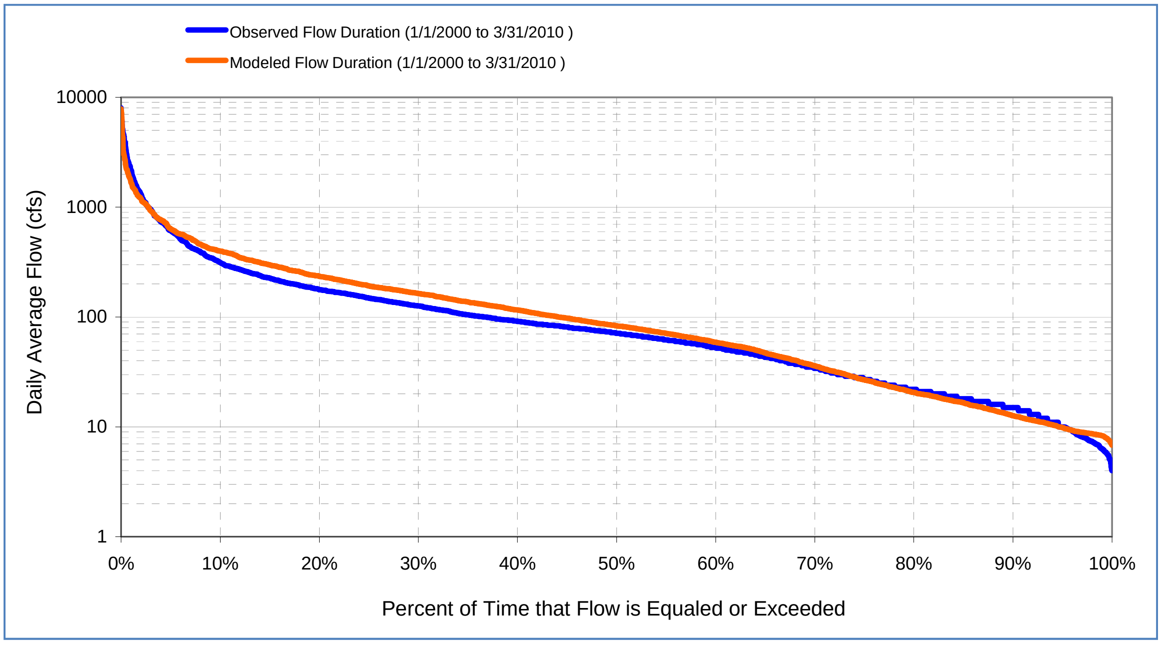

Figure E- 41. Flow Exceedence: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

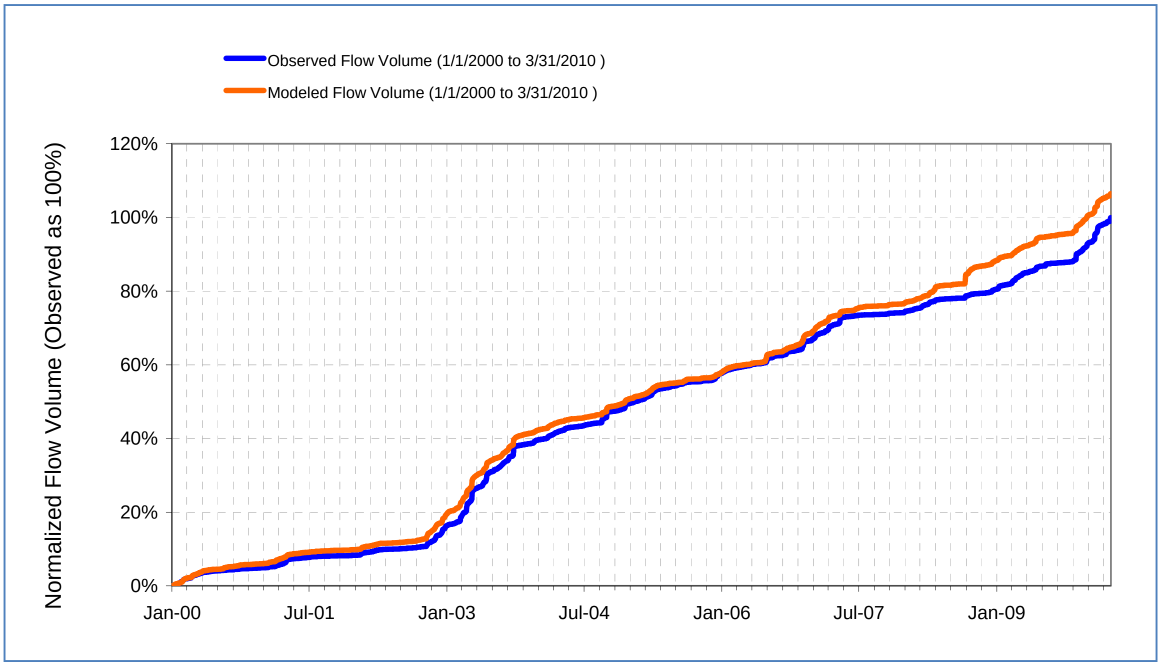

Figure E- 42. Flow Accumulation: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

Table E- 12. Summary Statistics: Model DSN 108 vs. USGS 02121500 Abbotts Creek at Lexington, NC

HSPF Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM DSN 108 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		**USGS 02121500 ABBOTTS CREEK AT LEXINGTON, NC** Hydrologic Unit Code: 3040103 Latitude: 35.80694444 Longitude: -80.2347222 Drainage Area (sq-mi): 174		
Total Simulated In-stream Flow:	**14.52**	Total Observed In-stream Flow:		**13.62**
Total of simulated highest 10% flows:	**7.43**	Total of Observed highest 10% flows:		**7.93**
Total of Simulated lowest 50% flows:	**1.35**	Total of Observed Lowest 50% flows:		**1.26**
Simulated Summer Flow Volume (months 7-9):	**2.78**	Observed Summer Flow Volume (7-9):		**2.38**
Simulated Fall Flow Volume (months 10-12):	**3.58**	Observed Fall Flow Volume (10-12):		**3.20**
Simulated Winter Flow Volume (months 1-3):	**4.87**	Observed Winter Flow Volume (1-3):		**4.94**
Simulated Spring Flow Volume (months 4-6):	**3.29**	Observed Spring Flow Volume (4-6):		**3.11**
Total Simulated Storm Volume:	**7.26**	Total Observed Storm Volume:		**7.57**
Simulated Summer Storm Volume (7-9):	**1.78**	Observed Summer Storm Volume (7-9):		**1.66**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	6.55	10		
Error in 50% lowest flows:	7.00	10		
Error in 10% highest flows:	-6.23	15		
Seasonal volume error - Summer:	16.74	30		
Seasonal volume error - Fall:	11.85	30		
Seasonal volume error - Winter:	-1.32	30		
Seasonal volume error - Spring:	5.79	30		
Error in storm volumes:	-4.08	20		
Error in summer storm volumes:	7.34	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.620	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.524	as E or E' approaches 1.0		

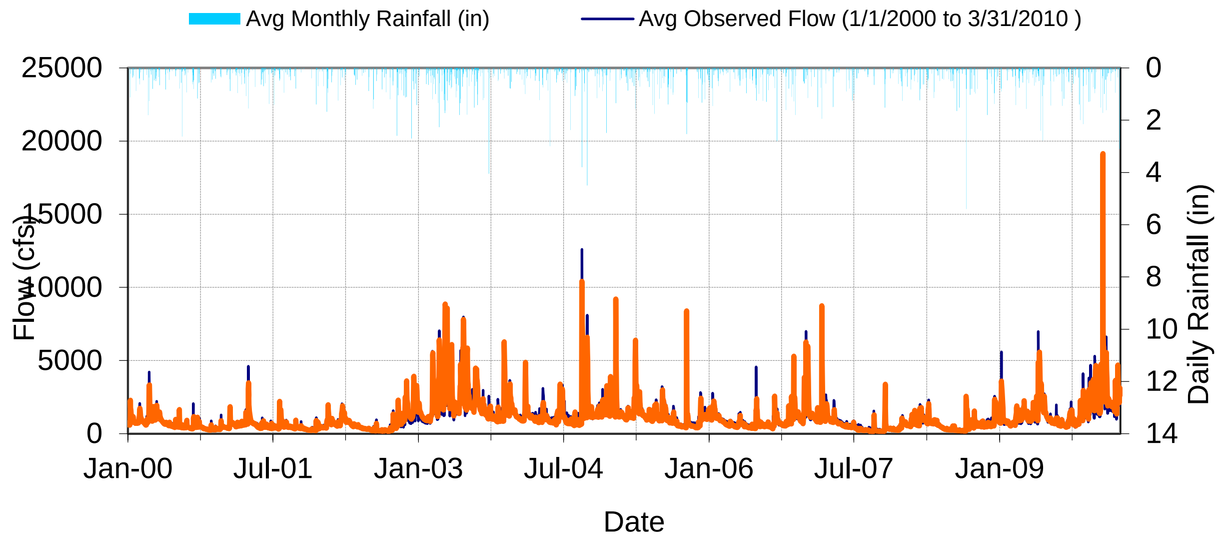

Figure E- 43. Mean Daily Flow: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

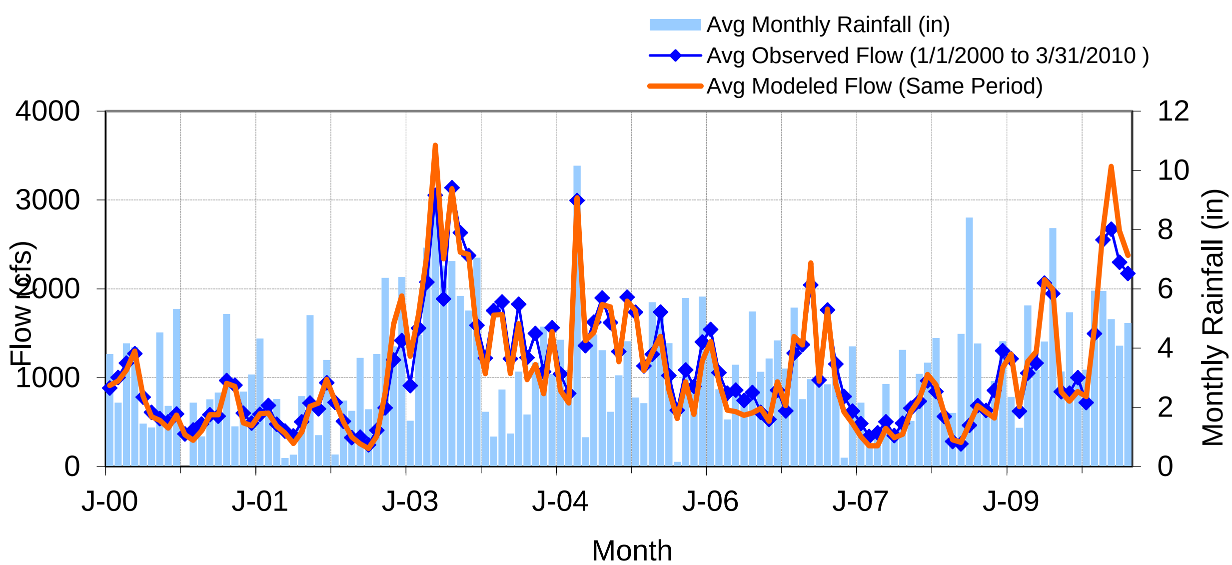

Figure E- 44. Mean Monthly Flow: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

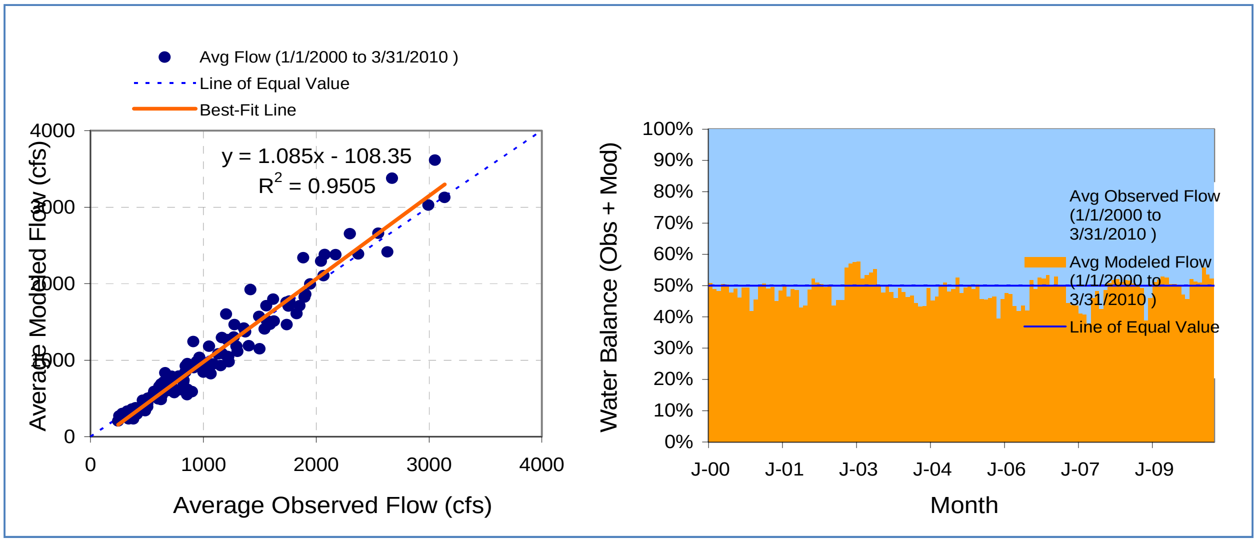

Figure E- 45. Monthly Flow Regression and Temporal Variation: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

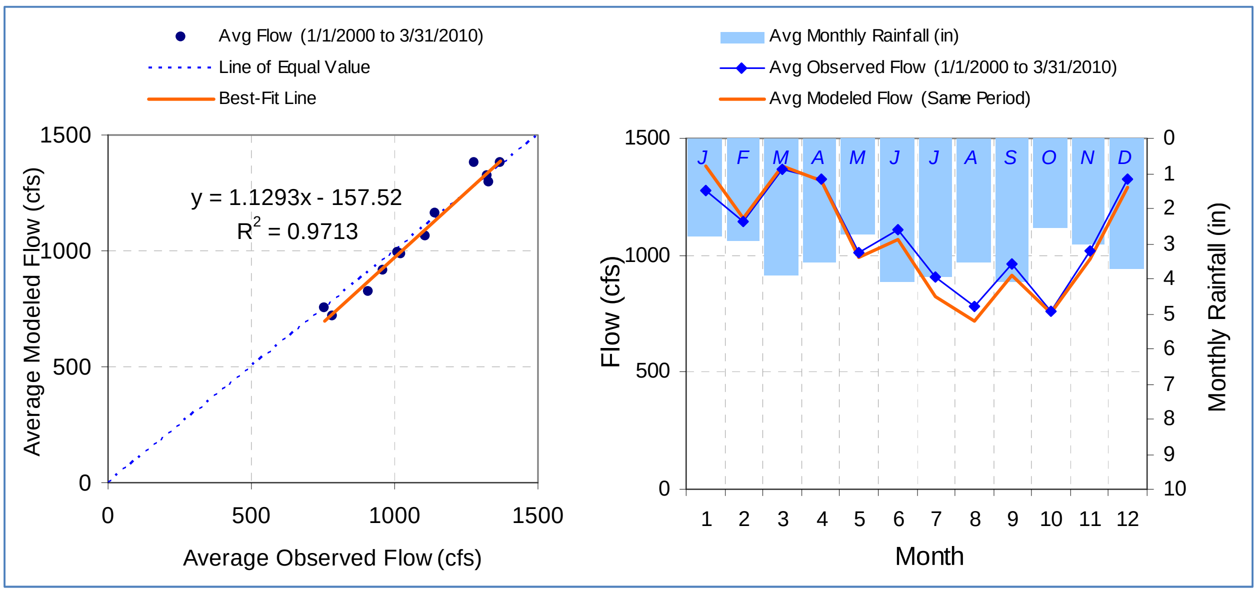

Figure E- 46. Seasonal Regression and Temporal Aggregate: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

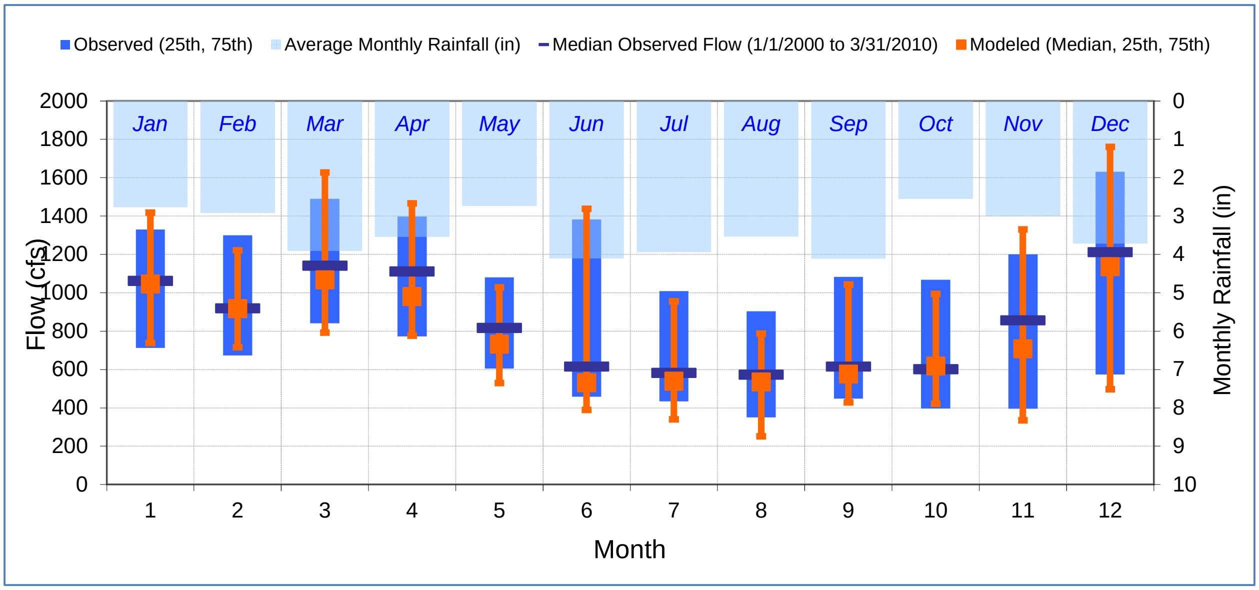

Figure E- 47. Seasonal Medians and Ranges: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

Table E- 13. Seasonal Summary: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	1277.78	1060.00	713.00	1330.00	1383.46	1045.30	737.35	1417.40
Feb	1144.86	918.00	673.50	1300.00	1158.69	916.82	716.11	1221.56
Mar	1369.41	1140.00	840.00	1490.00	1383.70	1067.61	792.06	1626.95
Apr	1322.37	1110.00	772.75	1397.50	1321.64	980.15	775.64	1466.06
May	1014.05	816.00	604.50	1080.00	990.81	732.45	529.87	1028.27
Jun	1108.08	614.00	458.50	1382.50	1065.94	530.61	388.75	1438.23
Jul	906.50	581.00	433.50	1007.50	821.44	538.68	340.62	955.24
Aug	781.99	571.50	349.75	903.25	715.46	534.69	252.22	786.06
Sep	962.18	614.00	448.00	1082.50	912.55	575.68	428.37	1042.25
Oct	758.27	600.00	396.50	1067.50	750.30	617.67	421.96	994.15
Nov	1021.92	854.50	395.75	1200.00	986.71	707.24	334.09	1329.73
Dec	1326.89	1210.00	573.00	1630.00	1293.71	1135.71	496.43	1760.91

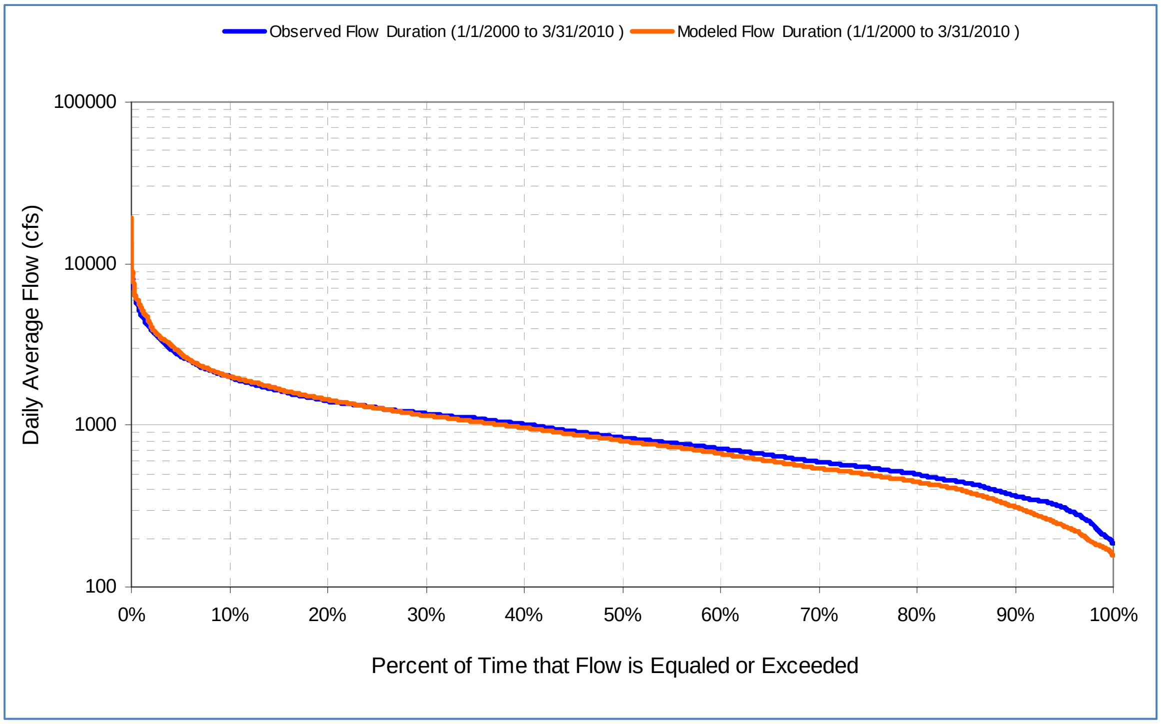

Figure E- 48. Flow Exceedence: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

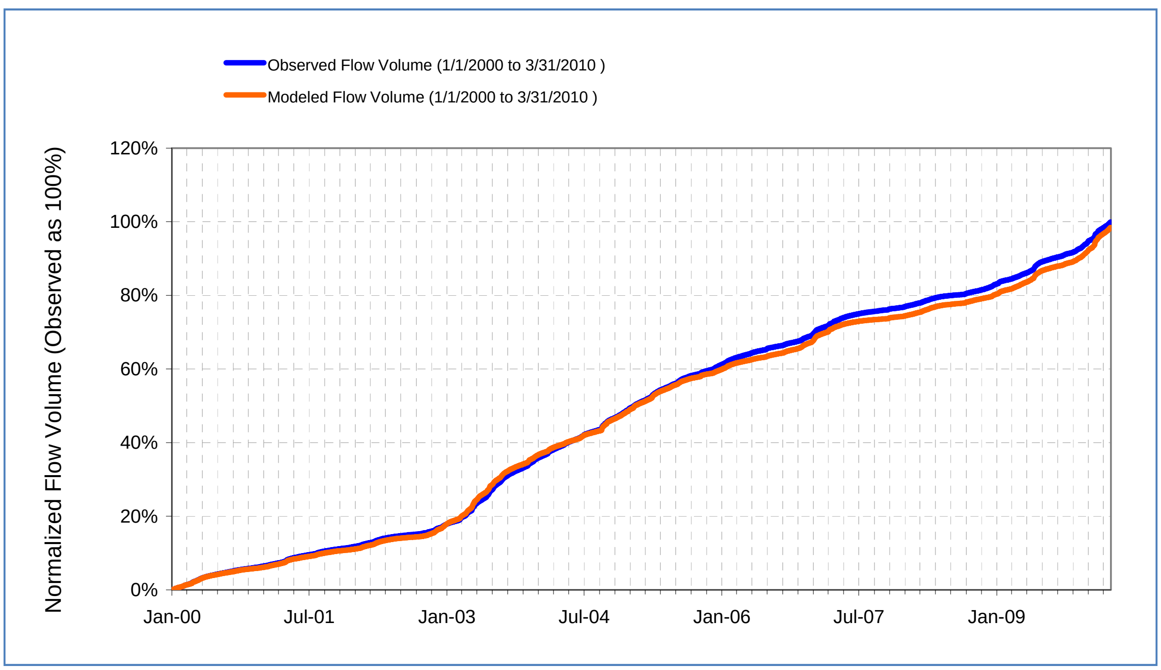

Figure E- 49. Flow Accumulation: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

Table E- 14. Summary Statistics: Model DSN 111 vs. USGS 02112250 Yadkin River at Elkin, NC

HSPF Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM DSN 111 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 02112250 YADKIN RIVER AT ELKIN, NC Hydrologic Unit Code: 3040101 Latitude: 36.2411111 Longitude: -80.8466667 Drainage Area (sq-mi): 869		
Total Simulated In-stream Flow:	**16.73**	Total Observed In-stream Flow:		**16.99**
Total of simulated highest 10% flows:	**5.23**	Total of Observed highest 10% flows:		**4.99**
Total of Simulated lowest 50% flows:	**3.84**	Total of Observed Lowest 50% flows:		**4.24**
Simulated Summer Flow Volume (months 7-9):	**3.13**	Observed Summer Flow Volume (7-9):		**3.39**
Simulated Fall Flow Volume (months 10-12):	**3.88**	Observed Fall Flow Volume (10-12):		**3.98**
Simulated Winter Flow Volume (months 1-3):	**5.45**	Observed Winter Flow Volume (1-3):		**5.26**
Simulated Spring Flow Volume (months 4-6):	**4.27**	Observed Spring Flow Volume (4-6):		**4.36**
Total Simulated Storm Volume:	**4.03**	Total Observed Storm Volume:		**4.06**
Simulated Summer Storm Volume (7-9):	**0.79**	Observed Summer Storm Volume (7-9):		**0.84**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-1.48	10		
Error in 50% lowest flows:	-9.45	10		
Error in 10% highest flows:	4.76	15		
Seasonal volume error - Summer:	-7.62	30		
Seasonal volume error - Fall:	-2.45	30		
Seasonal volume error - Winter:	3.59	30		
Seasonal volume error - Spring:	-1.92	30		
Error in storm volumes:	-0.92	20		
Error in summer storm volumes:	-6.18	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.841	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.675	as E or E' approaches 1.0		

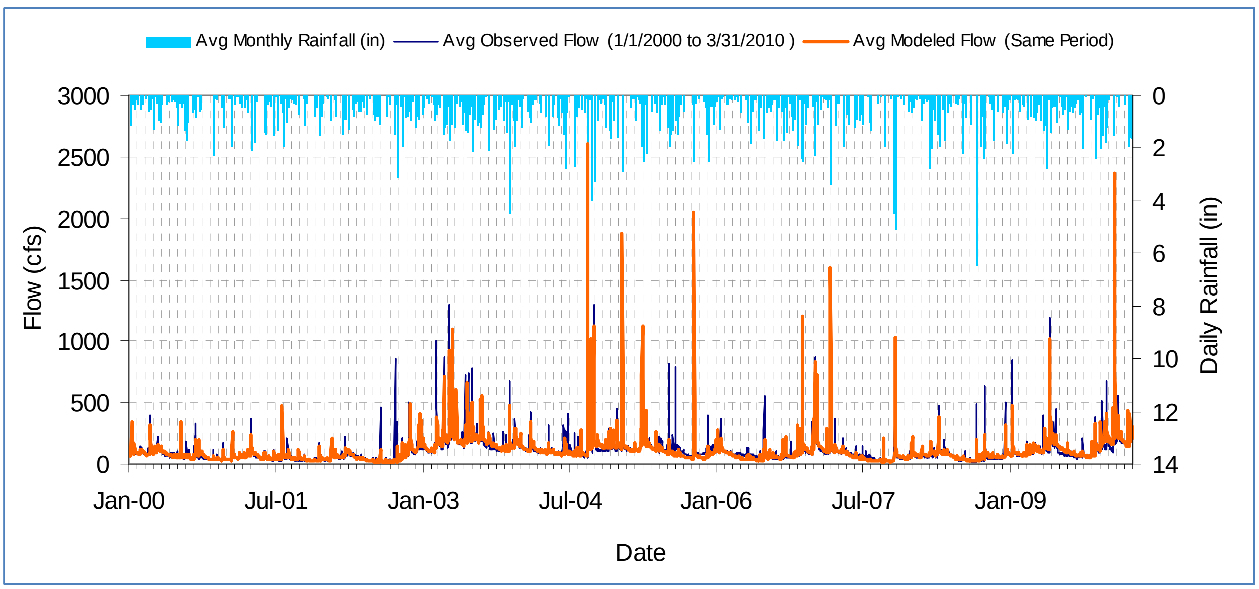

Figure E- 50. Mean Daily Flow: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

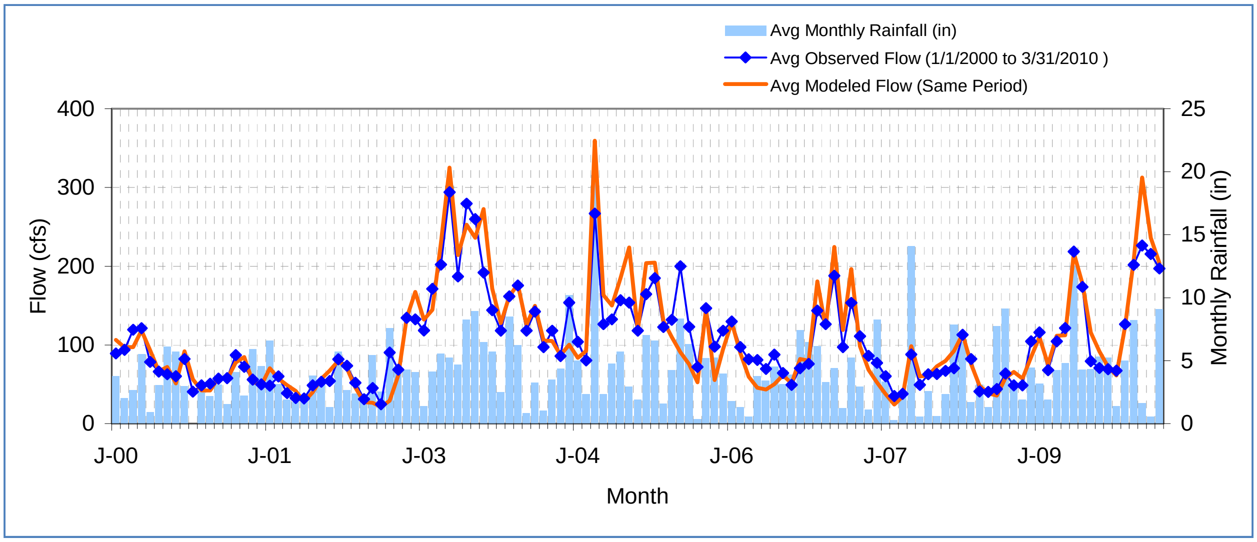

Figure E- 51. Mean Monthly Flow: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

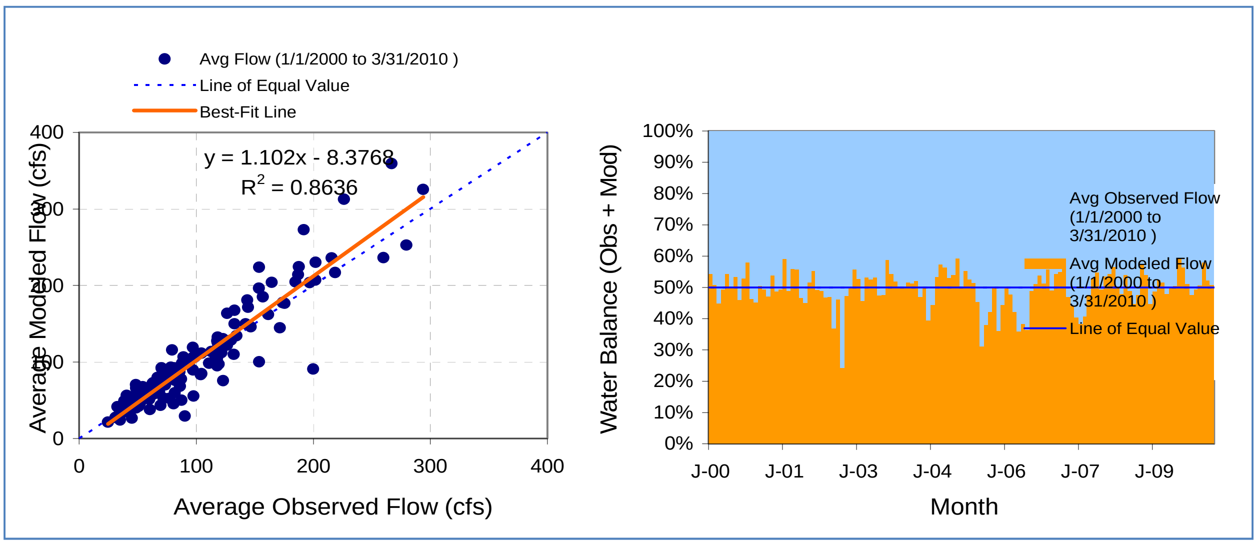

Figure E- 52. Monthly Flow Regression and Temporal Variation: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

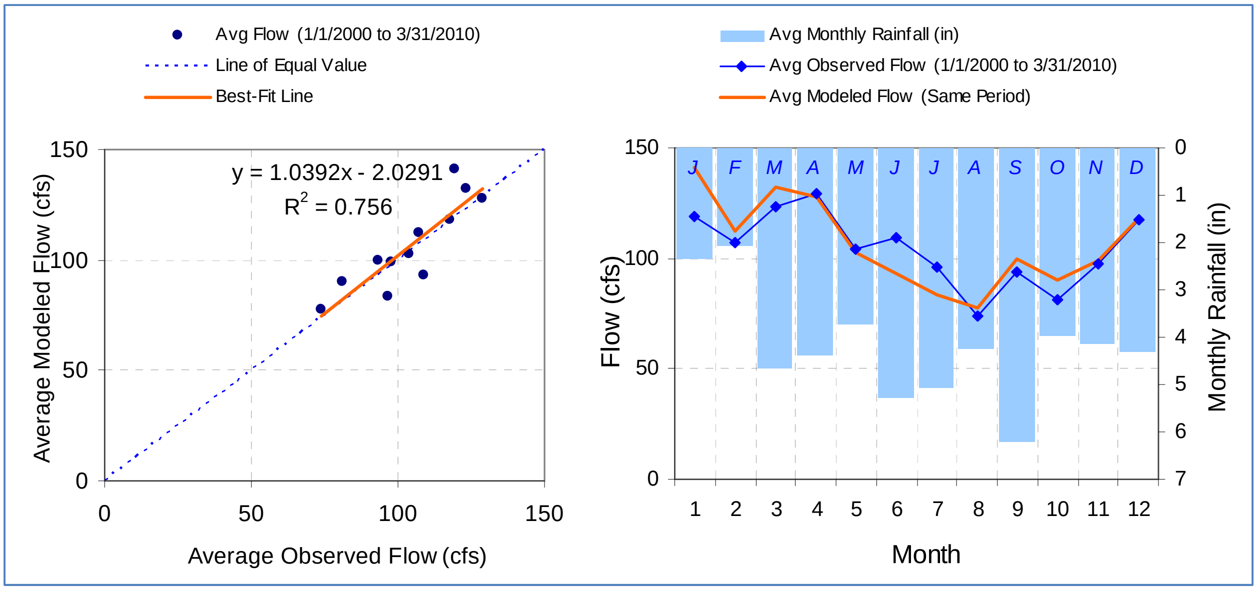

Figure E- 53. Seasonal Regression and Temporal Aggregate: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

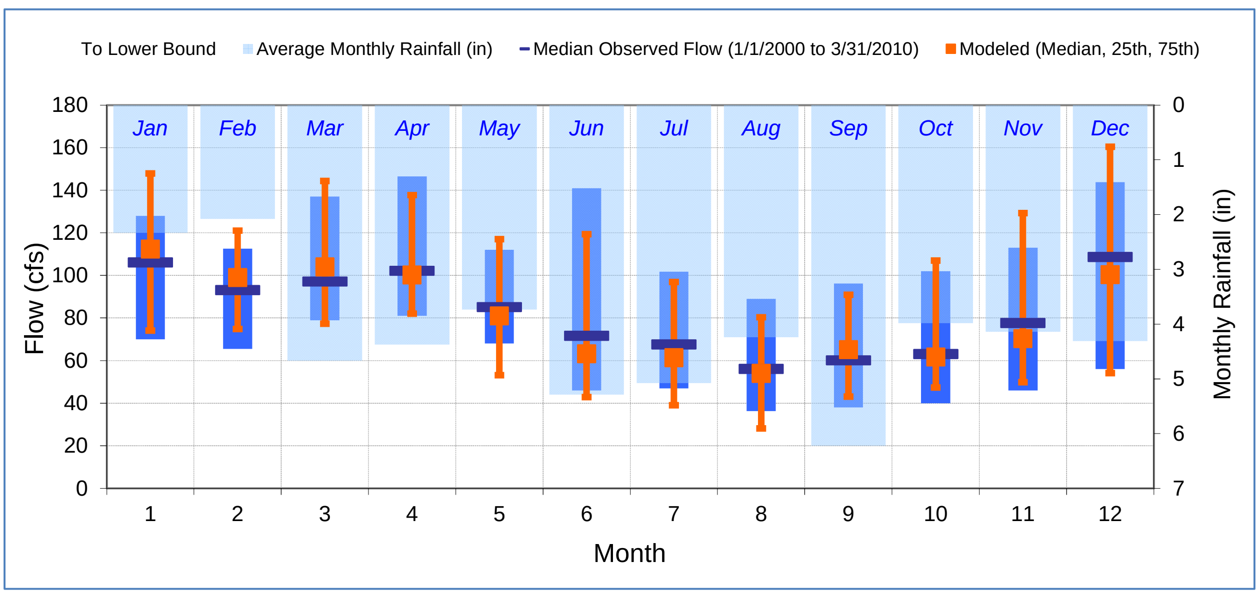

Figure E- 54. Seasonal Medians and Ranges: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

Table E- 15. Seasonal Summary: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	119.30	106.00	70.00	128.00	141.07	112.41	74.12	147.91
Feb	107.43	93.00	65.50	112.50	111.97	98.97	74.84	121.08
Mar	123.54	97.00	79.00	137.00	132.48	104.07	77.27	144.38
Apr	128.97	102.00	81.00	146.50	127.72	100.20	82.08	137.71
May	103.82	85.00	68.00	112.00	102.74	80.95	53.11	116.95
Jun	109.12	71.50	46.00	141.00	93.33	63.23	42.90	119.28
Jul	96.41	67.50	47.00	101.75	83.22	61.31	39.12	96.91
Aug	73.84	56.00	36.25	89.00	77.29	54.02	28.17	80.37
Sep	93.55	60.00	38.00	96.25	100.07	65.15	43.08	90.87
Oct	81.26	63.00	40.00	102.00	90.10	61.77	47.34	106.92
Nov	97.51	77.50	46.00	113.00	99.29	70.26	49.80	129.29
Dec	117.77	108.50	56.00	143.75	118.07	100.39	54.09	160.38

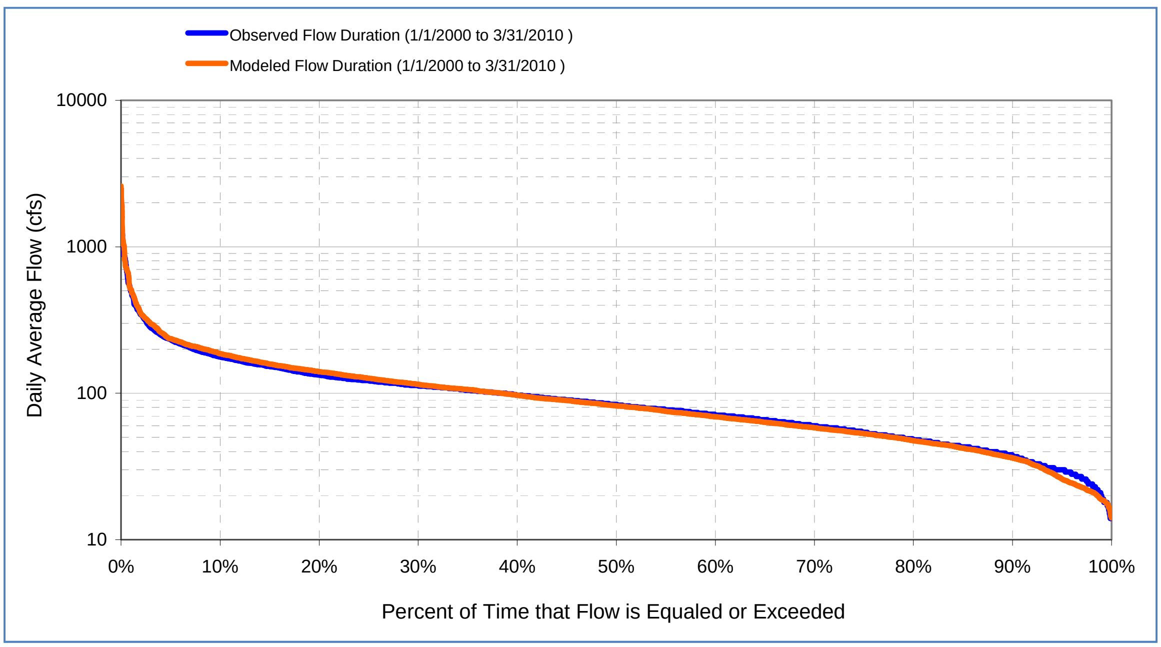

Figure E- 55. Flow Exceedence: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

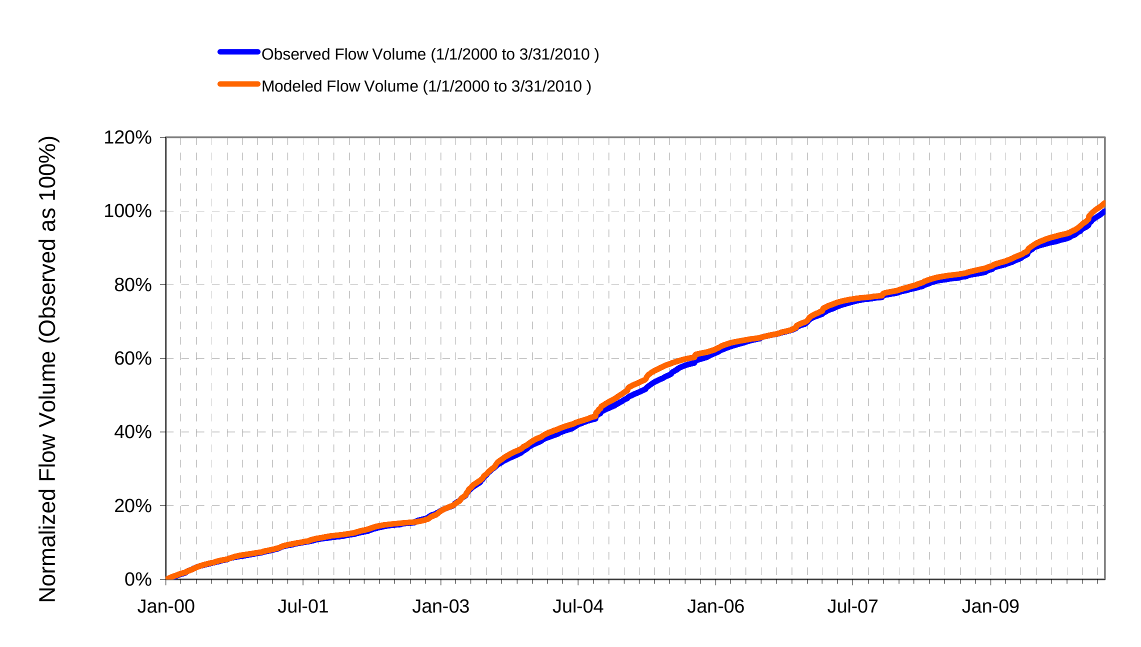

Figure E- 56. Flow Accumulation: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

Table E- 16. Summary Statistics: Model DSN 109 vs. USGS 02112360 Mitchell River near State Road, NC

HSPF Simulated Flow		**Observed Flow Gage**	
REACH OUTFLOW FROM DSN 109 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		**USGS 02112360 MITCHELL RIVER NEAR STATE ROAD, NC** Hydrologic Unit Code: 3040101 Latitude: 36.31138889 Longitude: -80.8072222 Drainage Area (sq-mi): 78.8	
Total Simulated In-stream Flow:	**18.44**	Total Observed In-stream Flow:	**18.04**
Total of simulated highest 10% flows:	**5.63**	Total of Observed highest 10% flows:	**5.30**
Total of Simulated lowest 50% flows:	**4.50**	Total of Observed Lowest 50% flows:	**4.64**
Simulated Summer Flow Volume (months 7-9):	**3.67**	Observed Summer Flow Volume (7-9):	**3.72**
Simulated Fall Flow Volume (months 10-12):	**4.34**	Observed Fall Flow Volume (10-12):	**4.19**
Simulated Winter Flow Volume (months 1-3):	**5.90**	Observed Winter Flow Volume (1-3):	**5.35**
Simulated Spring Flow Volume (months 4-6):	**4.52**	Observed Spring Flow Volume (4-6):	**4.77**
Total Simulated Storm Volume:	**3.48**	Total Observed Storm Volume:	**3.68**
Simulated Summer Storm Volume (7-9):	**0.77**	Observed Summer Storm Volume (7-9):	**0.95**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	2.23	10	
Error in 50% lowest flows:	-3.03	10	
Error in 10% highest flows:	6.37	15	
Seasonal volume error - Summer:	-1.32	30	
Seasonal volume error - Fall:	3.70	30	
Seasonal volume error - Winter:	10.22	30	
Seasonal volume error - Spring:	-5.26	30	
Error in storm volumes:	-5.41	20	
Error in summer storm volumes:	-18.45	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.574	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.497	as E or E' approaches 1.0	

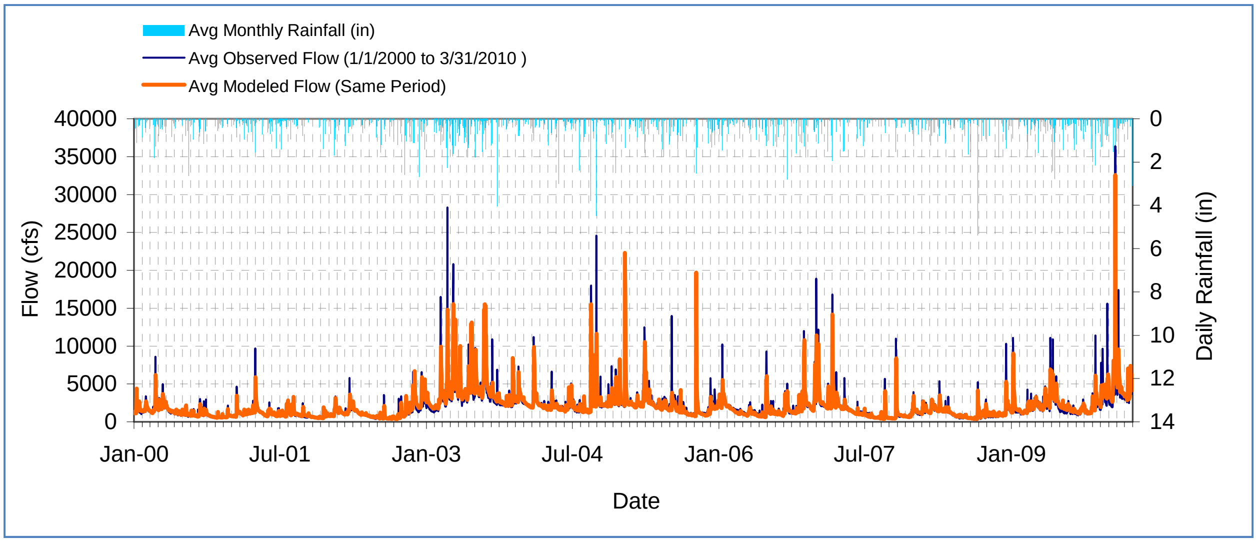

Figure E- 57. Mean Daily Flow: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

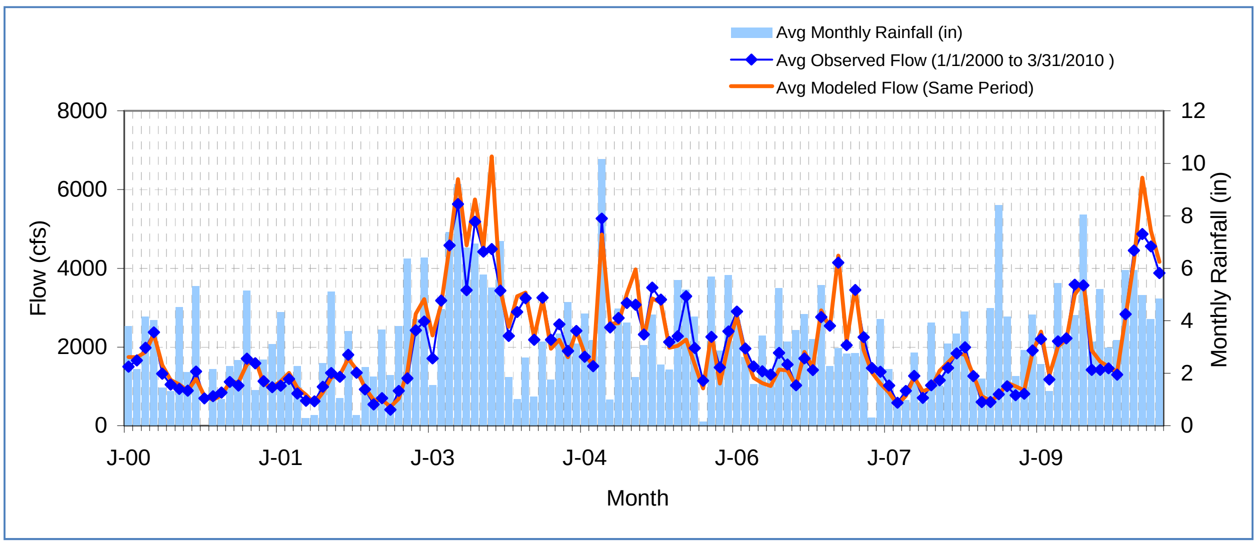

Figure E- 58. Mean Monthly Flow: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

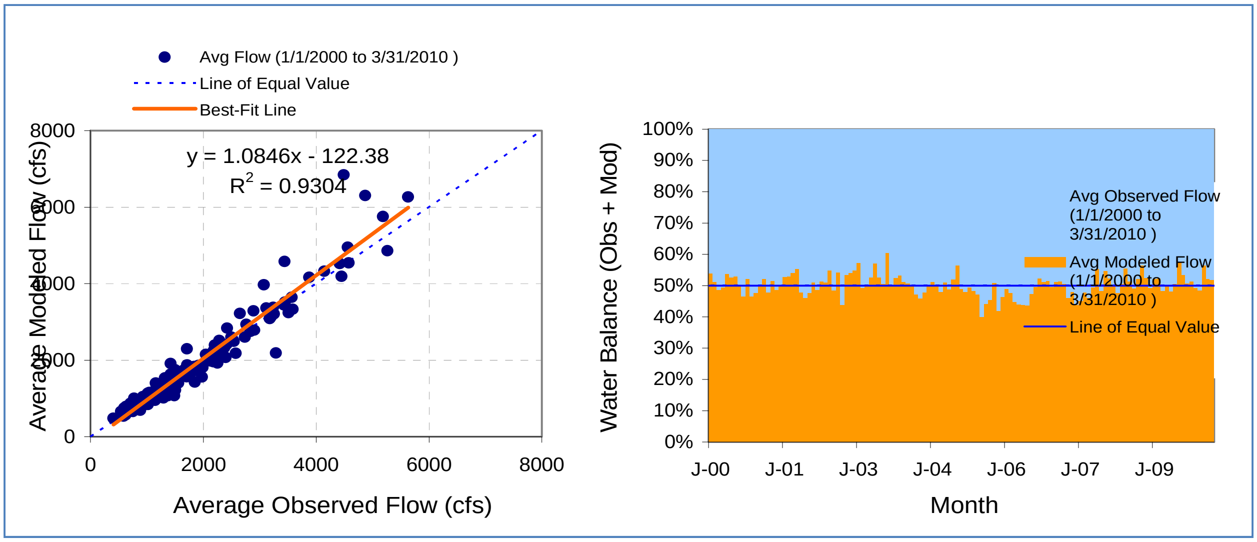

Figure E- 59. Monthly Flow Regression and Temporal Variation: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

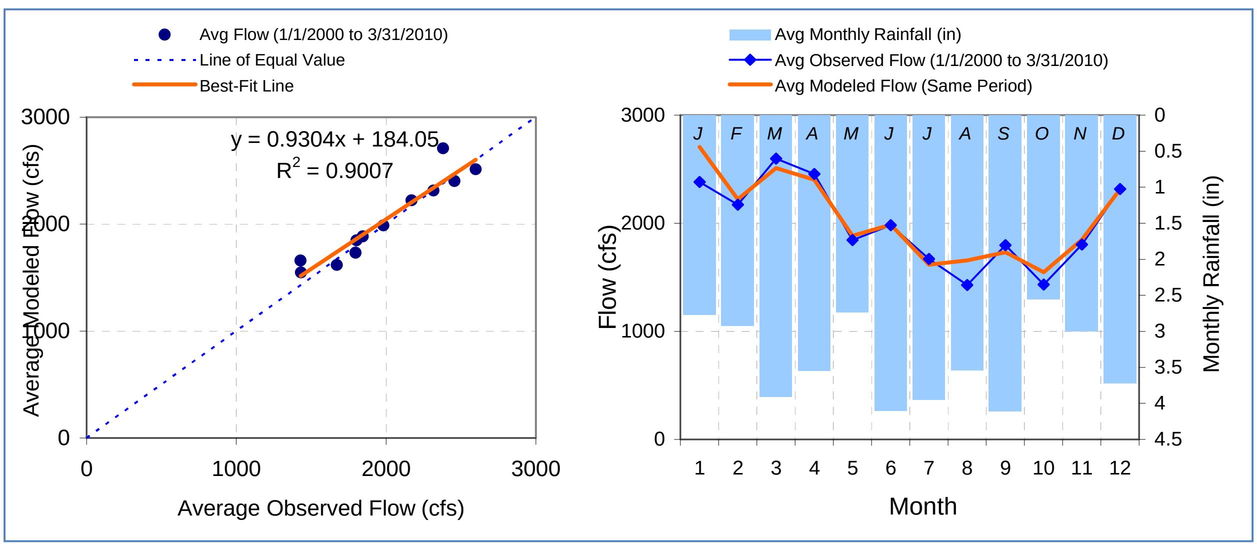

Figure E- 60. Seasonal Regression and Temporal Aggregate: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

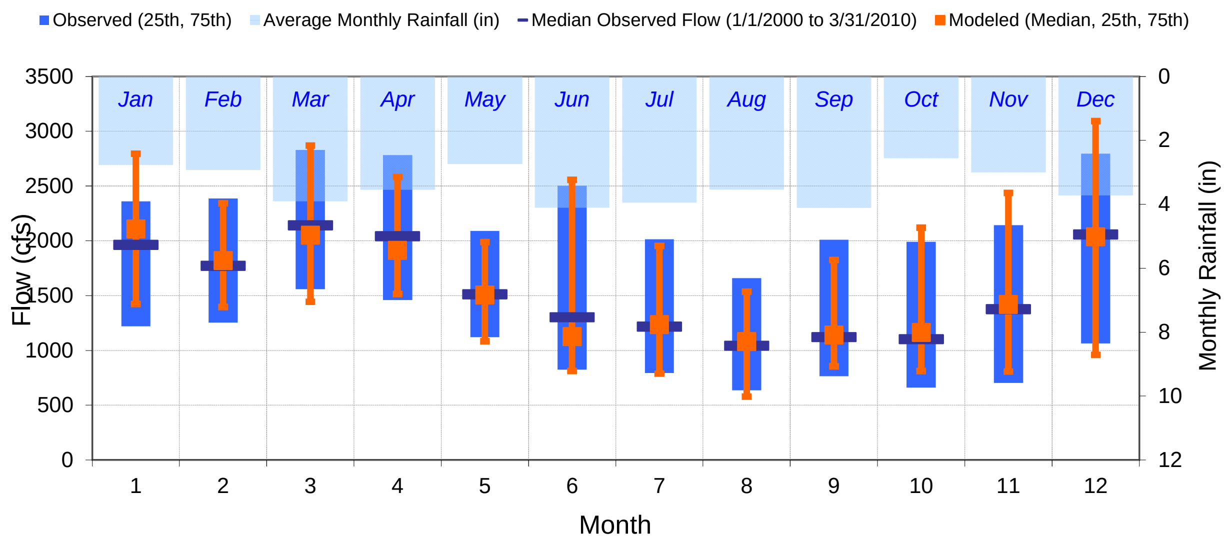

Figure E- 61. Seasonal Medians and Ranges: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

Table E- 17. Seasonal Summary: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	2381.14	1960.00	1220.00	2360.00	2707.33	2108.88	1423.51	2794.60
Feb	2170.58	1770.00	1255.00	2385.00	2221.07	1821.13	1395.03	2341.18
Mar	2597.89	2140.00	1560.00	2830.00	2510.94	2050.93	1443.35	2868.01
Apr	2455.87	2040.00	1460.00	2782.50	2401.56	1912.78	1514.18	2582.16
May	1844.41	1510.00	1120.00	2090.00	1884.19	1505.62	1082.83	1988.70
Jun	1981.91	1300.00	824.25	2502.50	1986.58	1125.67	811.68	2555.45
Jul	1670.59	1215.00	794.75	2015.00	1617.09	1235.87	788.14	1954.43
Aug	1429.63	1040.00	636.75	1660.00	1657.99	1081.33	577.45	1537.14
Sep	1796.96	1120.00	764.75	2010.00	1732.03	1140.13	855.44	1825.13
Oct	1432.36	1100.00	661.25	1990.00	1545.92	1163.92	811.82	2119.11
Nov	1802.85	1375.00	702.75	2142.50	1848.43	1420.20	806.75	2438.09
Dec	2316.40	2055.00	1062.50	2795.00	2314.14	2036.03	960.41	3091.38

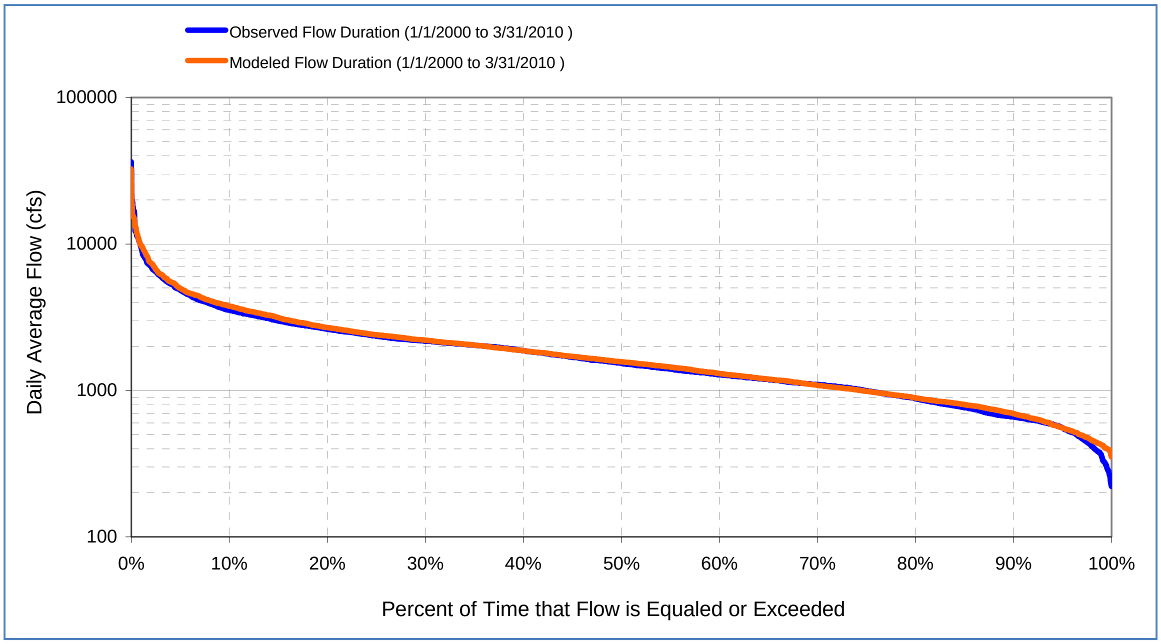

Figure E- 62. Flow Exceedence: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

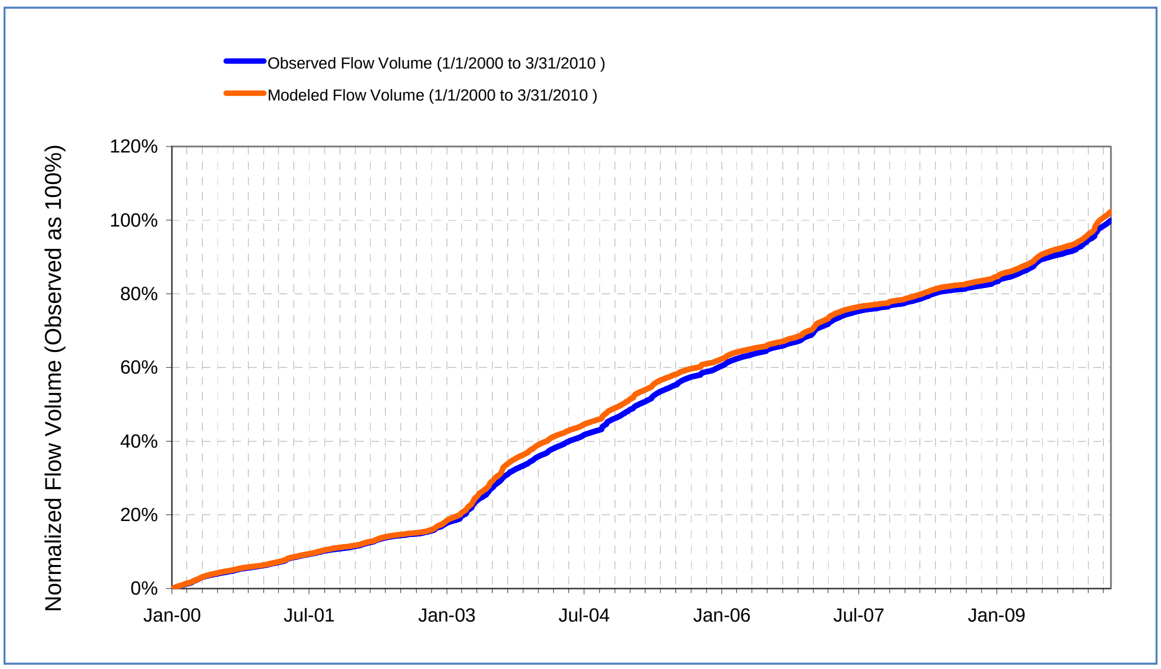

Figure E- 63. Flow Accumulation: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

Table E- 18. Summary Statistics: Model DSN 102 vs. USGS 02115360 Yadkin River at Enon, NC

HSPF Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM DSN 102 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 02115360 YADKIN RIVER AT ENON, NC Hydrologic Unit Code: 3040101 Latitude: 36.13166667 Longitude: -80.44388889 Drainage Area (sq-mi): 1694		
Total Simulated In-stream Flow:	**16.40**	Total Observed In-stream Flow:		**16.02**
Total of simulated highest 10% flows:	**4.94**	Total of Observed highest 10% flows:		**4.82**
Total of Simulated lowest 50% flows:	**3.99**	Total of Observed Lowest 50% flows:		**3.91**
Simulated Summer Flow Volume (months 7-9):	**3.29**	Observed Summer Flow Volume (7-9):		**3.21**
Simulated Fall Flow Volume (months 10-12):	**3.75**	Observed Fall Flow Volume (10-12):		**3.65**
Simulated Winter Flow Volume (months 1-3):	**5.29**	Observed Winter Flow Volume (1-3):		**5.08**
Simulated Spring Flow Volume (months 4-6):	**4.07**	Observed Spring Flow Volume (4-6):		**4.08**
Total Simulated Storm Volume:	**4.06**	Total Observed Storm Volume:		**4.53**
Simulated Summer Storm Volume (7-9):	**0.85**	Observed Summer Storm Volume (7-9):		**1.00**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	2.37	10		
Error in 50% lowest flows:	2.20	10		
Error in 10% highest flows:	2.52	15		
Seasonal volume error - Summer:	2.32	30		
Seasonal volume error - Fall:	2.83	30		
Seasonal volume error - Winter:	4.10	30		
Seasonal volume error - Spring:	-0.13	30		
Error in storm volumes:	-10.30	20		
Error in summer storm volumes:	-15.10	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.715	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.619	as E or E' approaches 1.0		

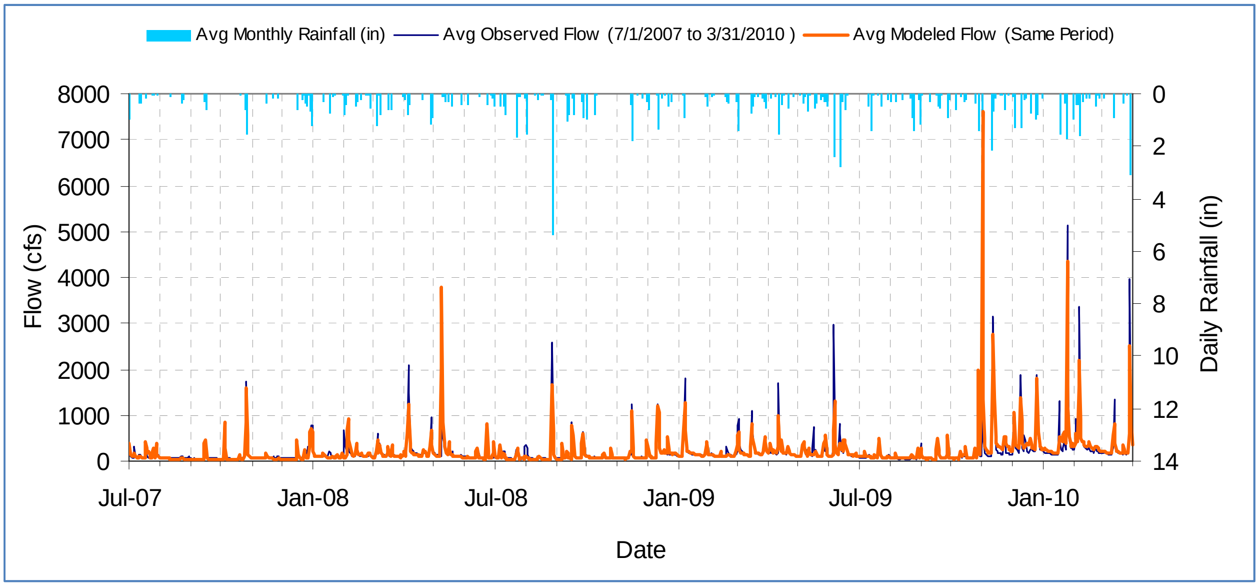

Figure E- 64. Mean Daily Flow: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

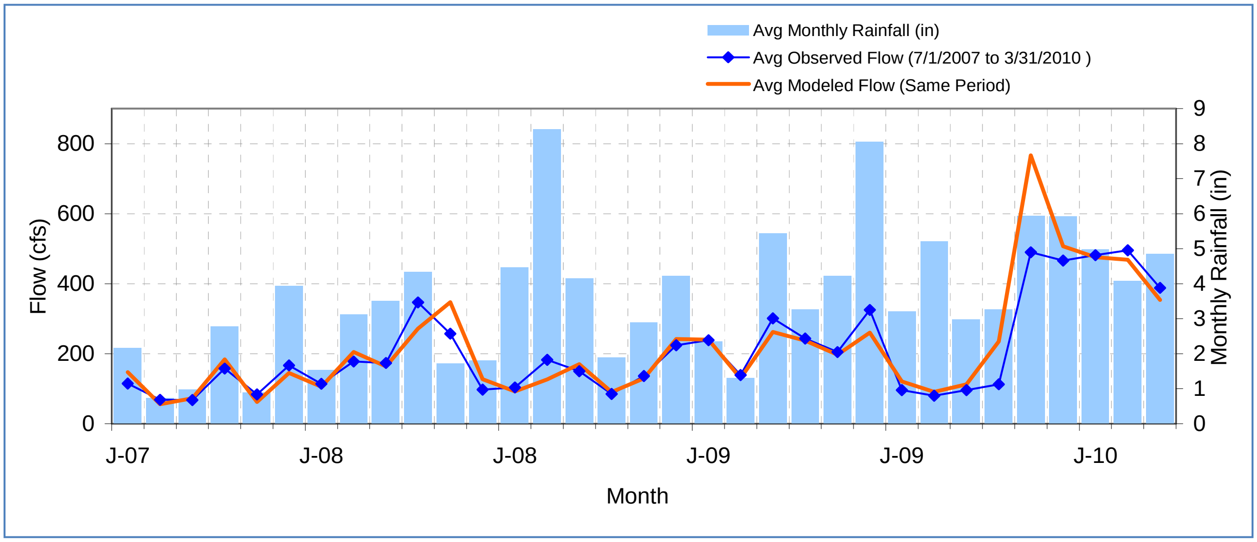

Figure E- 65. Mean Monthly Flow: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

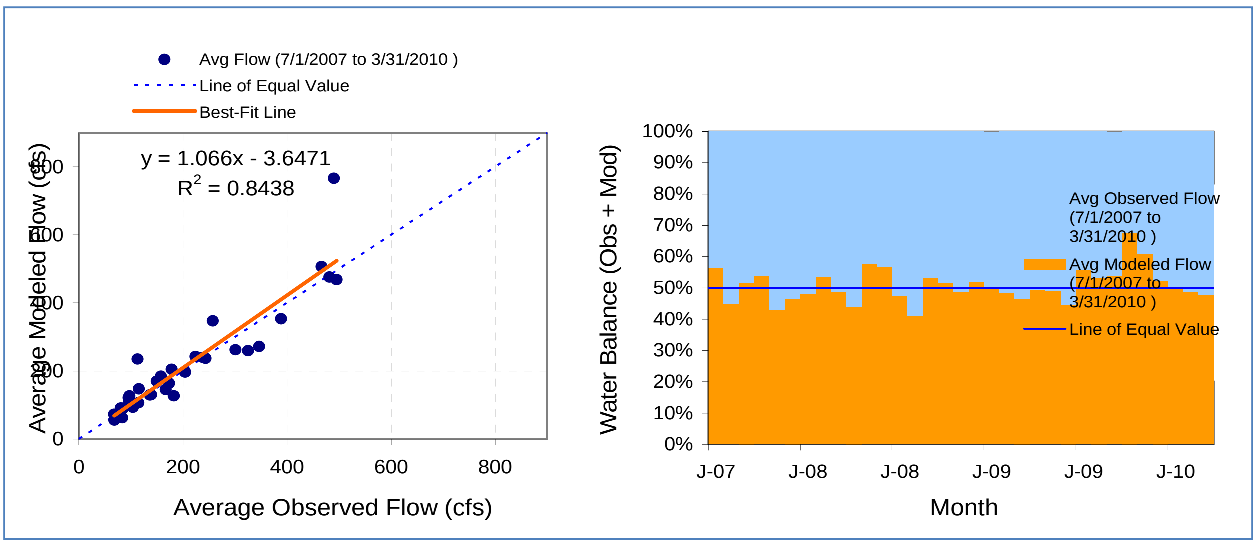

Figure E- 66. Monthly Flow Regression and Temporal Variation: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

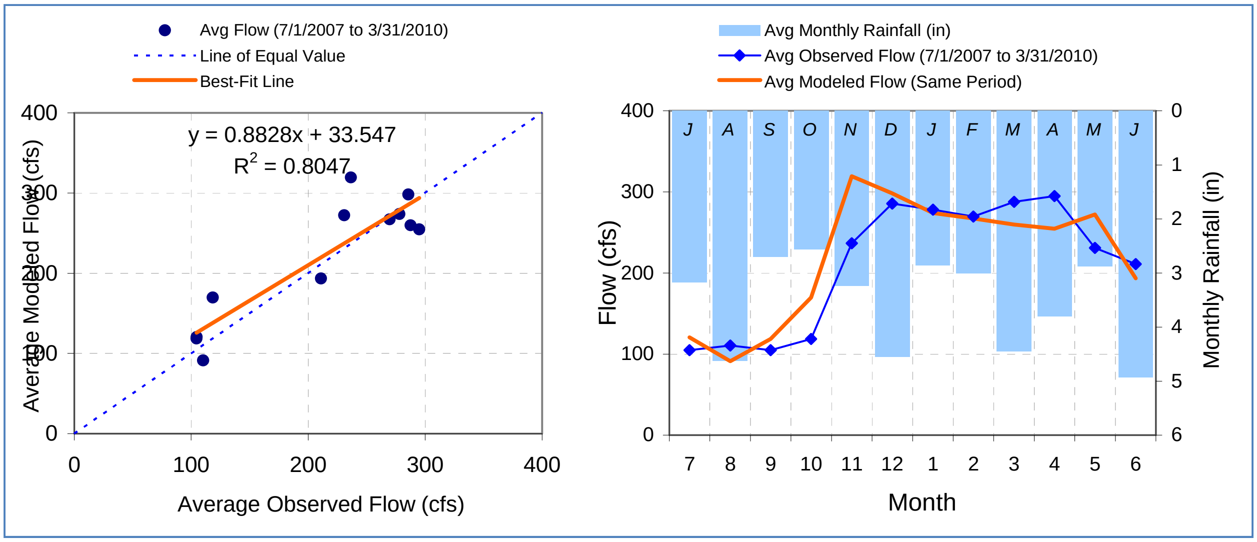

Figure E- 67. Seasonal Regression and Temporal Aggregate: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

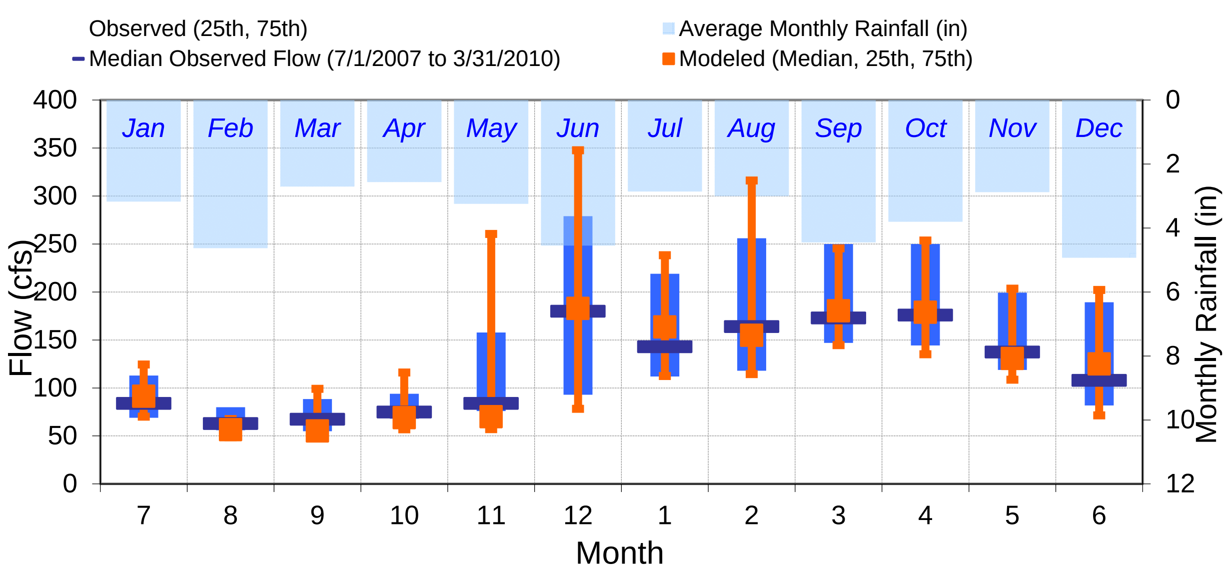

Figure E- 68. Seasonal Medians and Ranges: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

Figure E- 69. Seasonal Summary: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jul	104.87	84.00	69.00	113.00	120.56	91.37	70.05	124.51
Aug	110.35	63.00	56.00	80.00	91.30	56.57	48.68	67.55
Sep	104.66	67.50	55.00	88.50	118.50	55.17	47.81	99.13
Oct	118.55	75.00	68.00	94.00	169.86	69.01	56.89	116.04
Nov	236.57	84.00	76.00	157.75	319.34	70.08	57.08	260.42
Dec	285.74	180.00	93.00	279.00	298.22	182.89	78.28	347.76
Jan	278.11	143.00	112.00	219.00	273.84	163.46	112.40	238.34
Feb	269.69	164.00	118.00	256.00	267.12	154.91	114.47	316.10
Mar	287.68	173.00	147.00	250.00	259.78	180.31	144.61	245.55
Apr	294.90	176.00	144.25	250.00	254.66	178.86	135.06	253.66
May	230.89	137.50	118.75	199.25	272.15	130.64	108.55	203.44
Jun	211.13	108.00	81.75	189.25	193.44	124.94	71.49	202.18

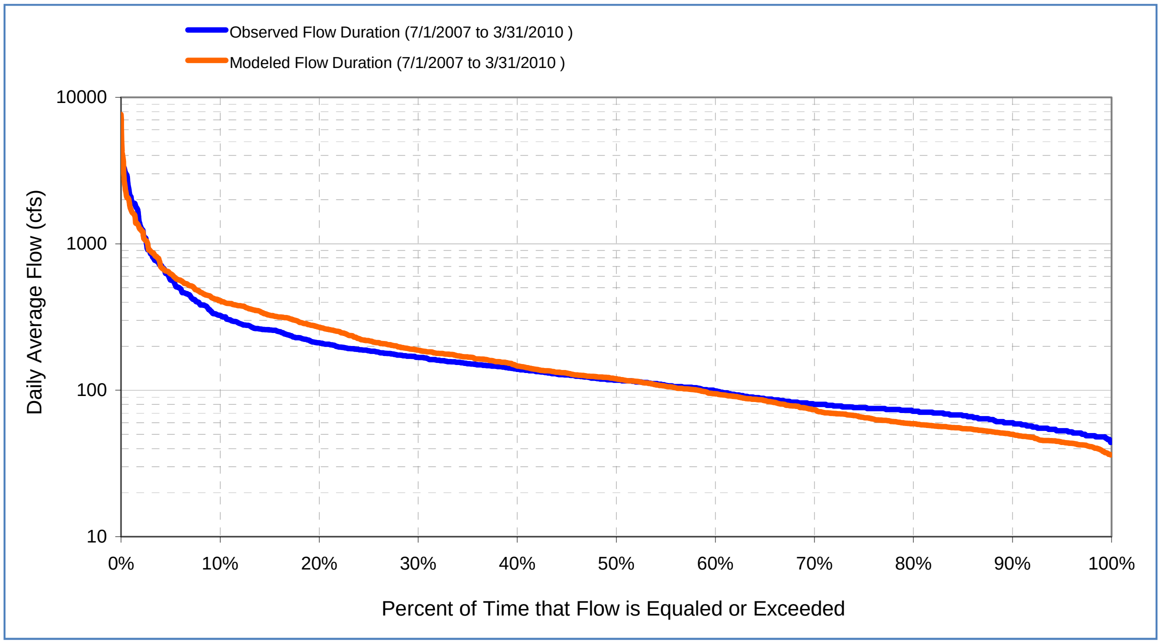

Figure E- 70. Flow Exceedence: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

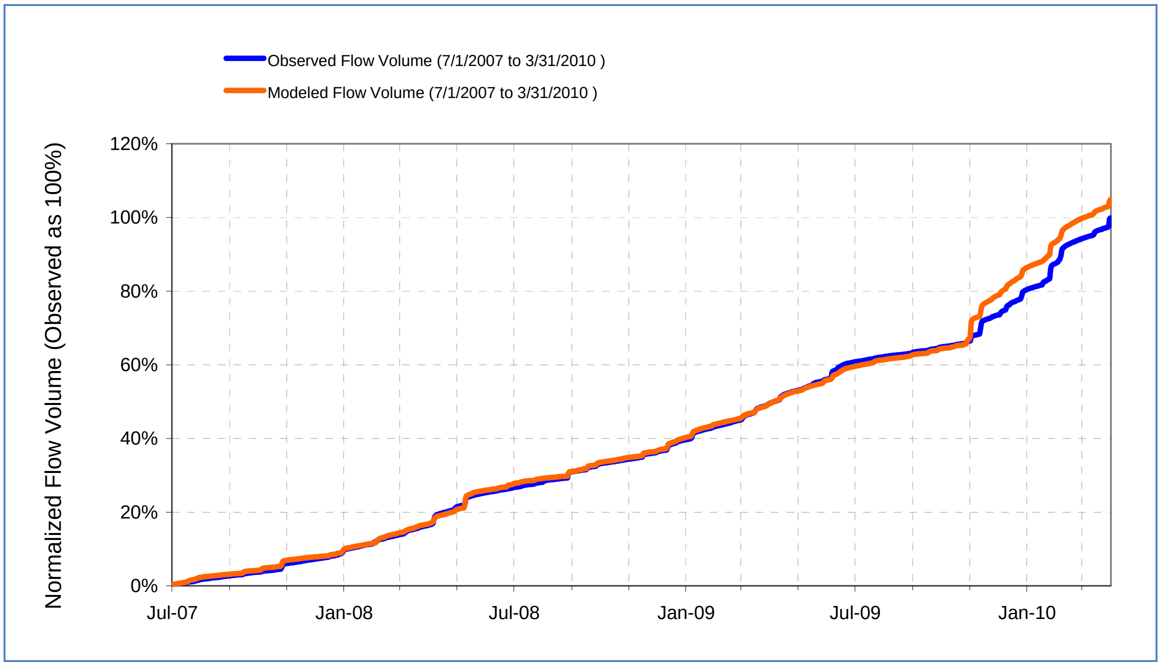

Figure E- 71. Flow Accumulation: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

Table E- 19. Summary Statistics: Model DSN 110 vs. USGS 02115860 Muddy Creek near Muddy Creek, NC

HSPF Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM DSN 110 2.75-Year Analysis Period: 7/1/2007 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		**USGS 02115860 MUDDY CREEK NEAR MUDDY CREEK, NC** Hydrologic Unit Code: 3040101 Latitude: 36.00027778 Longitude: -80.3402778 Drainage Area (sq-mi): 186		
Total Simulated In-stream Flow:	**15.89**	Total Observed In-stream Flow:		**15.15**
Total of simulated highest 10% flows:	**7.06**	Total of Observed highest 10% flows:		**7.00**
Total of Simulated lowest 50% flows:	**2.60**	Total of Observed Lowest 50% flows:		**2.87**
Simulated Summer Flow Volume (months 7-9):	**2.21**	Observed Summer Flow Volume (7-9):		**2.14**
Simulated Fall Flow Volume (months 10-12):	**5.25**	Observed Fall Flow Volume (10-12):		**4.28**
Simulated Winter Flow Volume (months 1-3):	**5.26**	Observed Winter Flow Volume (1-3):		**5.49**
Simulated Spring Flow Volume (months 4-6):	**3.18**	Observed Spring Flow Volume (4-6):		**3.25**
Total Simulated Storm Volume:	**7.30**	Total Observed Storm Volume:		**6.90**
Simulated Summer Storm Volume (7-9):	**1.00**	Observed Summer Storm Volume (7-9):		**0.84**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	4.89	10		
Error in 50% lowest flows:	-9.37	10		
Error in 10% highest flows:	0.82	15		
Seasonal volume error - Summer:	3.17	30		
Seasonal volume error - Fall:	22.72	30		
Seasonal volume error - Winter:	-4.25	30		
Seasonal volume error - Spring:	-2.05	30		
Error in storm volumes:	5.78	20		
Error in summer storm volumes:	18.44	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.597	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.570	as E or E' approaches 1.0		

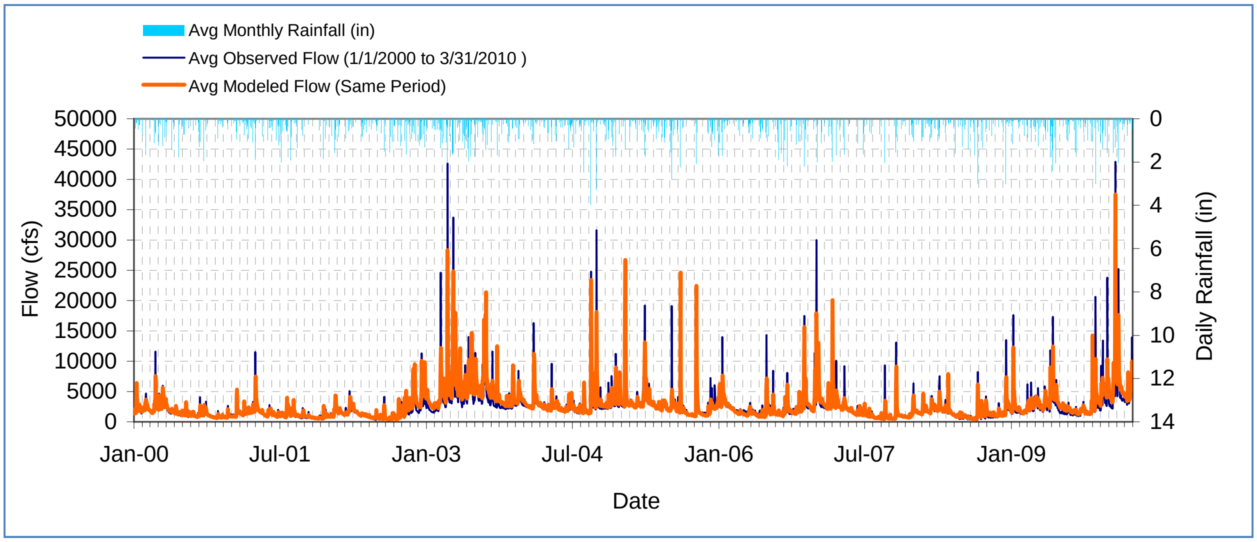

Figure E- 72. Mean Daily Flow: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

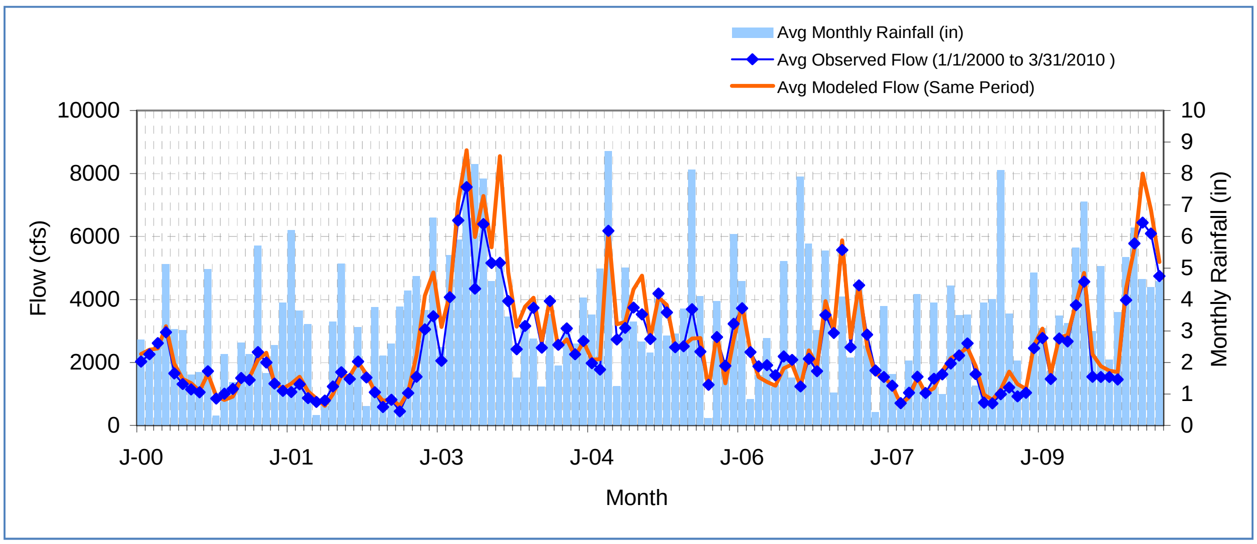

Figure E- 73. Mean Monthly Flow: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

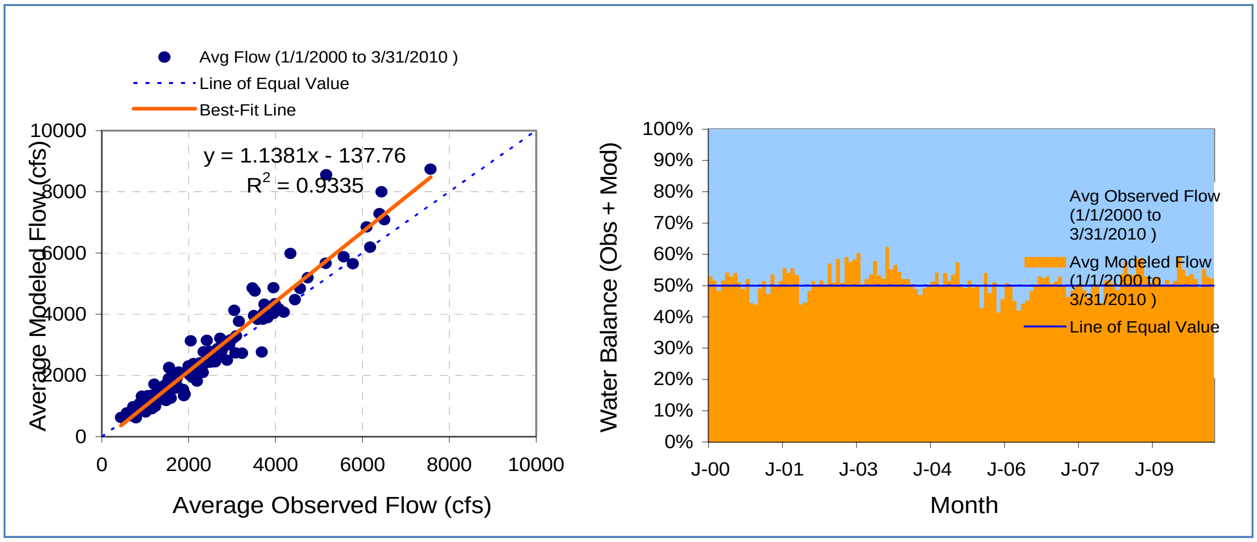

Figure E- 74. Monthly Flow Regression and Temporal Variation: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

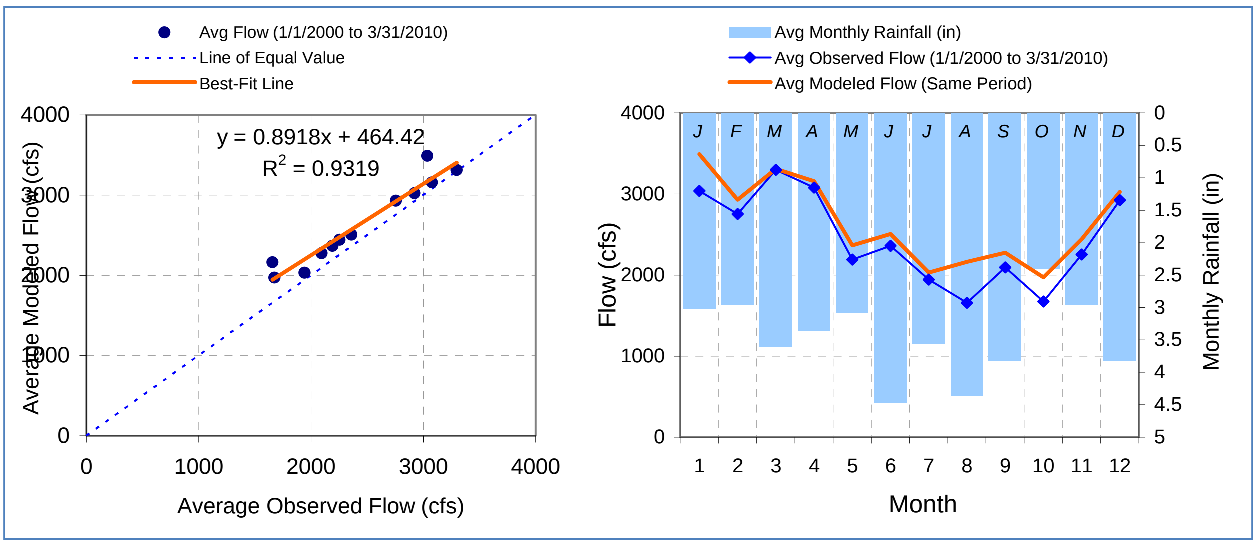

Figure E- 75. Seasonal Regression and Temporal Aggregate: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

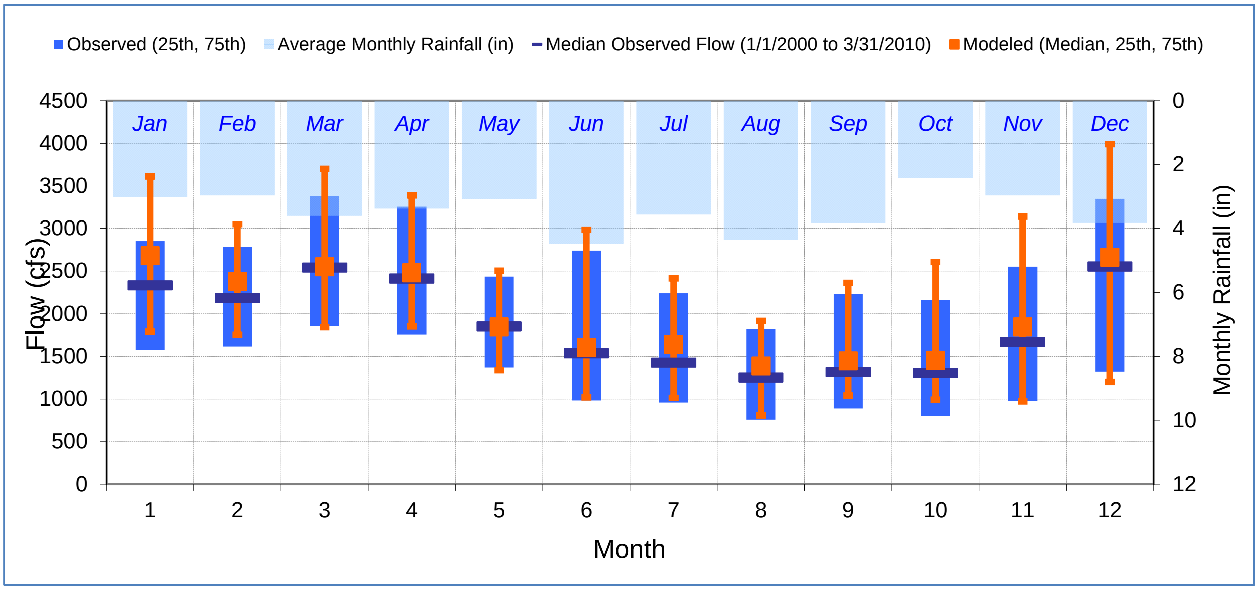

Figure E- 76. Seasonal Medians and Ranges: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

Table E- 20. Seasonal Summary: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Jan	3035.60	2330.00	1580.00	2850.00	3490.29	2679.50	1790.64	3611.08
Feb	2754.53	2180.00	1615.00	2785.00	2928.97	2377.29	1753.38	3049.99
Mar	3297.62	2540.00	1860.00	3380.00	3311.67	2550.54	1844.46	3701.74
Apr	3077.63	2410.00	1757.50	3257.50	3158.43	2480.41	1851.95	3390.63
May	2190.53	1850.00	1370.00	2435.00	2366.65	1846.31	1339.39	2504.41
Jun	2359.91	1535.00	982.75	2740.00	2506.13	1603.59	1019.60	2982.64
Jul	1943.78	1425.00	960.75	2240.00	2030.70	1641.72	1012.78	2416.67
Aug	1657.22	1250.00	758.25	1820.00	2163.50	1385.73	809.40	1916.28
Sep	2093.73	1315.00	890.50	2232.50	2274.54	1447.49	1039.78	2362.36
Oct	1674.88	1300.00	804.25	2160.00	1971.89	1453.89	992.45	2606.52
Nov	2255.61	1665.00	979.25	2552.50	2443.50	1846.71	973.67	3143.39
Dec	2922.89	2550.00	1320.00	3350.00	3024.04	2663.18	1200.14	3990.76

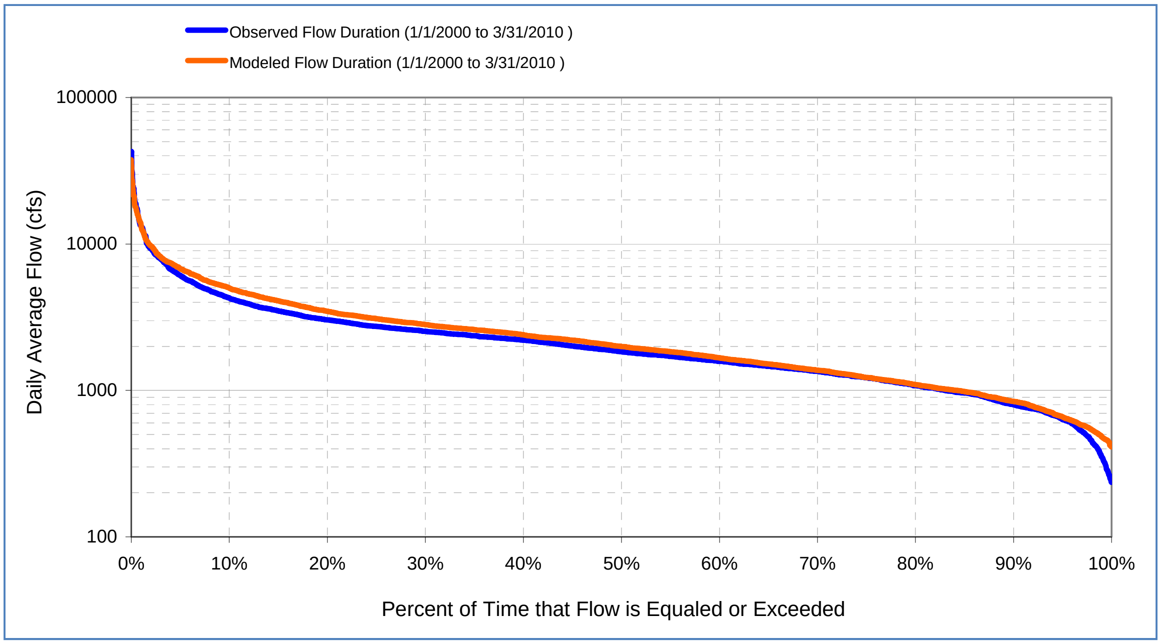

Figure E- 77. Flow Exceedence: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

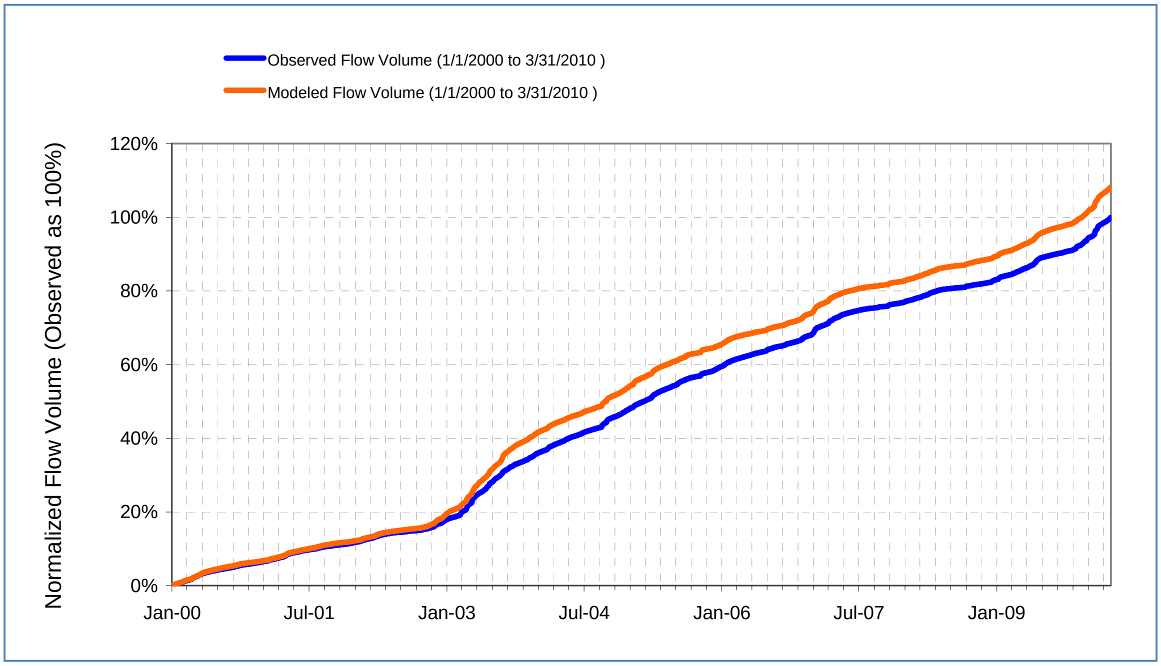

Figure E- 78. Flow Accumulation: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

Table E- 21. Summary Statistics: Model DSN 101 vs. USGS 02116500 Yadkin River at Yadkin College, NC

HSPF Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM DSN 101 10.25-Year Analysis Period: 1/1/2000 - 3/31/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 02116500 YADKIN RIVER AT YADKIN COLLEGE, NC Hydrologic Unit Code: 3040101 Latitude: 35.85666667 Longitude: -80.3869444 Drainage Area (sq-mi): 2280		
Total Simulated In-stream Flow:	**15.80**	Total Observed In-stream Flow:		**14.60**
Total of simulated highest 10% flows:	**4.94**	Total of Observed highest 10% flows:		**4.71**
Total of Simulated lowest 50% flows:	**3.71**	Total of Observed Lowest 50% flows:		**3.54**
Simulated Summer Flow Volume (months 7-9):	**3.16**	Observed Summer Flow Volume (7-9):		**2.78**
Simulated Fall Flow Volume (months 10-12):	**3.63**	Observed Fall Flow Volume (10-12):		**3.35**
Simulated Winter Flow Volume (months 1-3):	**5.14**	Observed Winter Flow Volume (1-3):		**4.80**
Simulated Spring Flow Volume (months 4-6):	**3.87**	Observed Spring Flow Volume (4-6):		**3.68**
Total Simulated Storm Volume:	**4.36**	Total Observed Storm Volume:		**4.57**
Simulated Summer Storm Volume (7-9):	**0.96**	Observed Summer Storm Volume (7-9):		**0.96**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	8.23	10		
Error in 50% lowest flows:	4.70	10		
Error in 10% highest flows:	4.87	15		
Seasonal volume error - Summer:	13.65	30		
Seasonal volume error - Fall:	8.55	30		
Seasonal volume error - Winter:	7.10	30		
Seasonal volume error - Spring:	5.31	30		
Error in storm volumes:	-4.64	20		
Error in summer storm volumes:	-0.09	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.761	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.576	as E or E' approaches 1.0		

Appendix E References

Donigian, A.S., Jr. 2000. HSPF Training Workshop Handbook and CD. Lecture #19. Calibration and Verification Issues. EPA Headquarters, Washington Information Center, 10-14 January, 2000. Prepared for U.S. EPA, Office of Water, Office of Science and Technology, Washington, DC.

Donigian, A.S. Jr., J.C. Imhoff, B.R. Bicknell, and J.L. Kittle, Jr. 1984. Application Guide for Hydrological Simulation Program – FORTRAN (HSPF). EPA-600/3-84-065. Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

Lumb. A.M., R.B. McCammon, and J.L. Kittle, Jr. 1994. User's Manual for an Expert System (HSPEXP) for Calibration of the Hydrological Simulation Program – FORTRAN. Water-Resources Investigation Report 94-4168. U.S. Geological Survey, Reston, VA.

USEPA. 2000. BASINS Technical Note 6, Estimating Hydrology and Hydraulic Parameters for HSPF. EPA-823-R00-012. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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Appendix F. Sediment and Water Temperature Calibration/Validation

Tables in this section contain the following information for the calibration period (2005-2010) and the validation period (2000-2004):

Count: Number of days with samples (multiple observations on a single day are averaged)

Concentration average error: Average of relative error ([simulated – observed]/observed) calculated from daily average concentration.

Concentration median error: Median of relative error ([simulated – observed]/observed) calculated from daily average concentration.

Paired load average error: Average of relative error ([simulated – observed]/observed) on load estimates calculated with daily average concentrations and daily average simulated flow.

Paired load median error: Median of relative error ([simulated – observed]/observed) on load estimates calculated with daily average concentrations and daily average simulated flow.

Paired t, concentration: Probability value from Student's t test of equality of simulated and observed means.

Paired t, load: Probability value from Student's t test of equality of simulated and observed loads, calculated from daily average concentrations and daily average simulated flow.

Long-term load vs. stratified regression estimate: Relative error on cumulative total load estimates ([simulated – observed]/observed) with "observed" loads calculated with observed flows and concentrations estimated from a stratified regression of the natural log of observed concentration on the natural log of observed flow. Stratification breakpoint assigned between one and two times the median flow.

Monthly load NSE: Nash-Sutcliffe coefficient of model fit efficiency calculated from simulated monthly loads and monthly loads estimated by the stratified regression estimator.

Table F- 1. Yadkin River at Yadkin College Summary Statistics, TSS

	2005-2010	2000-2004
Count	173	77
Concentration average error	-0.4%	-7.5%
Concentration median error	-2.1%	-7.5%
Paired load average error	37.2%	-22.8%
Paired load median error	-0.4%	-1.5%
Paired t, concentration	0.89	0.70
Paired t, load	0.34	0.47
Long-term load vs. stratified regression estimate	-26.8%	-36.3%
Monthly load NSE	0.60	0.43

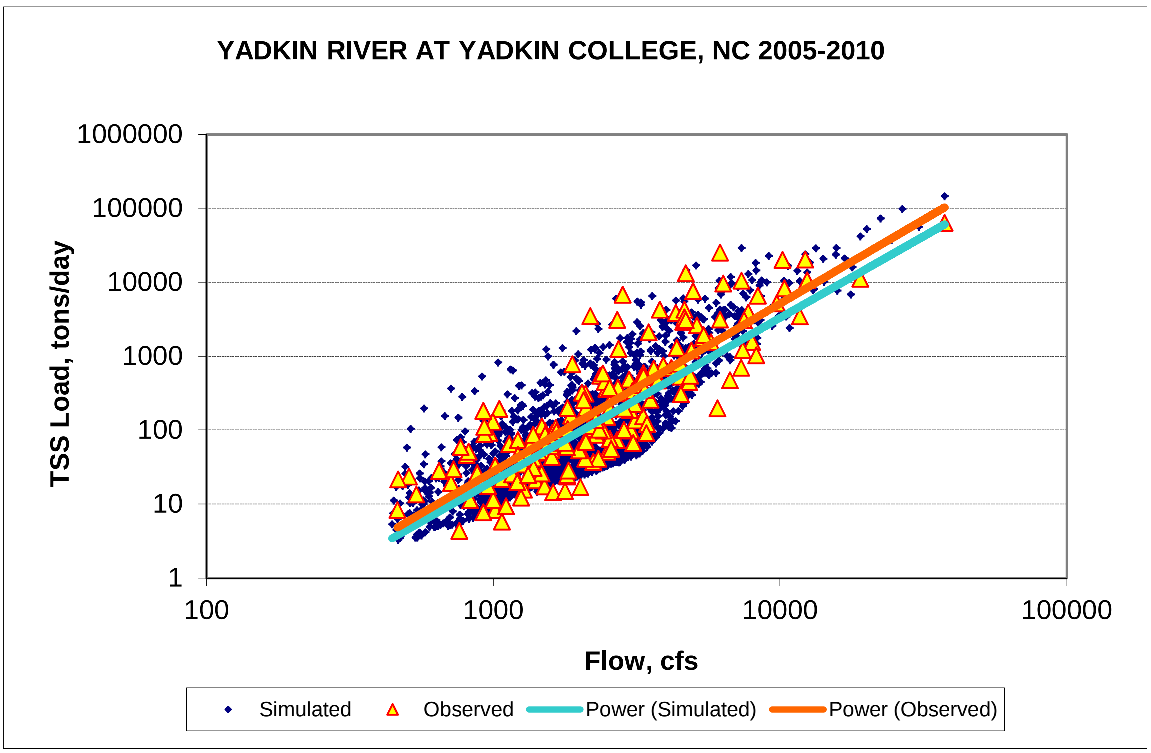

Figure F- 1. TSS Load Power Plot, Calibration Period, Yadkin River at Yadkin College

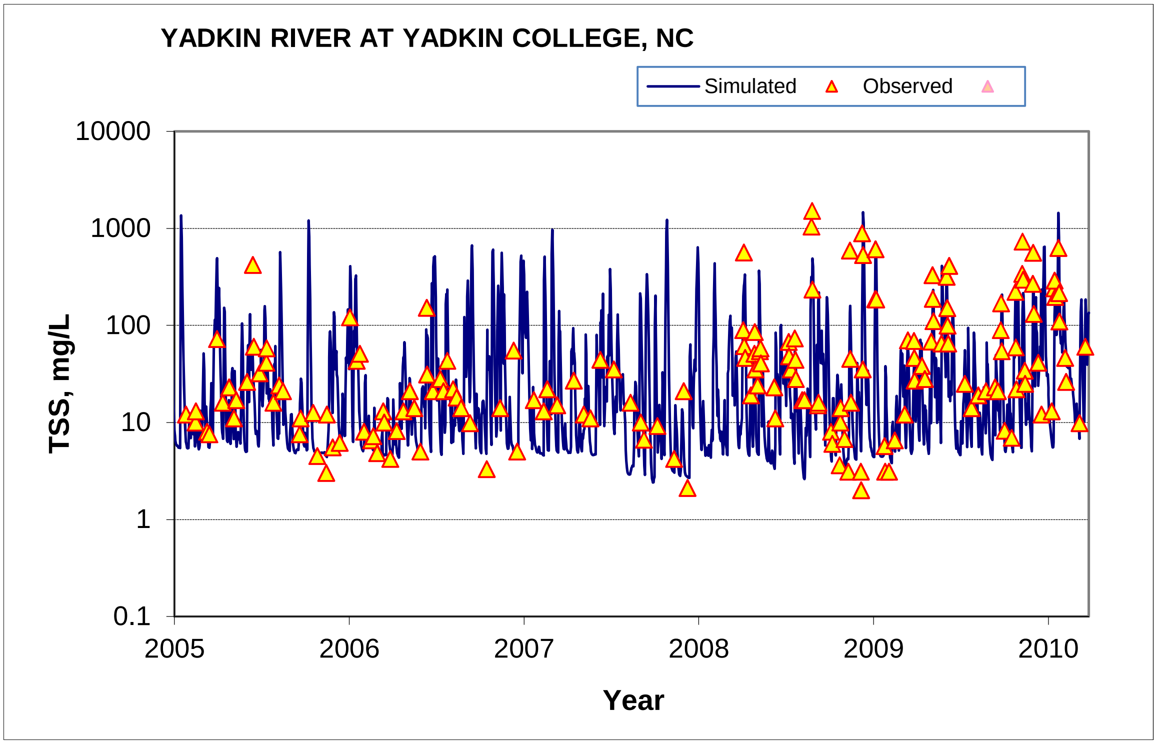

Figure F- 2. TSS Concentration Time Series, Calibration Period, Yadkin River at Yadkin College

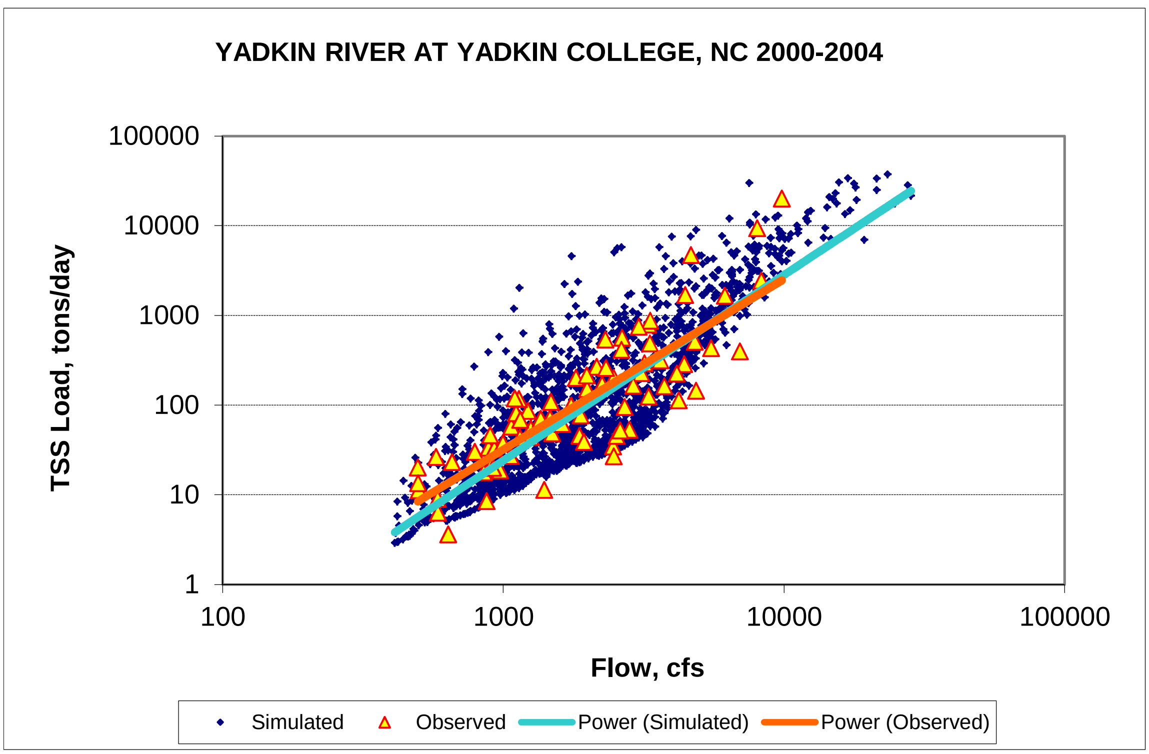

Figure F- 3. TSS Load Power Plot, Validation Period, Yadkin River at Yadkin College

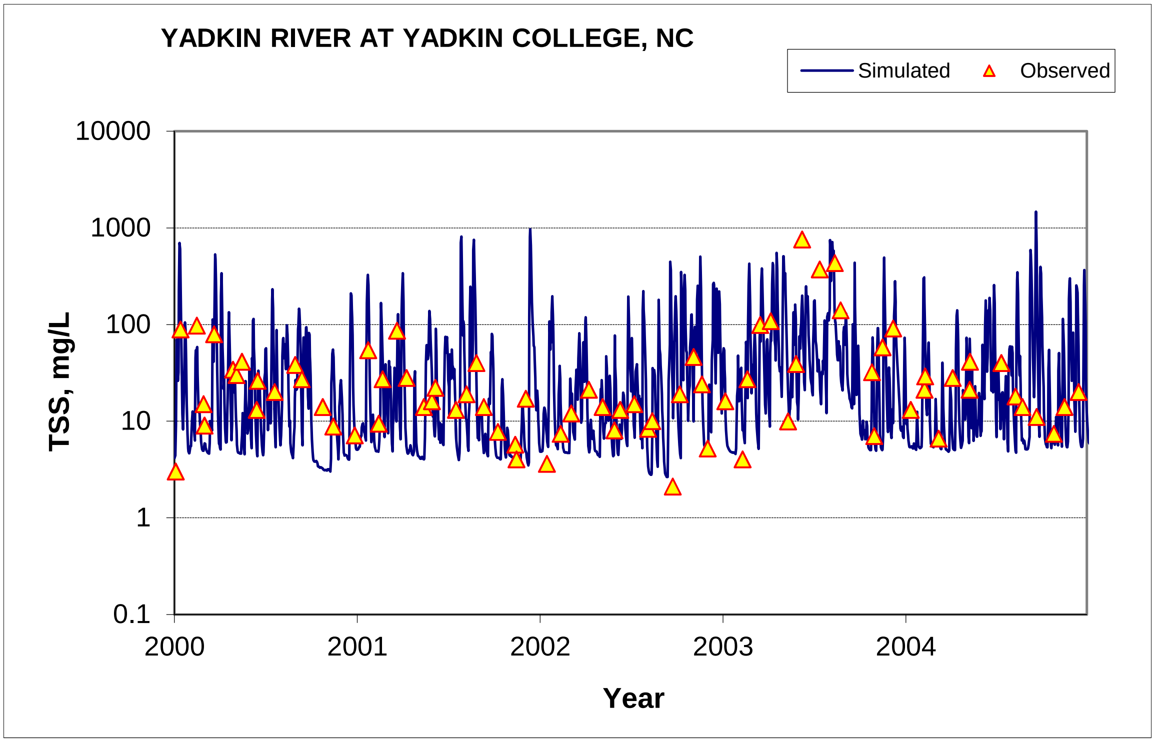

Figure F- 4. **TSS Concentration Time Series, Validation Period, Yadkin River at Yadkin College**

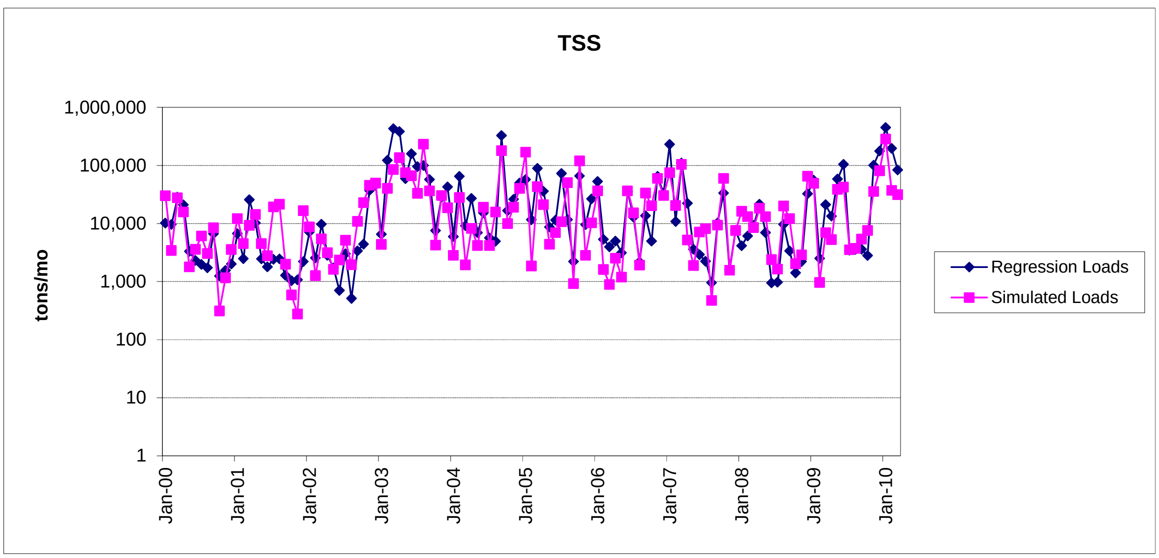

Figure F- 5. **TSS Monthly Load Series, Yadkin River at Yadkin College**

Table F- 2. Summary Statistics, TSS, South Yadkin River near Mocksville

	2005-2010	2000-2004
Count	114	19
Concentration average error	29.8%	-37.7%
Concentration median error	-0.6%	-12.5%
Paired load average error	138.8%	-32.1%
Paired load median error	-0.1%	-2.6%
Paired t, concentration	0.31	0.14
Paired t, load	0.02	0.31
Long-term load vs. stratified regression estimate	-7.7%	-7.5%
Monthly load NSE	0.73	0.26

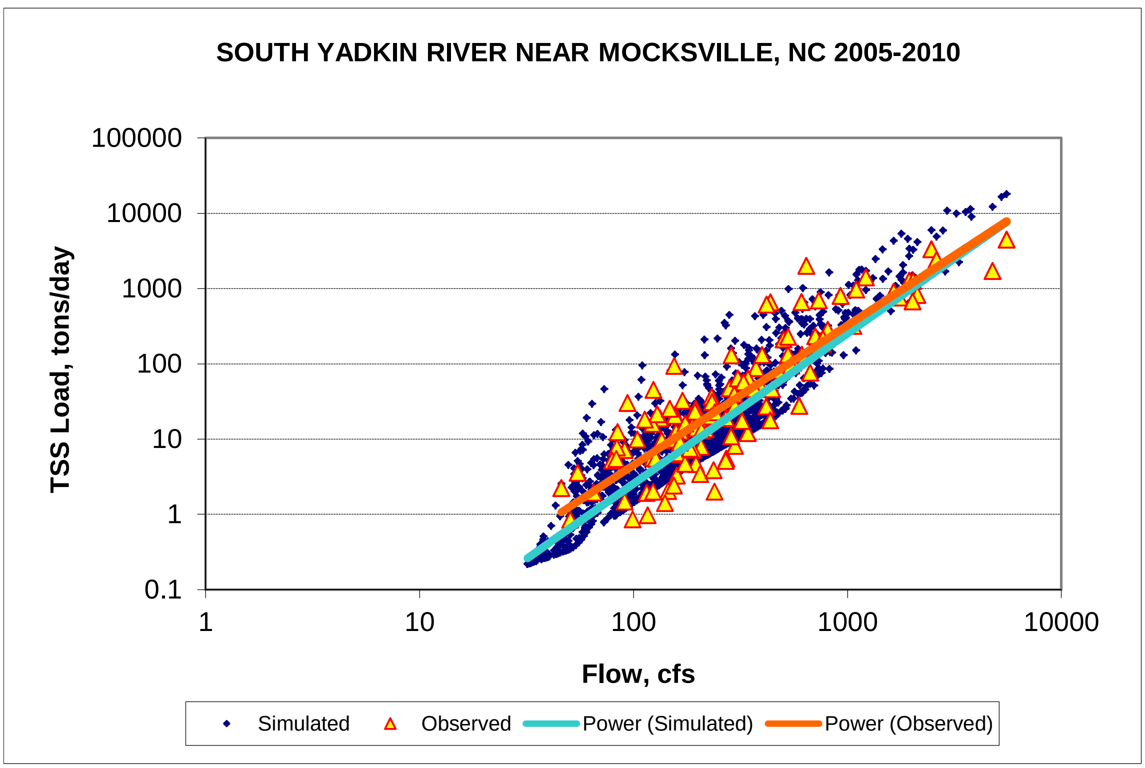

Figure F- 6. TSS Load Power Plot, Calibration Period, South Yadkin River near Mocksville

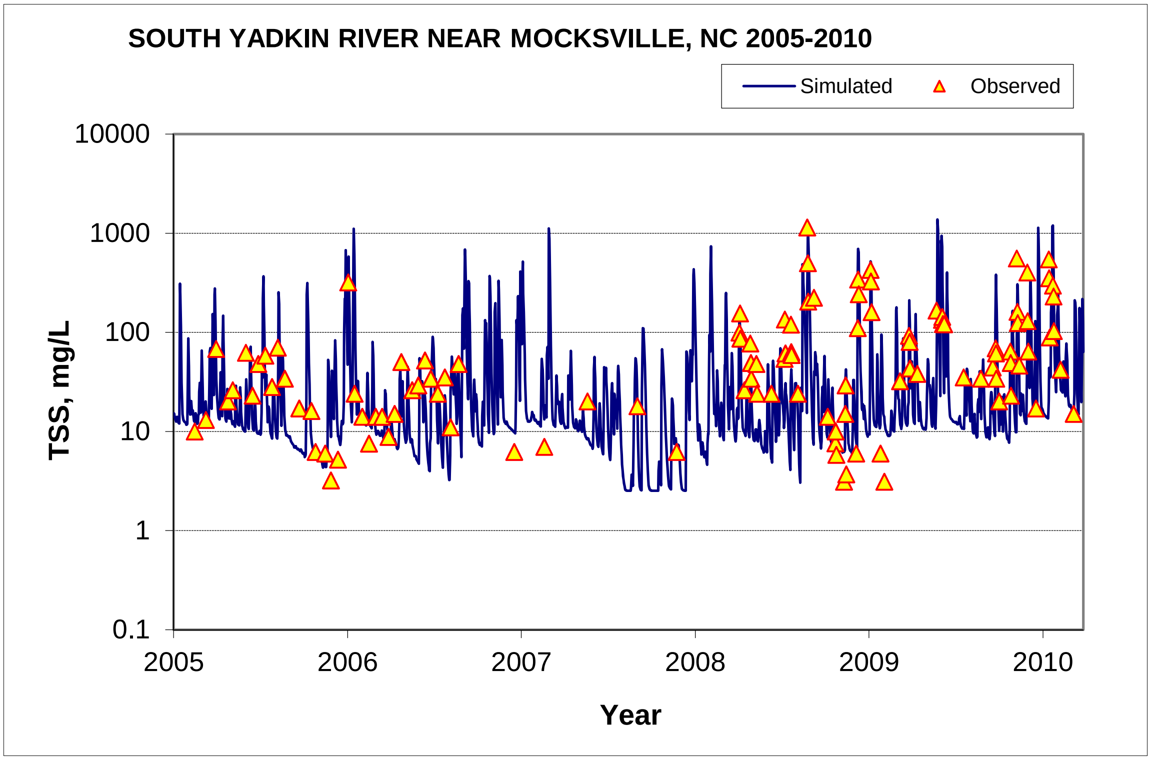

Figure F- 7. TSS Concentration Time Series, Calibration Period, South Yadkin River near Mocksville

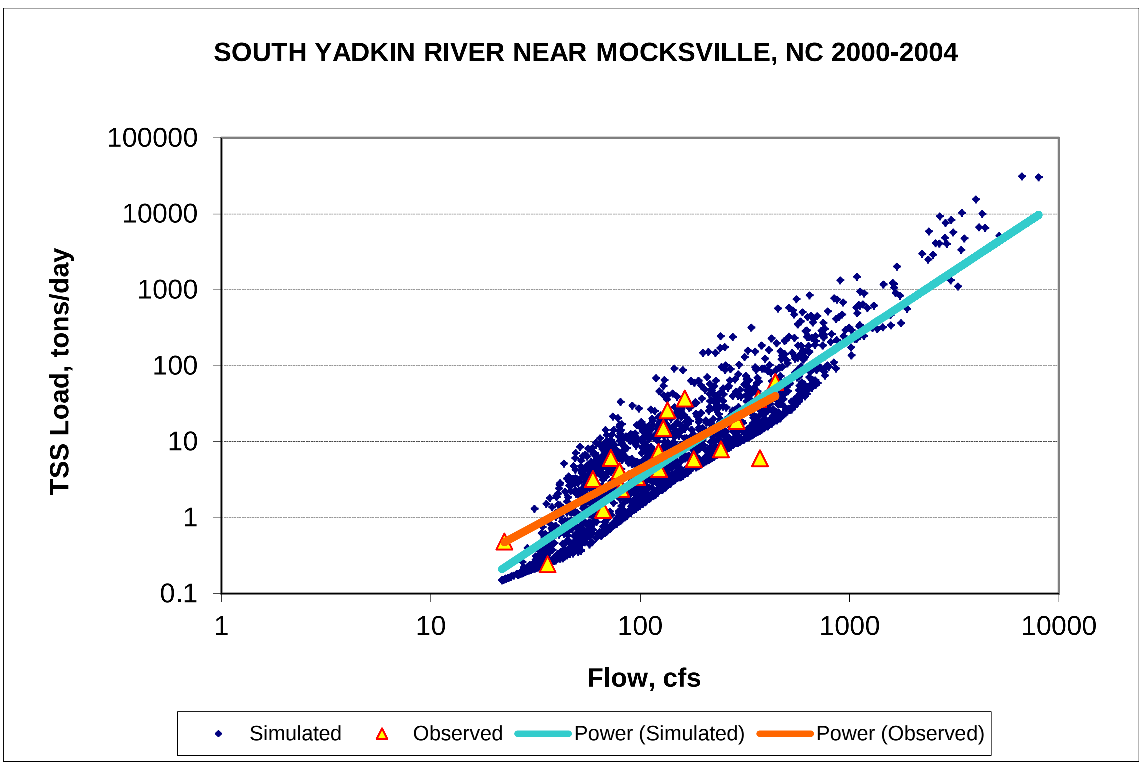

Figure F- 8. TSS Load Power Plot, Validation Period, South Yadkin River near Mocksville

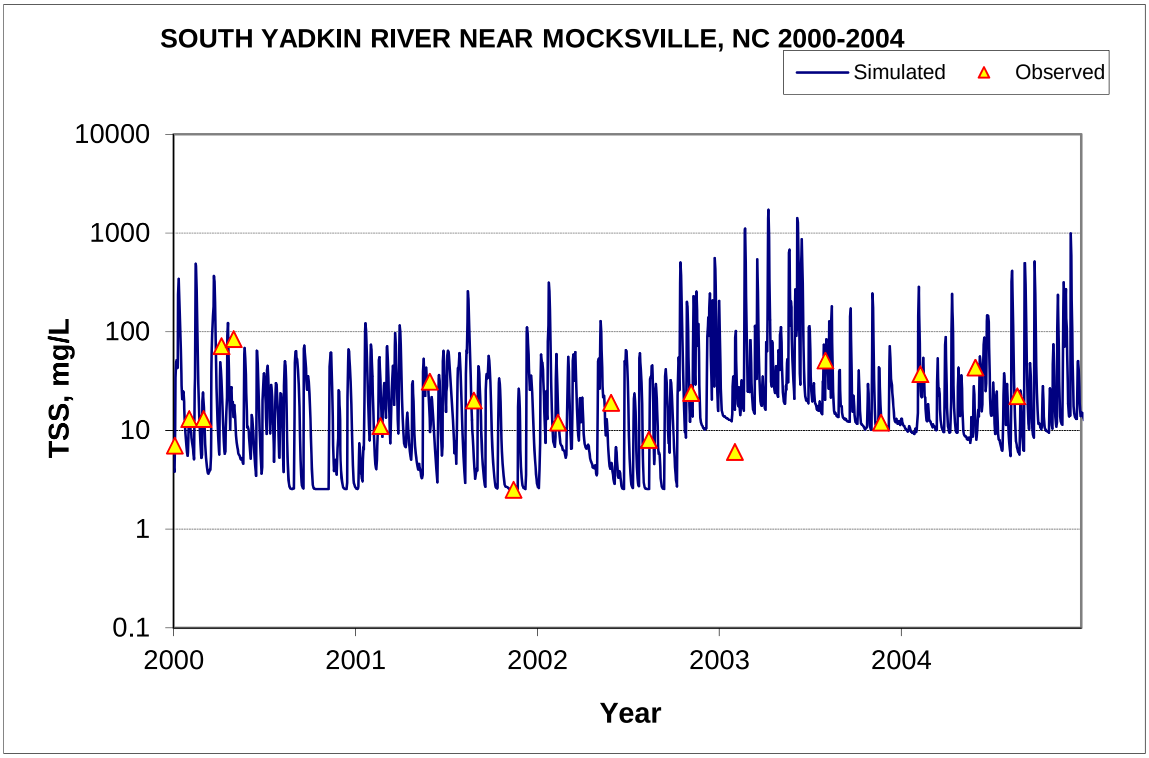

Figure F- 9. TSS Concentration Time Series, Validation Period, South Yadkin River near Mocksville

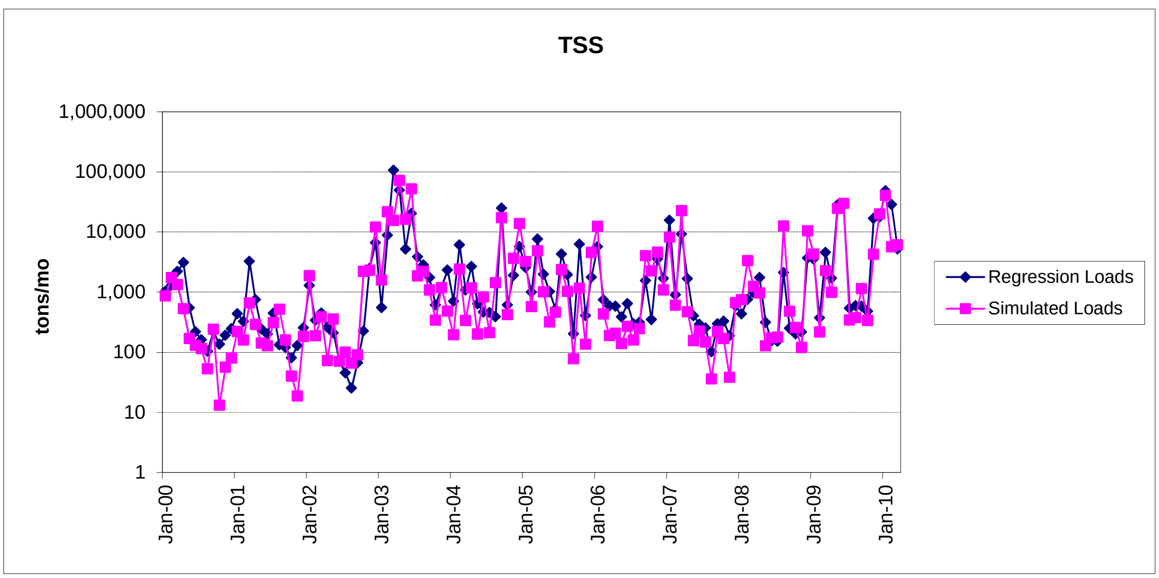

Figure F- 10. TSS Monthly Load Series, South Yadkin River near Mocksville

Table F- 3. Summary Statistics, TSS, Abbotts Creek near Lexington

	2005-2010	2000-2004
Count	134	23
Concentration average error	26.1%	15.5%
Concentration median error	-3.4%	-18.8%
Paired load average error	-0.1%	-20.2%
Paired load median error	-0.1%	-6.4%
Paired t, concentration	0.32	0.54
Paired t, load	0.72	0.50
Long-term load vs. stratified regression estimate	3.2%	-28.7%
Monthly load NSE	0.18	0.59

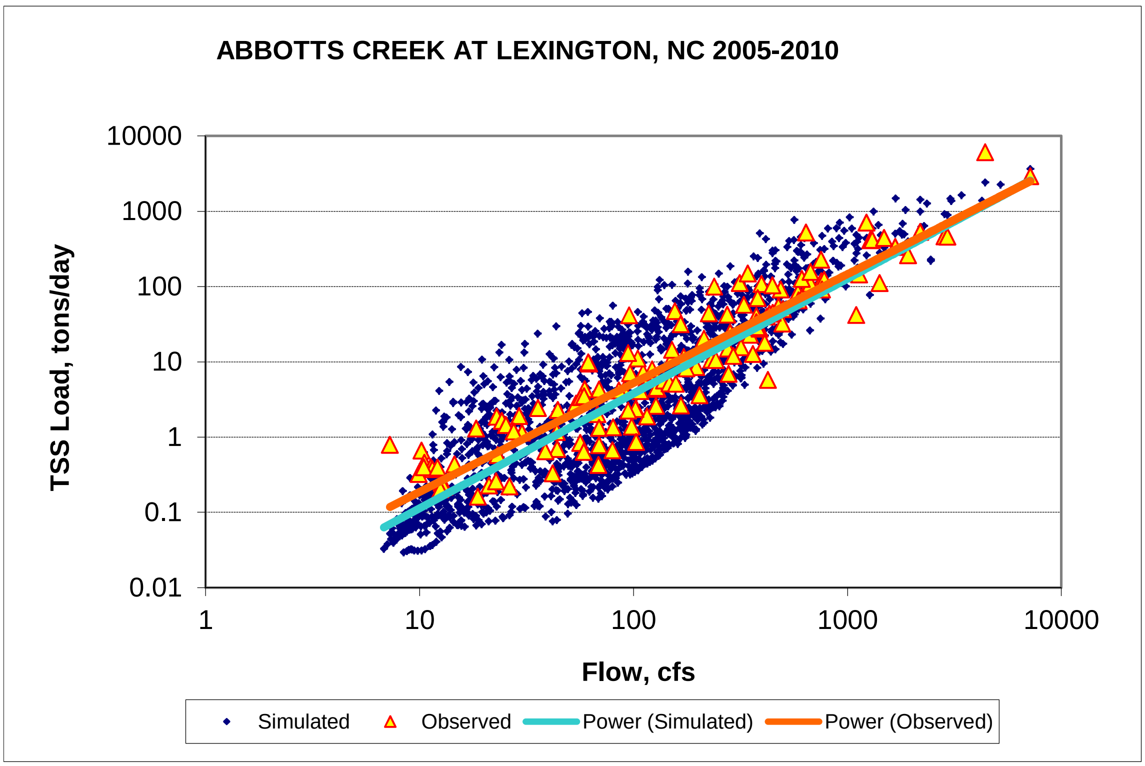

Figure F- 11. TSS Load Power Plot, Calibration Period, Abbotts Creek near Lexington

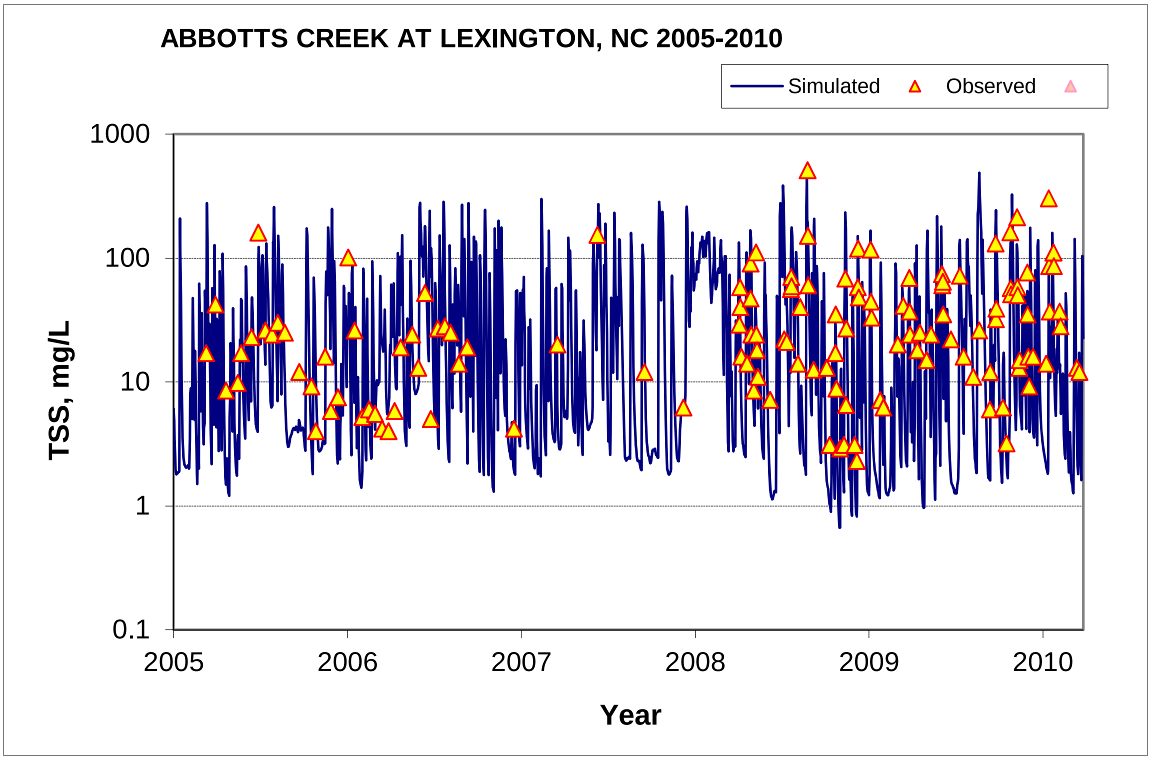

Figure F- 12. TSS Concentration Time Series, Calibration Period, Abbotts Creek near Lexington

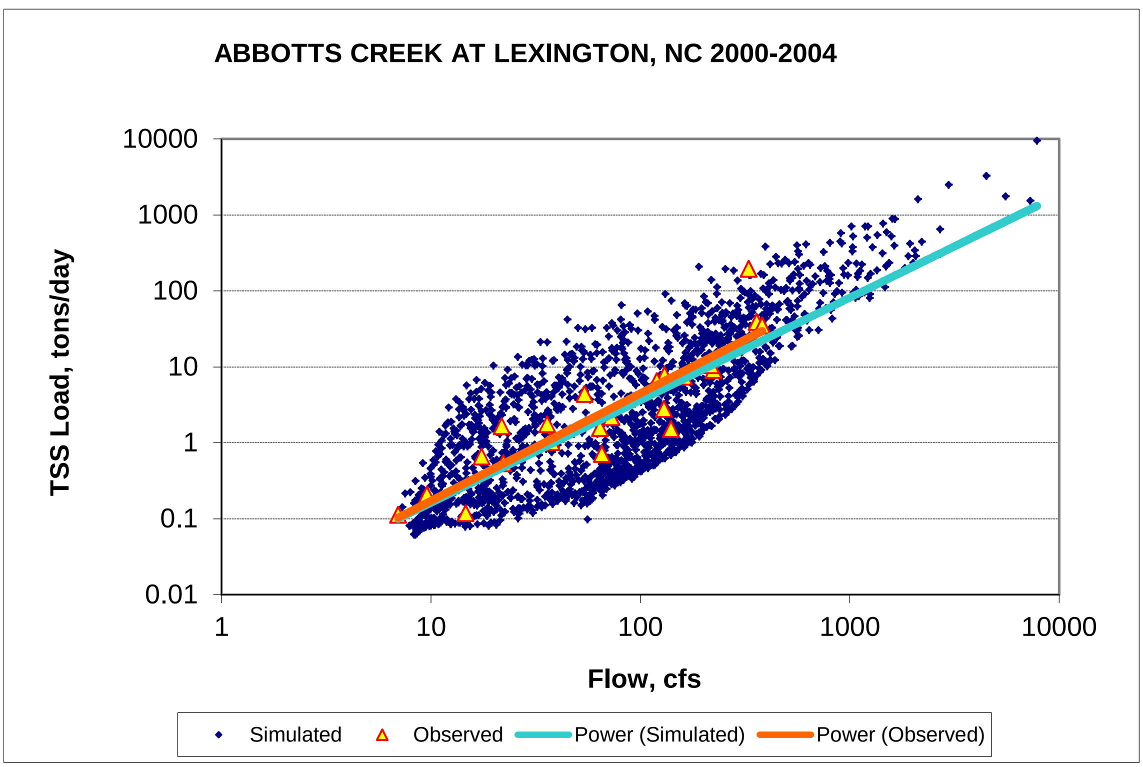

Figure F- 13. TSS Load Power Plot, Validation Period, Abbotts Creek near Lexington

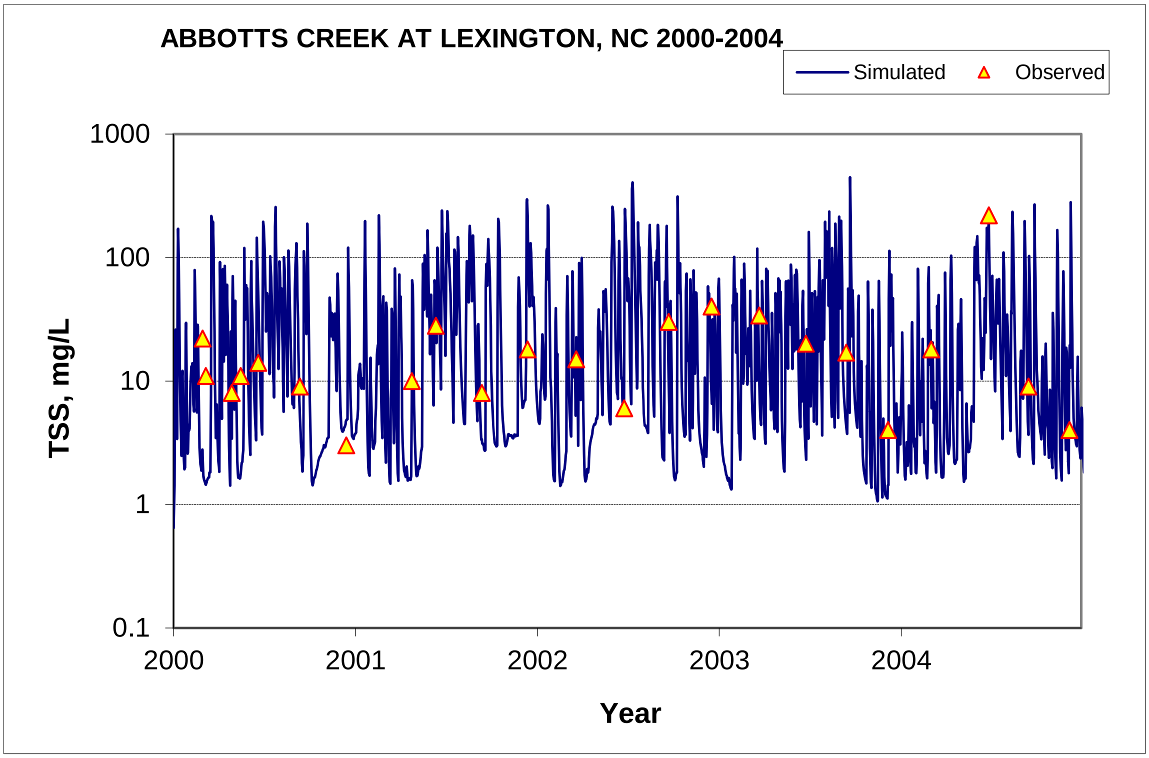

Figure F- 14. TSS Concentration Time Series, Validation Period, Abbotts Creek near Lexington

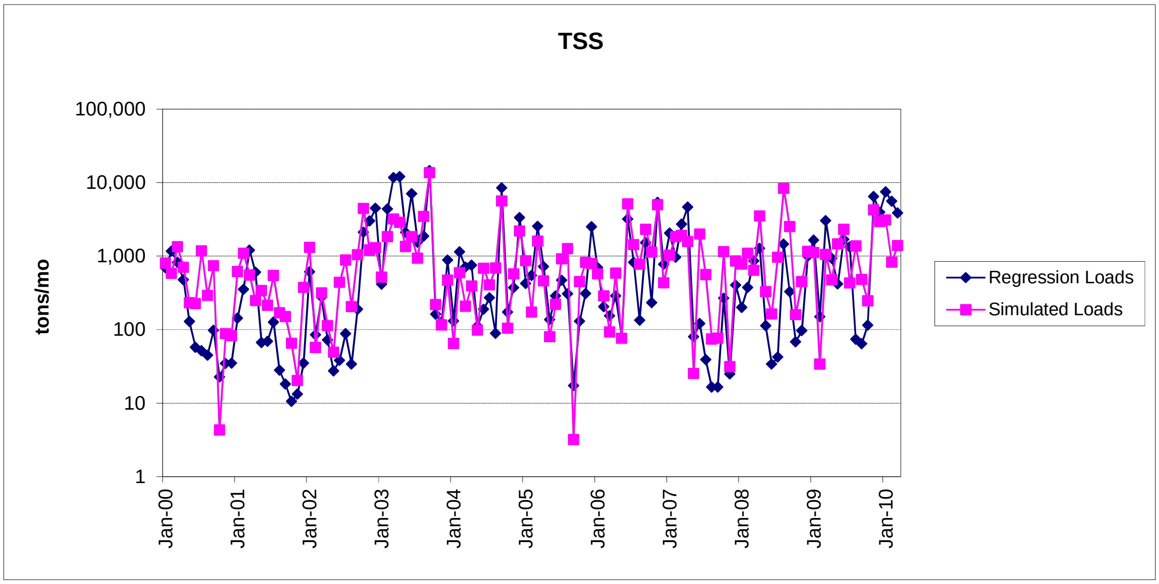

Figure F- 15. TSS Monthly Load Series, Abbotts Creek near Lexington

Table F- 4. Summary Statistics, TSS, Roaring River at Roaring River

	2005-2010	2000-2004
Count	104	22
Concentration average error	-14.6%	-14.0%
Concentration median error	-1.3%	-11.2%
Paired load average error	11.1%	182.9%
Paired load median error	-0.2%	-10.7%
Paired t, concentration	0.55	0.56
Paired t, load	0.56	0.16
Long-term load vs. stratified regression estimate	-18.1%	-38.5%
Monthly load NSE	0.31	0.68

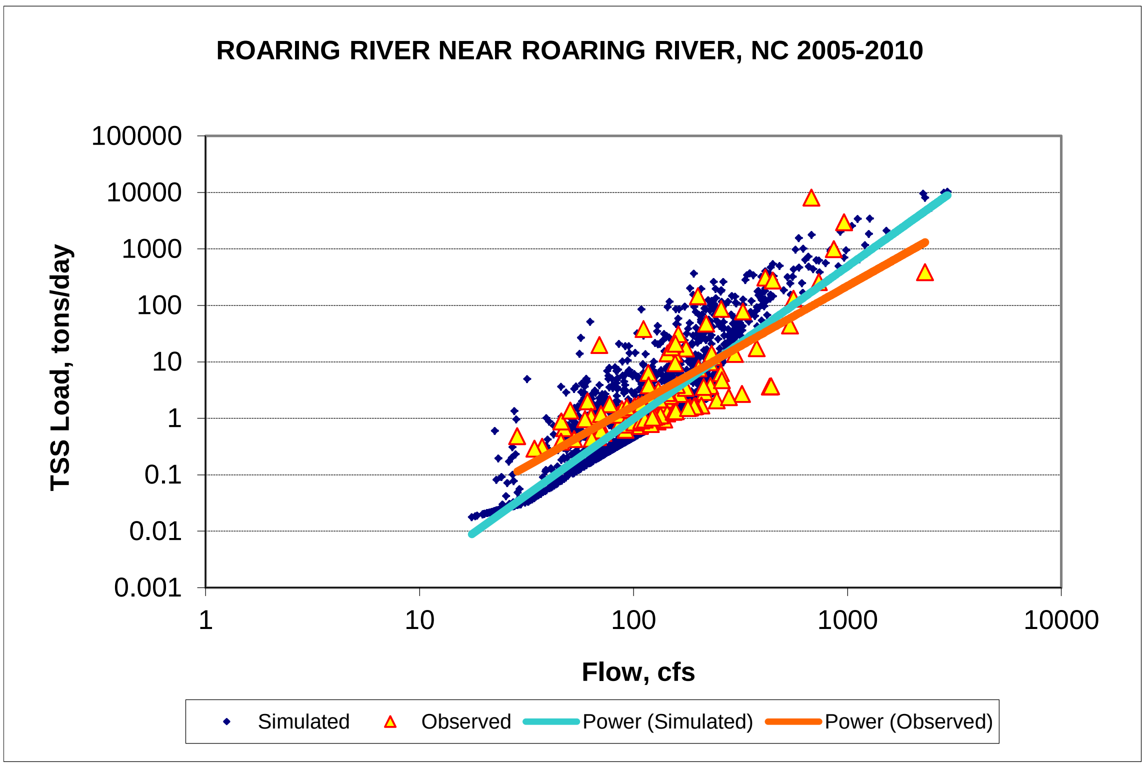

Figure F- 16. TSS Load Power Plot, Calibration Period, Roaring River at Roaring River

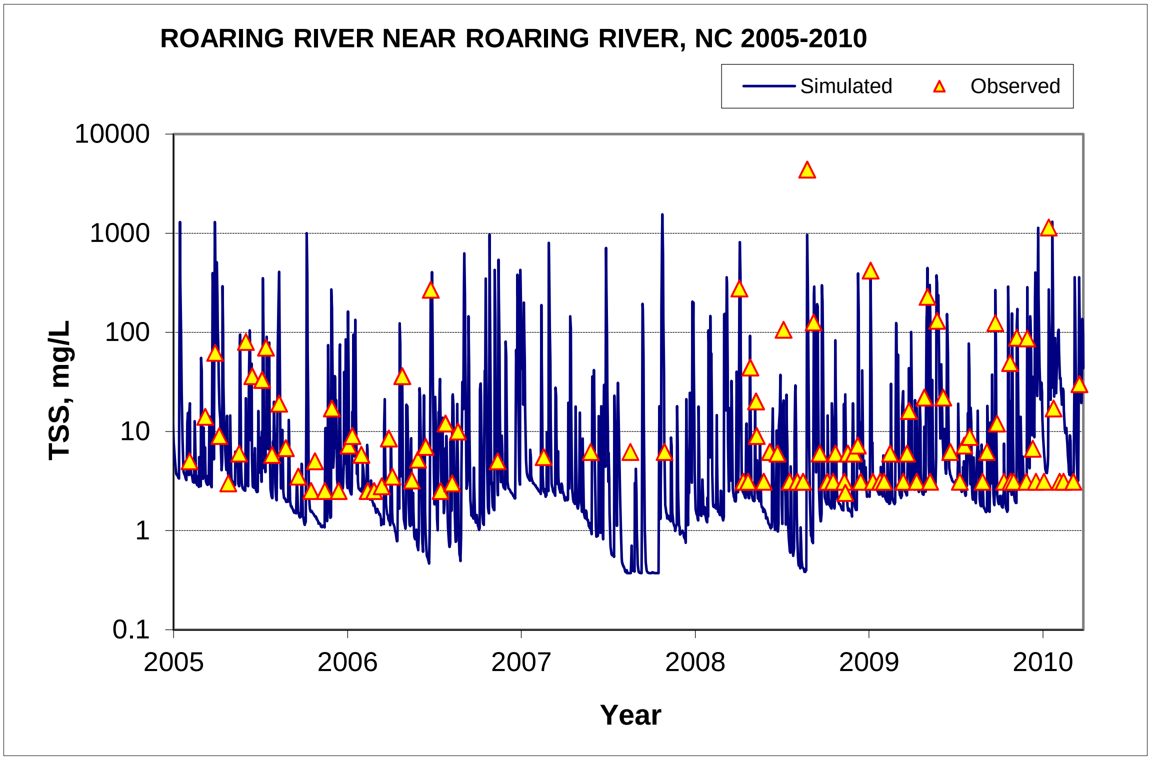

Figure F- 17. TSS Concentration Time Series, Calibration Period, Roaring River at Roaring River

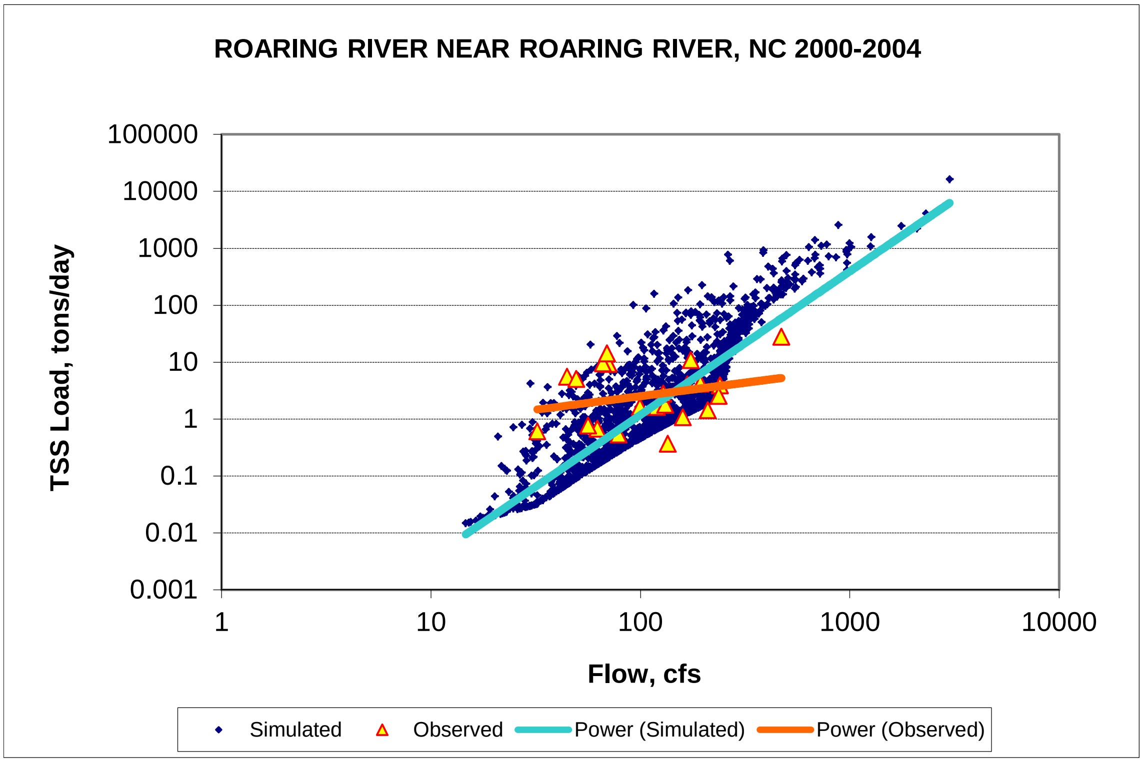

Figure F- 18. TSS Load Power Plot, Validation Period, Roaring River at Roaring River

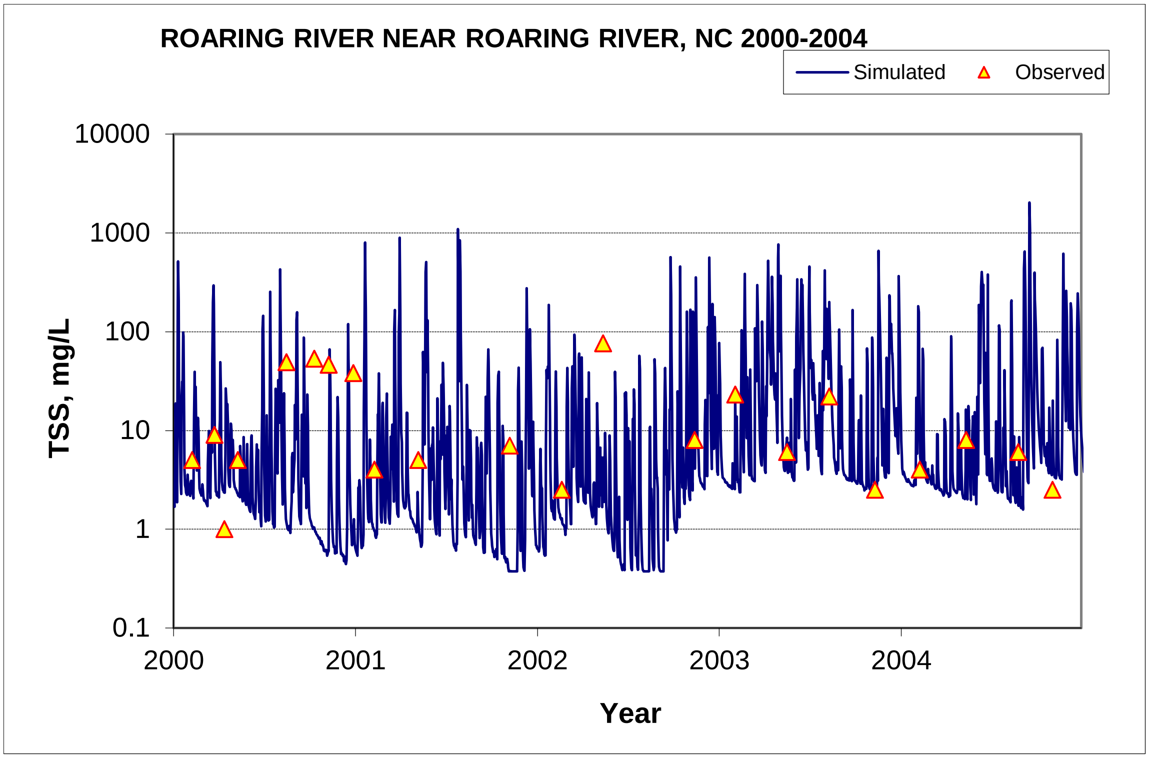

Figure F- 19. TSS Concentration Time Series, Validation Period, Roaring River at Roaring River

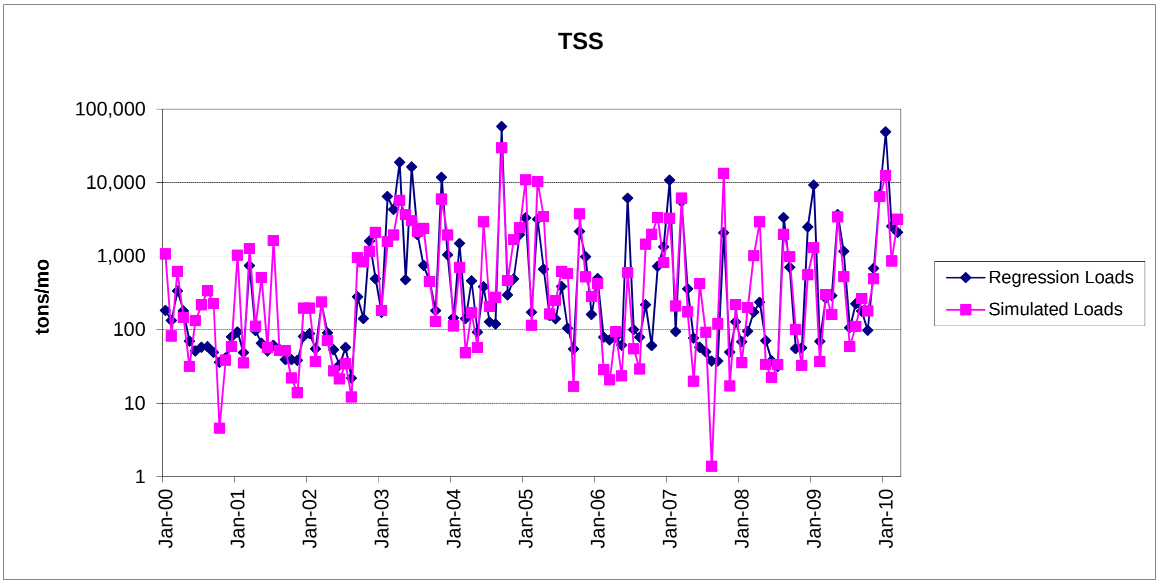

Figure F- 20. TSS Monthly Load Series, Roaring River at Roaring River

Table F- 5. Summary Statistics, TSS, Muddy Creek at Muddy Creek

	2005-2010	2000-2004
Count	64	-
Concentration average error	-27.6%	-
Concentration median error	2.6%	-
Paired load average error	-47.6%	-
Paired load median error	0.2%	-
Paired t, concentration	0.36	-
Paired t, load	0.17	-
Long-term load vs. stratified regression estimate	-89.5%	-
Monthly load NSE	-0.02	-

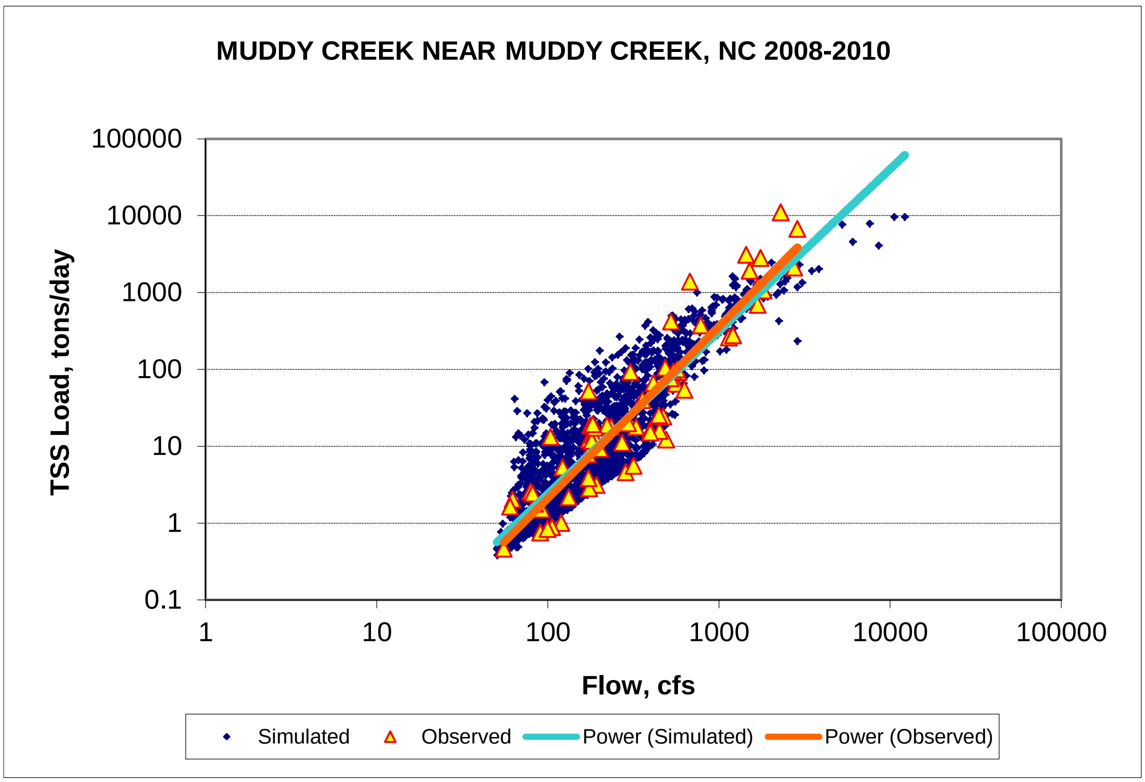

Figure F- 21. TSS Load Power Plot, Calibration Period, Muddy Creek at Muddy Creek

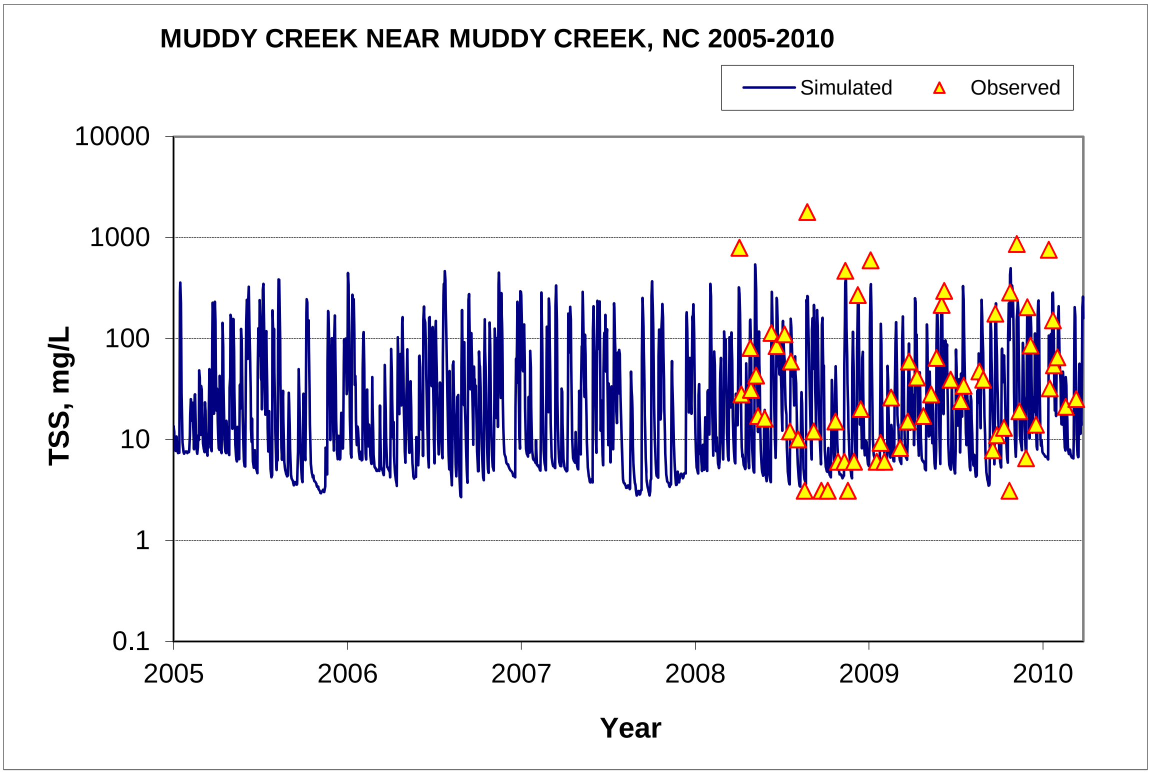

Figure F- 22. TSS Concentration Time Series, Calibration Period, Muddy Creek at Muddy Creek

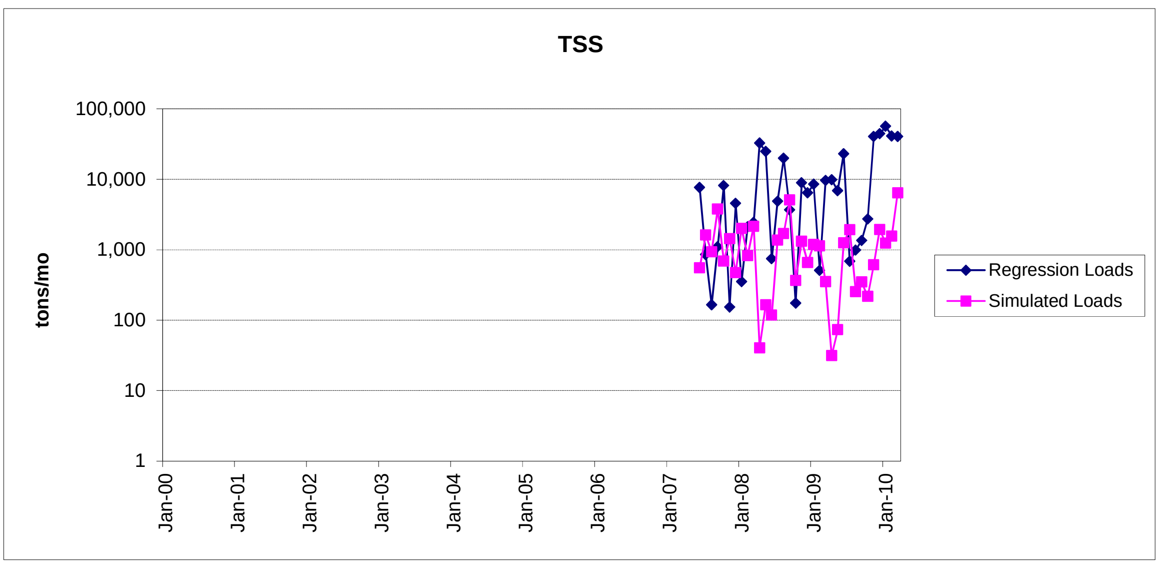

Figure F- 23. TSS Monthly Load Series, Muddy Creek at Muddy Creek

Table F- 6. Summary Statistics, TSS, Second Creek near Barber

	2005-2010	2000-2004
Count	54	23
Concentration average error	-38.9%	-34.1%
Concentration median error	-0.9%	0.5%
Paired load average error	-5.5%	-2.1%
Paired load median error	0.0%	0.1%
Paired t, concentration	0.25	0.40
Paired t, load	0.64	0.62
Long-term load vs. stratified regression estimate	-50.1%	-58.4%
Monthly load NSE	0.35	0.32

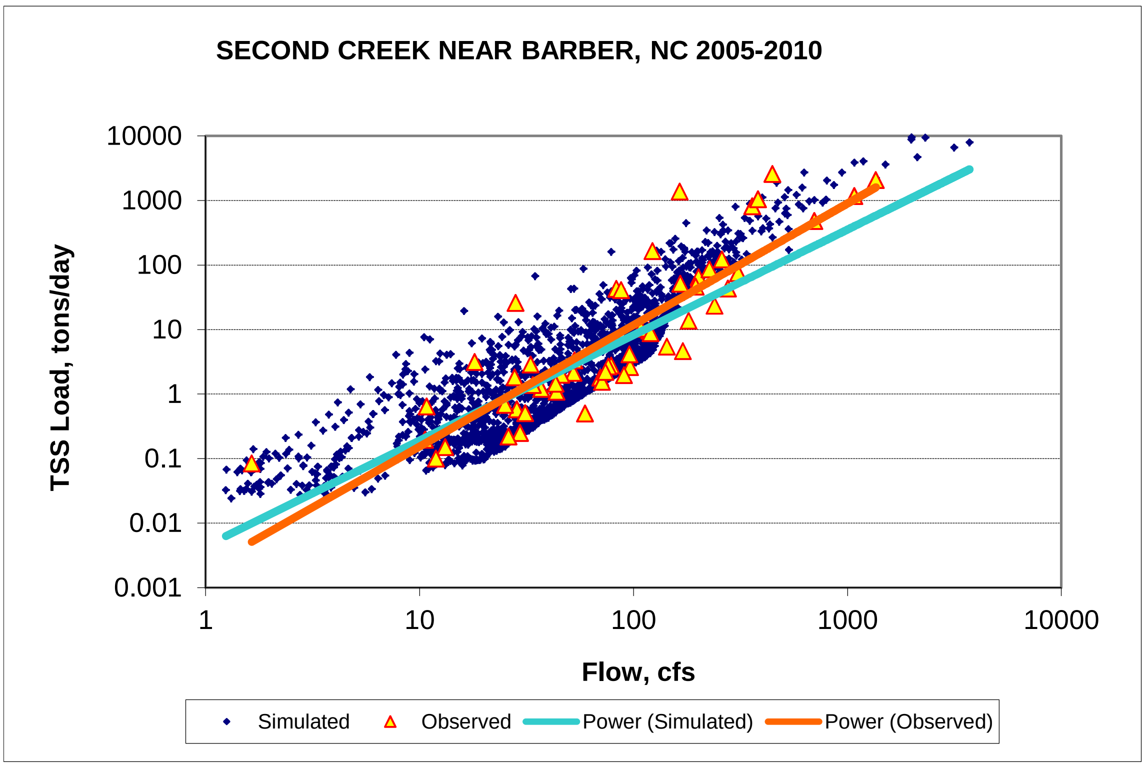

Figure F- 24. TSS Load Power Plot, Calibration Period, Second Creek near Barber

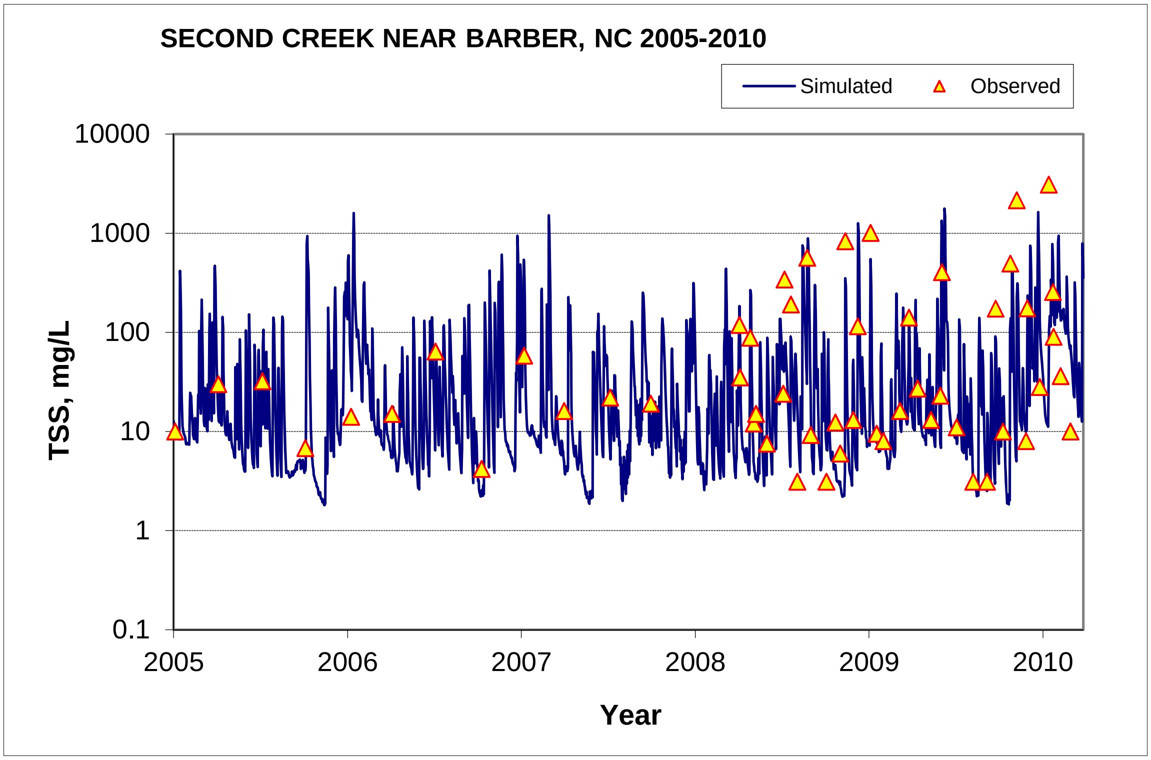

Figure F- 25. TSS Concentration Time Series, Calibration Period, Second Creek near Barber

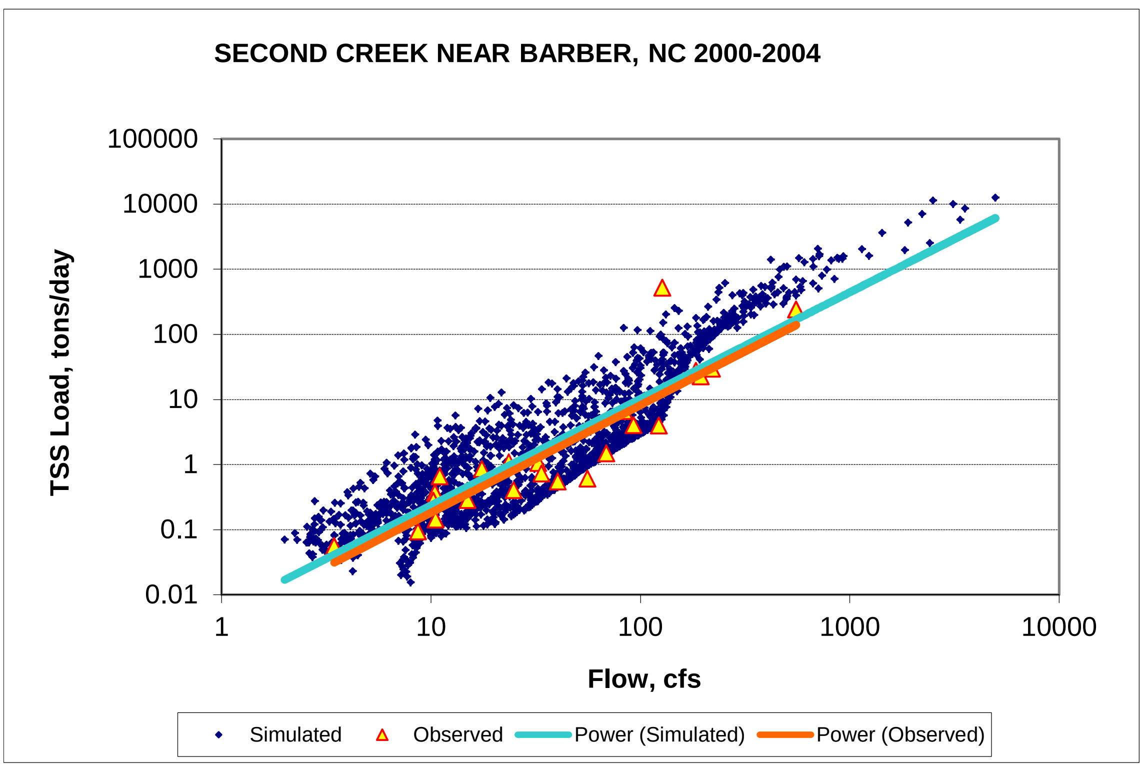

Figure F- 26. TSS Load Power Plot, Validation Period, Second Creek near Barber

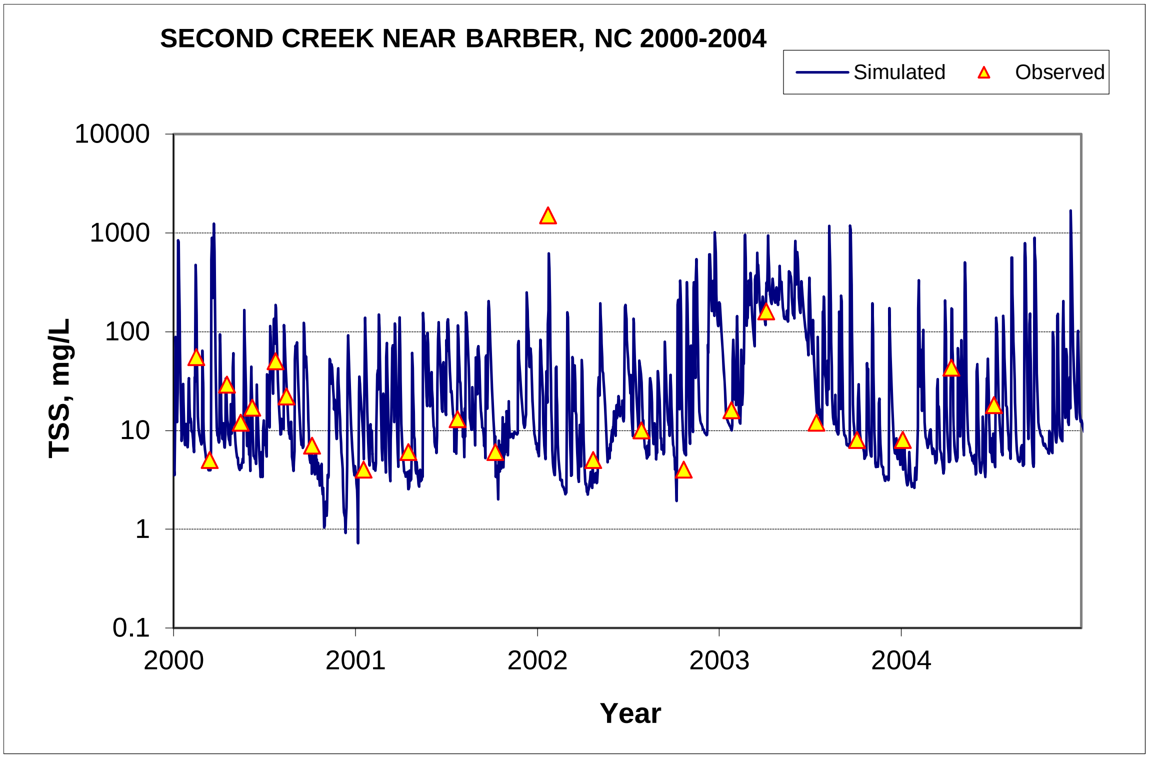

Figure F- 27. TSS Concentration Time Series, Validation Period, Second Creek near Barber

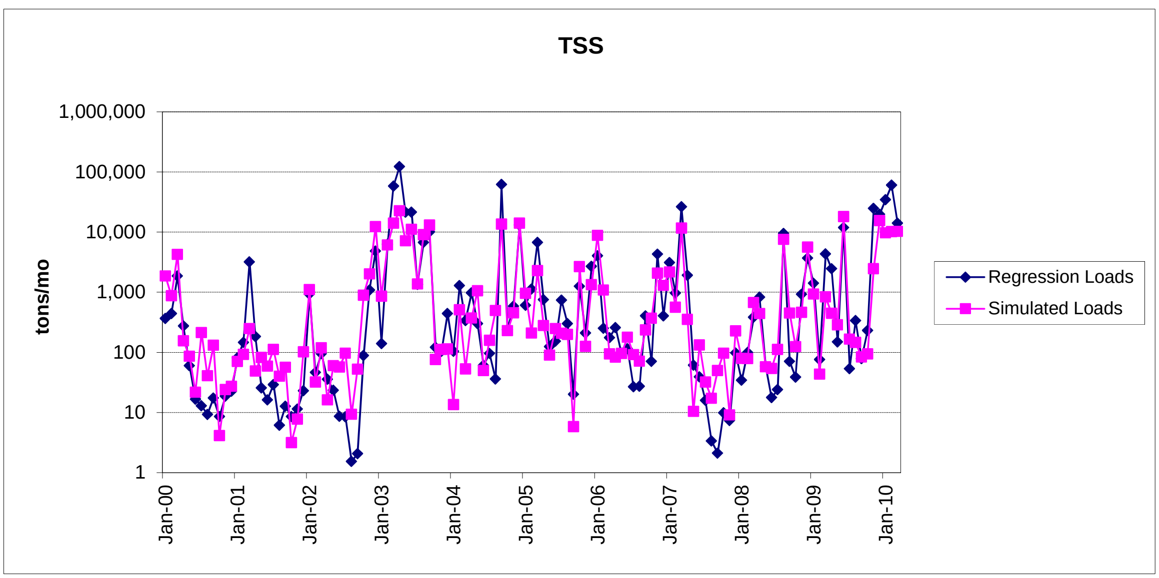

Figure F- 28. TSS Monthly Load Series, Second Creek near Barber

Table F- 7. Summary Statistics, TSS, Yadkin River at Enon

	2005-2010	2000-2004
Count	79	25
Concentration average error	16.3%	29.4%
Concentration median error	-3.1%	-2.7%
Paired load average error	46.7%	10.3%
Paired load median error	-0.7%	-0.7%
Paired t, concentration	0.55	0.43
Paired t, load	0.36	0.58
Long-term load vs. stratified regression estimate	-45.6%	-48.5%
Monthly load NSE	0.40	0.28

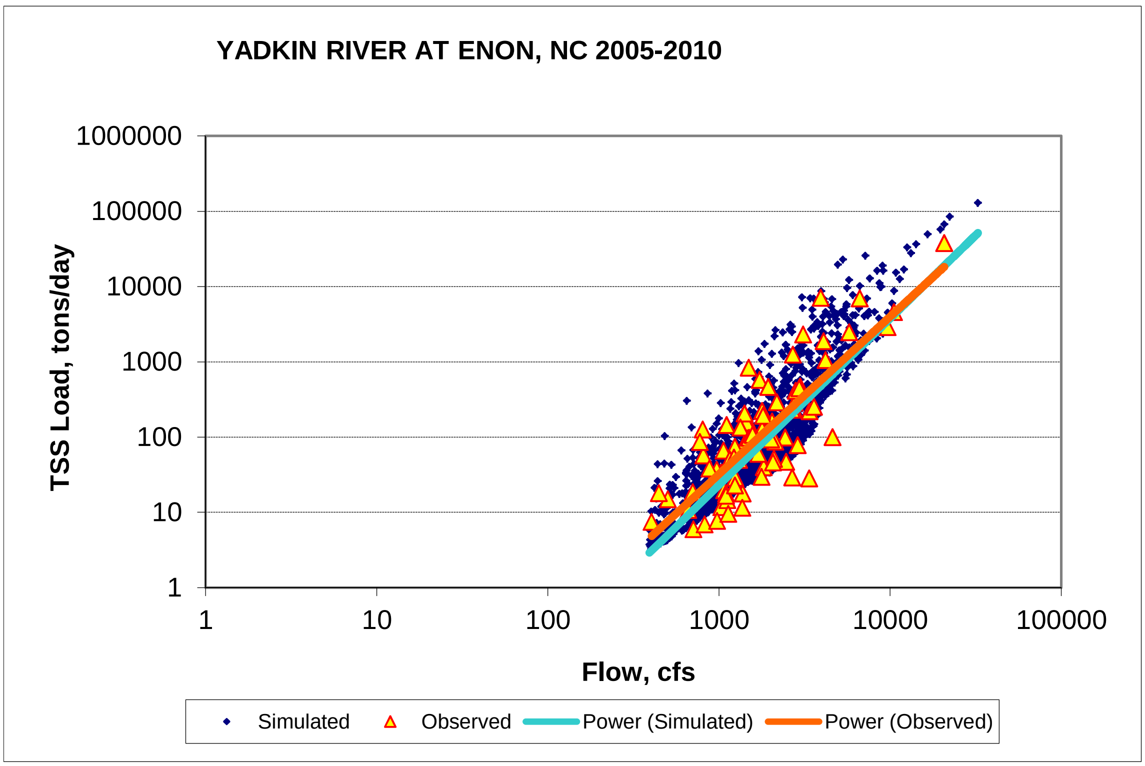

Figure F- 29. TSS Load Power Plot, Calibration Period, Yadkin River at Enon

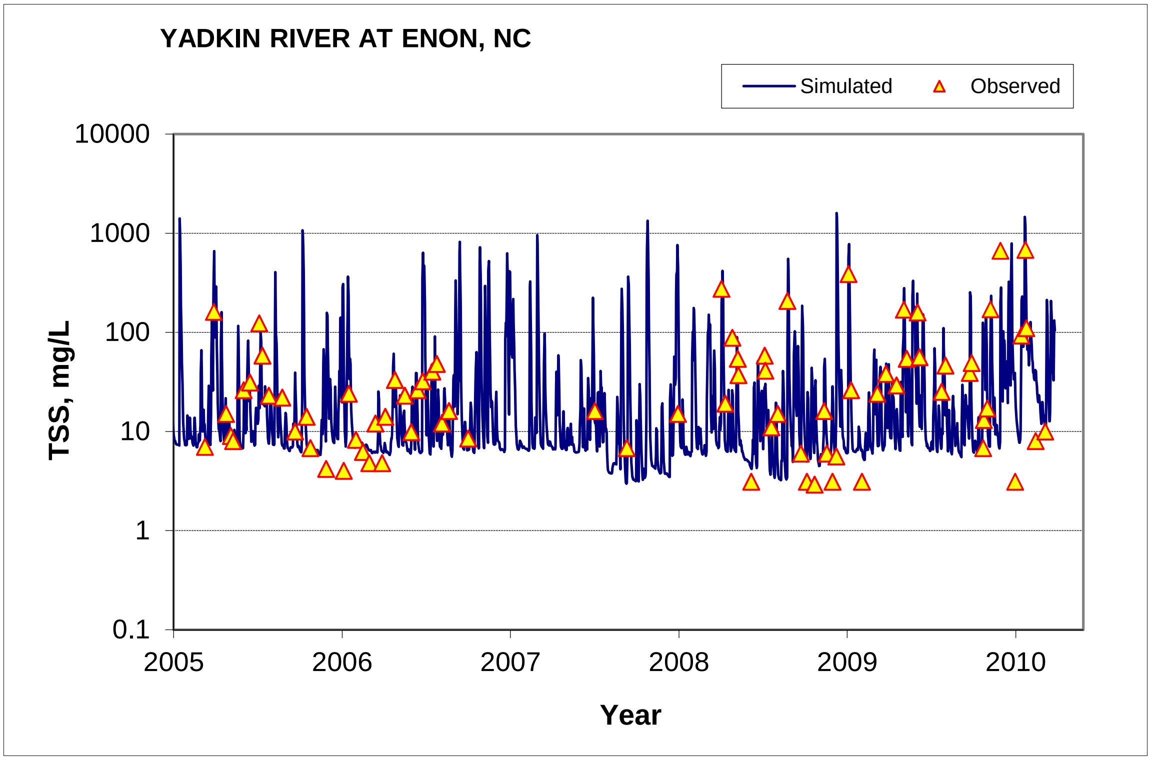

Figure F- 30. TSS Concentration Time Series, Calibration Period, Yadkin River at Enon

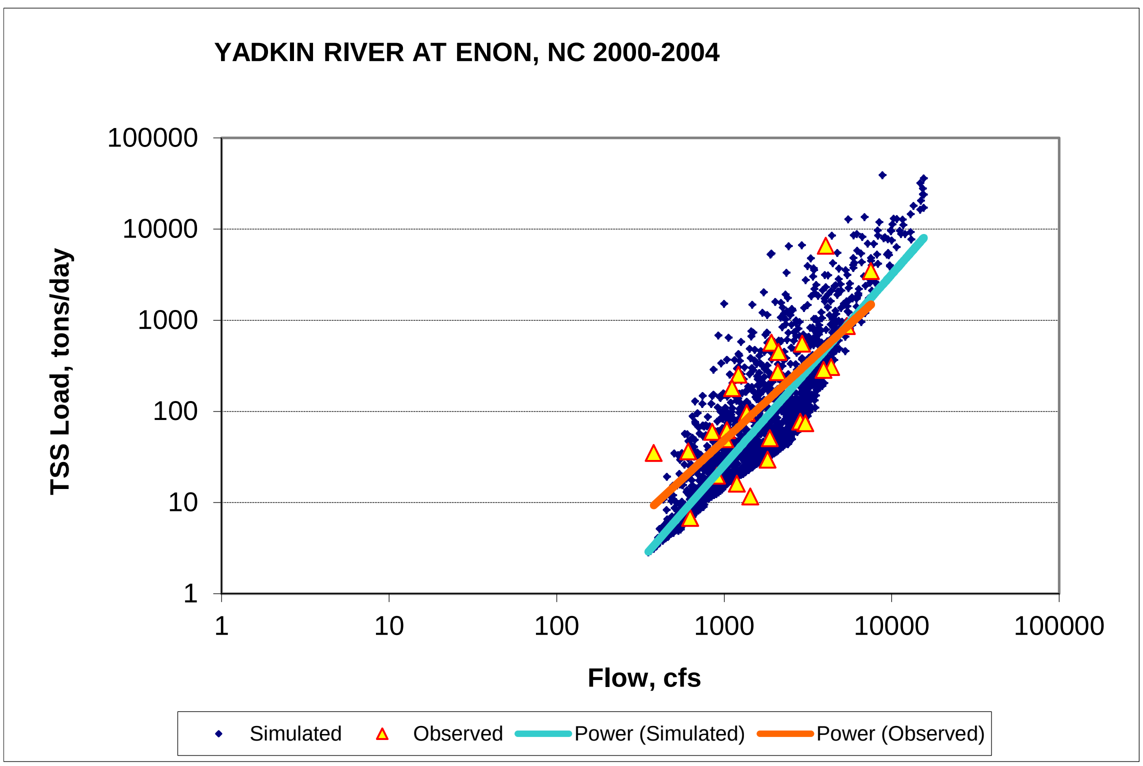

Figure F- 31. TSS Load Power Plot, Validation Period, Yadkin River at Enon

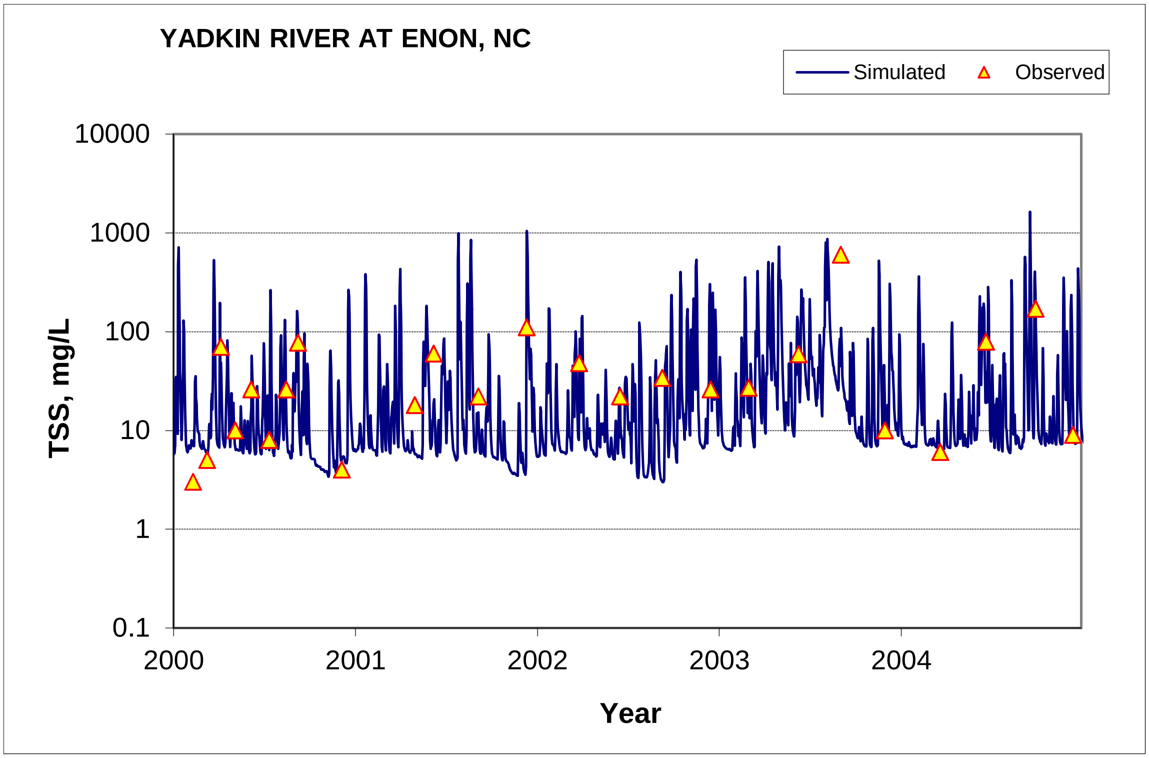

Figure F- 32. TSS Concentration Time Series, Validation Period, Yadkin River at Enon

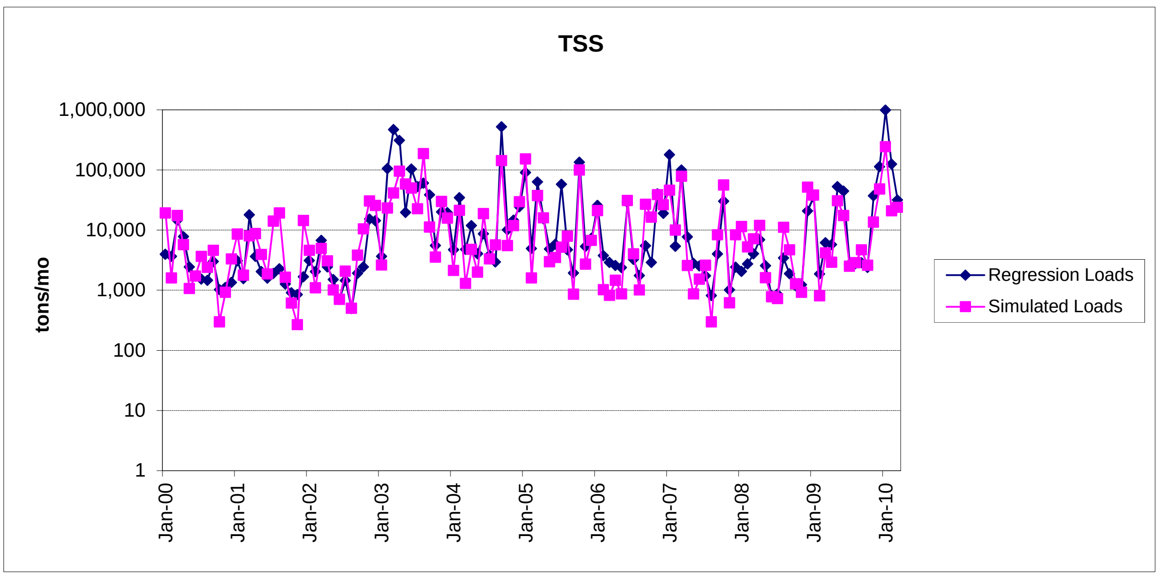

Figure F- 33. TSS Monthly Load Series, Yadkin River at Enon

Table F- 8. Summary Statistics, TSS, Yadkin River at Elkin

	2005-2010	2000-2004
Count	79	22
Concentration average error	-36.2%	-10.7%
Concentration median error	-0.1%	-1.2%
Paired load average error	-40.5%	-5.2%
Paired load median error	0.0%	-0.9%
Paired t, concentration	0.24	0.70
Paired t, load	0.24	0.69
Long-term load vs. stratified regression estimate	-37.8%	-54.0%
Monthly load NSE	0.63	0.40

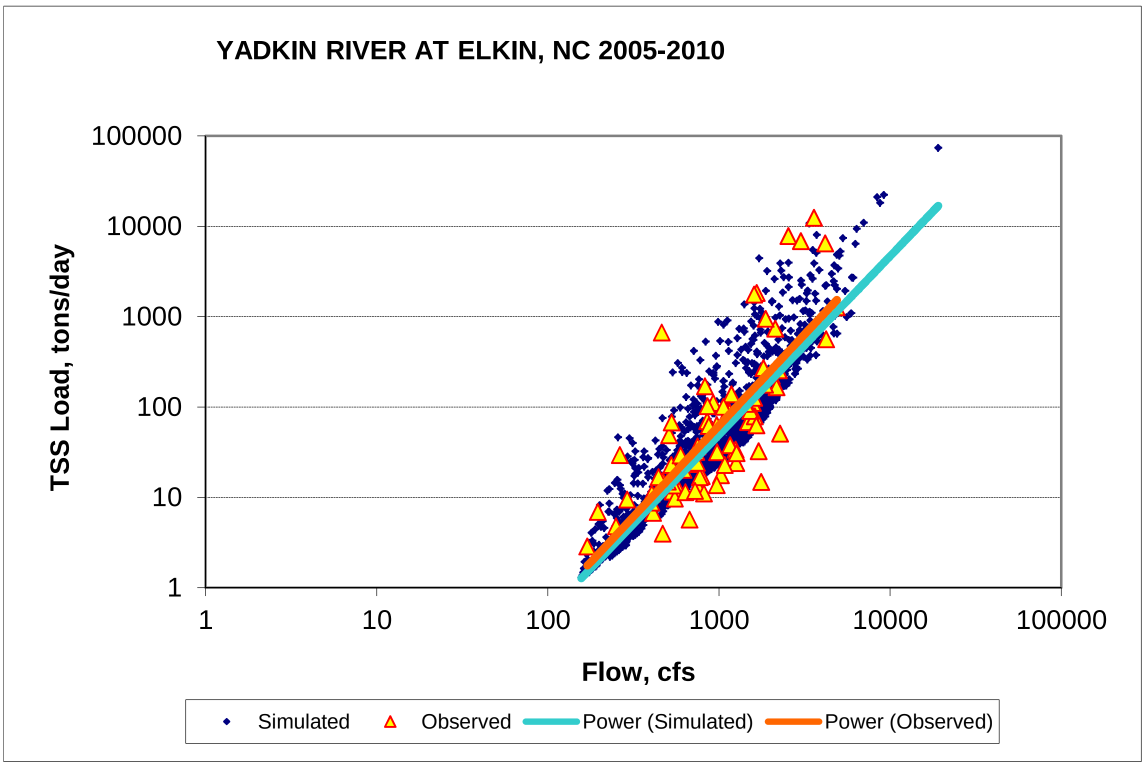

Figure F- 34. TSS Load Power Plot, Calibration Period, Yadkin River at Elkin

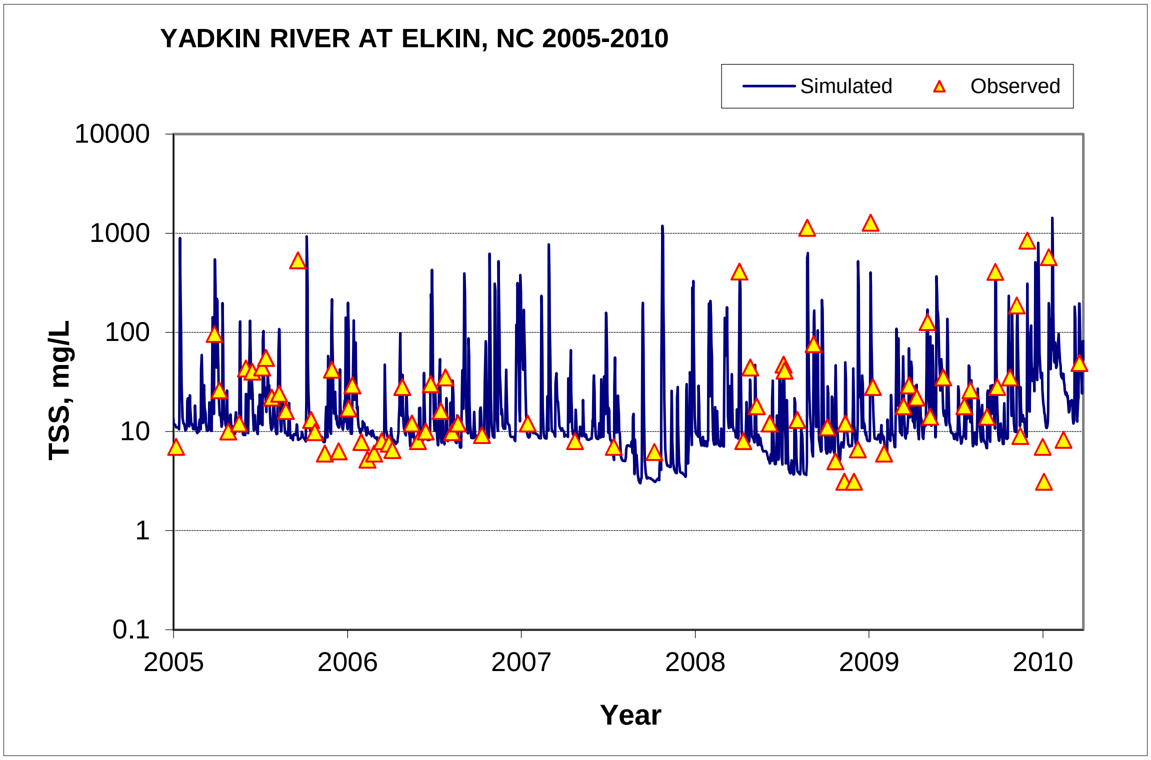

Figure F- 35. TSS Concentration Time Series, Calibration Period, Yadkin River at Elkin

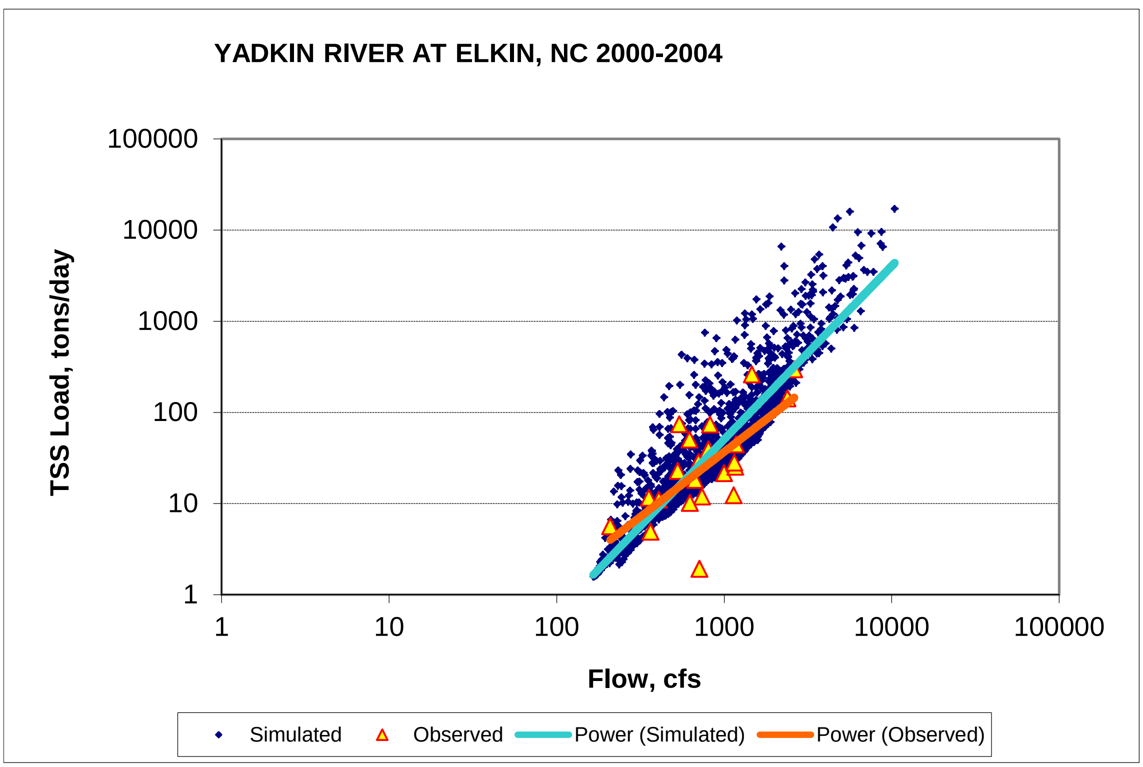

Figure F- 36. TSS Load Power Plot, Validation Period, Yadkin River at Elkin

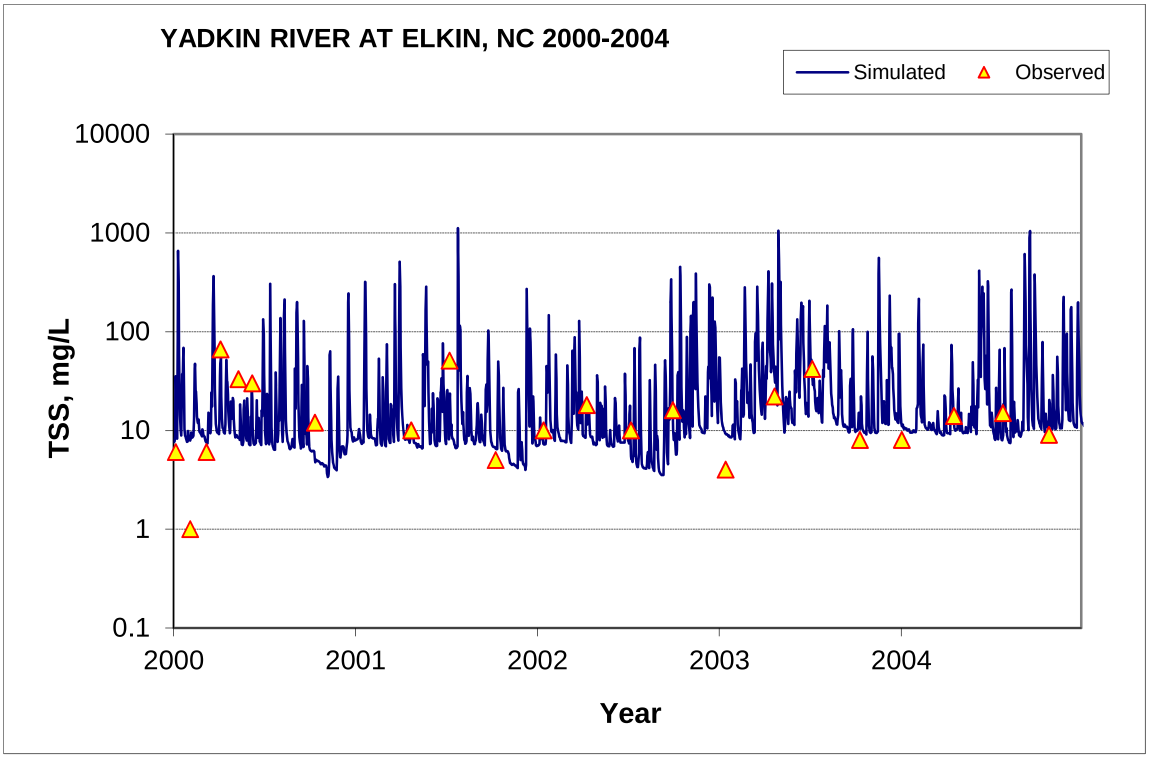

Figure F- 37. TSS Concentration Time Series, Validation Period, Yadkin River at Elkin

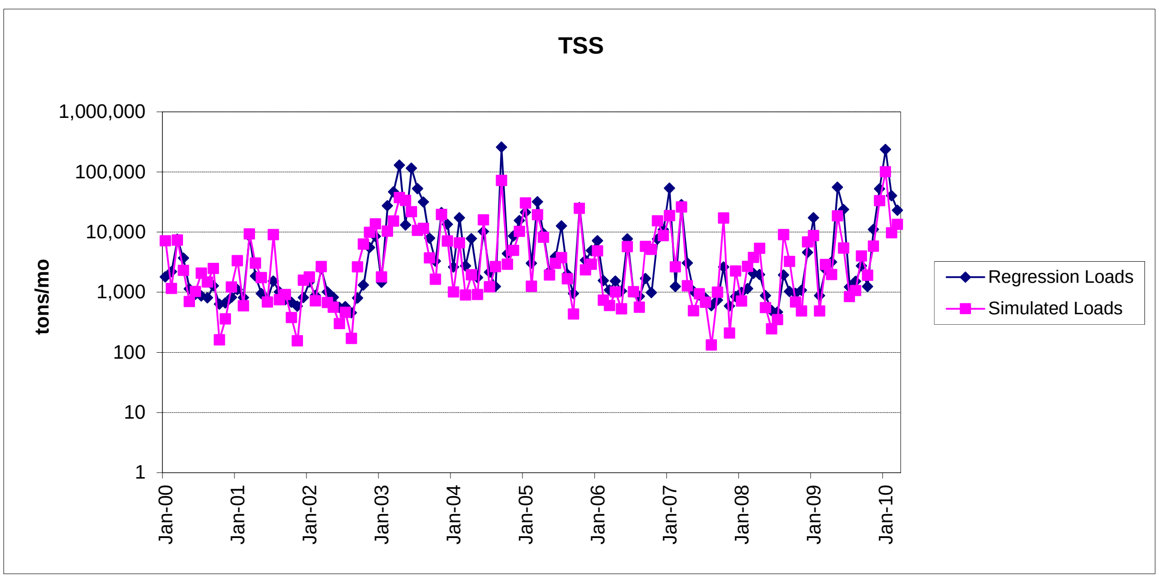

Figure F- 38. TSS Monthly Load Series, Yadkin River at Elkin

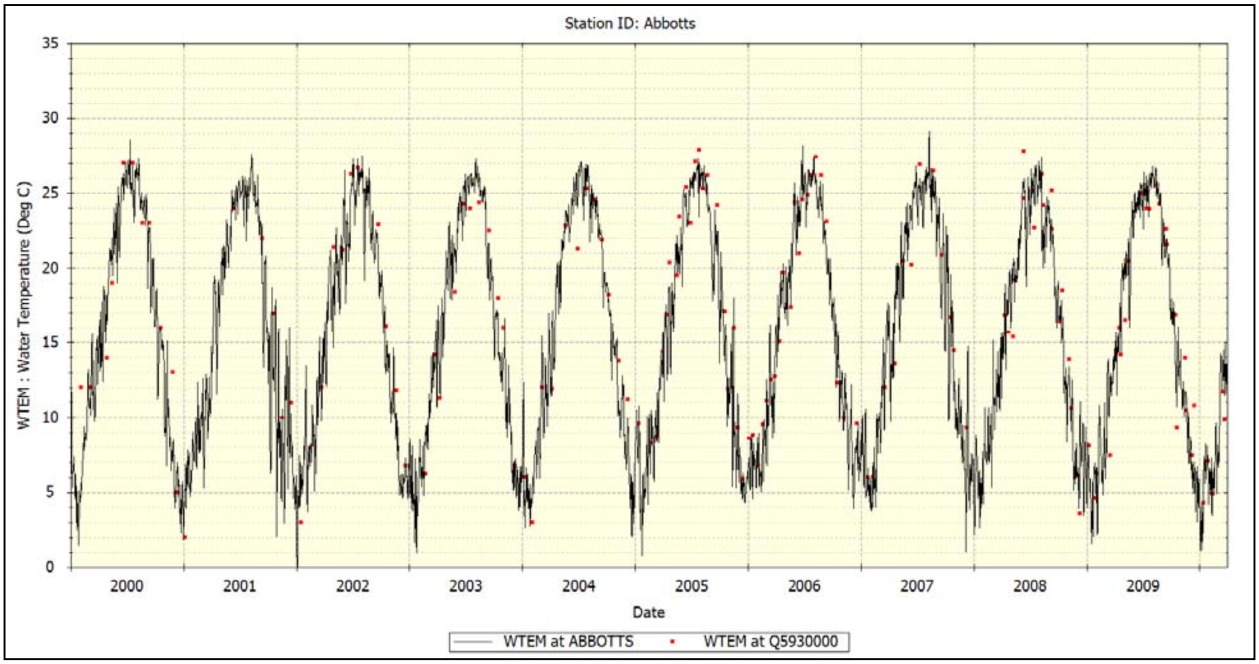

Figure F- 39. Water Temperature Calibration, Abbotts Creek

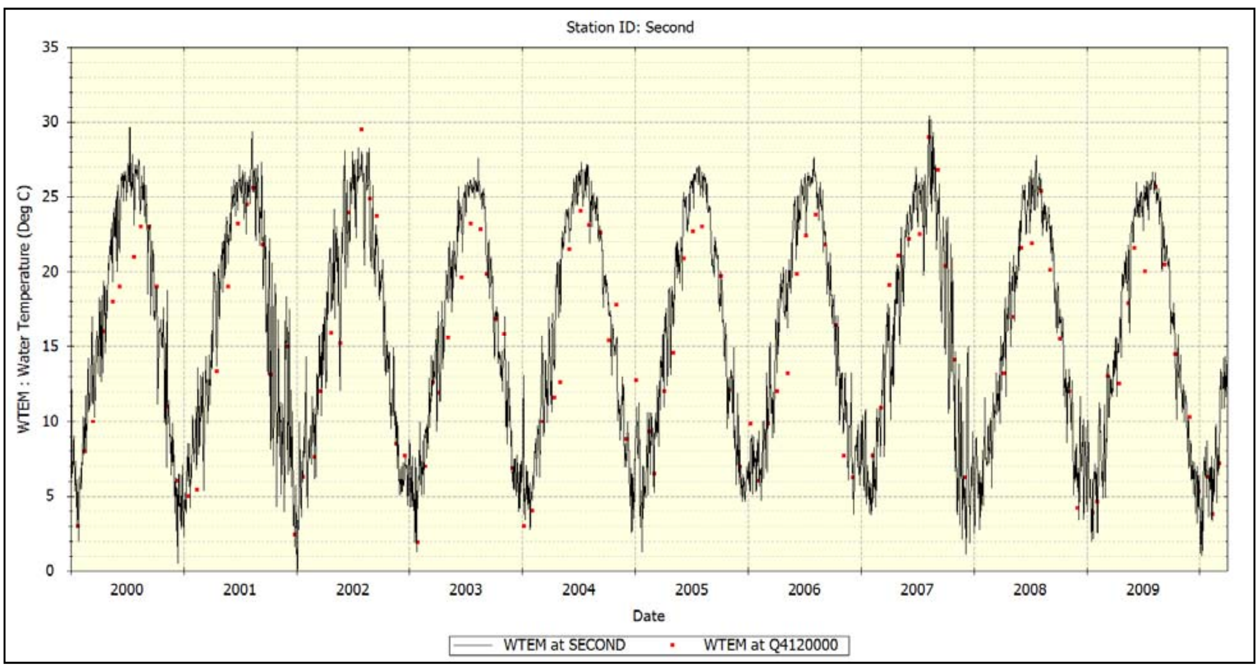

Figure F- 40. Water Temperature Calibration, Second Creek

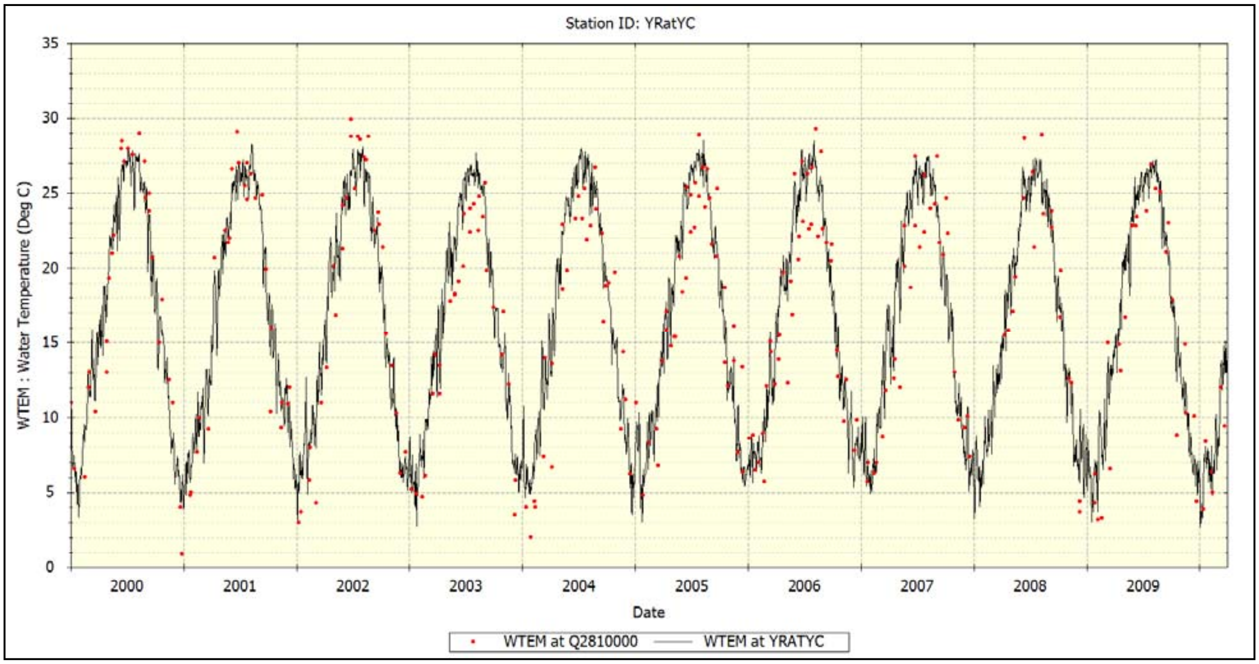

Figure F- 41. Water Temperature Calibration, Yadkin River at Yadkin College

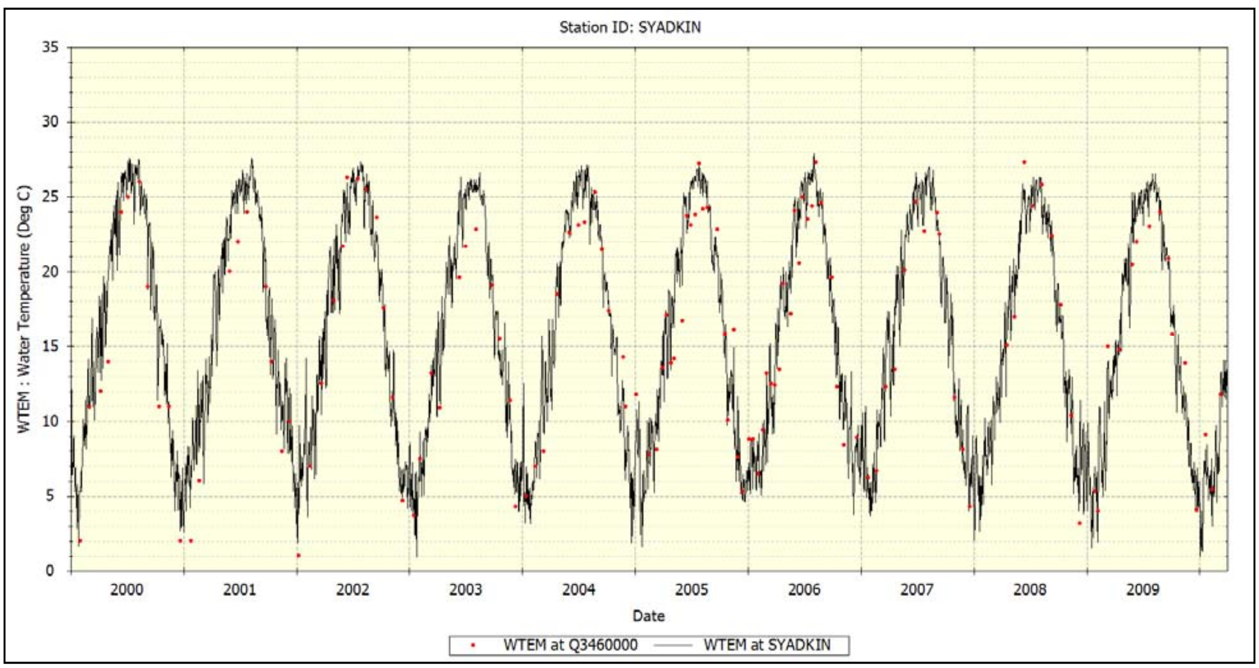

Figure F- 42. Water Temperature Calibration, South Yadkin River

Appendix G. Nutrients and DO/BOD Calibration/ Validation

Tables in this section contain the following information for the calibration period (2005-2010) and the validation period (2000-2004):

Count: Number of days with samples (multiple observations on a single day are averaged)

Concentration average error: Average of relative error ([simulated – observed]/observed) calculated from daily average concentration.

Concentration median error: Median of relative error ([simulated – observed]/observed) calculated from daily average concentration.

Paired load average error: Average of relative error ([simulated – observed]/observed) on load estimates calculated with daily average concentrations and daily average simulated flow.

Paired load median error: Median of relative error ([simulated – observed]/observed) on load estimates calculated with daily average concentrations and daily average simulated flow.

Paired t, concentration: Probability value from Student's t test of equality of simulated and observed means.

Paired t, load: Probability value from Student's t test of equality of simulated and observed loads, calculated from daily average concentrations and daily average simulated flow.

Long-term load vs. stratified regression estimate: Relative error on cumulative total load estimates ([simulated – observed]/observed) with "observed" loads calculated with observed flows and concentrations estimated from a stratified regression of the natural log of observed concentration on the natural log of observed flow. Stratification breakpoint assigned between one and two times the median flow.

Monthly load NSE: Nash-Sutcliffe coefficient of model fit efficiency calculated from simulated monthly loads and monthly loads estimated by the stratified regression estimator.

Table G- 1. Yadkin River at Yadkin College Summary Statistics, Total P

	2005-2010	2000-2004
Count	166	74
Concentration average error	-30.1%	-27.6%
Concentration median error	2.3%	-5.2%
Paired load average error	9.6%	-15.4%
Paired load median error	1.3%	-2.9%
Paired t, concentration	0.20	0.20
Paired t, load	0.66	0.64
Long-term load vs. stratified regression estimate	-11.6%	-11.2%
Monthly load NSE	0.51	0.62

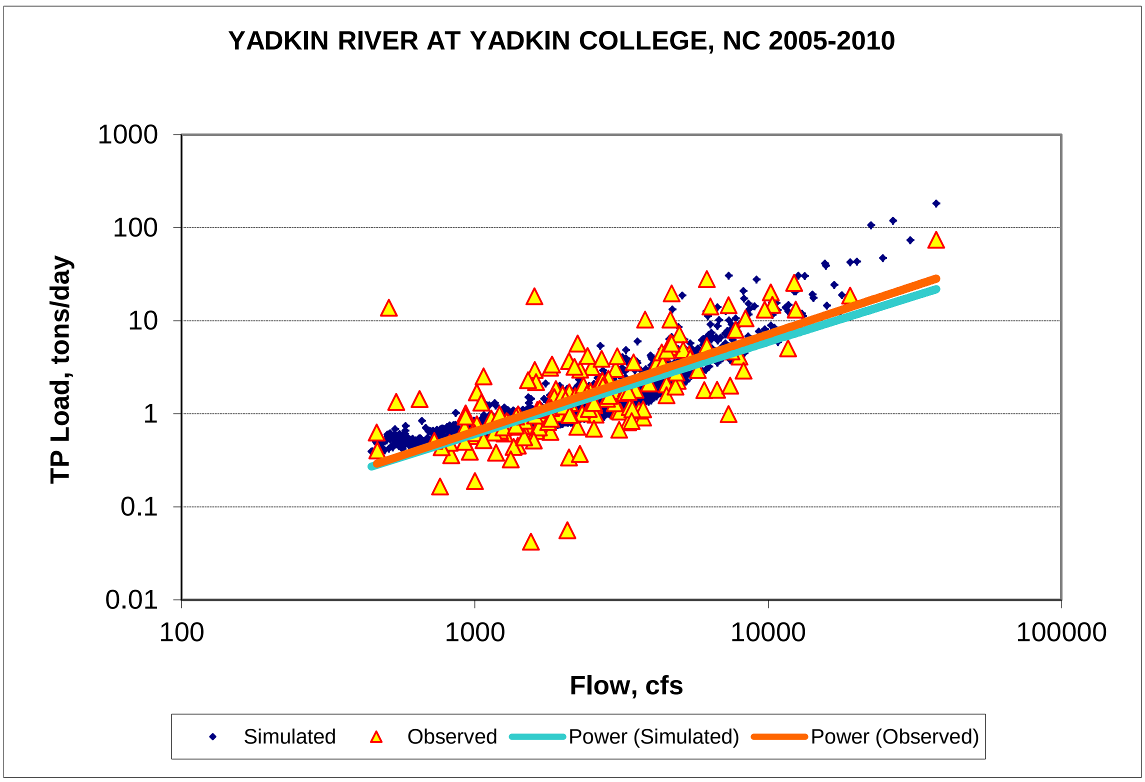

Figure G- 1. Total P Load Power Plot, Calibration Period

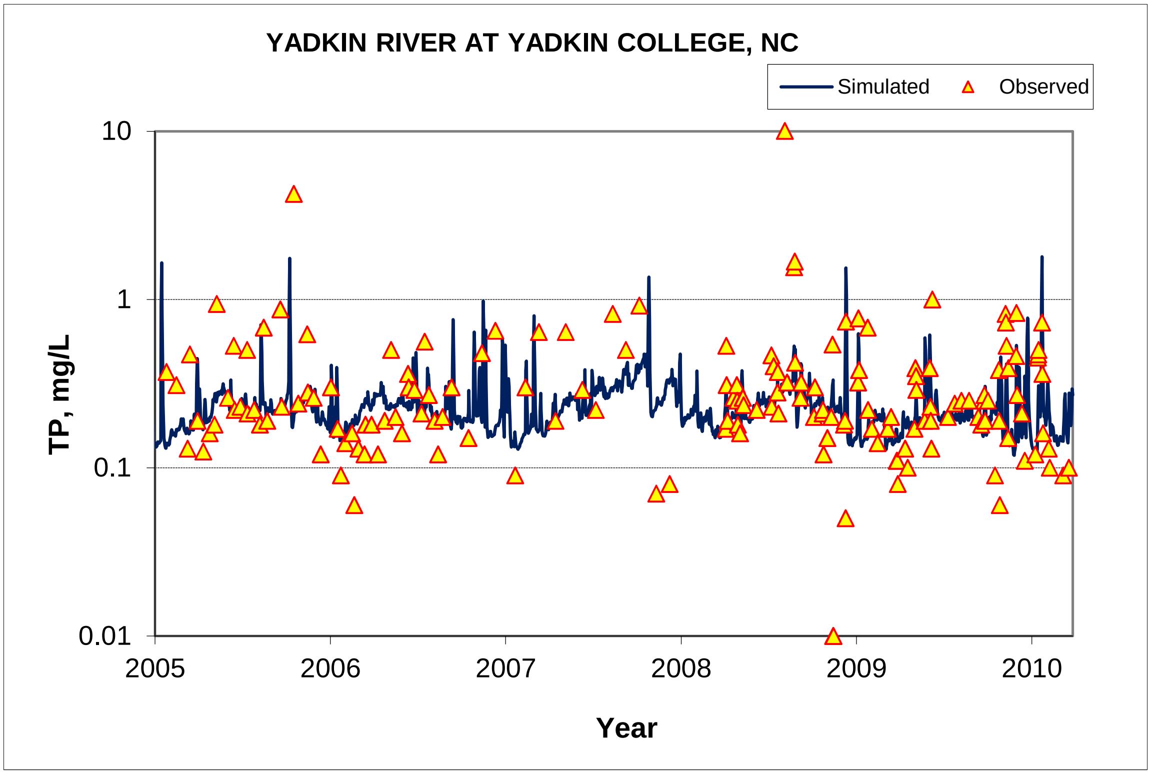

Figure G- 2. Total P Concentration Time Series, Calibration Period

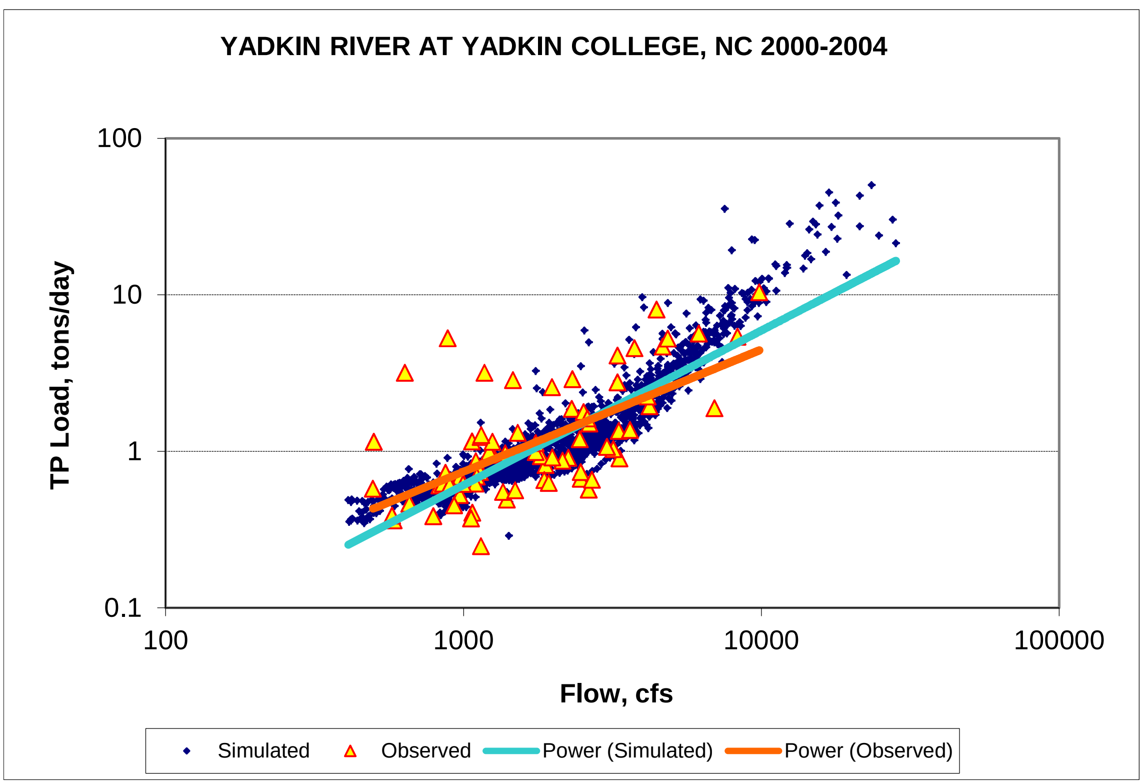

Figure G- 3. Total P Load Power Plot, Validation Period

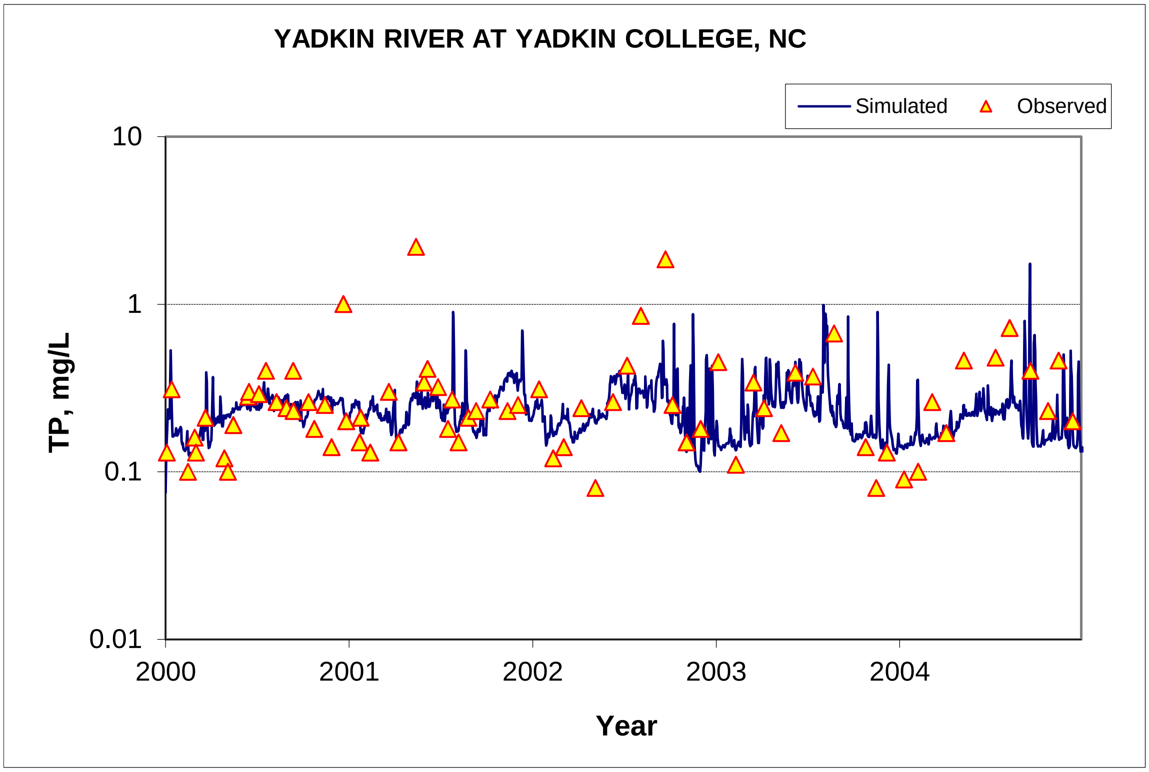

Figure G- 4. Total P Concentration Time Series, Validation Period

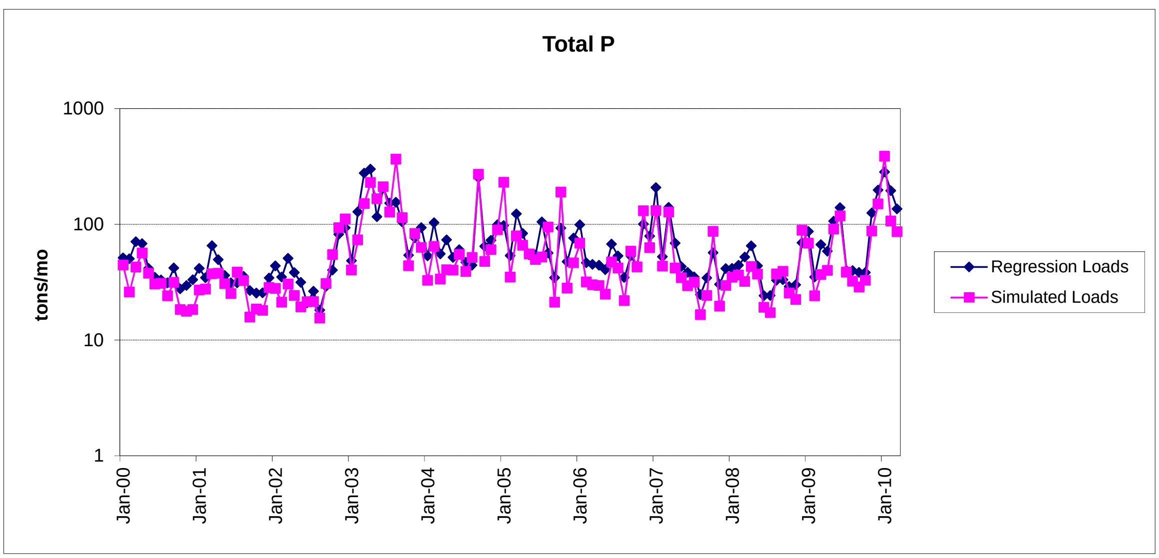

Figure G- 5. Total P Monthly Load Series

Table G- 2. Yadkin River at Yadkin College Summary Statistics, Total N

	2005-2010	2000-2004
Count	167	72
Concentration average error	-8.3%	-12.0%
Concentration median error	-5.7%	-5.8%
Paired load average error	14.3%	-11.1%
Paired load median error	-3.3%	-3.6%
Paired t, concentration	1.00	0.97
Paired t, load	0.61	0.78
Long-term load vs. stratified regression estimate	4.2%	1.7%
Monthly load NSE	0.63	0.67

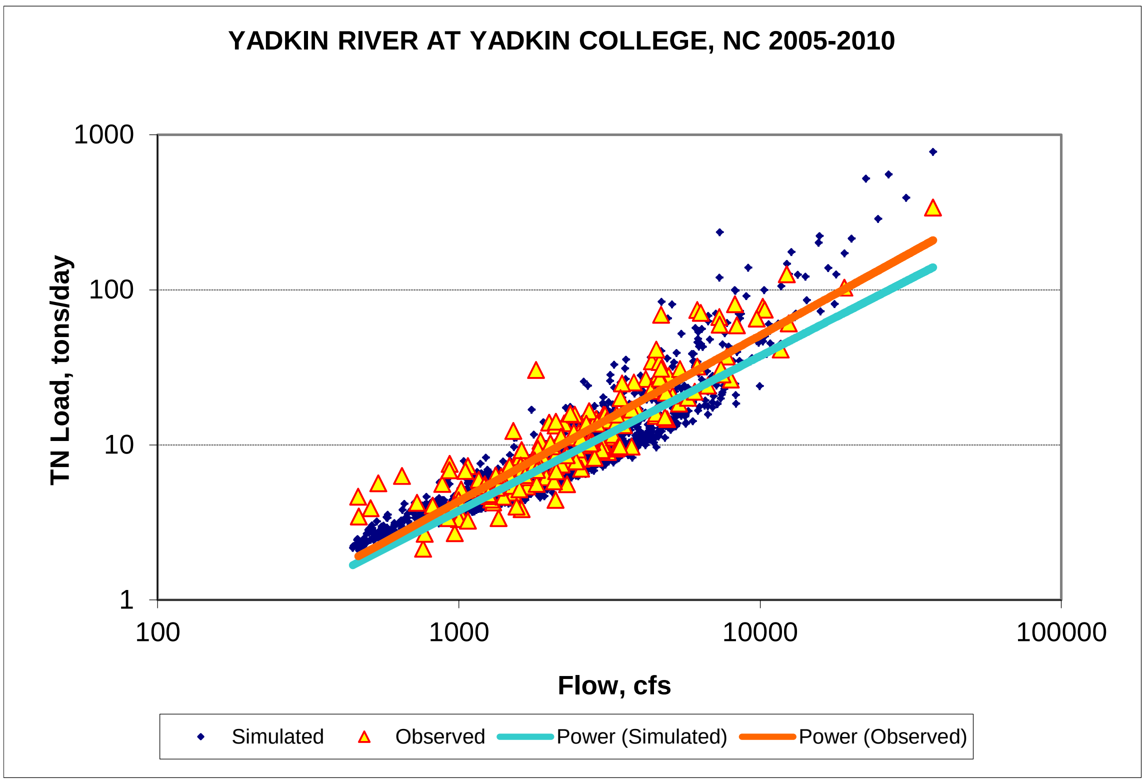

Figure G- 6. Total N Load Power Plot, Calibration Period

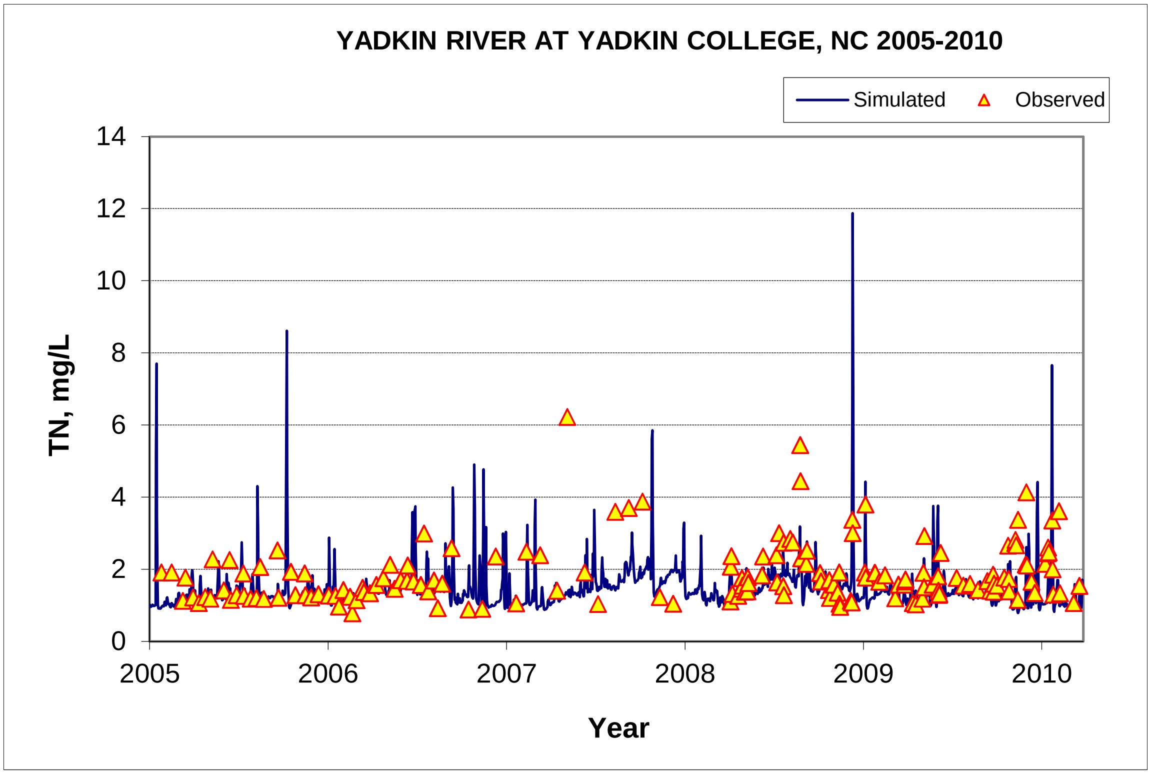

Figure G- 7. Total N Concentration Time Series, Calibration Period

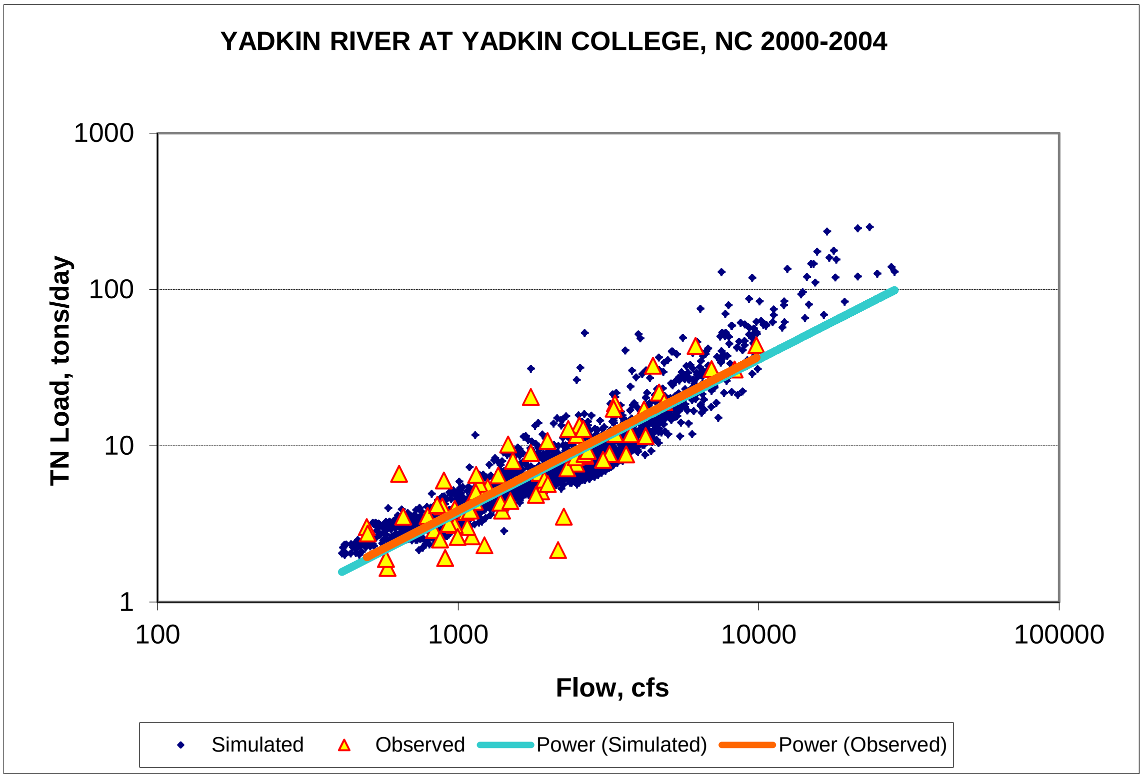

Figure G- 8. Total N Load Power Plot, Validation Period

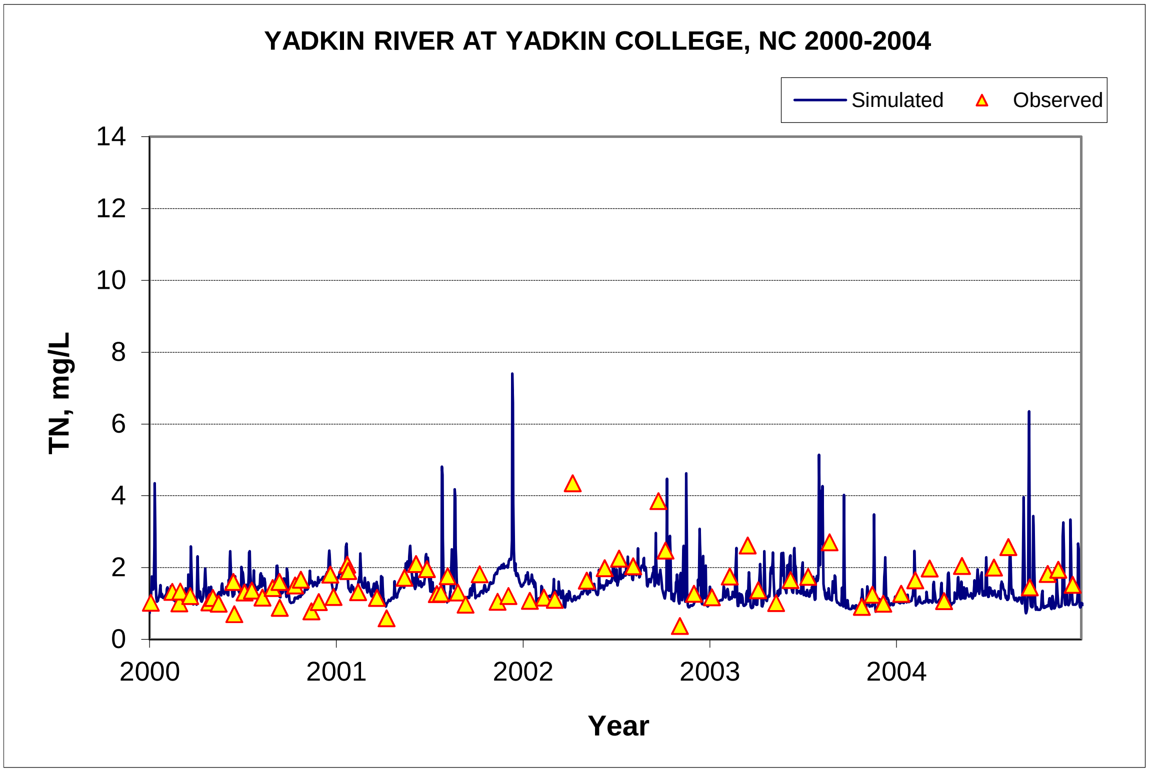

Figure G- 9. Total N Concentration Time Series, Validation Period

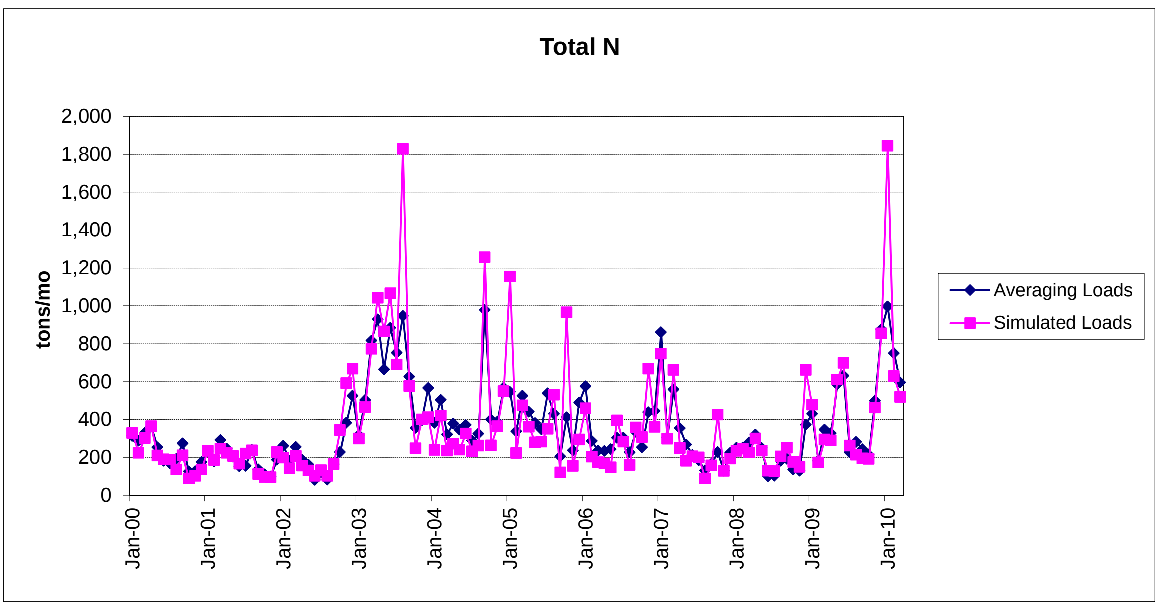

Figure G- 10. Yadkin River at Yadkin College Total N Monthly Load Series

Table G- 3. Nutrient Species Simulation, Yadkin River at Yadkin College, 2005-2010

	NO_2+NO_3-N	NH_4-N	Organic N	PO_4-P	Organic P
Count	173	174	174	64	59
Average Observed (mg/L)	1.03	0.09	0.72	0.09	0.37
Concentration average error	-11.8%	-32.0%	-4.0%	13.9%	-30.1%
Concentration median error	-7.0%	-10.2%	-2.3%	17.0%	2.3%
Paired load average error	2.2%	-41.5%	27.9%	76.5%	9.6%
Paired load median error	-4.2%	-3.2%	-1.0%	13.5%	1.3%

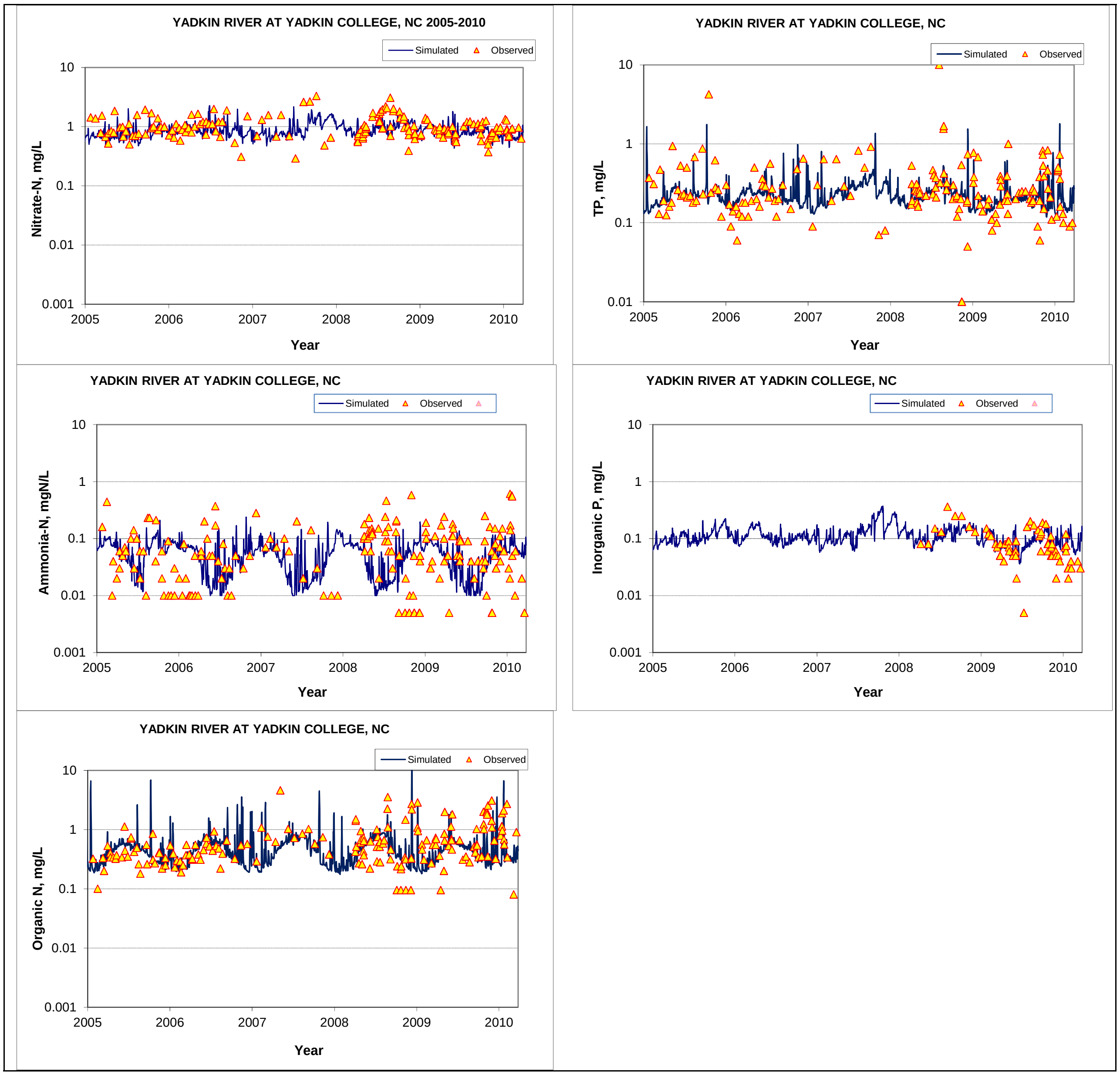

Figure G- 11. Nutrient Species Simulation, Yadkin River at Yadkin College

Table G- 4. Summary Statistics, Total P, South Yadkin River near Mocksville

	2005-2010	2000-2004
Count	109	16
Concentration average error	-1.2%	-6.6%
Concentration median error	3.6%	25.7%
Paired load average error	60.0%	-18.2%
Paired load median error	0.5%	21.8%
Paired t, concentration	0.94	0.76
Paired t, load	0.16	0.53
Long-term load vs. stratified regression estimate	-20.2%	-20.2%
Monthly load NSE	0.75	0.34

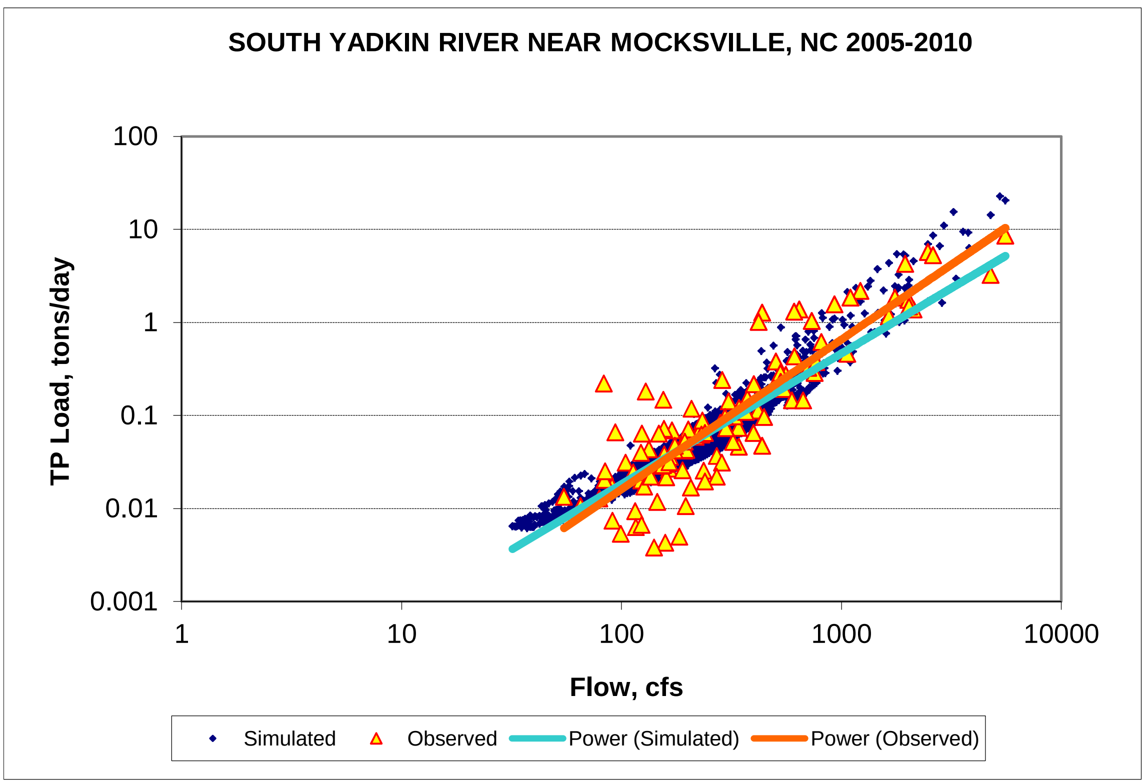

Figure G- 12. Total P Load Power Plot, Calibration Period, South Yadkin River near Mocksville

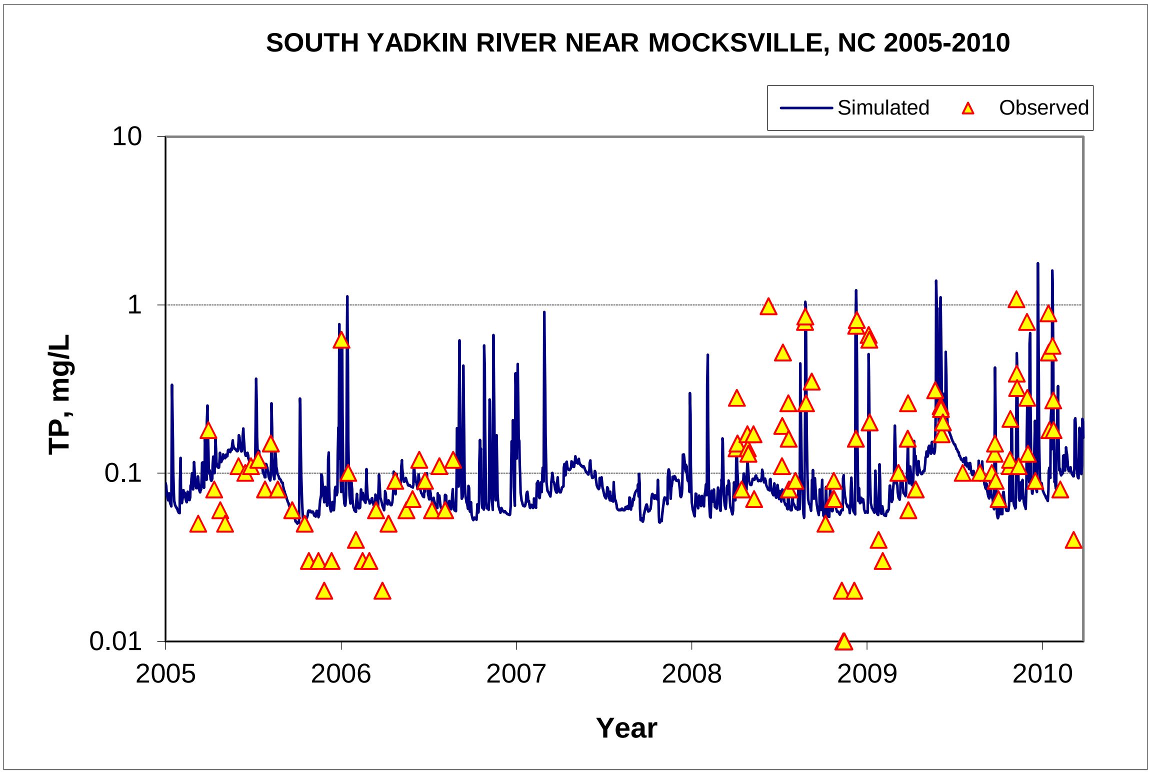

Figure G- 13. Total P Concentration Time Series, Calibration Period, South Yadkin River near Mocksville

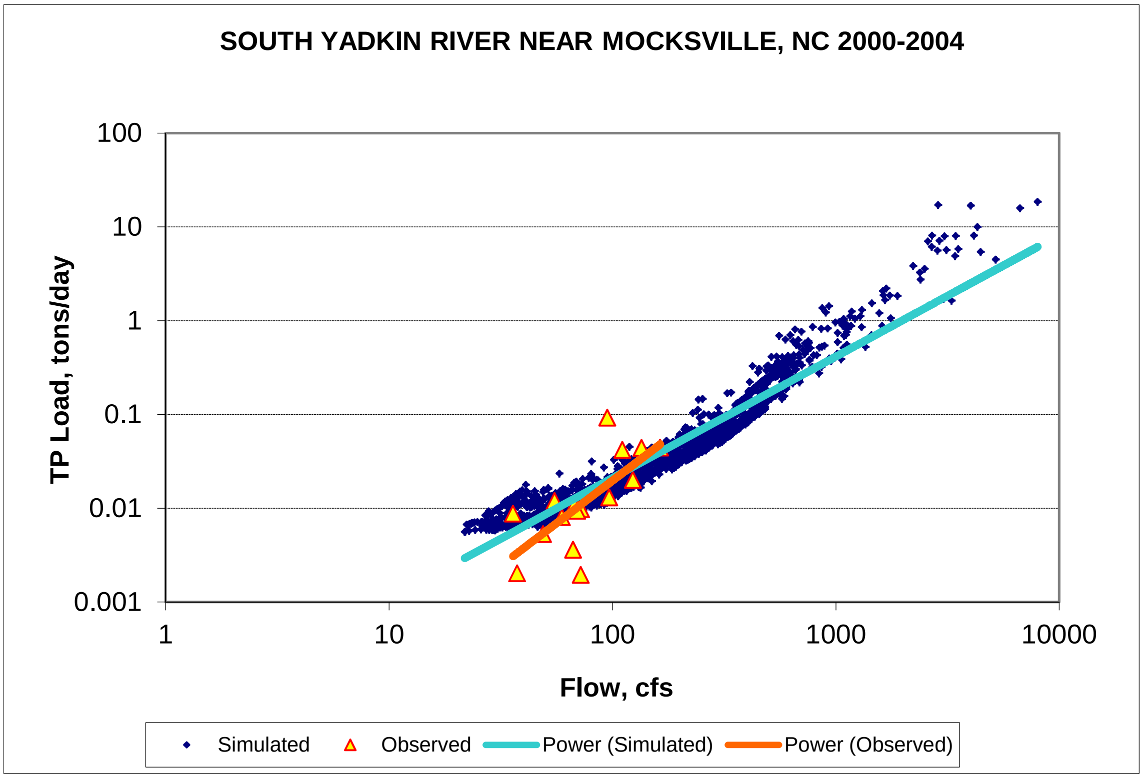

Figure G- 14. Total P Load Power Plot, Validation Period, South Yadkin River near Mocksville

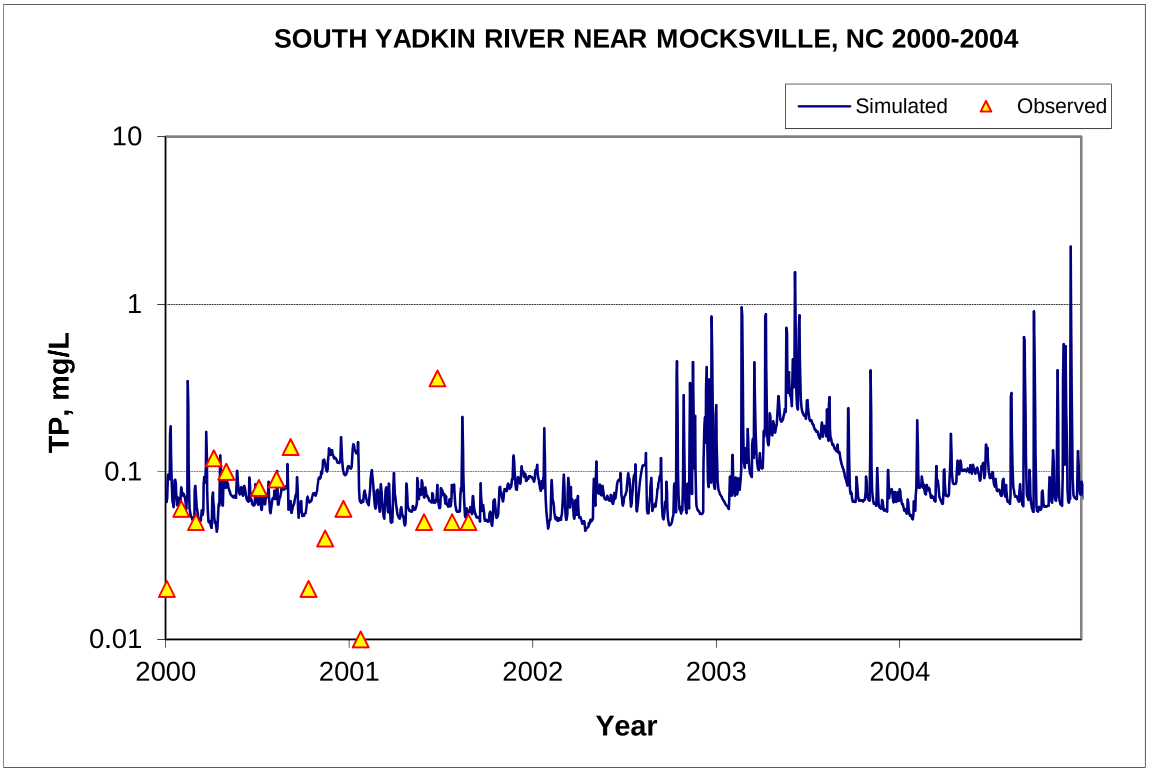

Figure G- 15. Total P Concentration Time Series, Validation Period, South Yadkin River near Mocksville

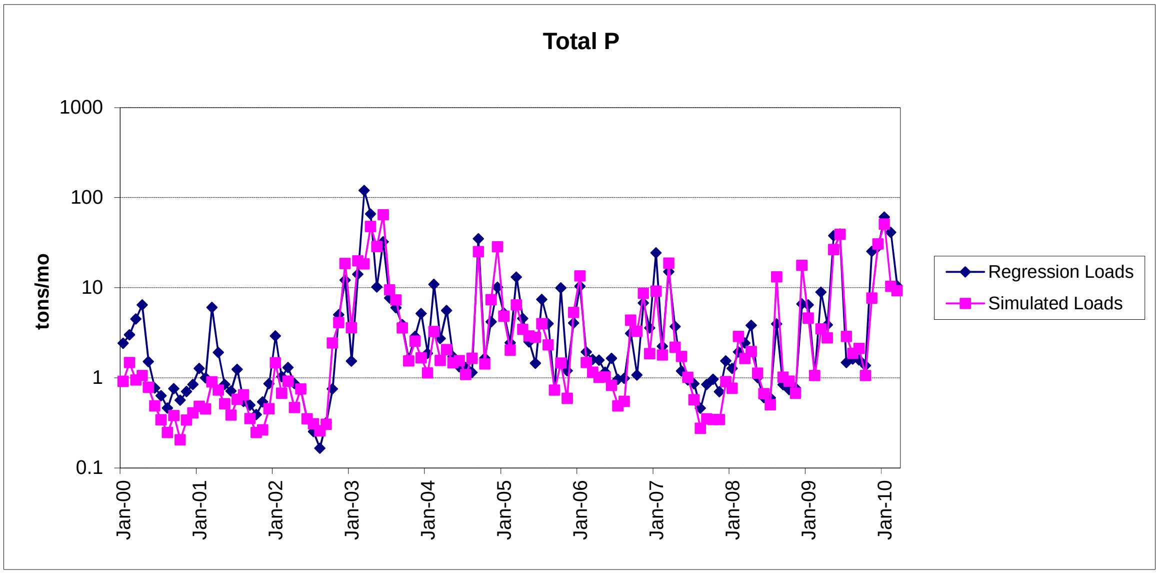

Figure G- 16. Total P Monthly Load Series, South Yadkin River near Mocksville

Table G- 5. Summary Statistics, Total N, South Yadkin River near Mocksville

	2005-2010	2000-2004
Count	109	15
Concentration average error	7.0%	13.3%
Concentration median error	-4.1%	7.7%
Paired load average error	56.7%	13.0%
Paired load median error	-1.1%	5.3%
Paired t, concentration	0.96	0.81
Paired t, load	0.14	0.68
Long-term load vs. stratified regression estimate	23.3%	46.5%
Monthly load NSE	0.75	0.37

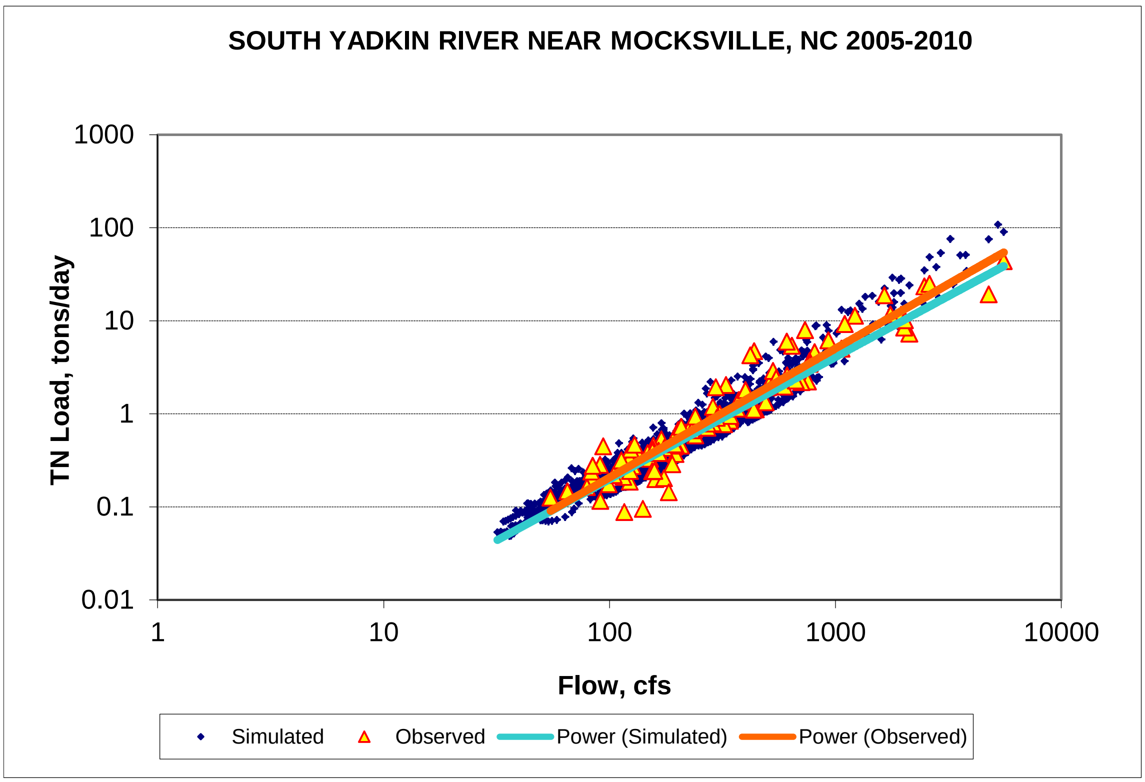

Figure G- 17. Total N Load Power Plot, Calibration Period, South Yadkin River near Mocksville

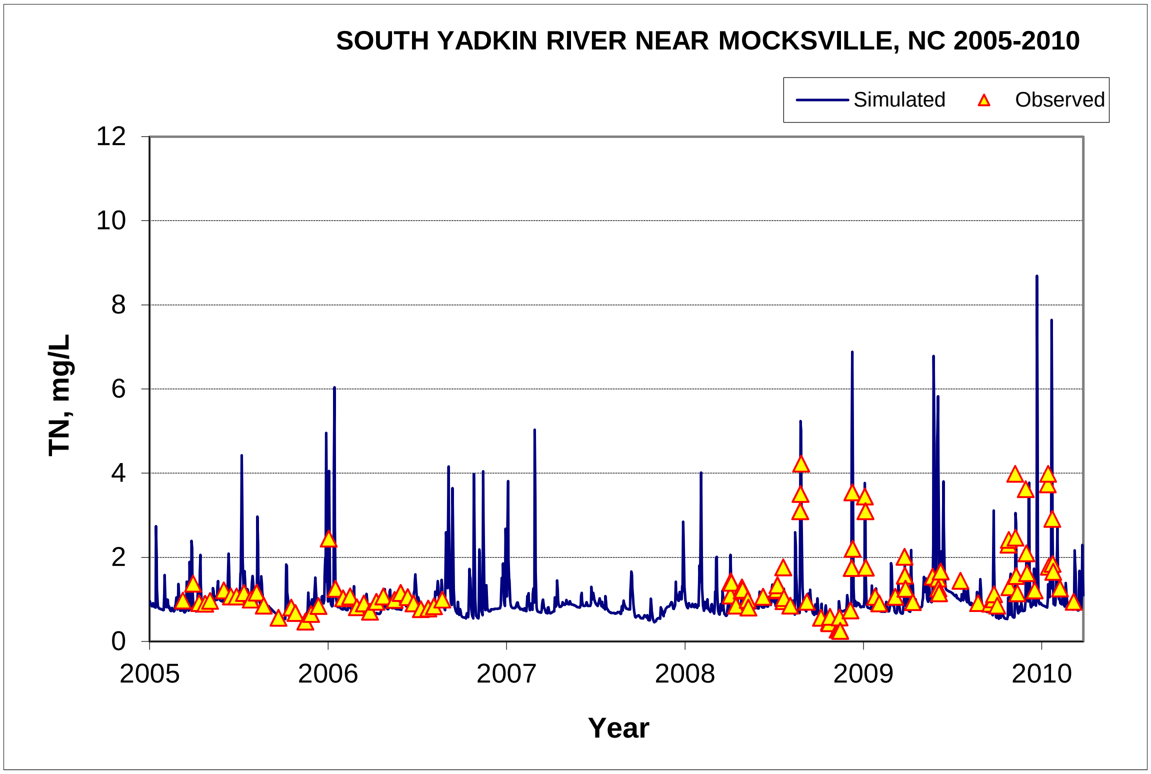

Figure G- 18. Total N Concentration Time Series, Calibration Period, South Yadkin River near Mocksville

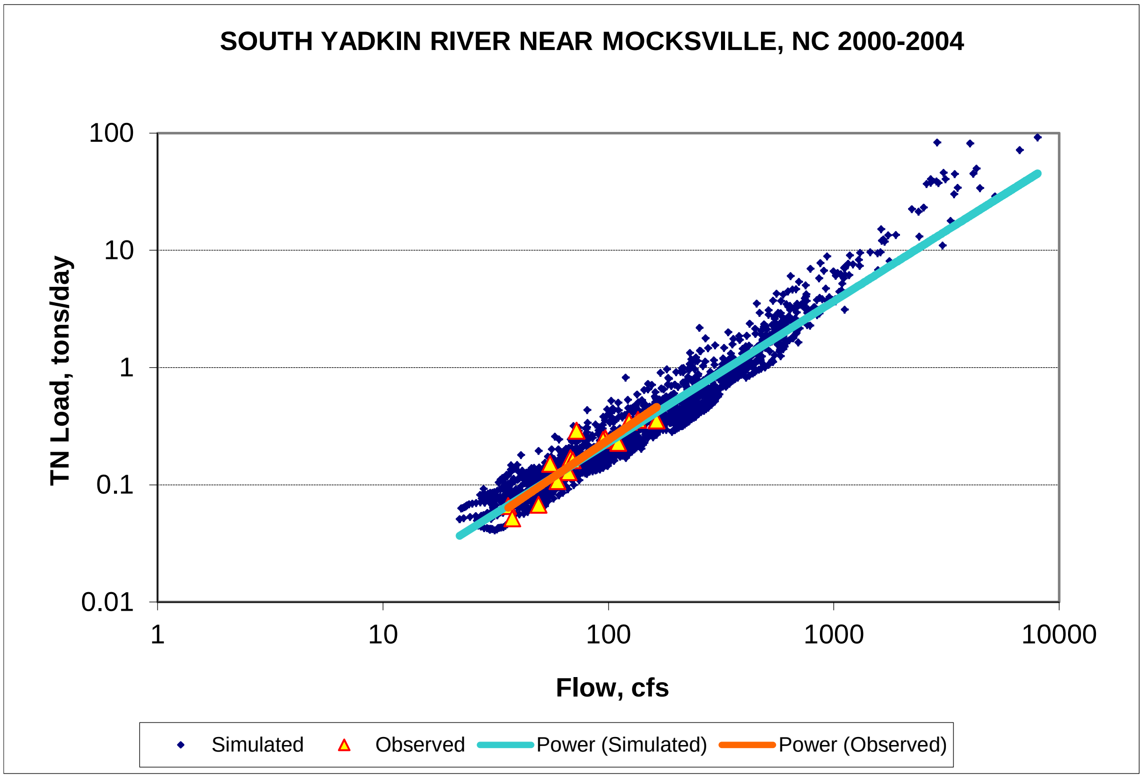

Figure G- 19. Total N Load Power Plot, Validation Period, South Yadkin River near Mocksville

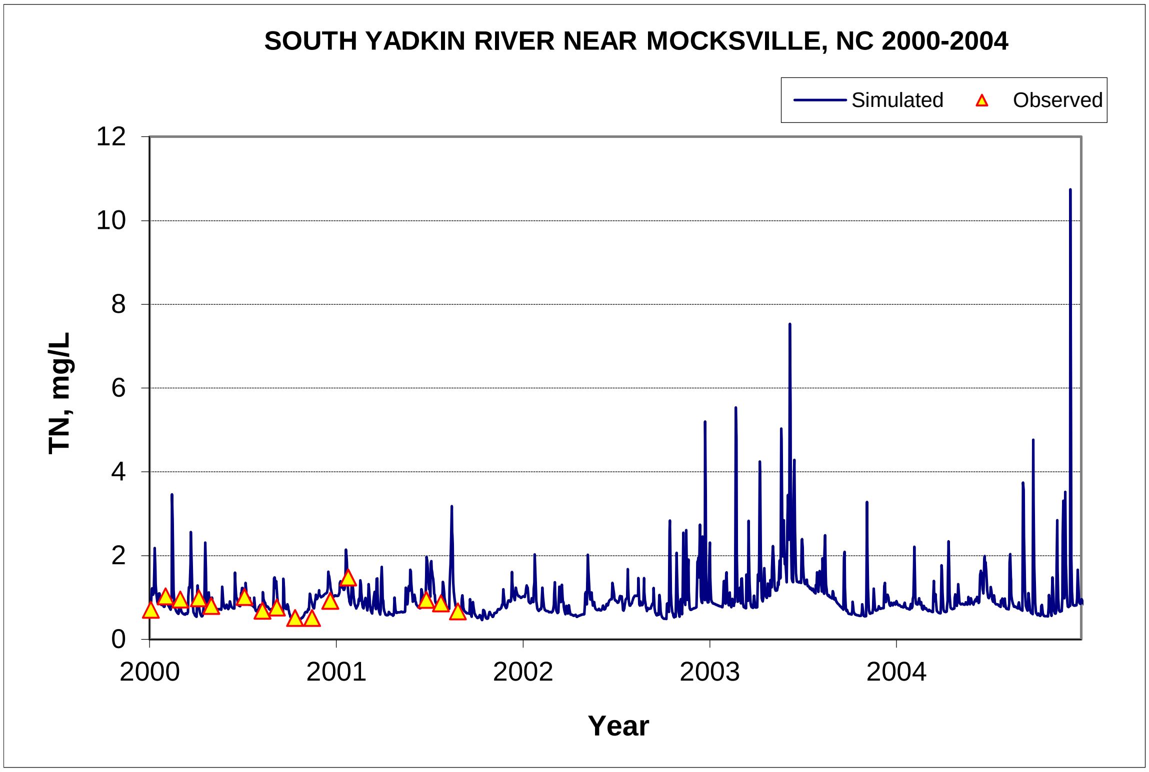

Figure G- 20. Total N Concentration Time Series, Validation Period, South Yadkin River near Mocksville

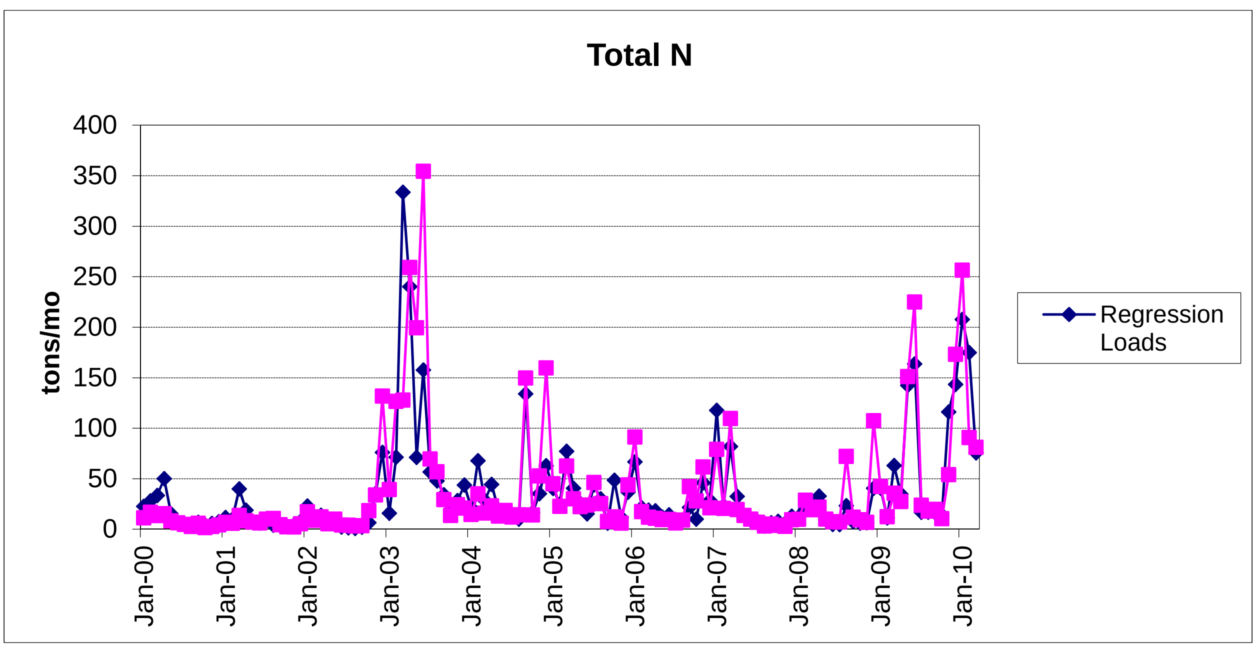

Figure G- 21. Total N Monthly Load Series, South Yadkin River near Mocksville

Table G- 6. Nutrient Species Simulation, South Yadkin River near Mocksville, 2005-2010

	NO_2+NO_3-N	NH_4-N	Organic N	PO_4-P	Organic P
Count	109	109	108	47	47
Average Observed (mg/L)	0.65	0.06	0.68	0.02	0.20
Concentration average error	4.7%	-21.5%	7.2%	-10.0%	-9.0%
Concentration median error	-10.0%	13.0%	-2.7%	6.0%	-1.3%
Paired load average error	25.8%	-31.7%	84.1%	-30.2%	103.1%
Paired load median error	-2.9%	2.1%	-0.4%	2.0%	-0.2%

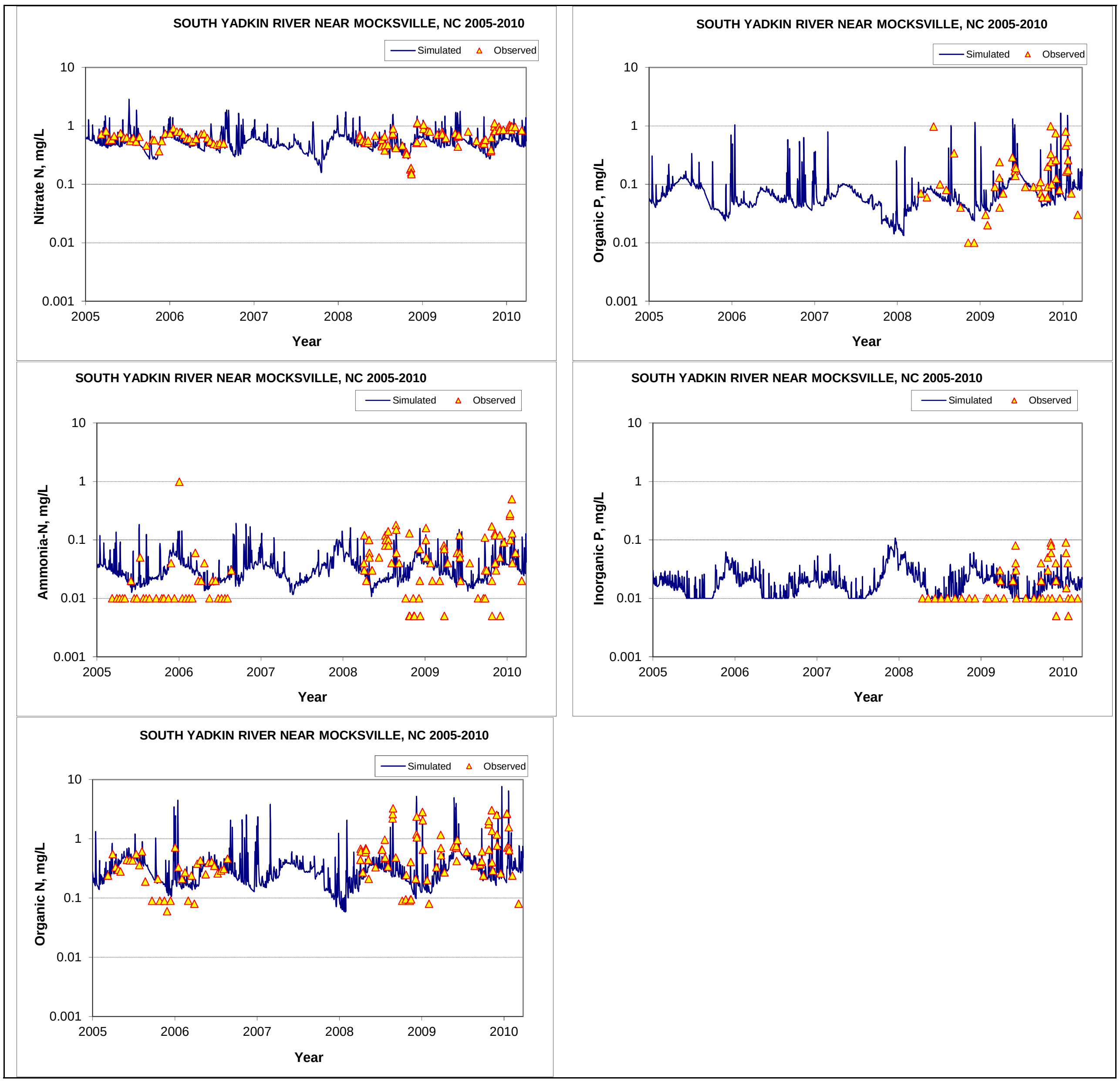

Figure G- 22. Nutrient Species Simulation, South Yadkin River near Mocksville

Table G- 7. Summary Statistics, Total P, Abbotts Creek near Lexington

	2005-2010	2000-2004
Count	147	33
Concentration average error	-6.```3%	-12.2%
Concentration median error	-1.7%	-4.9%
Paired load average error	-2.4%	-19.0%
Paired load median error	-0.5%	-8.3%
Paired t, concentration	0.99	0.75
Paired t, load	0.77	0.52
Long-term load vs. stratified regression estimate	4.9%	4.9%
Monthly load NSE	0.36	0.82

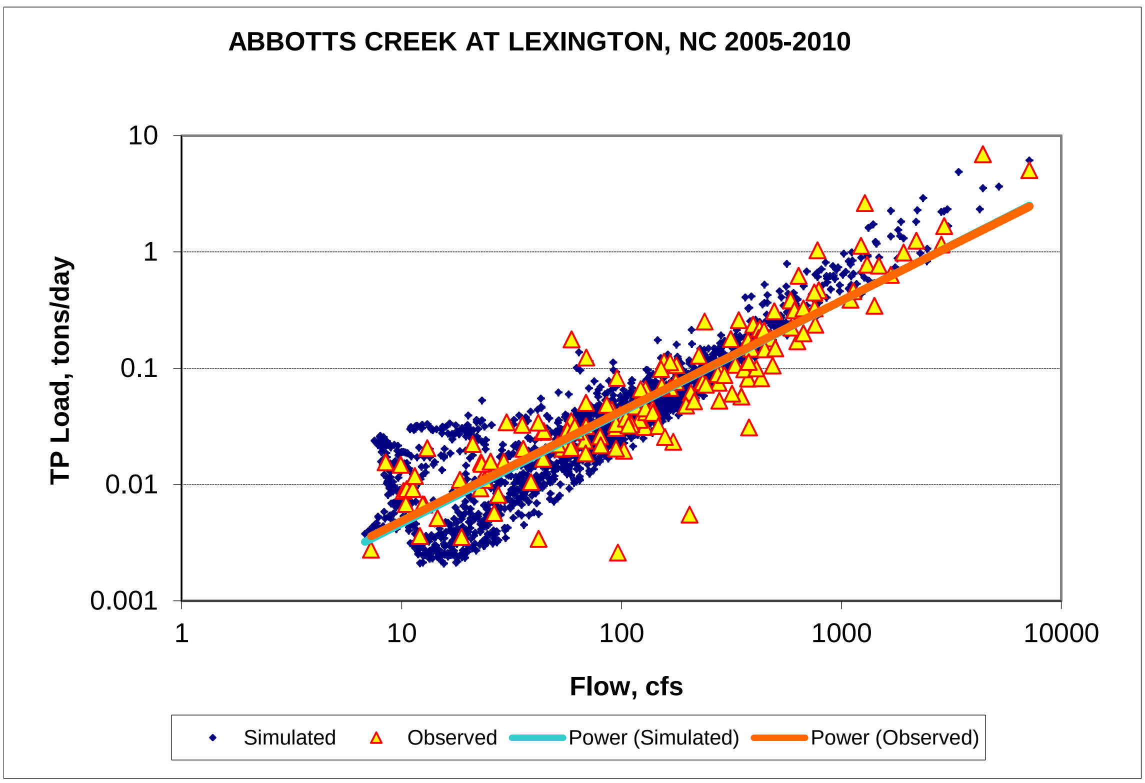

Figure G- 23. Total P Load Power Plot, Calibration Period, Abbotts Creek near Lexington

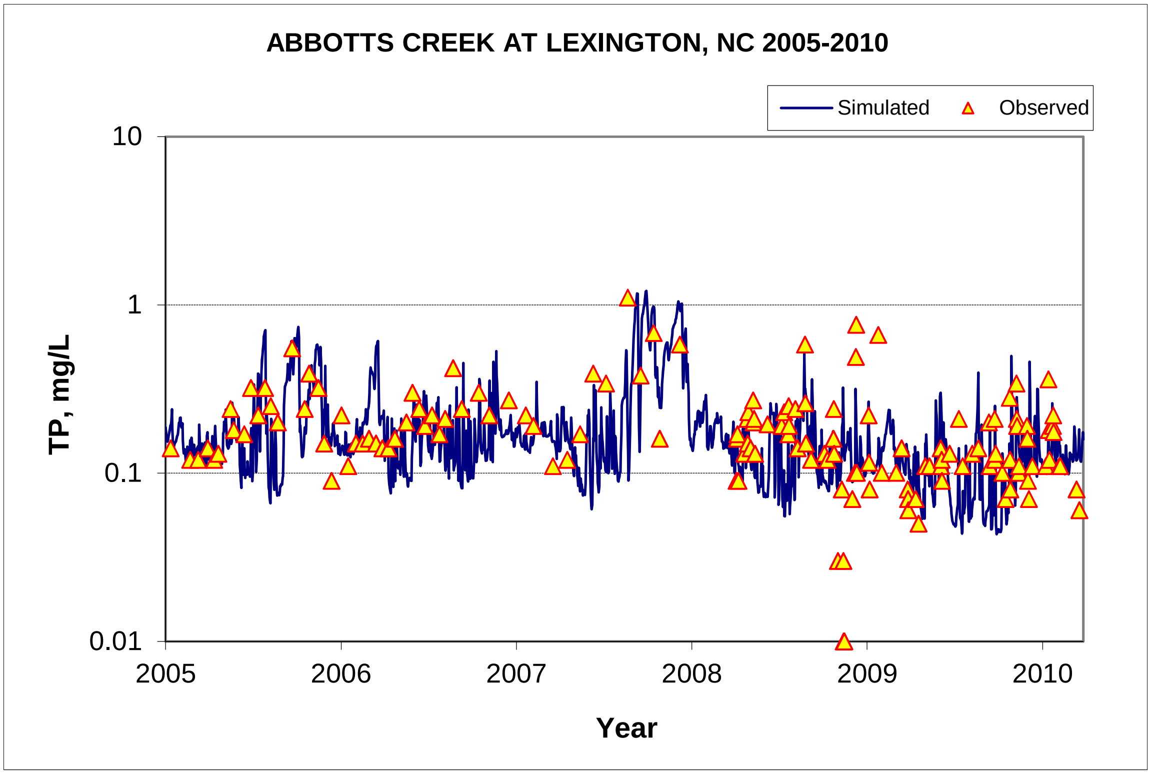

Figure G- 24. Total P Concentration Time Series, Calibration Period, Abbotts Creek near Lexington

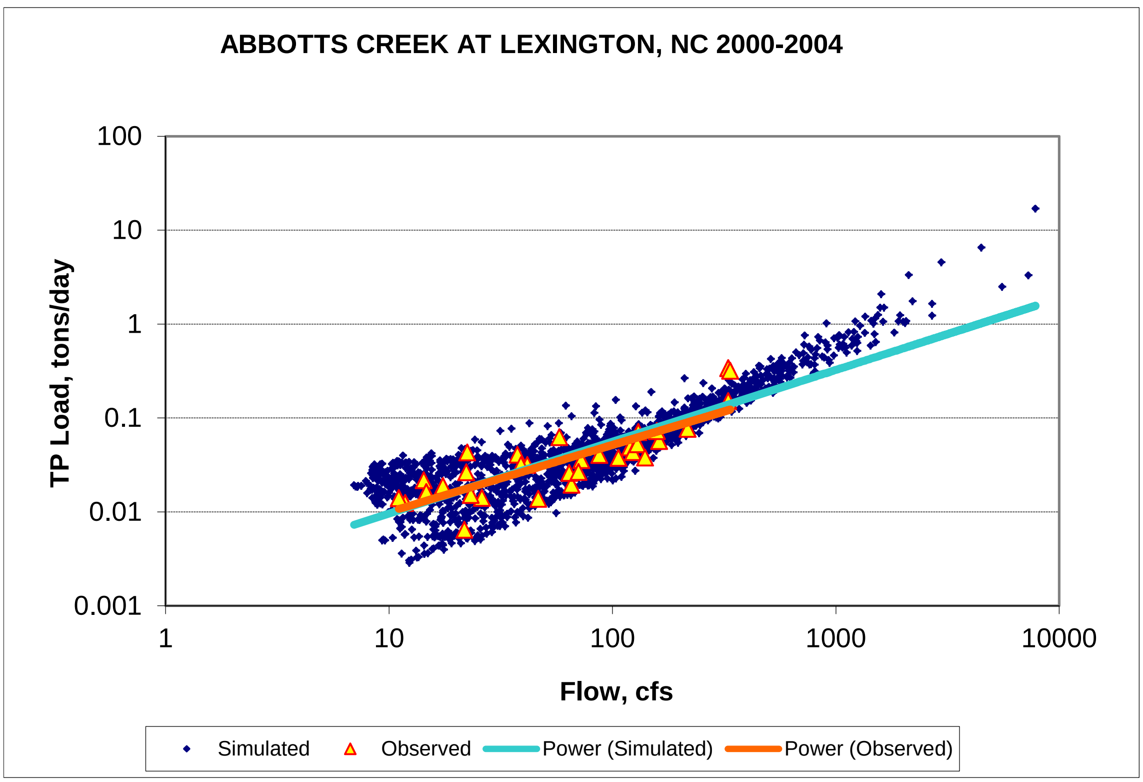

Figure G- 25. Total P Load Power Plot, Validation Period, Abbotts Creek near Lexington

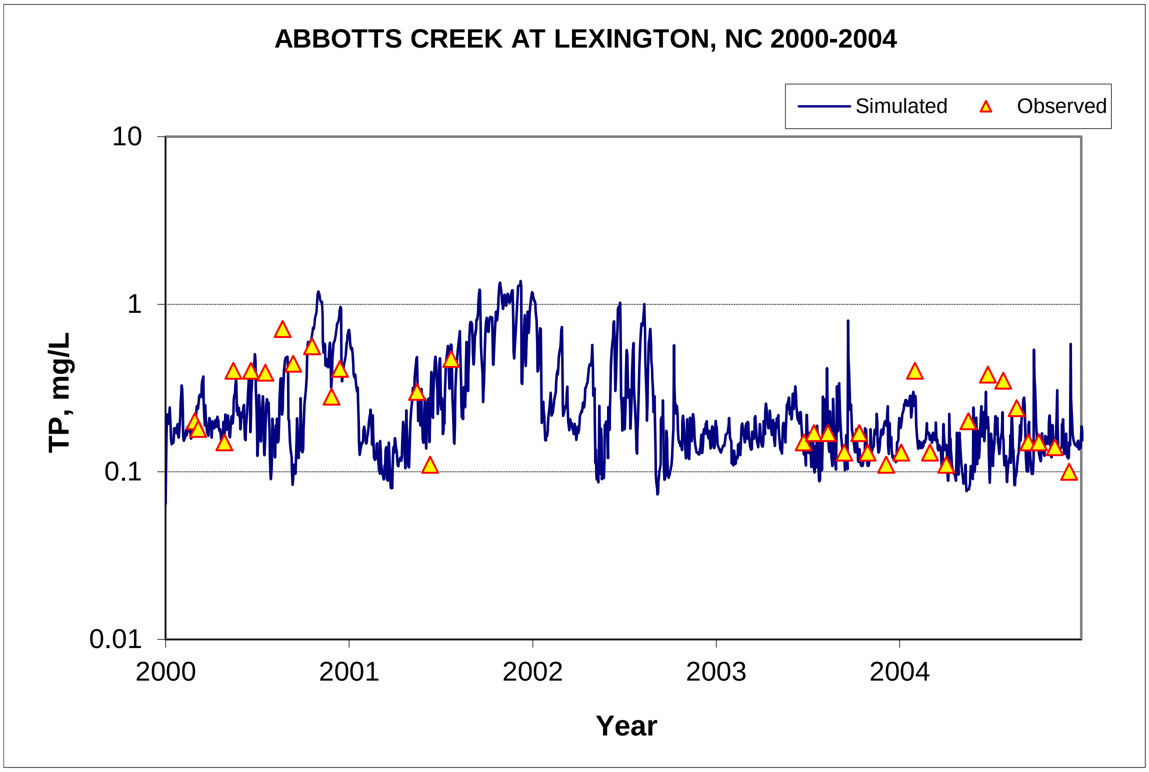

Figure G- 26. Total P Concentration Time Series, Validation Period, Abbotts Creek near Lexington

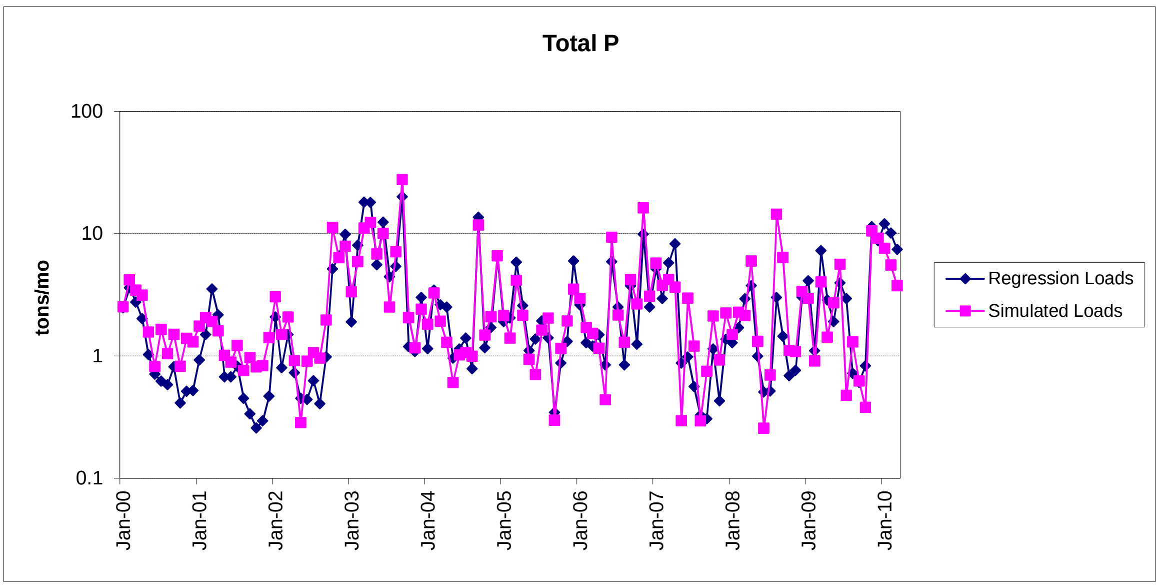

Figure G- 27. Total P Monthly Load Series, Abbotts Creek near Lexington

Table G- 8. Summary Statistics, Total N, Abbotts Creek near Lexington

	2005-2010	2000-2004
Count	147	32
Concentration average error	-8.1%	-46.7%
Concentration median error	3.3%	-23.0%
Paired load average error	4.5%	-9.6%
Paired load median error	1.0%	-26.1%
Paired t, concentration	0.99	0.00
Paired t, load	0.79	0.73
Long-term load vs. stratified regression estimate	9.3%	-6.9%
Monthly load NSE	0.25	0.77

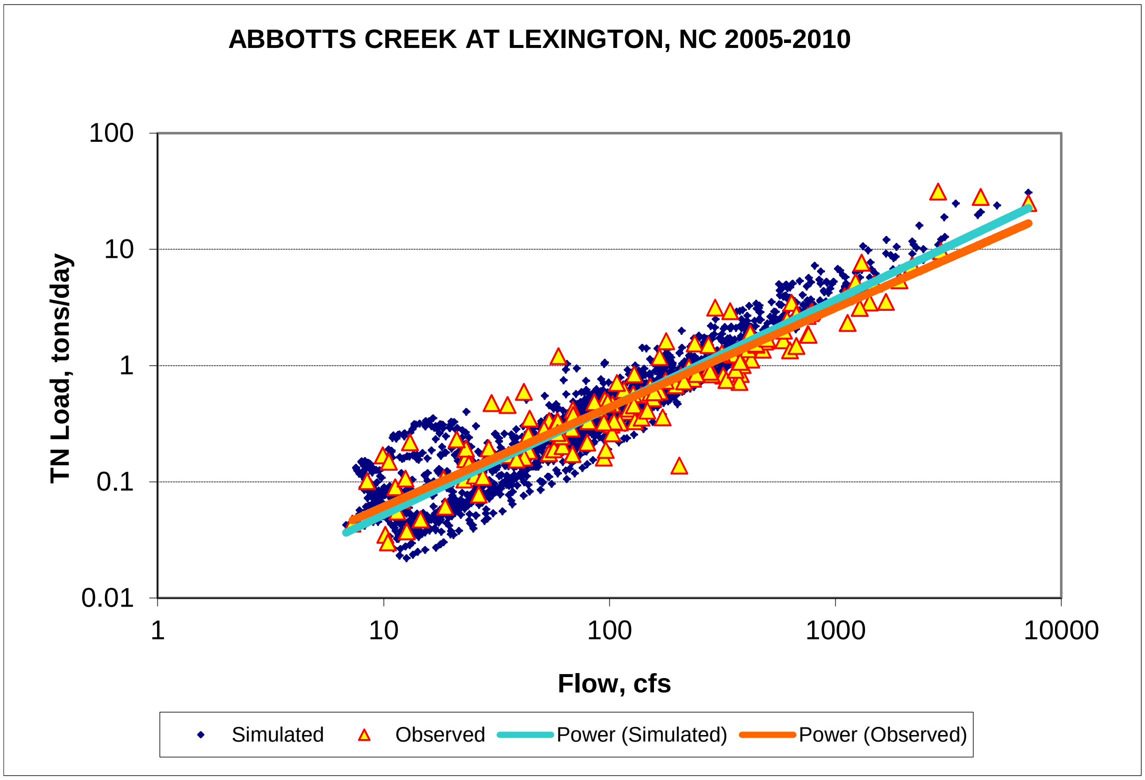

Figure G- 28. Total N Load Power Plot, Calibration Period, Abbotts Creek near Lexington

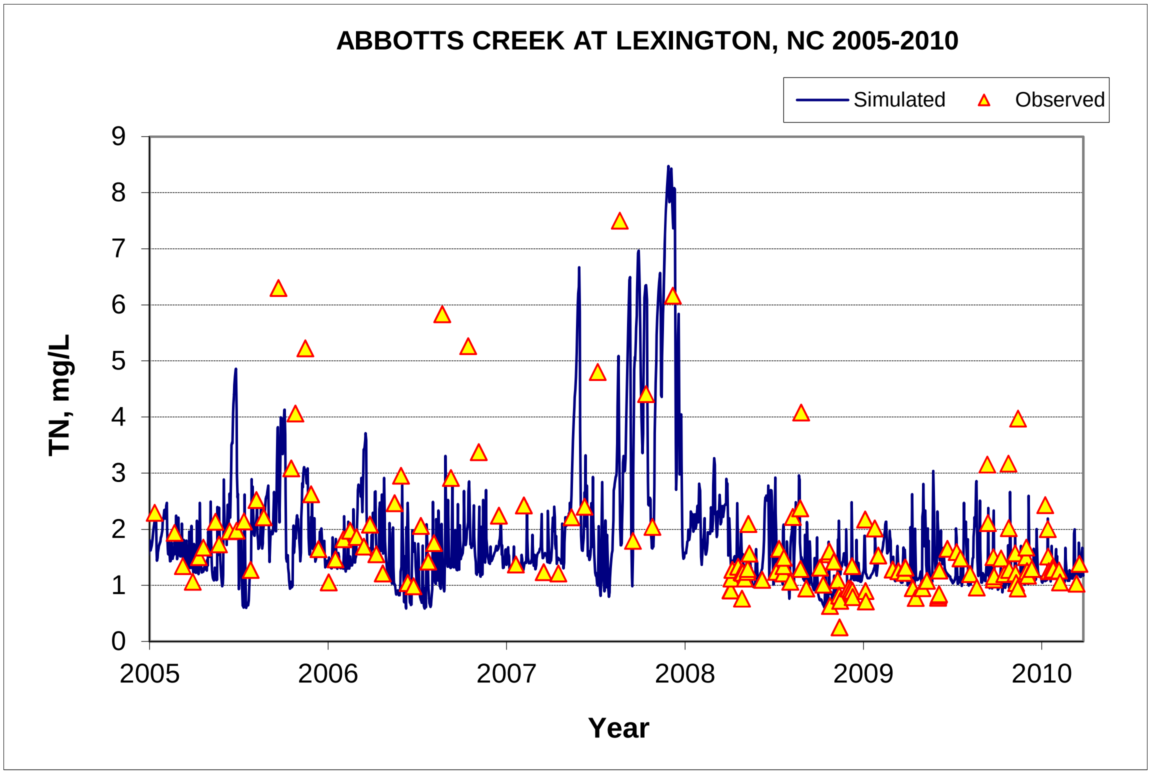

Figure G- 29. Total N Concentration Time Series, Calibration Period, Abbotts Creek near Lexington

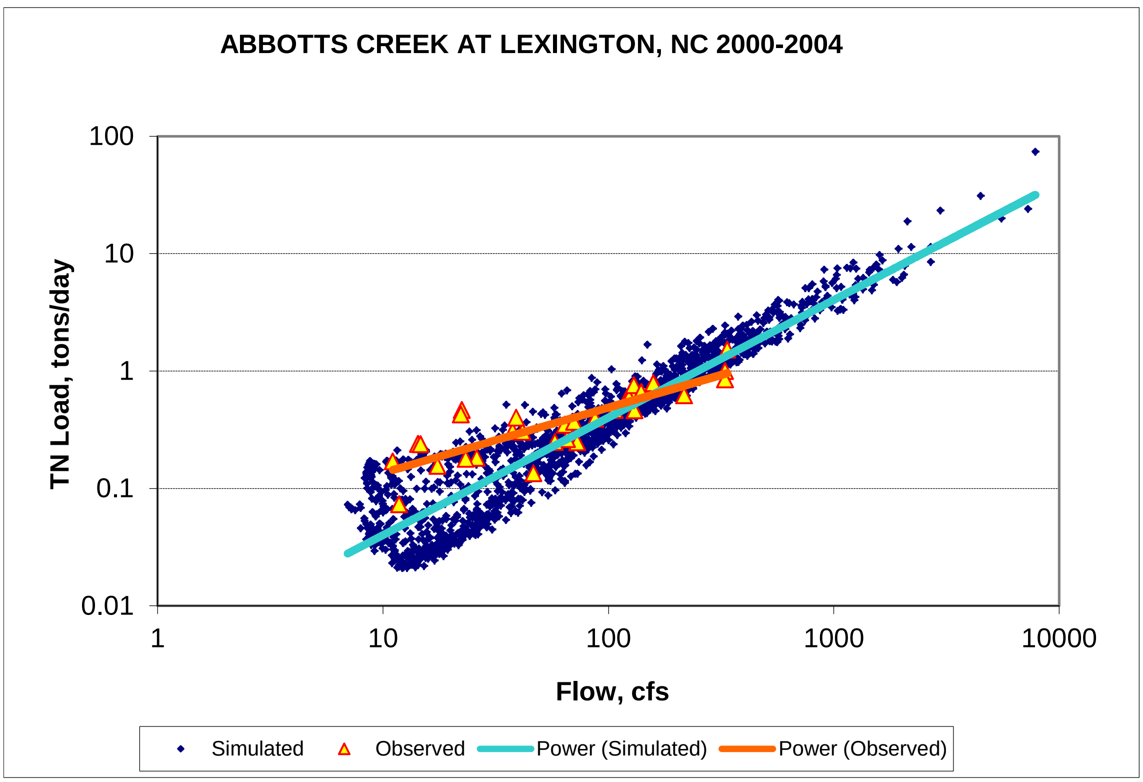

Figure G- 30. Total N Load Power Plot, Validation Period, Abbotts Creek near Lexington

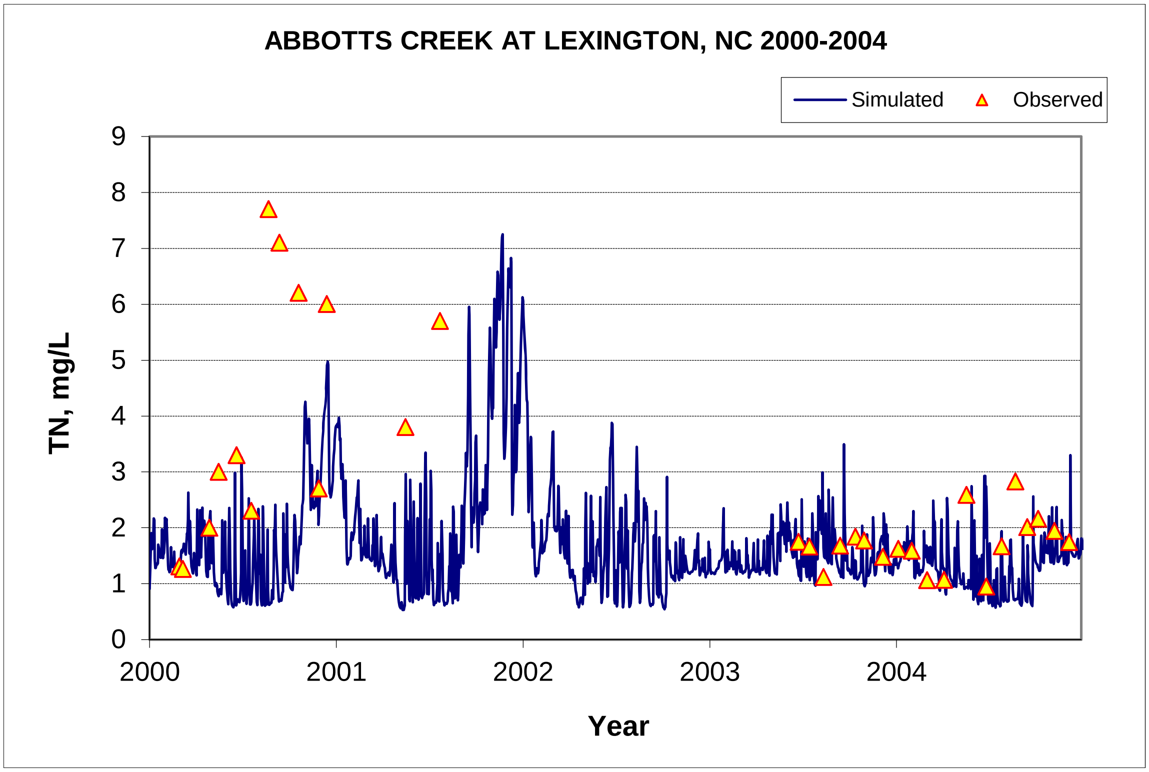

Figure G- 31. Total N Concentration Time Series, Validation Period, Abbotts Creek near Lexington

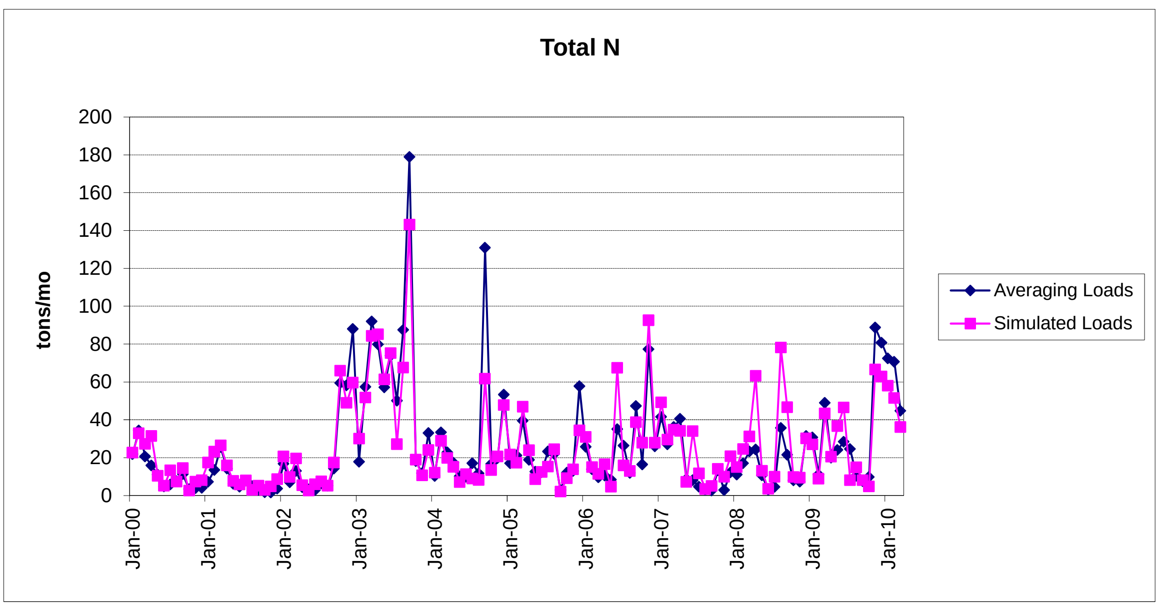

Figure G- 32. Total N Monthly Load Series, Abbotts Creek near Lexington

Table G- 9. Nutrient Species Simulation, Abbotts Creek at Lexington, 2005-2010

	NO_2+NO_3-N	NH_4-N	Organic N	PO_4-P	Organic P
Count	147	147	146	60	59
Average Observed (mg/L)	0.99	0.09	0.73	0.04	0.10
Concentration average error	-5.1%	1.9%	-26.5%	51.2%	-14.6%
Concentration median error	19.6%	23.2%	-21.0%	80.5%	-23.8%
Paired load average error	73.6%	-14.6%	-30.0%	73.4%	1.3%
Paired load median error	13.0%	5.4%	-2.4%	34.3%	-3.5%

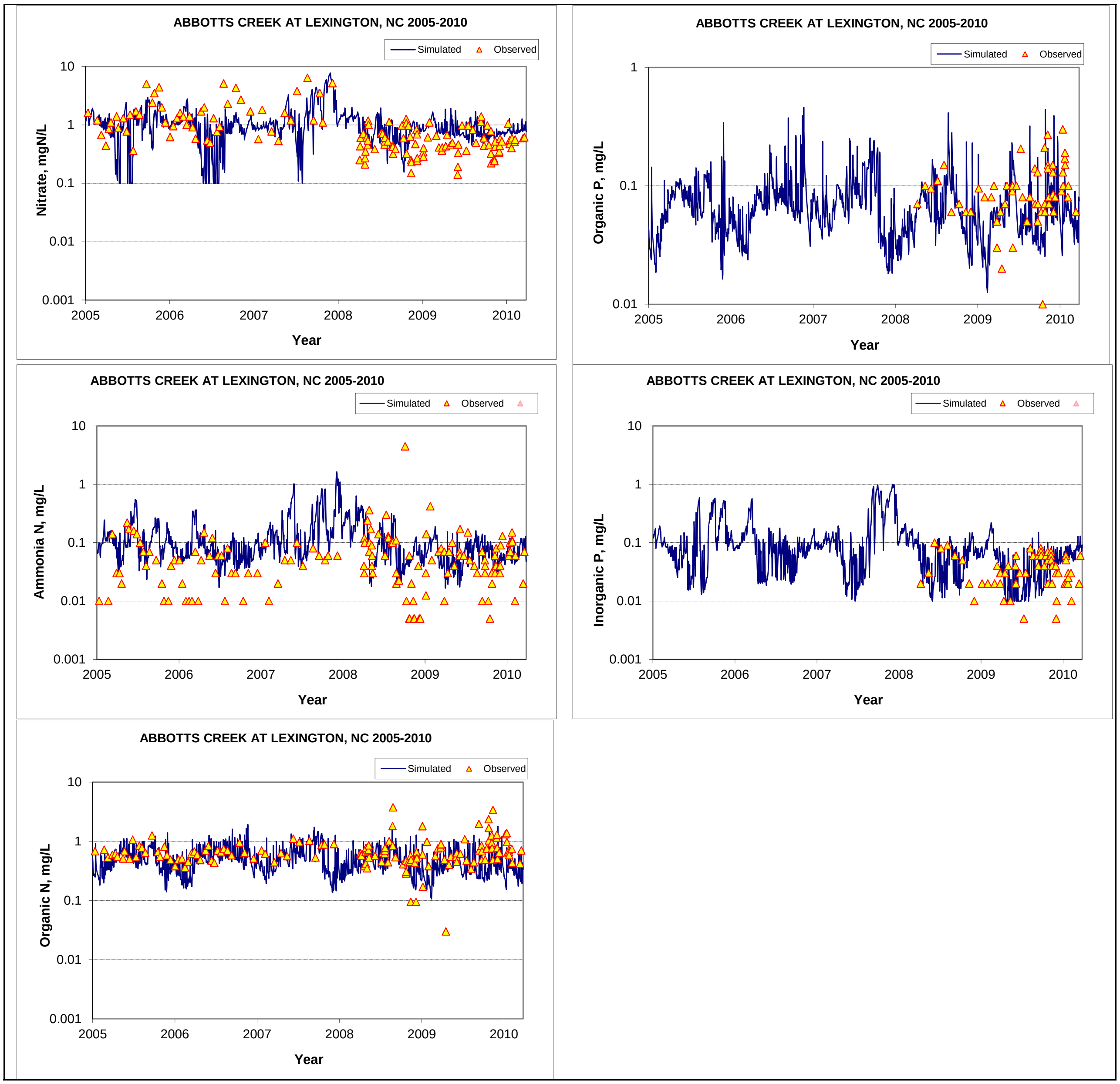

Figure G- 33. Nutrient Species Simulation, Abbotts Creek at Lexington

Table G- 10. Summary Statistics, Total P, Roaring River at Roaring River

	2005-2010	2000-2004
Count	97	15
Concentration average error	-14.1%	-17.2%
Concentration median error	25.3%	7.8%
Paired load average error	-21.8%	-0.3%
Paired load median error	6.4%	7.6%
Paired t, concentration	0.61	0.54
Paired t, load	0.48	0.73
Long-term load vs. stratified regression estimate	3.9%	-3.7%
Monthly load NSE	0.39	0.85

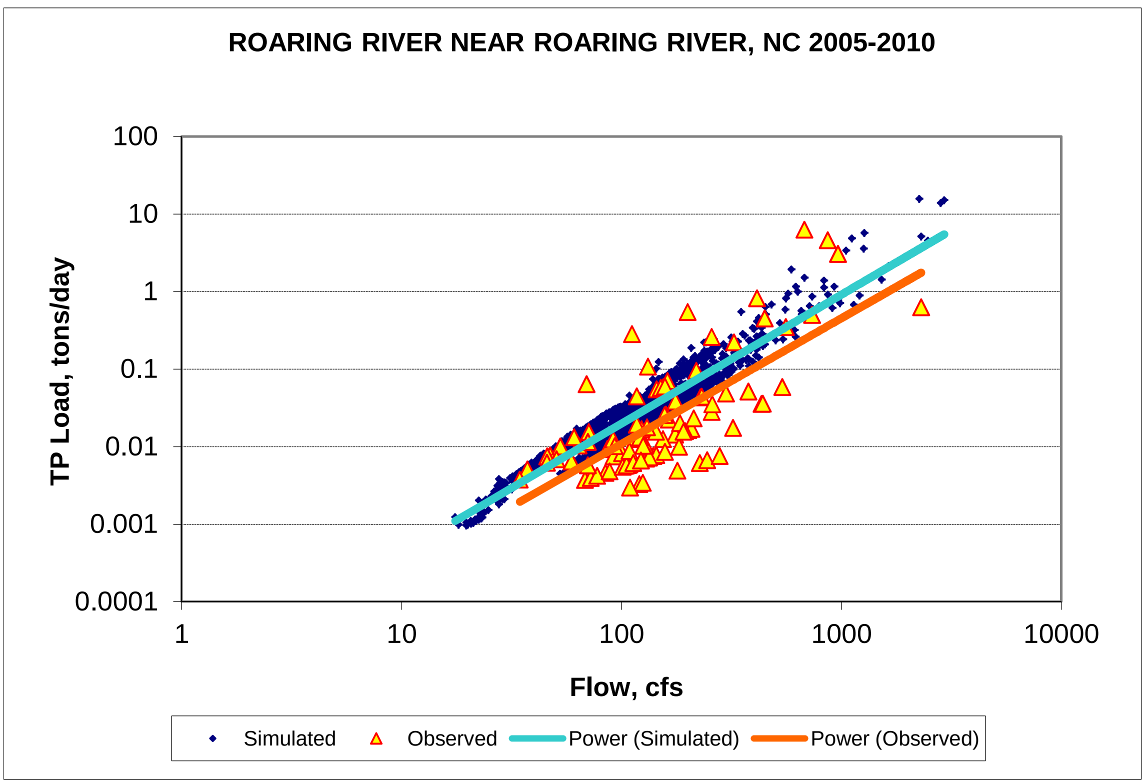

Figure G- 34. Total P Load Power Plot, Calibration Period, Roaring River at Roaring River

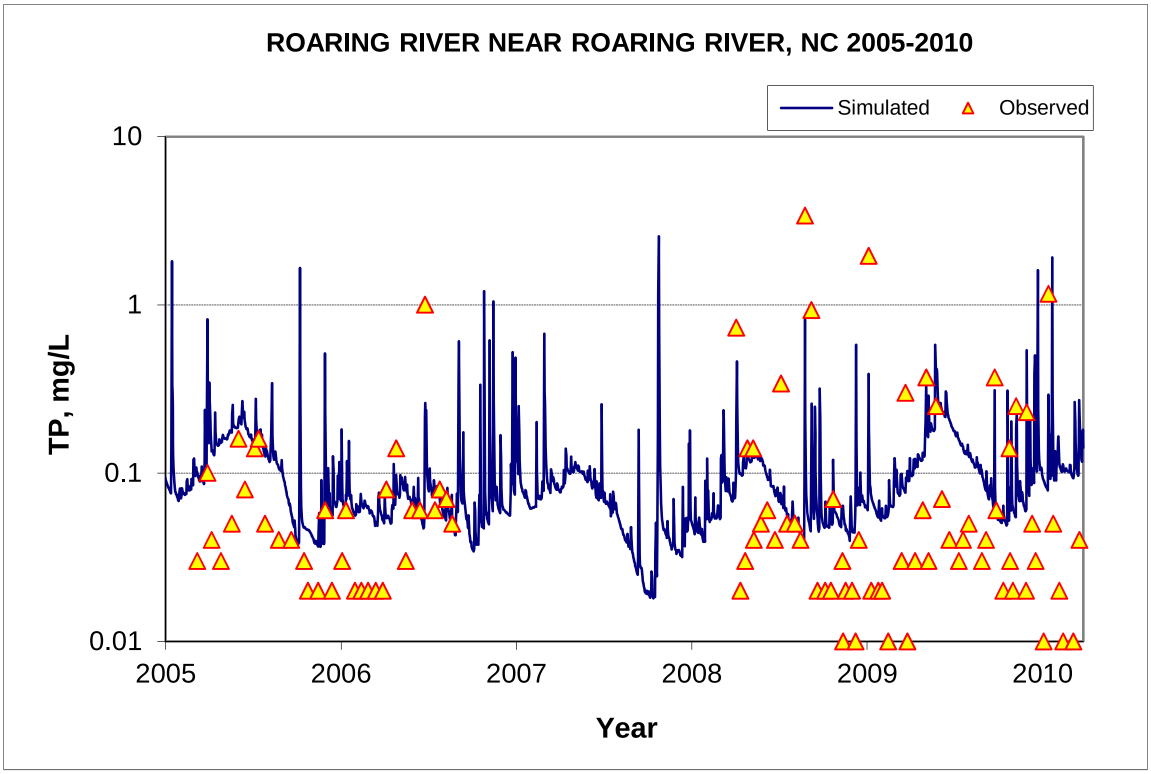

Figure G- 35. Total P Concentration Time Series, Calibration Period, Roaring River at Roaring River

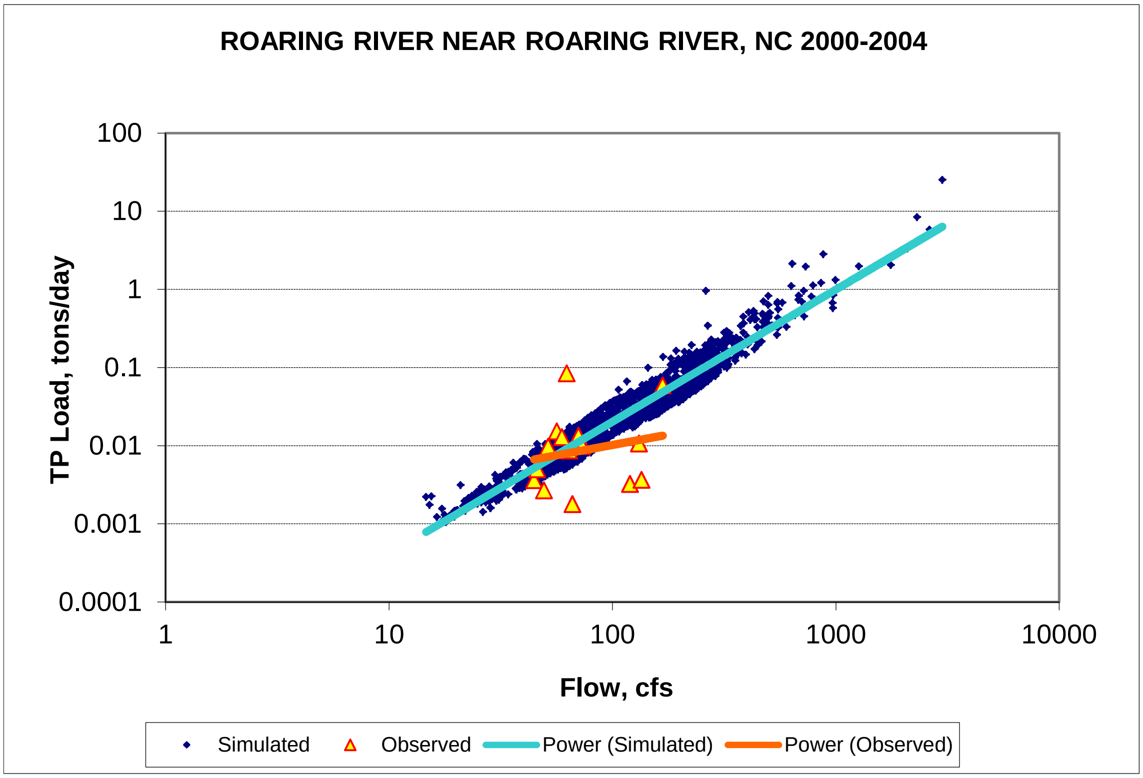

Figure G- 36. Total P Load Power Plot, Validation Period, Roaring River at Roaring River

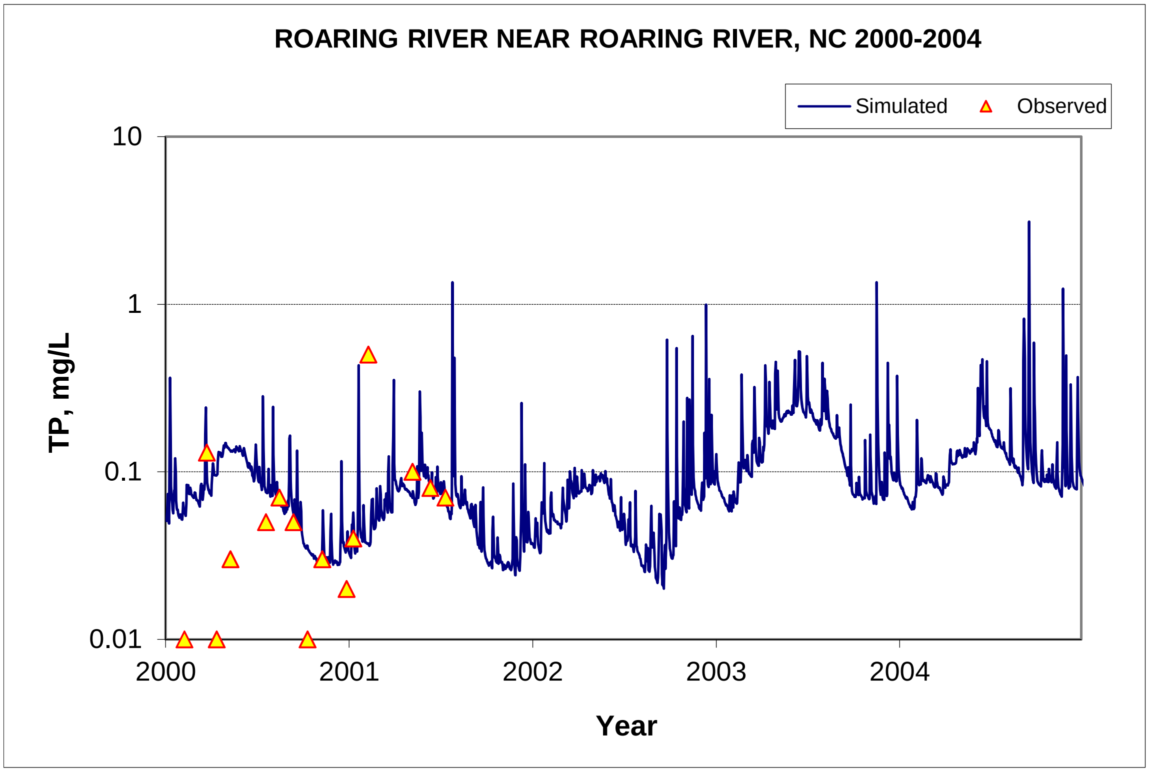

Figure G- 37. Total P Concentration Time Series, Validation Period, Roaring River at Roaring River

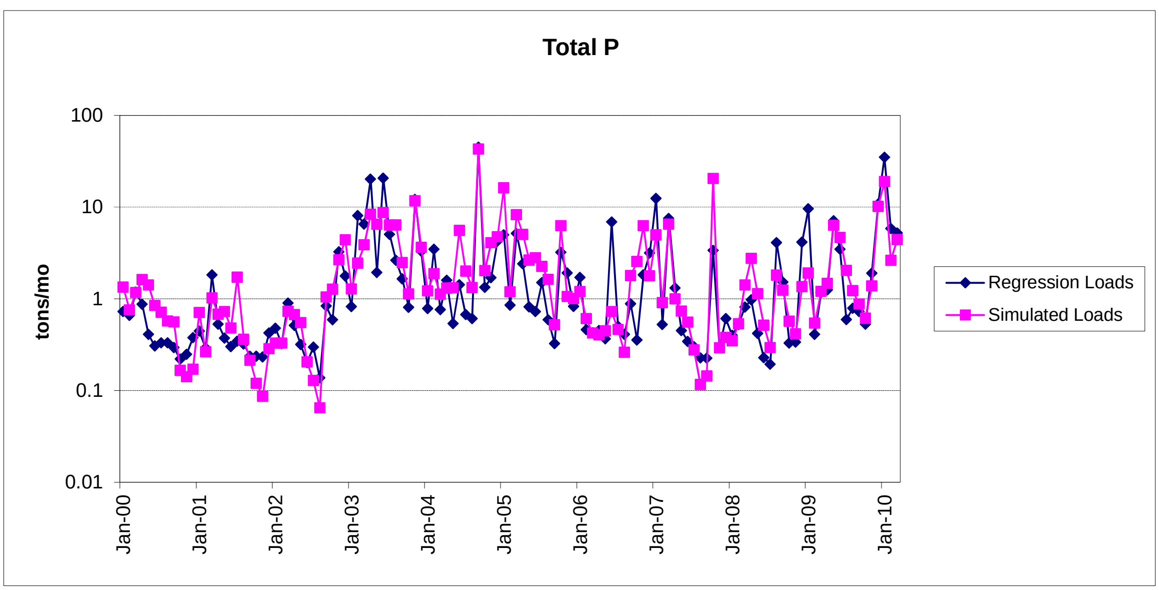

Figure G- 38. Total P Monthly Load Series, Roaring River at Roaring River

Table G-11. Summary Statistics, Total N, Roaring River at Roaring River

	2005-2010	2000-2004
Count	97	13
Concentration average error	-3.1%	-21.1%
Concentration median error	6.6%	-1.1%
Paired load average error	-5.7%	-14.5%
Paired load median error	1.6%	-0.9%
Paired t, concentration	0.94	0.46
Paired t, load	0.69	0.65
Long-term load vs. stratified regression estimate	27.7%	36.2%
Monthly load NSE	0.42	0.79

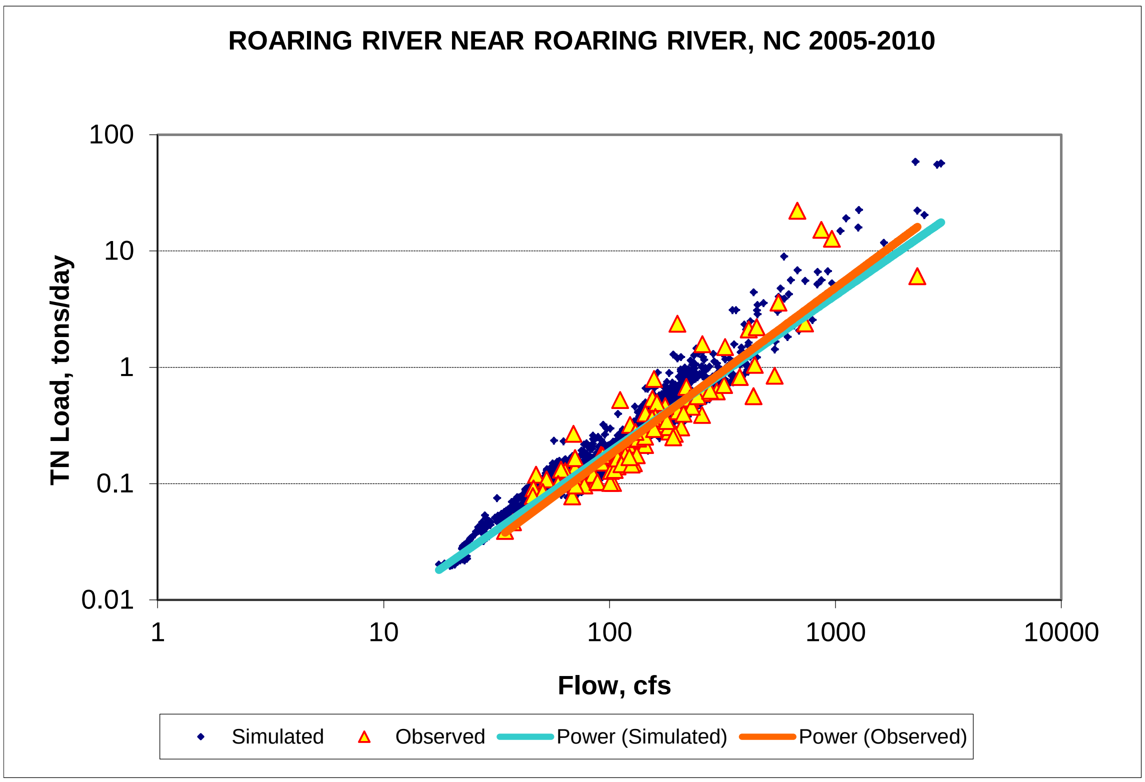

Figure G- 39. Total N Load Power Plot, Calibration Period, Roaring River at Roaring River

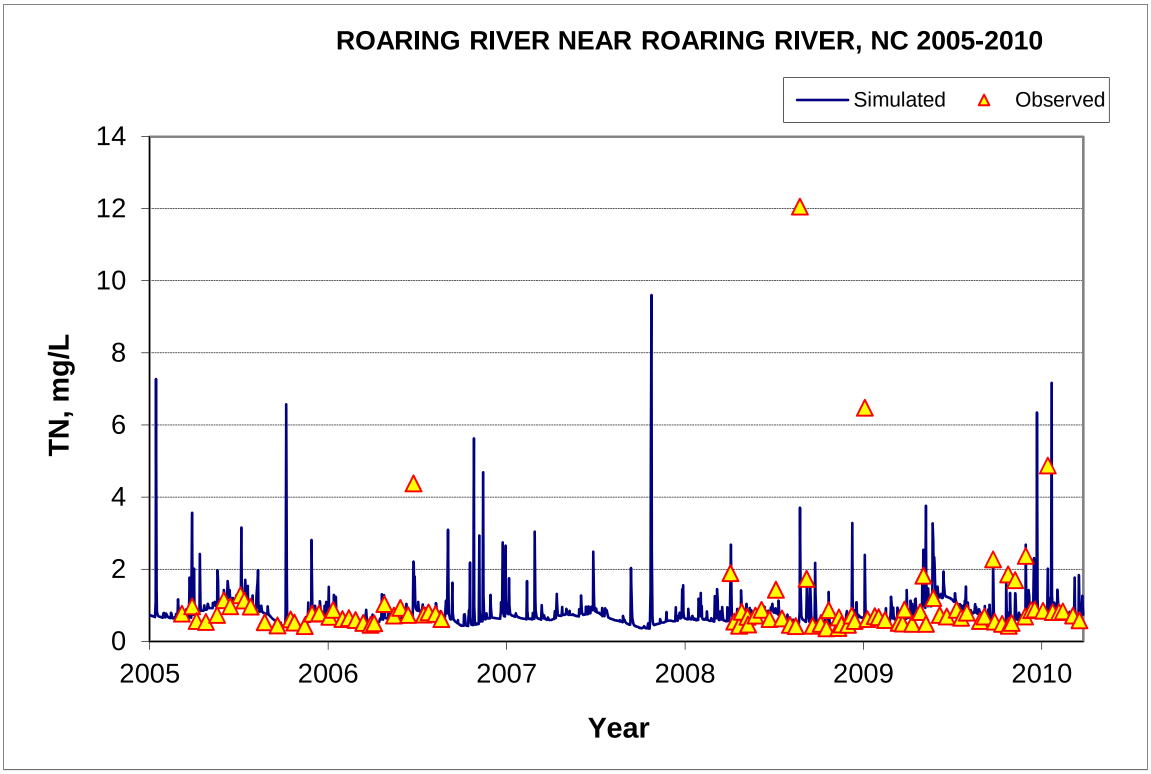

Figure G- 40. Total N Concentration Time Series, Calibration Period, Roaring River at Roaring River

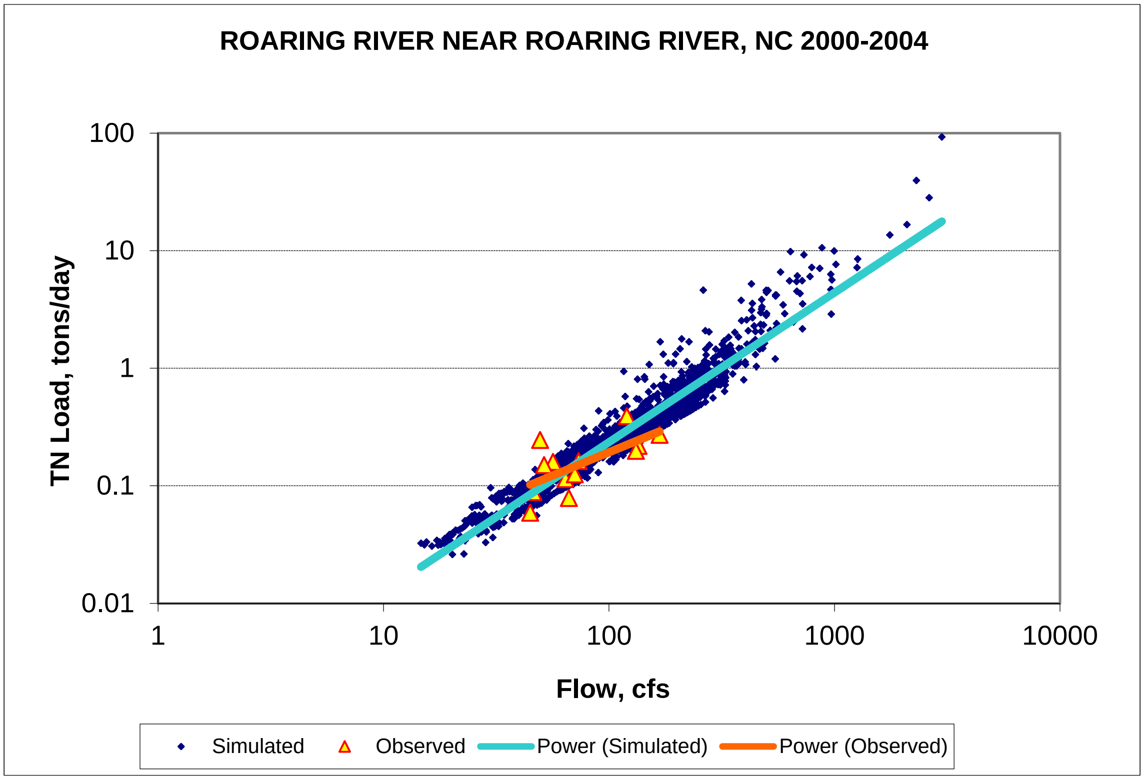

Figure G- 41. Total N Load Power Plot, Validation Period, Roaring River at Roaring River

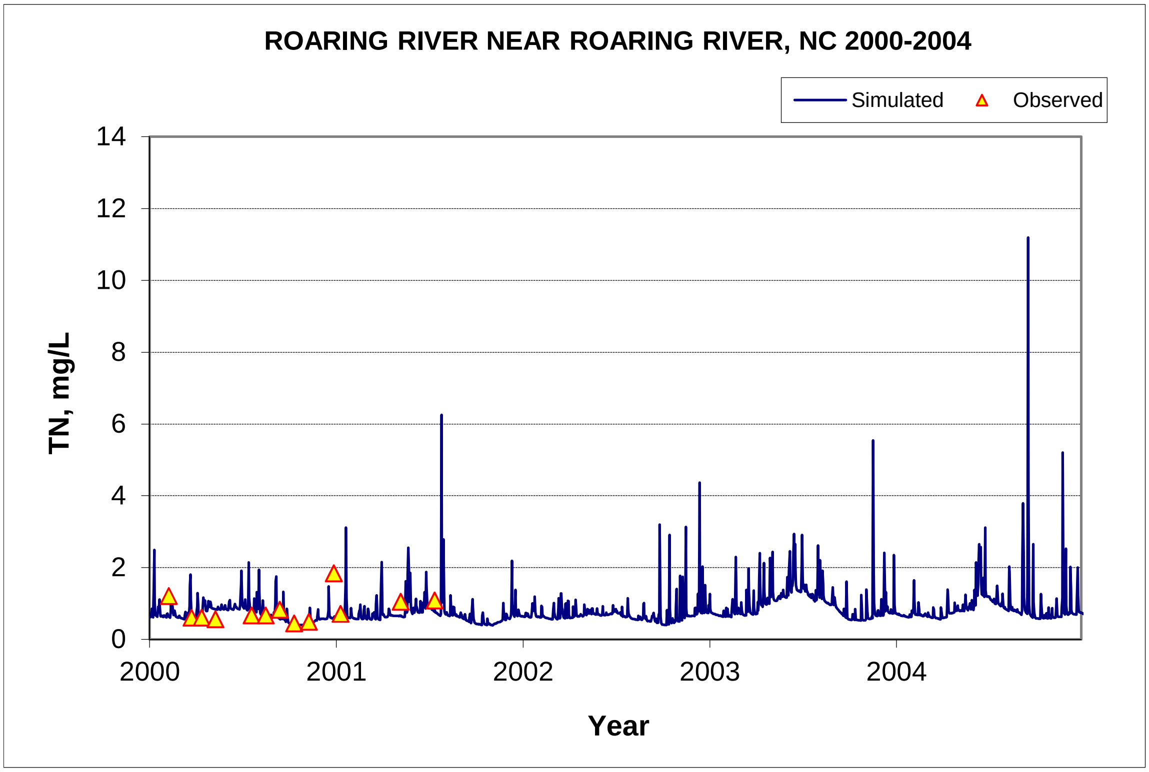

Figure G- 42. Total N Concentration Time Series, Validation Period, Roaring River at Roaring River

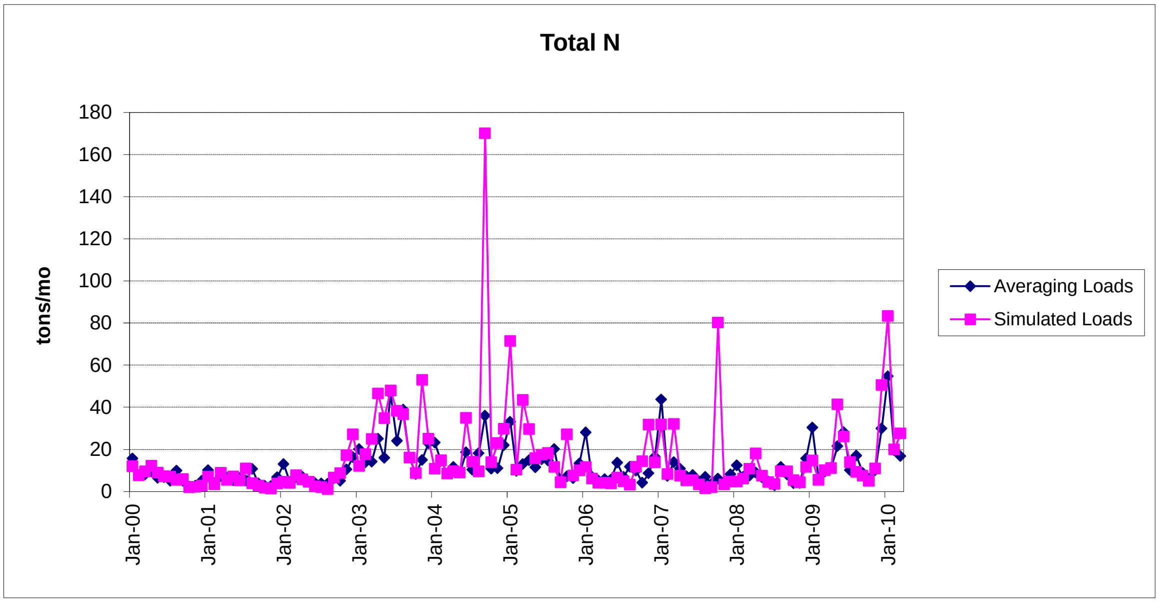

Figure G- 43. Total N Monthly Load Series, Roaring River at Roaring River

Table G- 12. Summary Statistics, Total P, Muddy Creek at Muddy Creek

	2005-2010	2000-2004
Count	64	-
Concentration average error	5.9%	-
Concentration median error	11.6%	-
Paired load average error	-7.0%	-
Paired load median error	6.3%	-
Paired t, concentration	0.99	-
Paired t, load	0.76	-
Long-term load vs. stratified regression estimate	-54.1%	-
Monthly load NSE	0.40	-

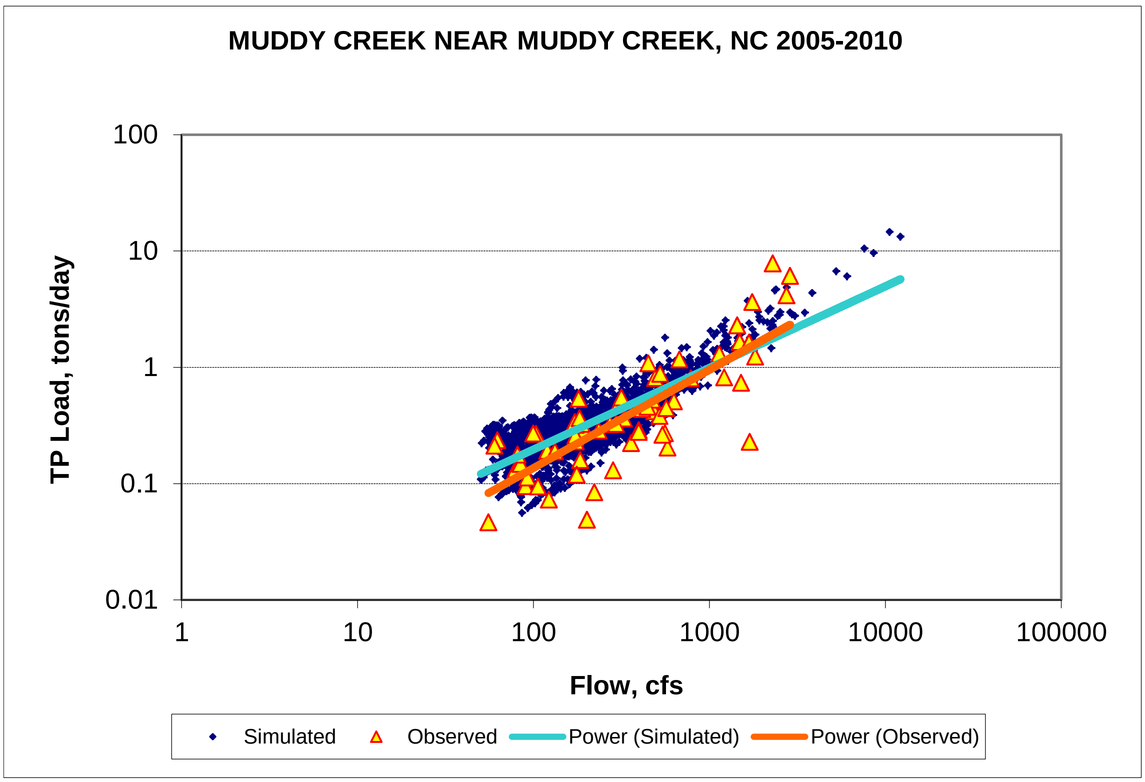

Figure G- 44. Total P Load Power Plot, Calibration Period, Muddy Creek at Muddy Creek

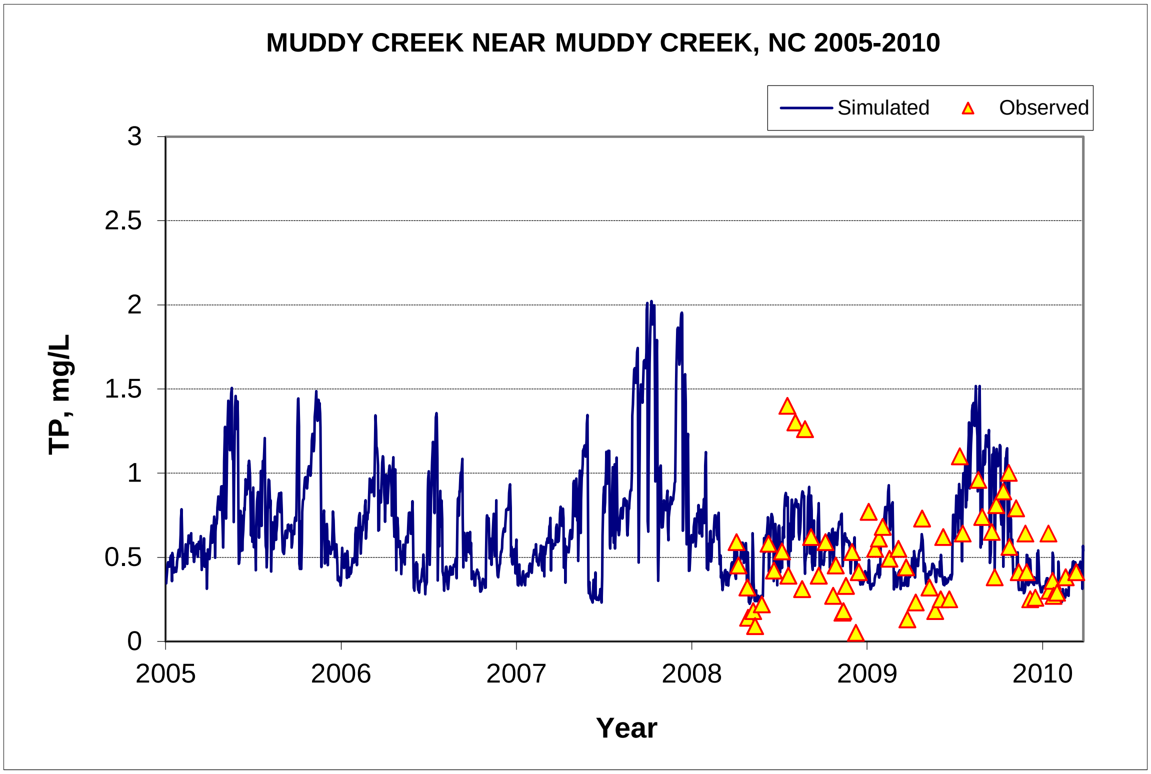

Figure G- 45. Total P Concentration Time Series, Calibration Period, Muddy Creek at Muddy Creek

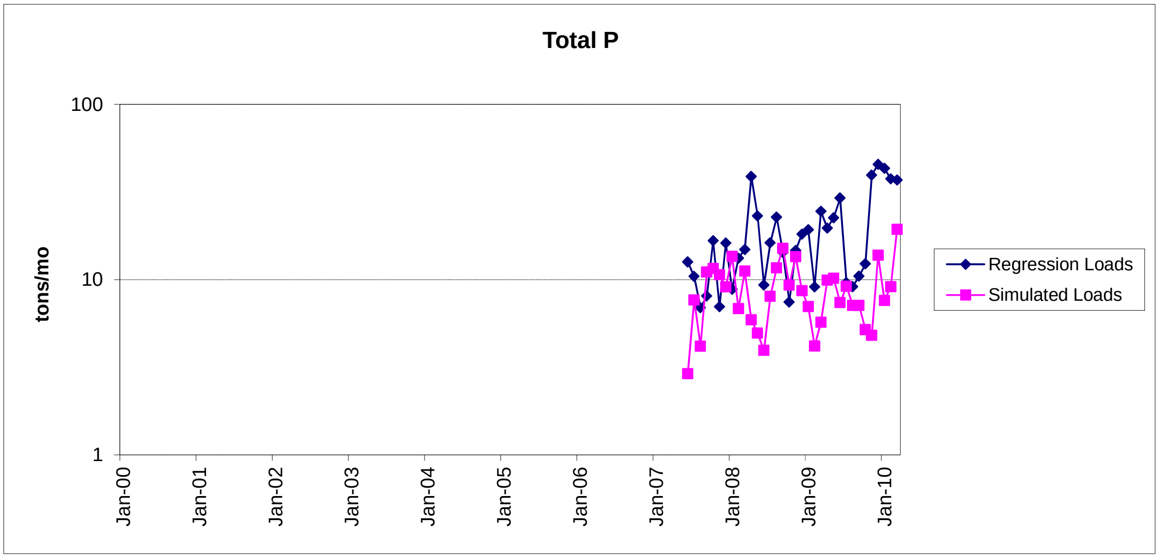

Figure G- 46. Total P Monthly Load Series, Muddy Creek at Muddy Creek

Table G- 13. Summary Statistics, Total N, Muddy Creek at Muddy Creek

	2005-2010	2000-2004
Count	64	-
Concentration average error	5.5%	-
Concentration median error	3.4%	-
Paired load average error	-1.6%	-
Paired load median error	1.8%	-
Paired t, concentration	1.00	-
Paired t, load	0.89	-
Long-term load vs. stratified regression estimate	-57.6%	-
Monthly load NSE	0.39	-

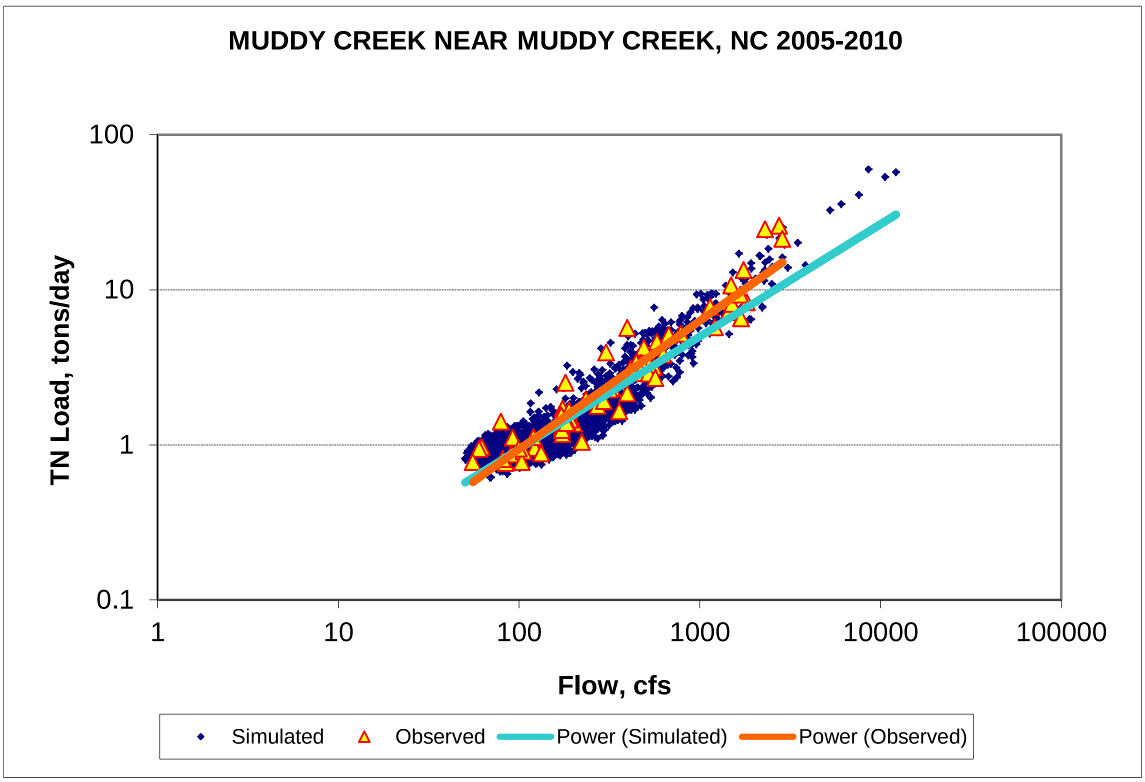

Figure G- 47. Total N Load Power Plot, Calibration Period, Muddy Creek at Muddy Creek

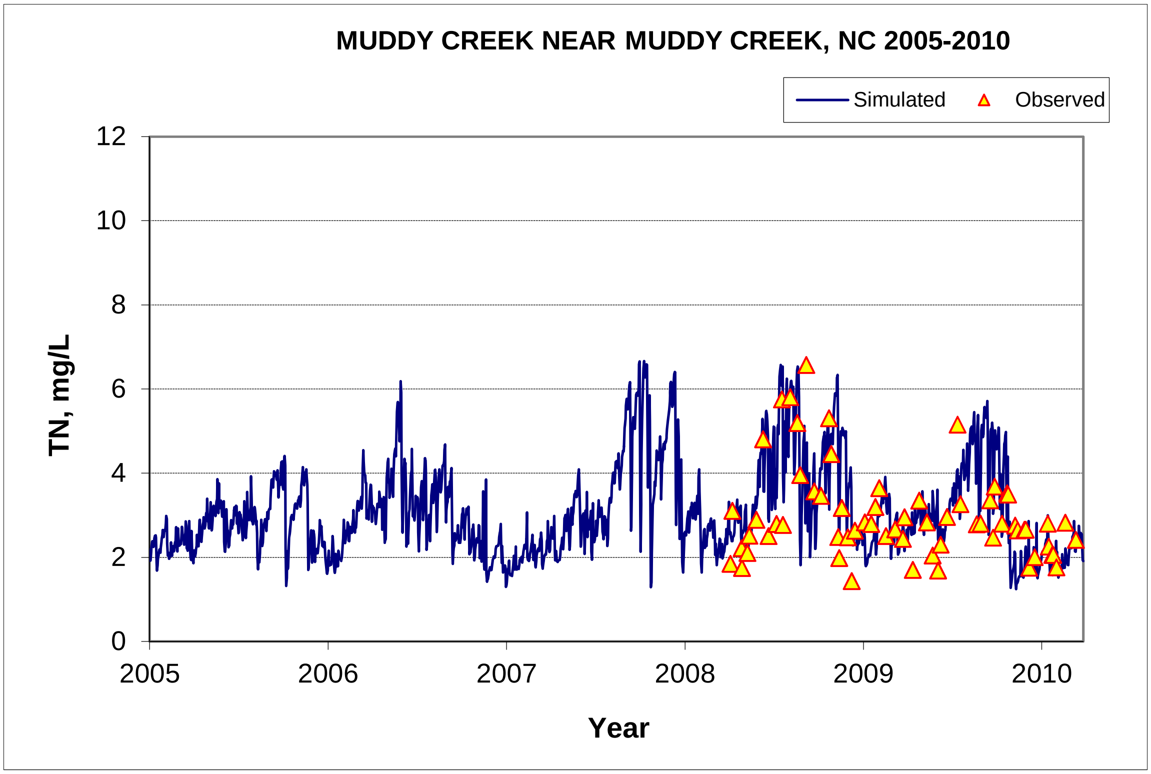

Figure G- 48. Total N Concentration Time Series, Calibration Period, Muddy Creek at Muddy Creek

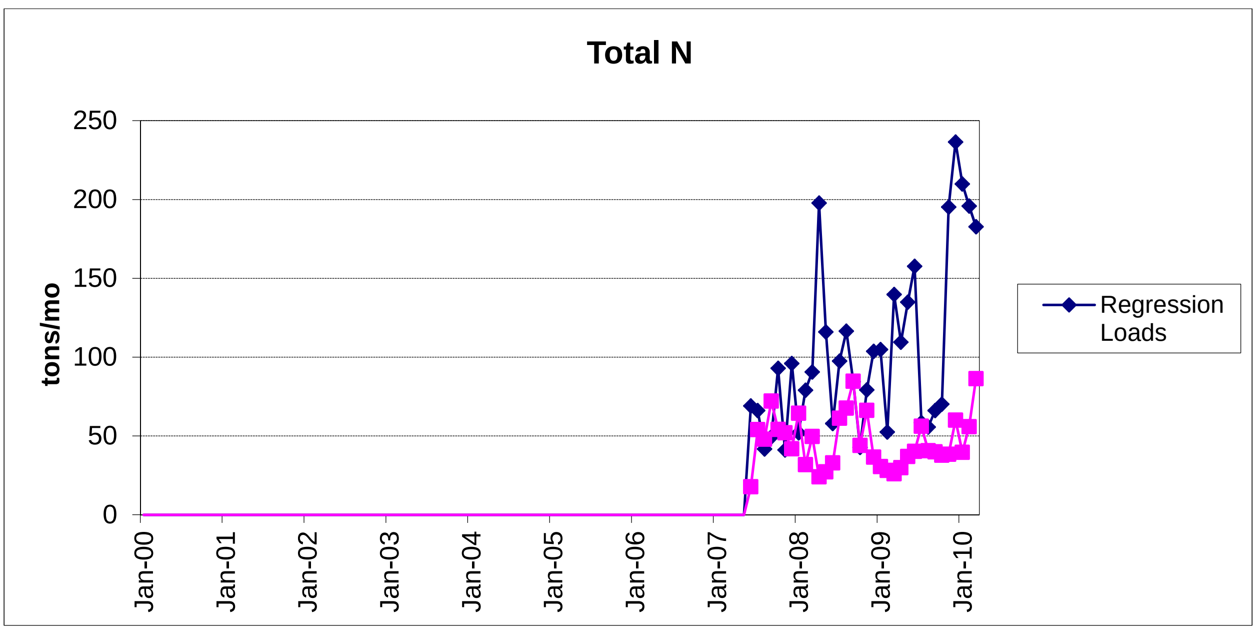

Figure G- 49. Total N Monthly Load Series, Muddy Creek at Muddy Creek

Table G- 14. Summary Statistics, Total P, Second Creek near Barber

	2005-2010	2000-2004
Count	42	18
Concentration average error	-31.1%	-28.7%
Concentration median error	5.1%	-20.8%
Paired load average error	-16.5%	39.7%
Paired load median error	0.6%	-14.0%
Paired t, concentration	0.27	0.25
Paired t, load	0.54	0.37
Long-term load vs. stratified regression estimate	-30.3%	-22.4%
Monthly load NSE	0.57	0.63

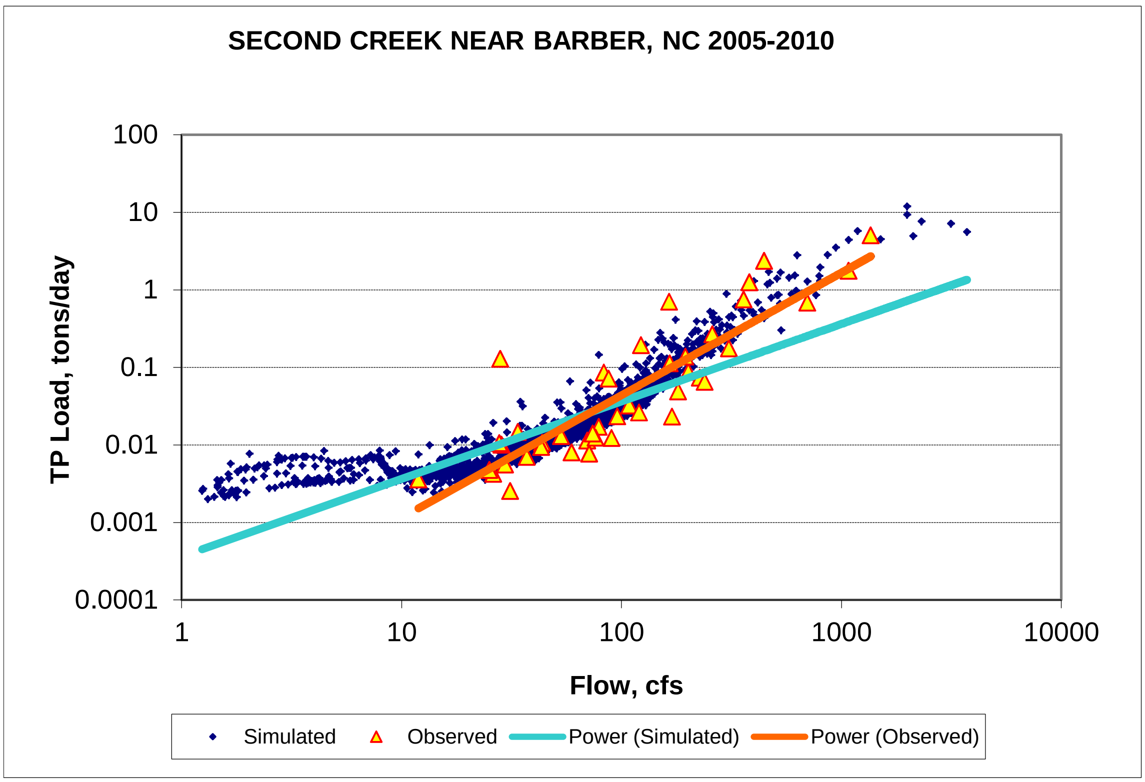

Figure G- 50. Total P Load Power Plot, Calibration Period, Second Creek near Barber

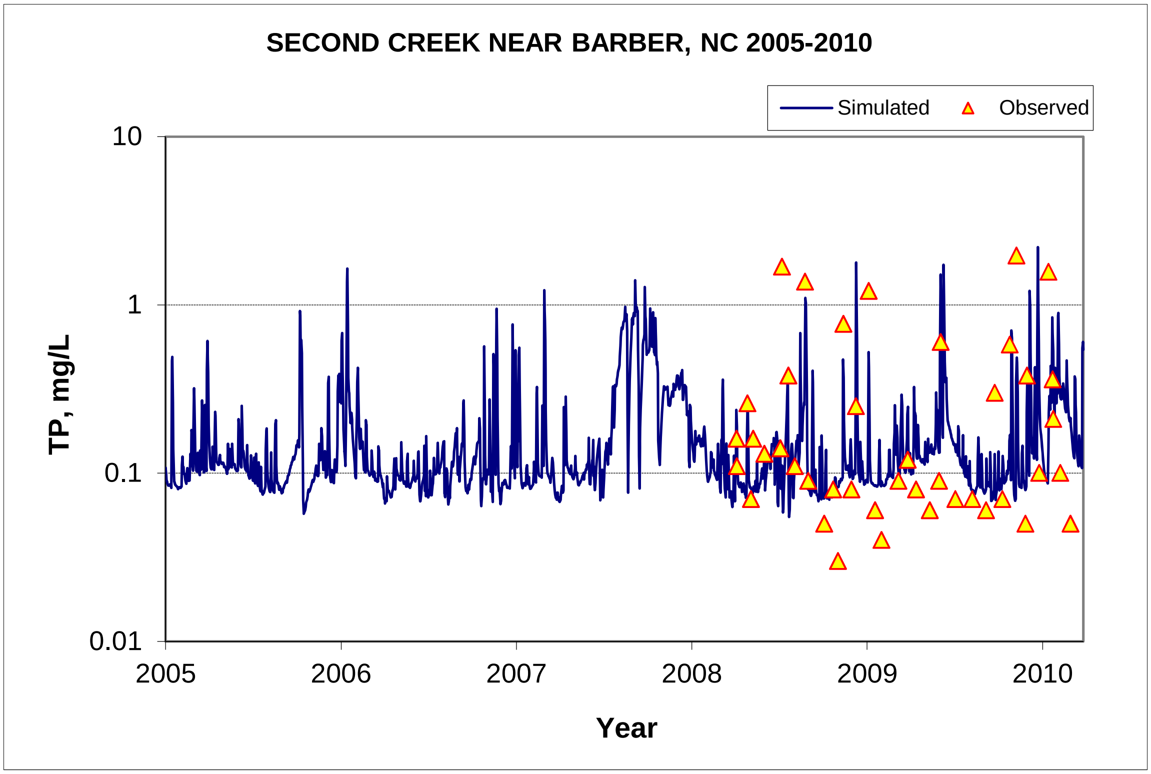

Figure G- 51. Total P Concentration Time Series, Calibration Period, Second Creek near Barber

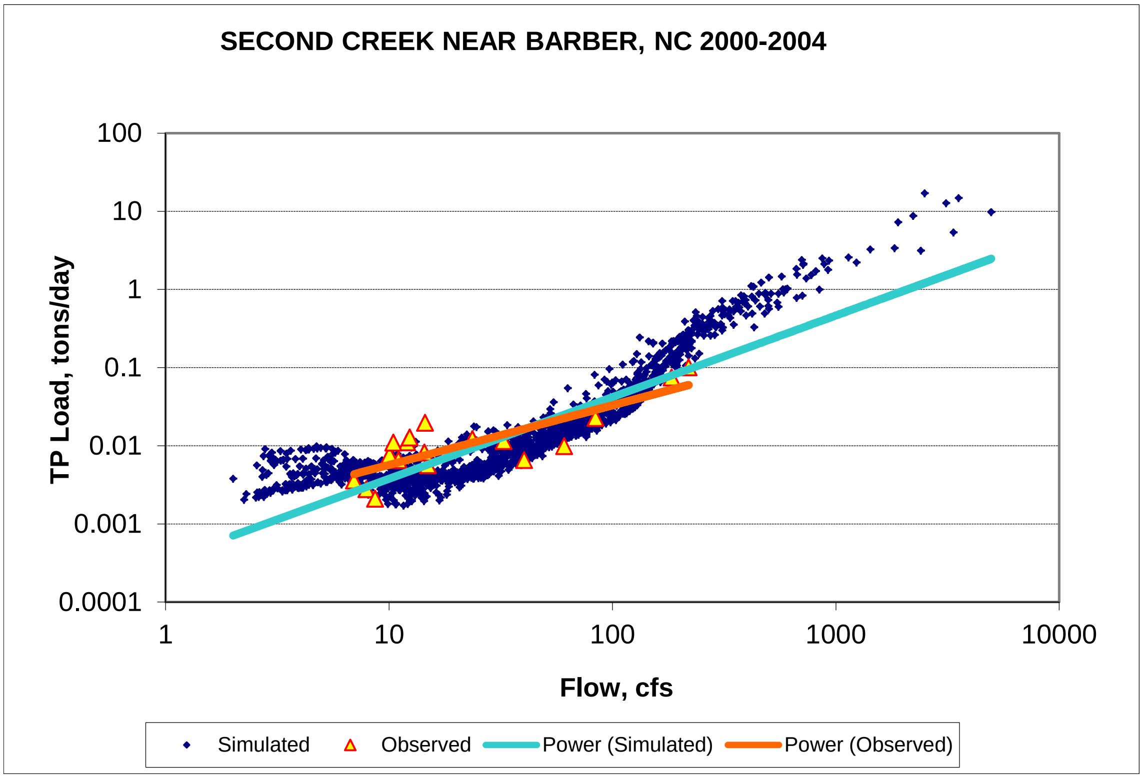

Figure G- 52. Total P Load Power Plot, Validation Period, Second Creek near Barber

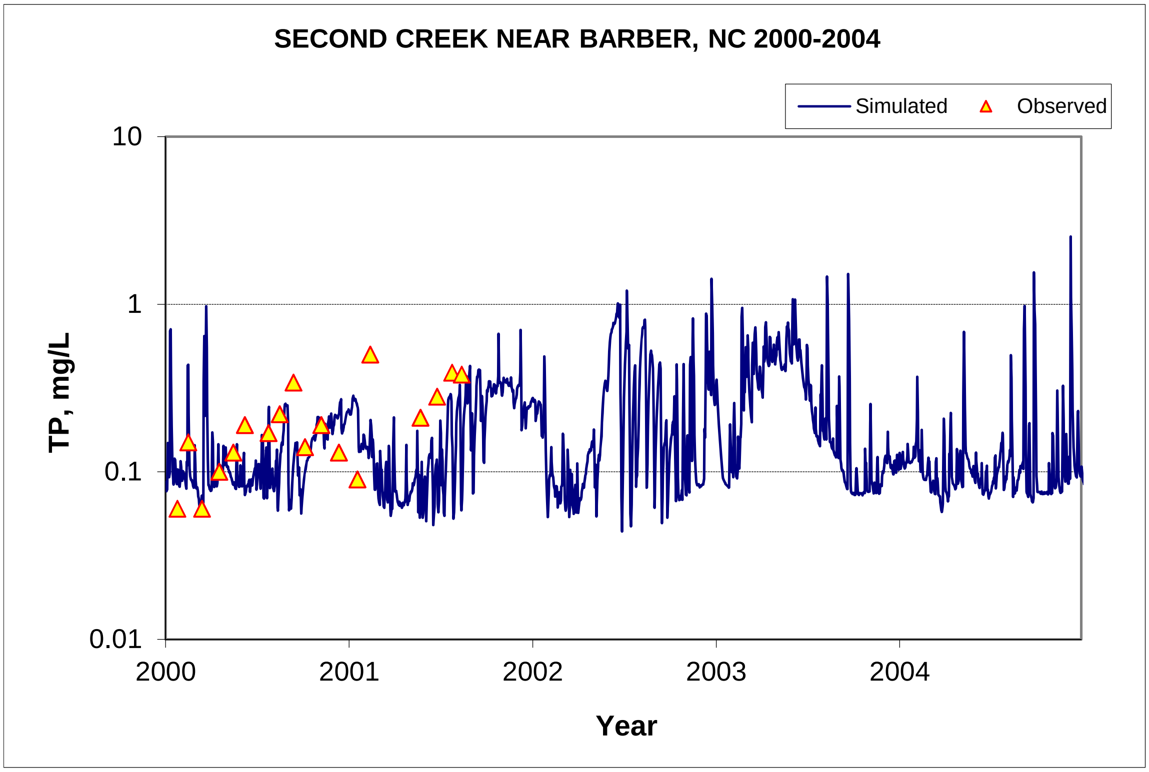

Figure G- 53. Total P Concentration Time Series, Validation Period, Second Creek near Barber

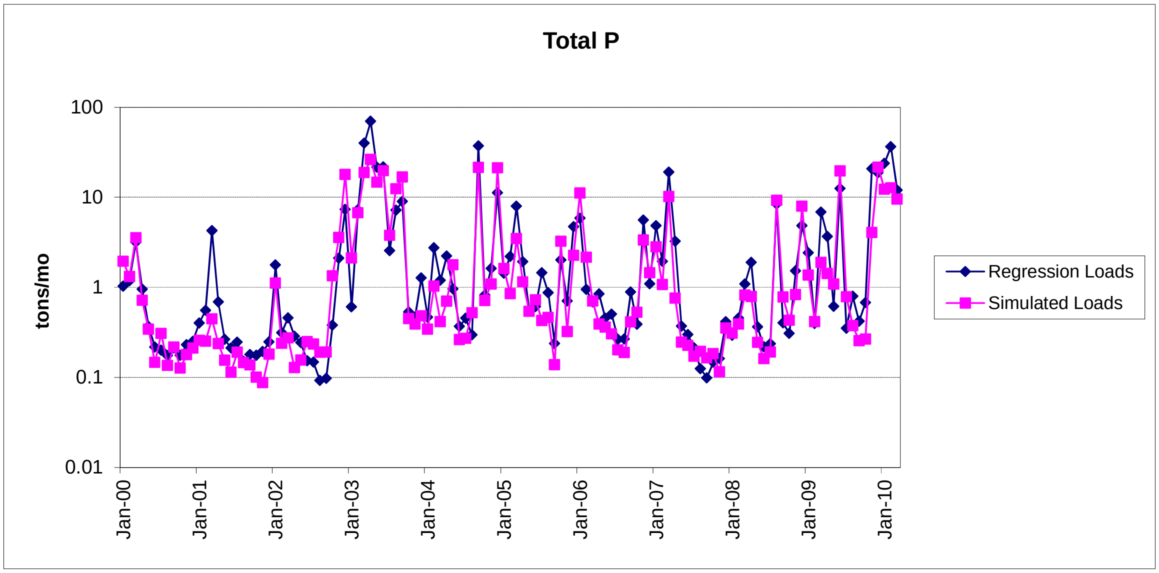

Figure G- 54. Total P Monthly Load Series, Second Creek near Barber

Table G- 15. Summary Statistics, Total N, Second Creek near Barber

	2005-2010	2000-2004
Count	42	15
Concentration average error	-6.5%	-6.8%
Concentration median error	-7.4%	-17.1%
Paired load average error	26.9%	12.9%
Paired load median error	-1.3%	-8.2%
Paired t, concentration	0.86	0.88
Paired t, load	0.44	0.56
Long-term load vs. stratified regression estimate	7.4%	19.4%
Monthly load NSE	0.41	0.49

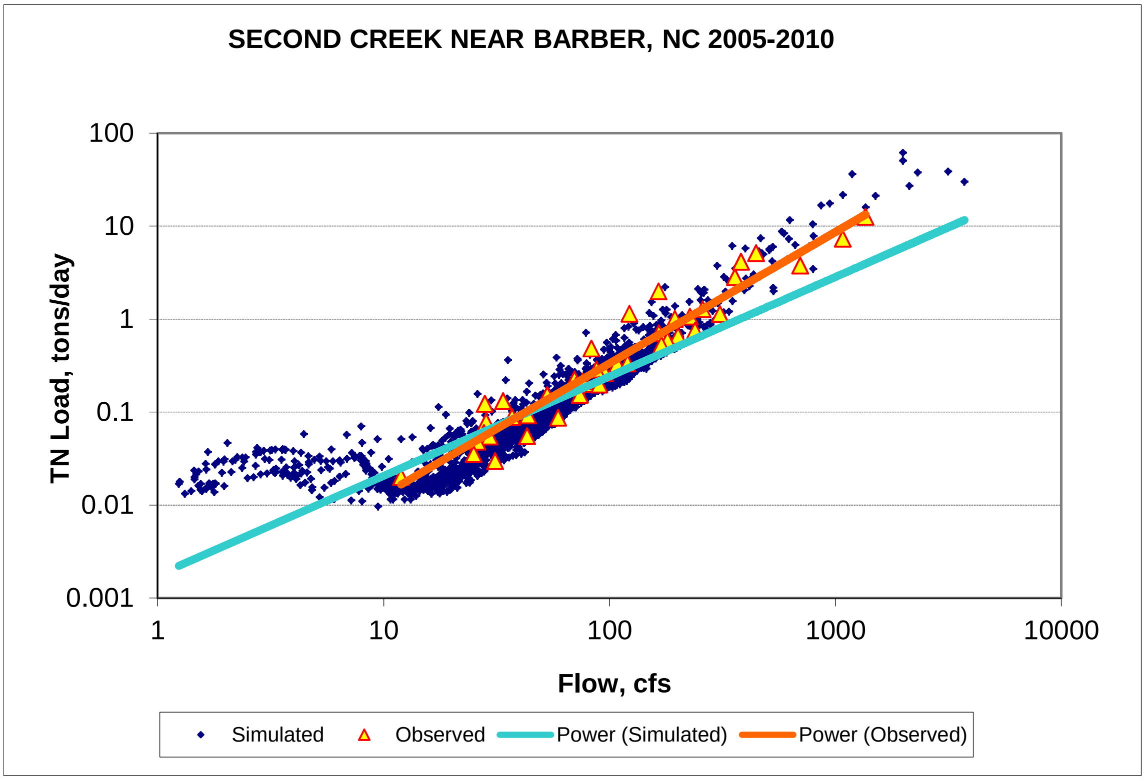

Figure G- 55. Total N Load Power Plot, Calibration Period, Second Creek near Barber

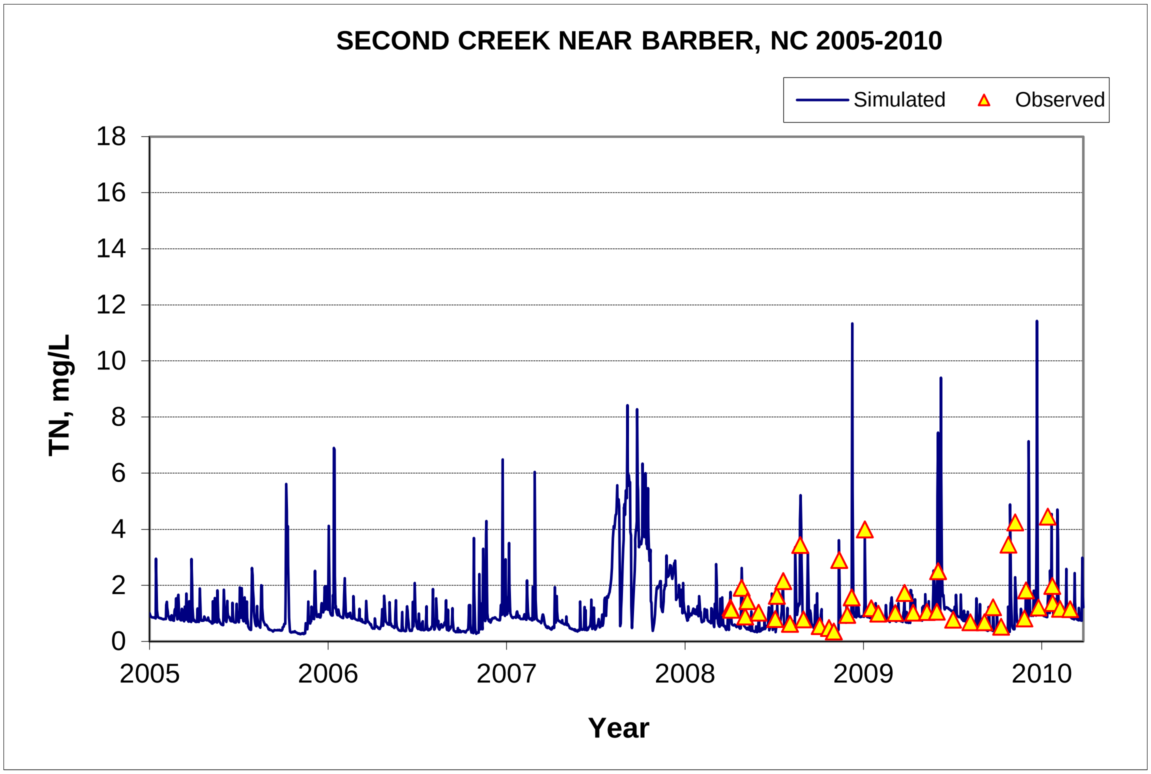

Figure G- 56. Total N Concentration Time Series, Calibration Period, Second Creek near Barber

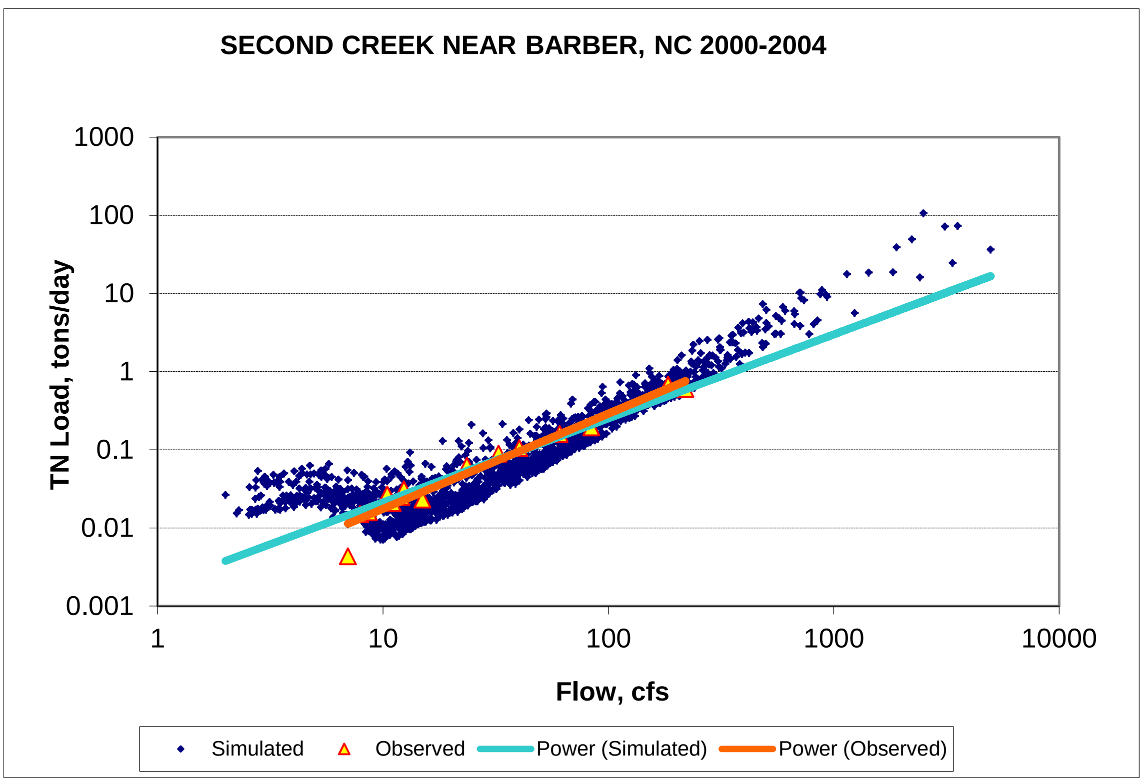

Figure G- 57. Total N Load Power Plot, Validation Period, Second Creek near Barber

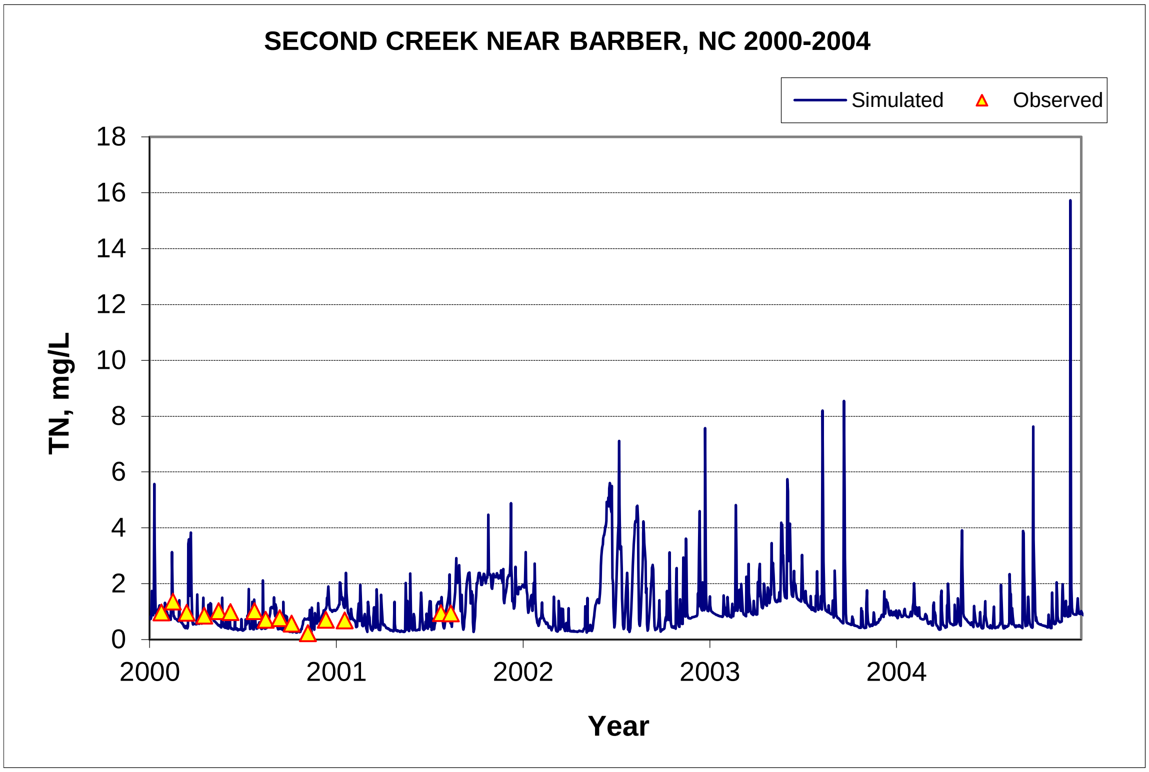

Figure G- 58. Total N Concentration Time Series, Validation Period, Second Creek near Barber

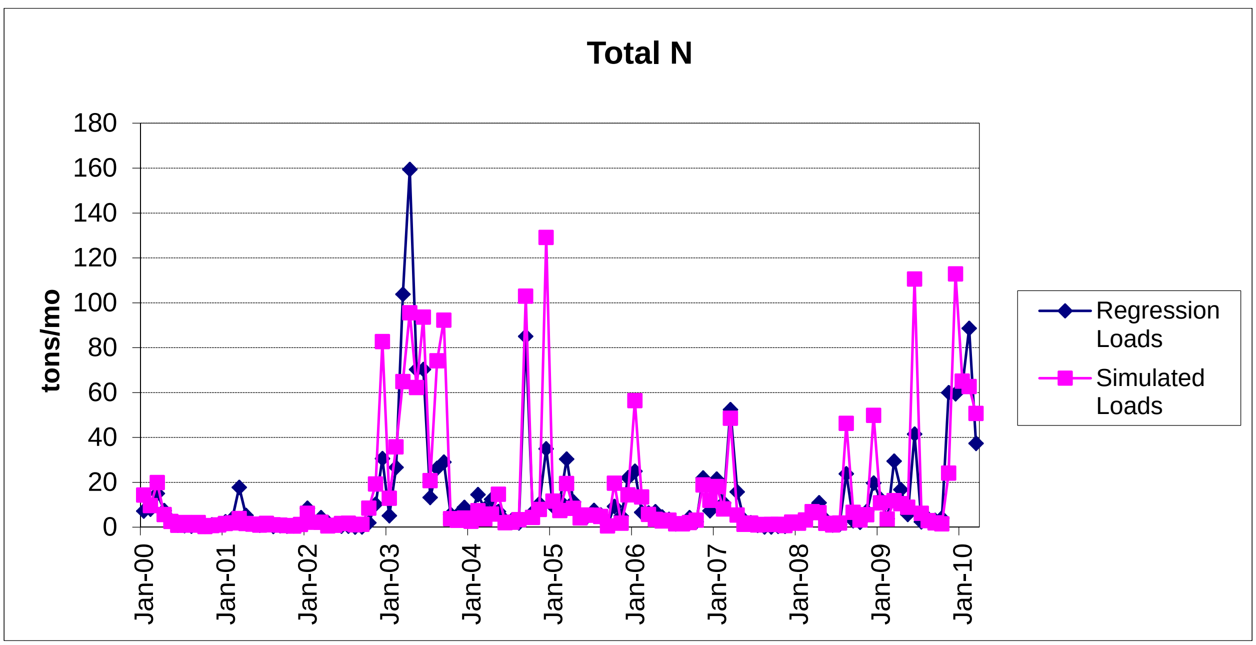

Figure G- 59. Total N Monthly Load Series, Second Creek near Barber

Table G- 16. Summary Statistics, Total P, Yadkin River at Enon

	2005-2010	2000-2004
Count	77	15
Concentration average error	8.0%	8.5%
Concentration median error	-0.1%	14.1%
Paired load average error	26.3%	9.3%
Paired load median error	0.0%	11.3%
Paired t, concentration	0.95	0.94
Paired t, load	0.43	0.72
Long-term load vs. stratified regression estimate	29.0%	30.5%
Monthly load NSE	0.21	0.56

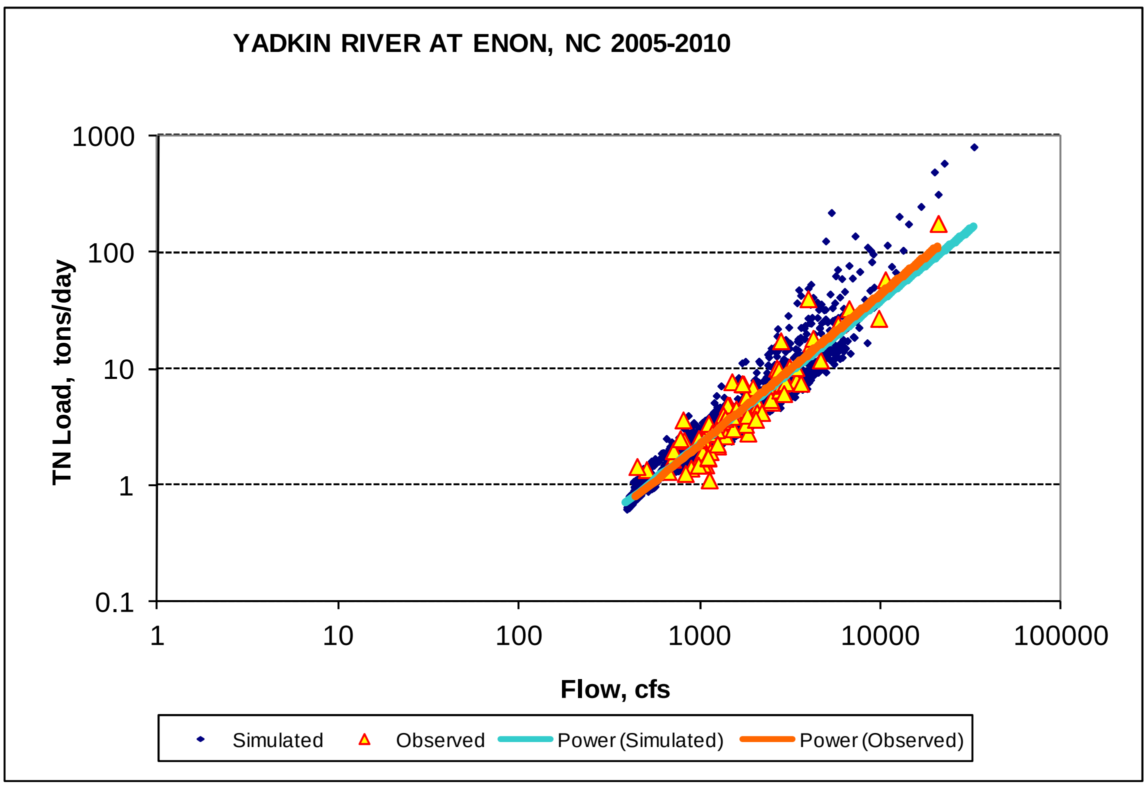

Figure G- 60. Total P Load Power Plot, Calibration Period, Yadkin River at Enon

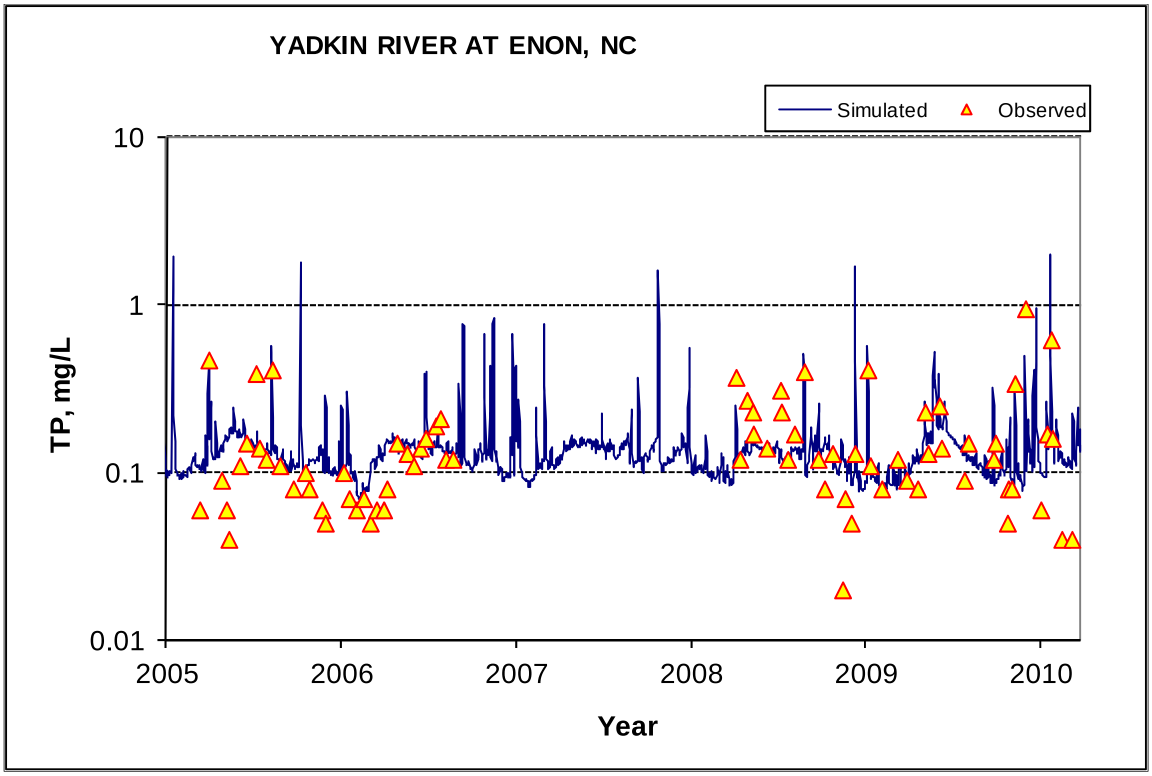

Figure G- 61. Total P Concentration Time Series, Calibration Period, Yadkin River at Enon

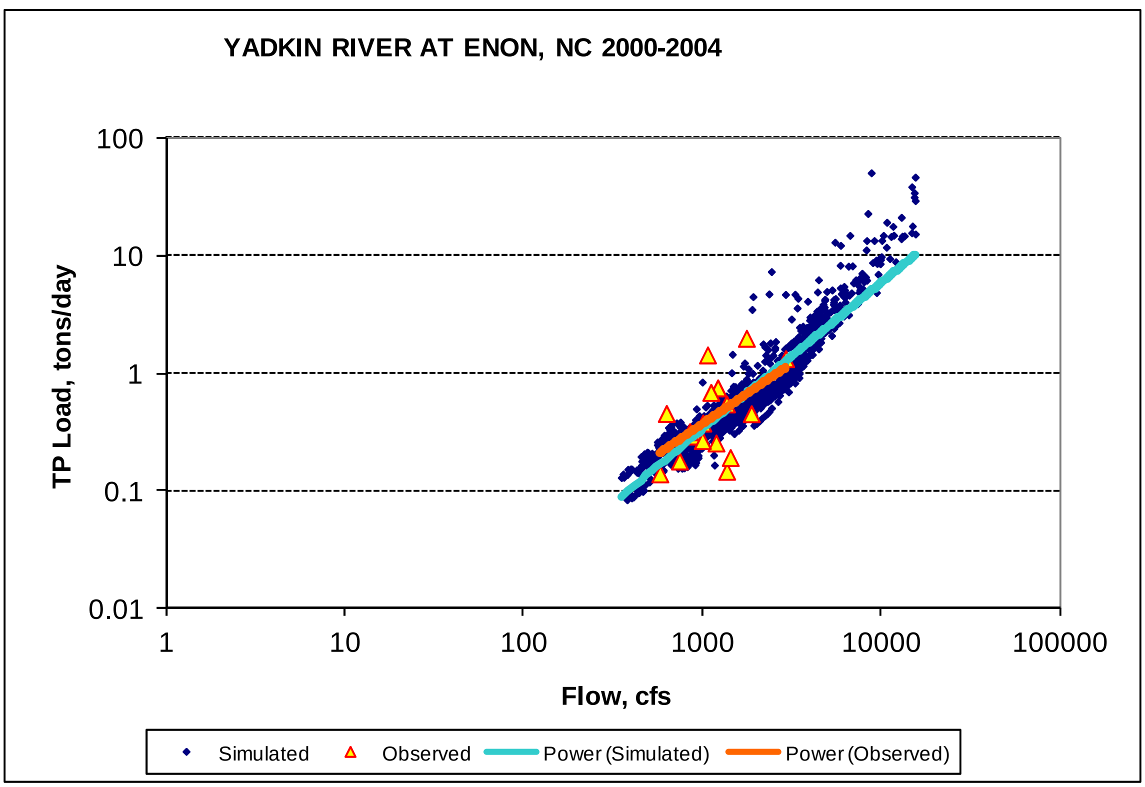

Figure G- 62. Total P Load Power Plot, Validation Period, Yadkin River at Enon

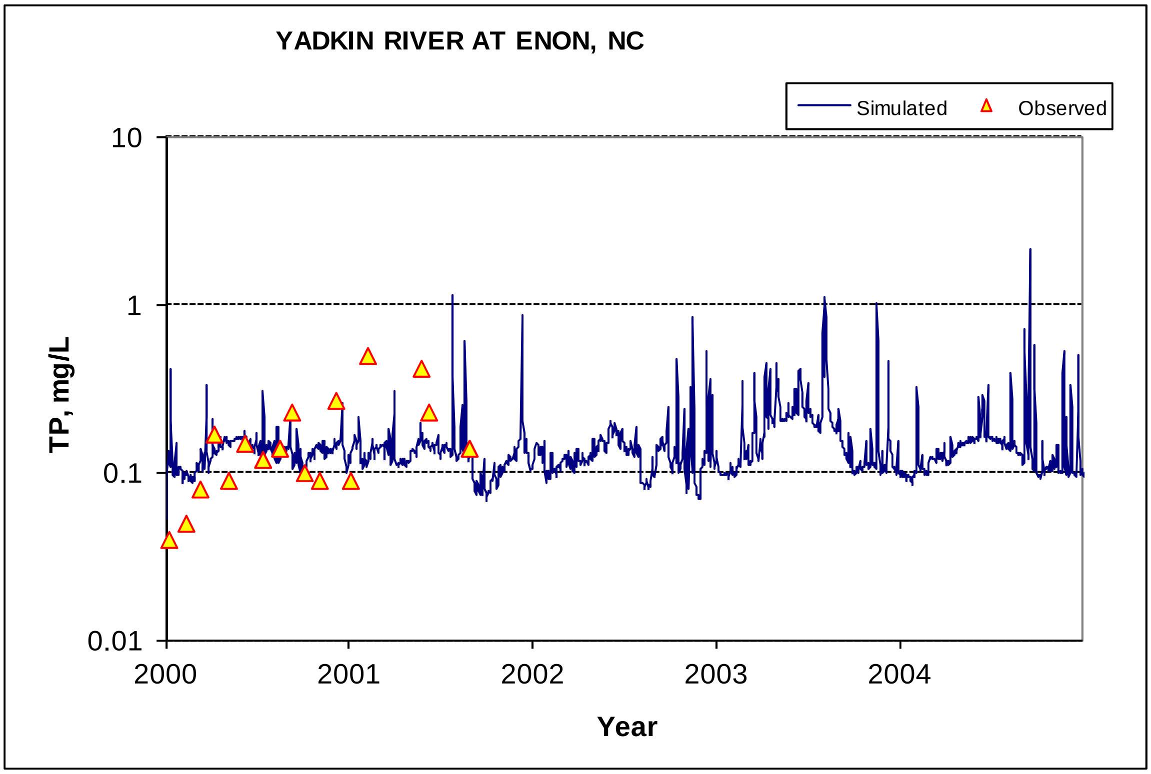

Figure G- 63. Total P Concentration Time Series, Validation Period, Yadkin River at Enon

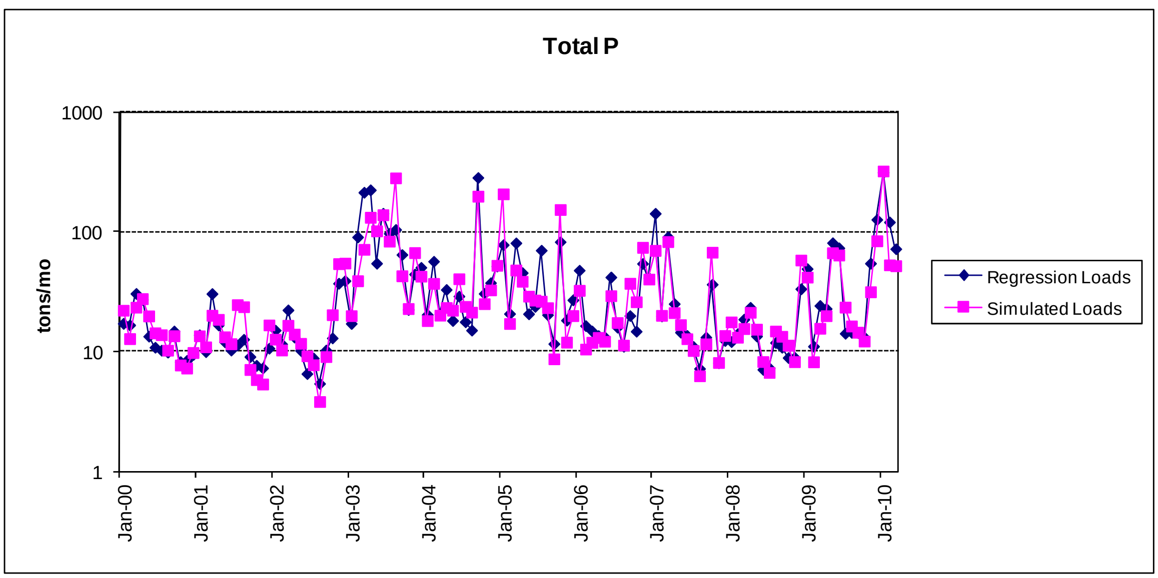

Figure G- 64. Total P Monthly Load Series, Yadkin River at Enon

Table G- 17. Summary Statistics, Total N, Yadkin River at Enon

	2005-2010	2000-2004
Count	77	15
Concentration average error	8.0%	8.5%
Concentration median error	-0.1%	14.1%
Paired load average error	26.3%	9.3%
Paired load median error	0.0%	11.3%
Paired t, concentration	0.95	0.94
Paired t, load	0.43	0.72
Long-term load vs. stratified regression estimate	29.0%	30.5%
Monthly load NSE	0.21	0.56

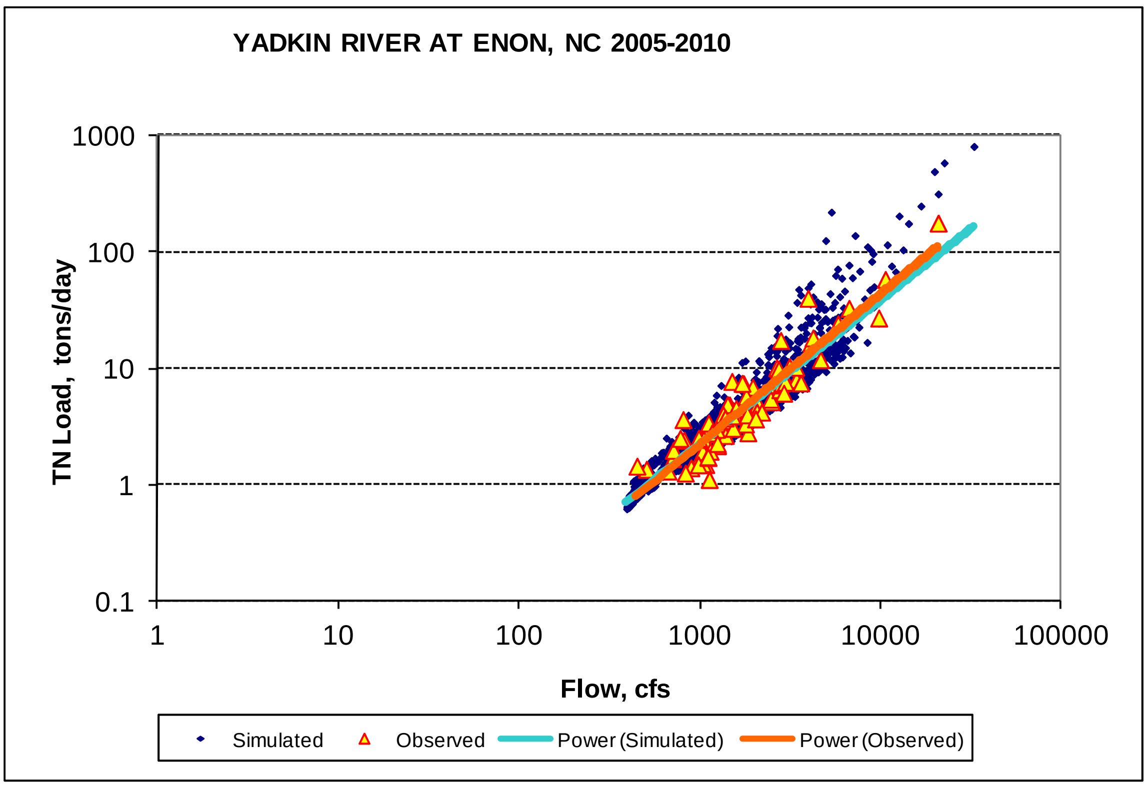

Figure G- 65. Total N Load Power Plot, Calibration Period, Yadkin River at Enon

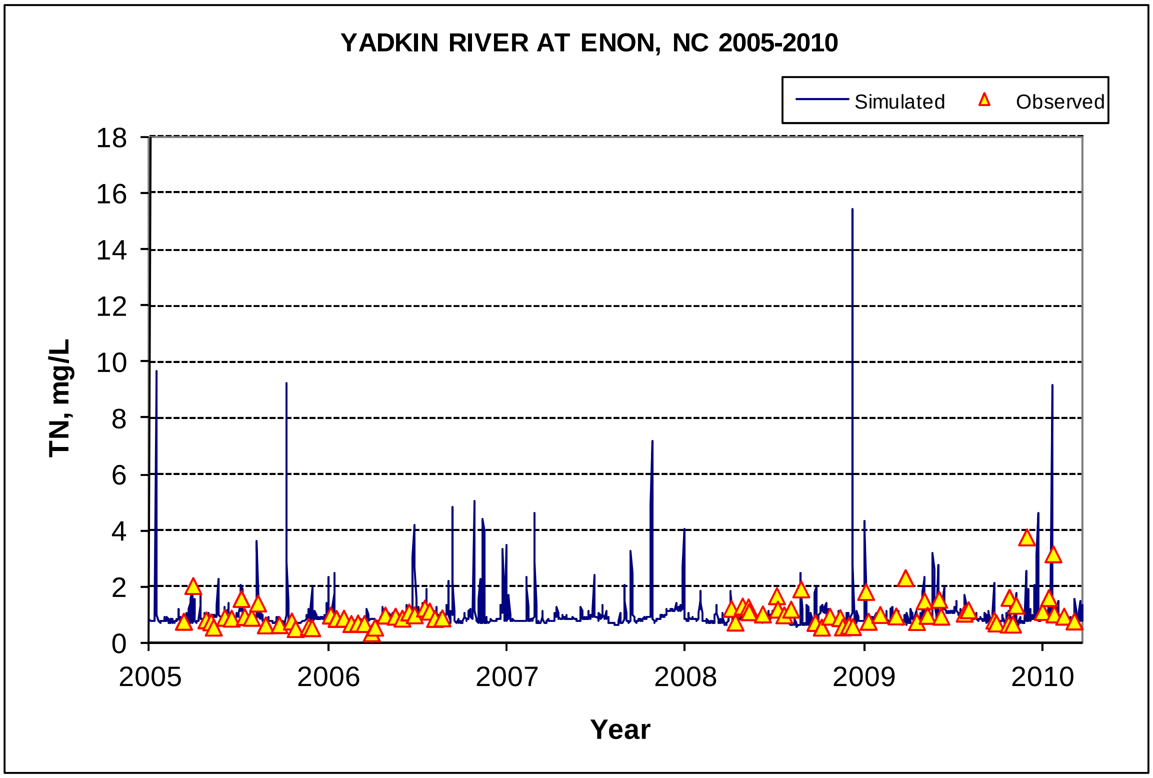

Figure G- 66. Total N Concentration Time Series, Calibration Period, Yadkin River at Enon

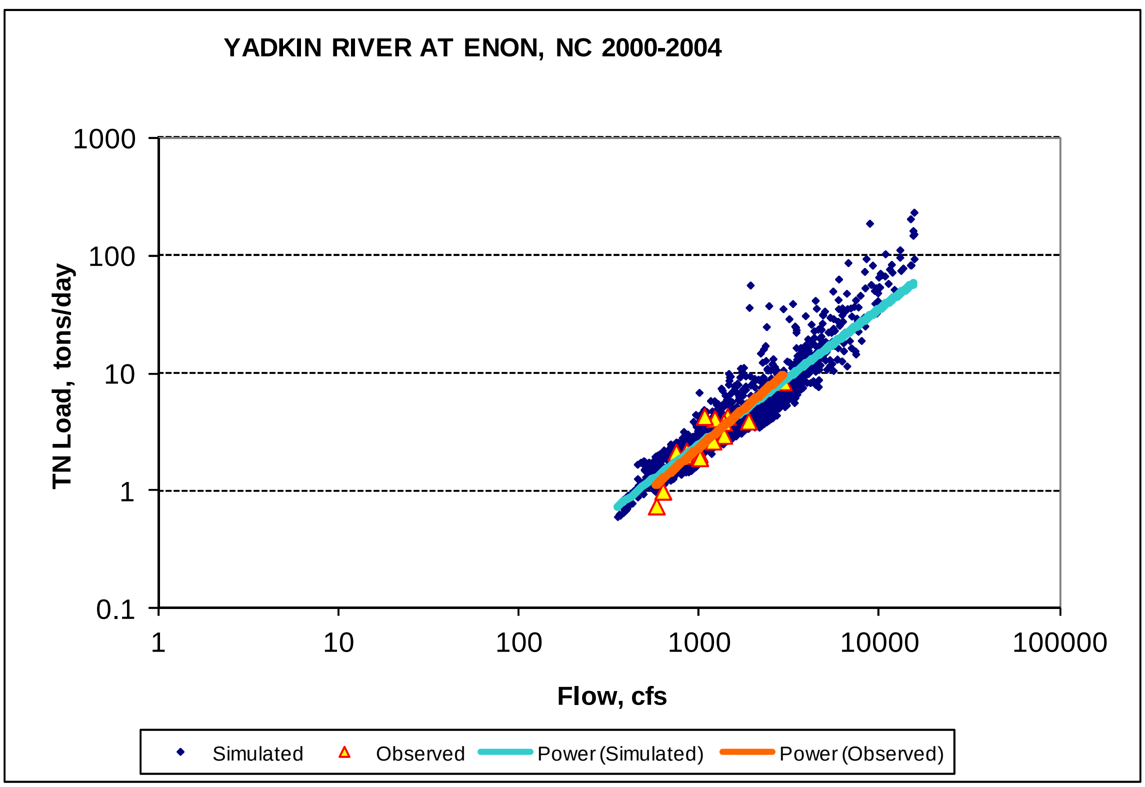

Figure G- 67. Total N Load Power Plot, Validation Period, Yadkin River at Enon

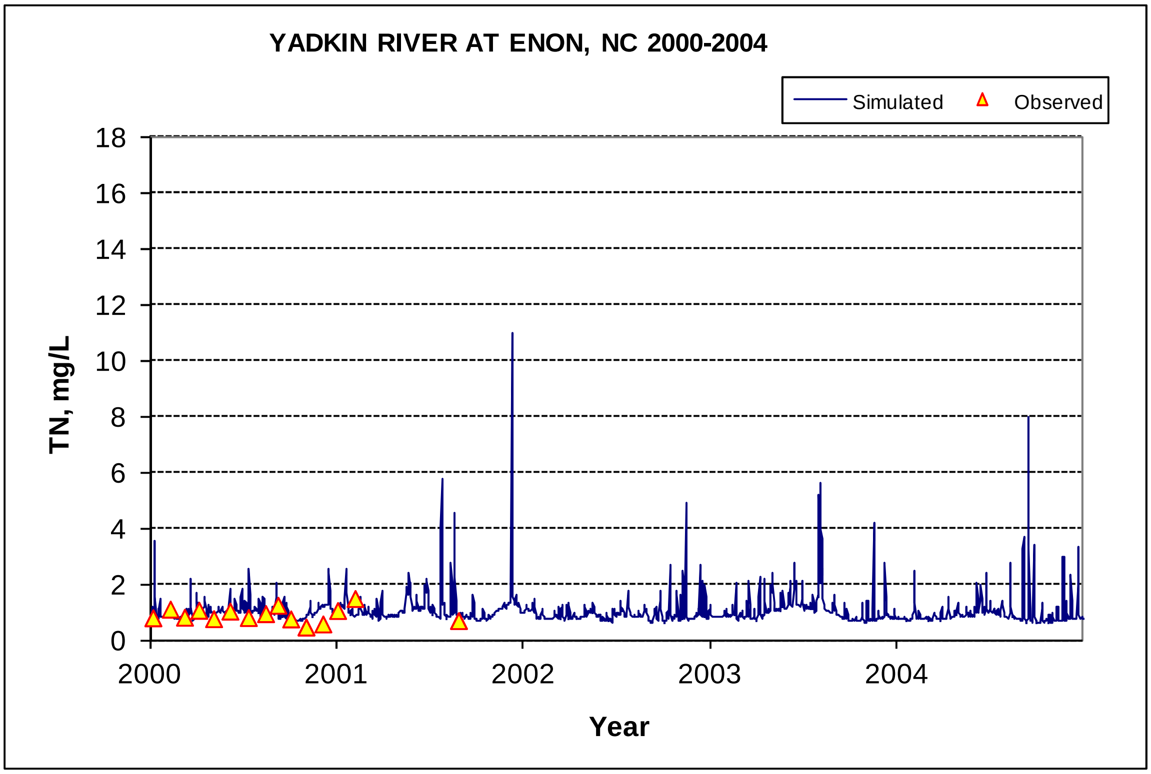

Figure G- 68. Total N Concentration Time Series, Validation Period, Yadkin River at Enon

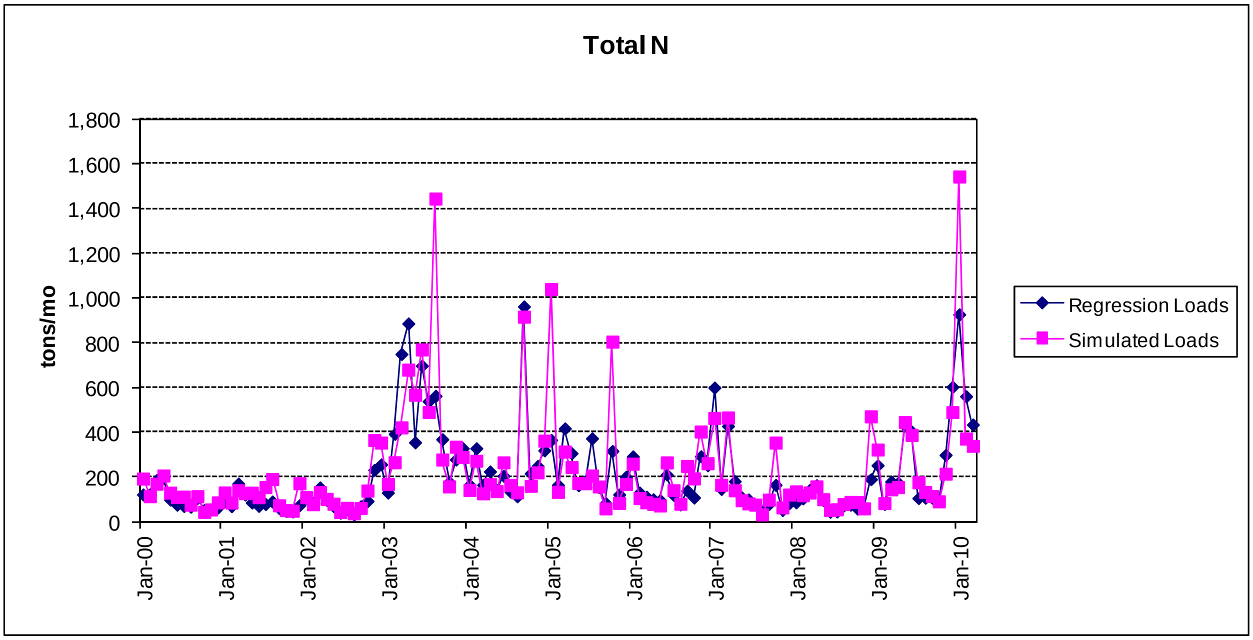

Figure G- 69. Total N Monthly Load Series, Yadkin River at Enon

Table G- 18. Summary Statistics, Total P, Yadkin River at Elkin

	2005-2010	2000-2004
Count	73	18
Concentration average error	-16.3%	-6.4%
Concentration median error	7.1%	5.7%
Paired load average error	-33.7%	-5.9%
Paired load median error	3.2%	4.5%
Paired t, concentration	0.61	0.91
Paired t, load	0.30	0.83
Long-term load vs. stratified regression estimate	-13.7%	-26.5%
Monthly load NSE	0.79	0.72

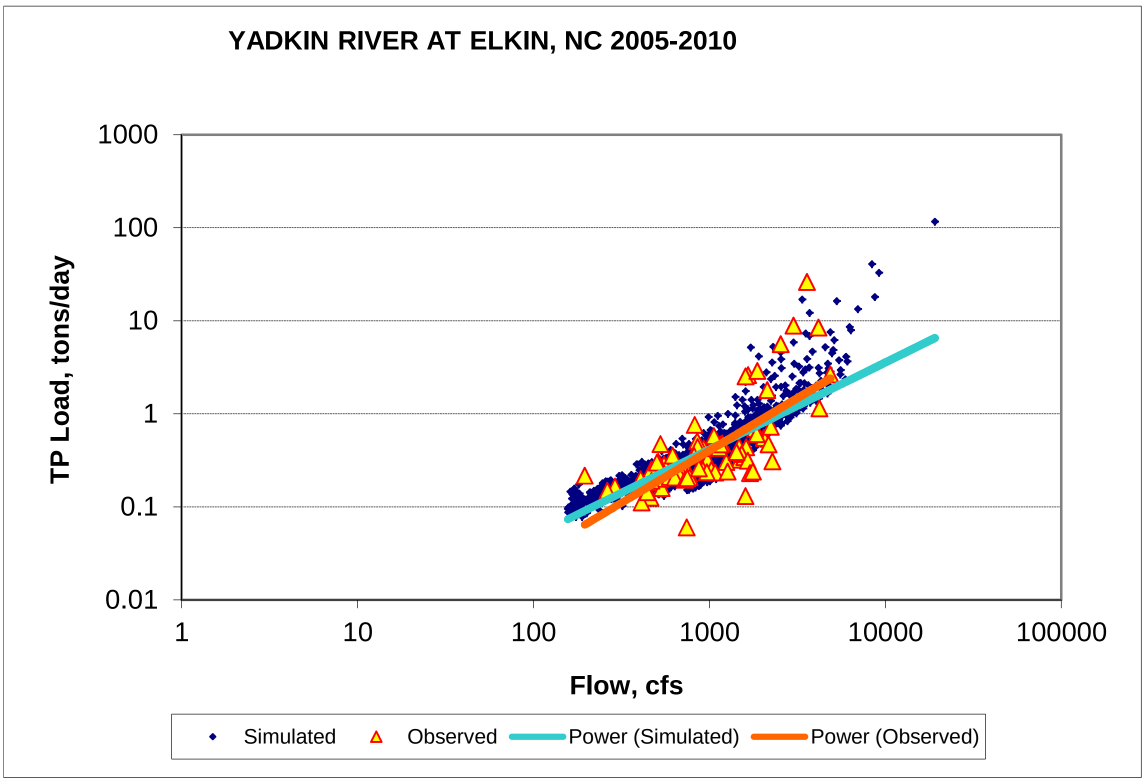

Figure G- 70. Total P Load Power Plot, Calibration Period, Yadkin River at Elkin

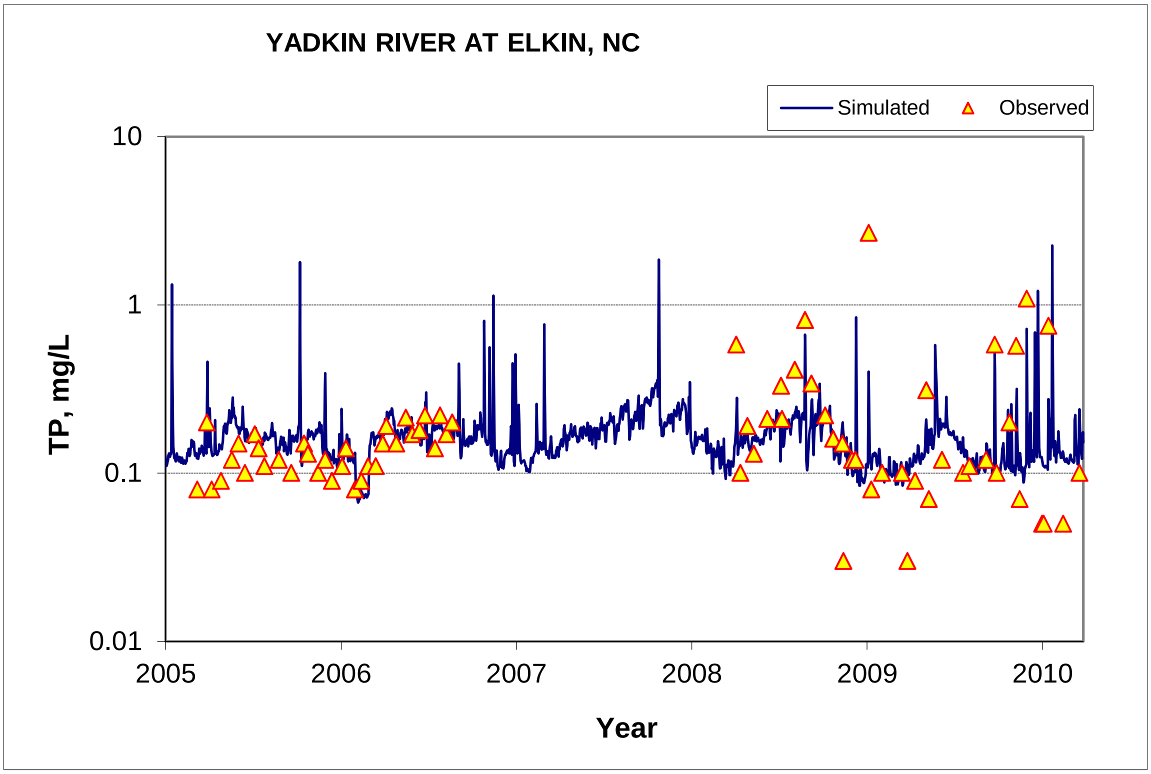

Figure G- 71. Total P Concentration Time Series, Calibration Period, Yadkin River at Elkin

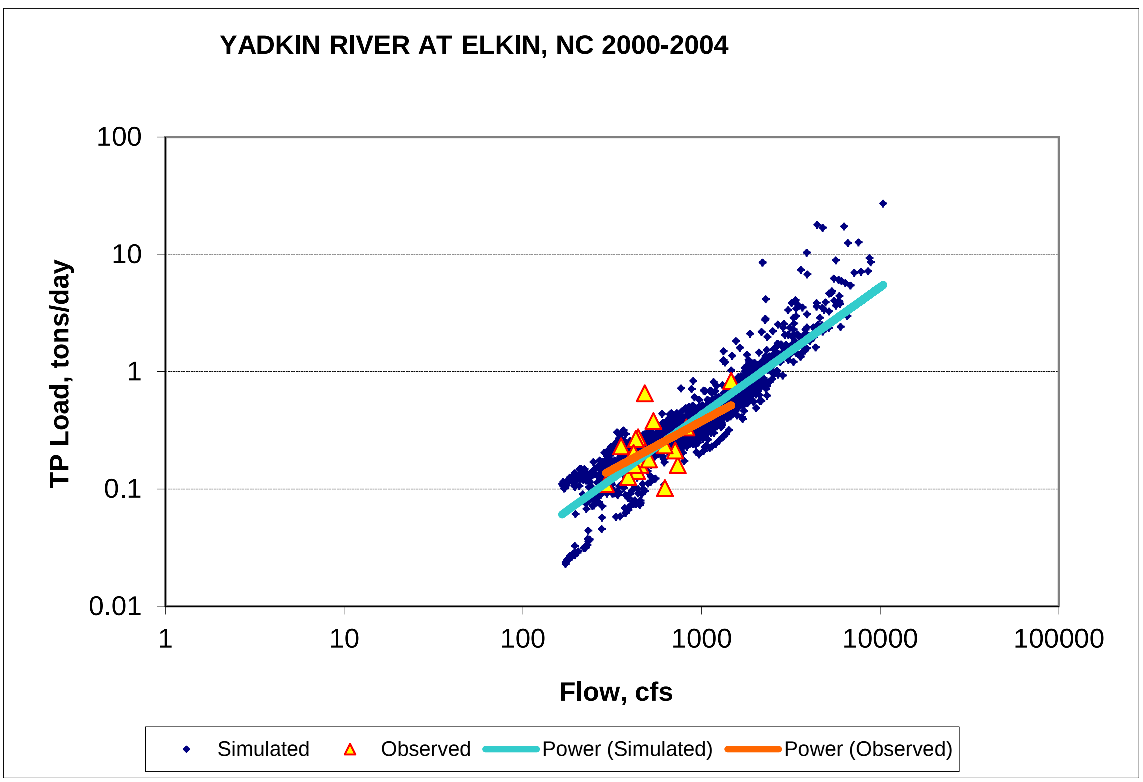

Figure G- 72. Total P Load Power Plot, Validation Period, Yadkin River at Elkin

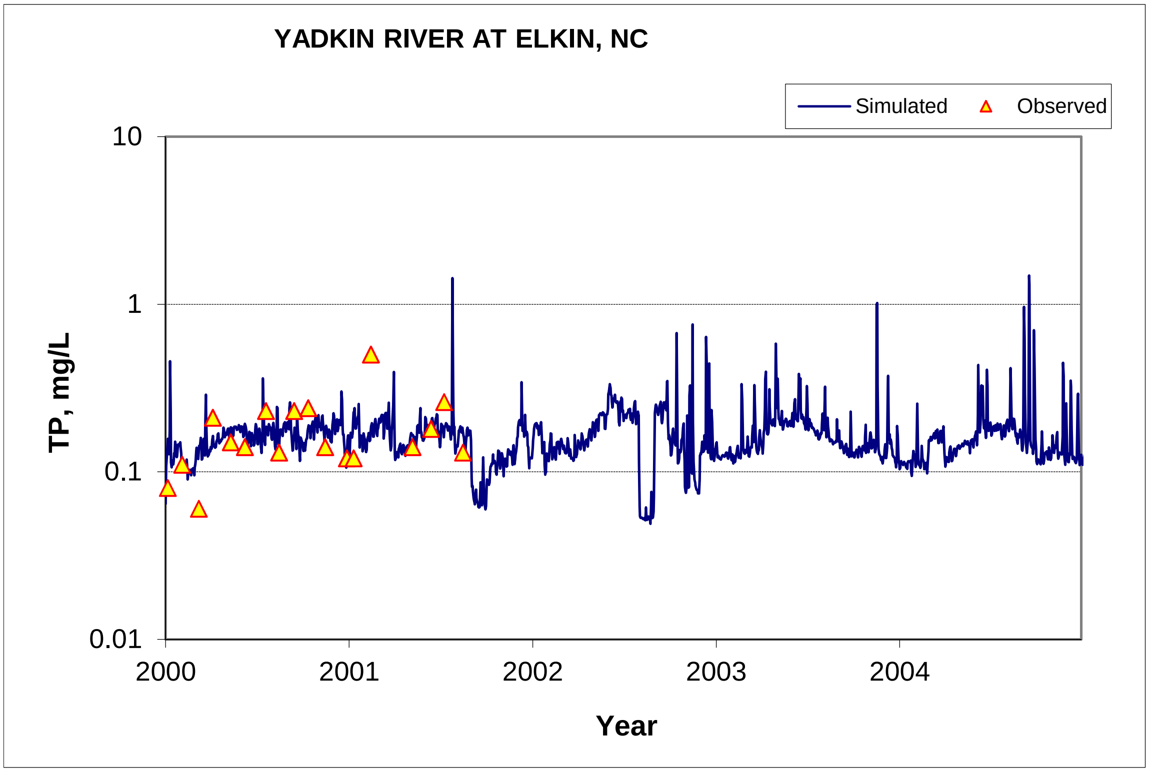

Figure G- 73. Total P Concentration Time Series, Validation Period, Yadkin River at Elkin

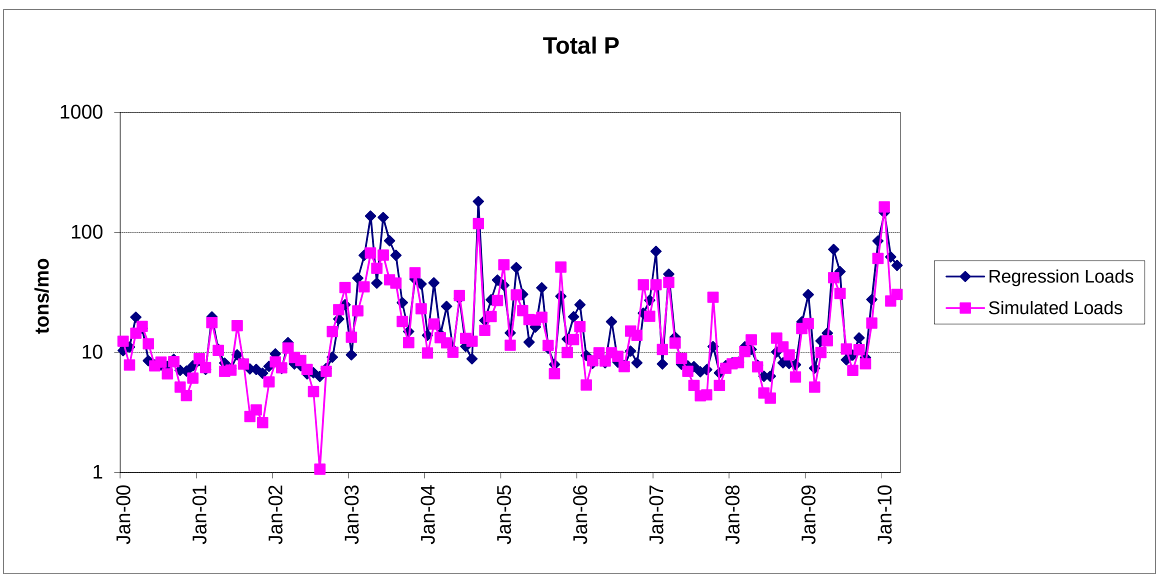

Figure G- 74. Total P Monthly Load Series, Yadkin River at Elkin

Table G- 19. Summary Statistics, Total N, Yadkin River at Elkin

	2005-2010	2000-2004
Count	73	16
Concentration average error	-13.3%	2.1%
Concentration median error	-1.5%	-1.8%
Paired load average error	-20.4%	4.2%
Paired load median error	-0.7%	-1.4%
Paired t, concentration	0.80	1.00
Paired t, load	0.49	0.83
Long-term load vs. stratified regression estimate	-11.2%	-13.2%
Monthly load NSE	0.77	0.75

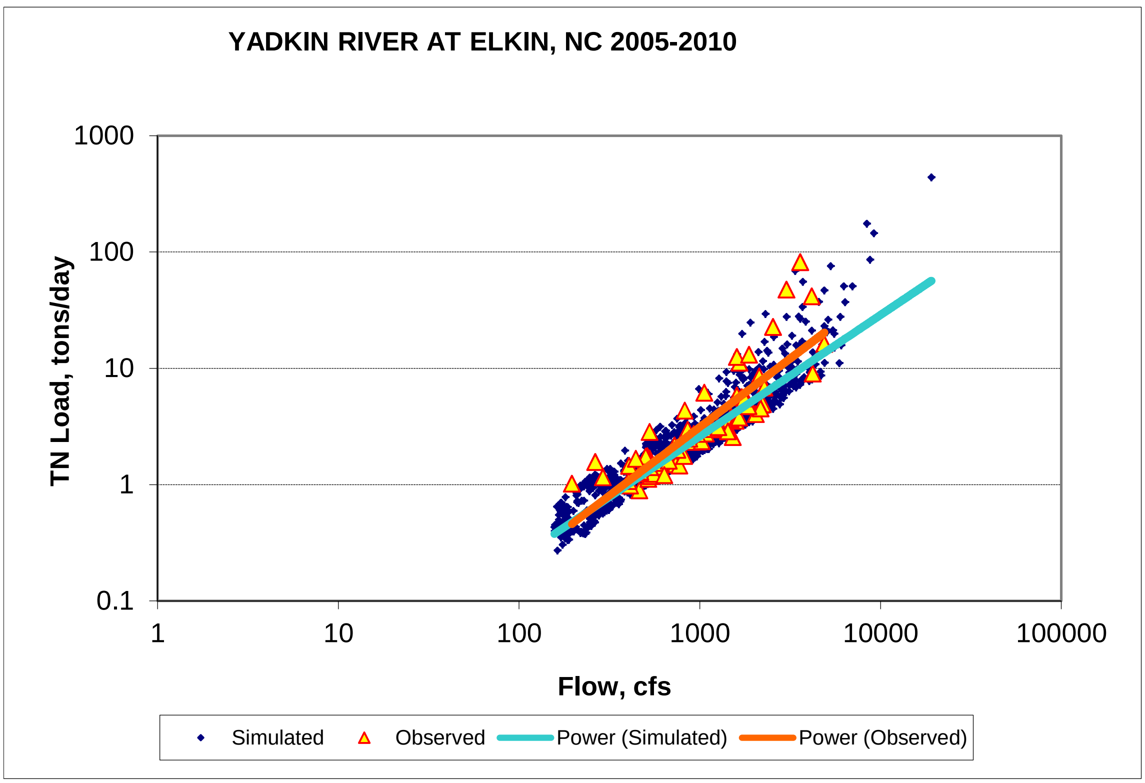

Figure G- 75. Total N Load Power Plot, Calibration Period, Yadkin River at Elkin

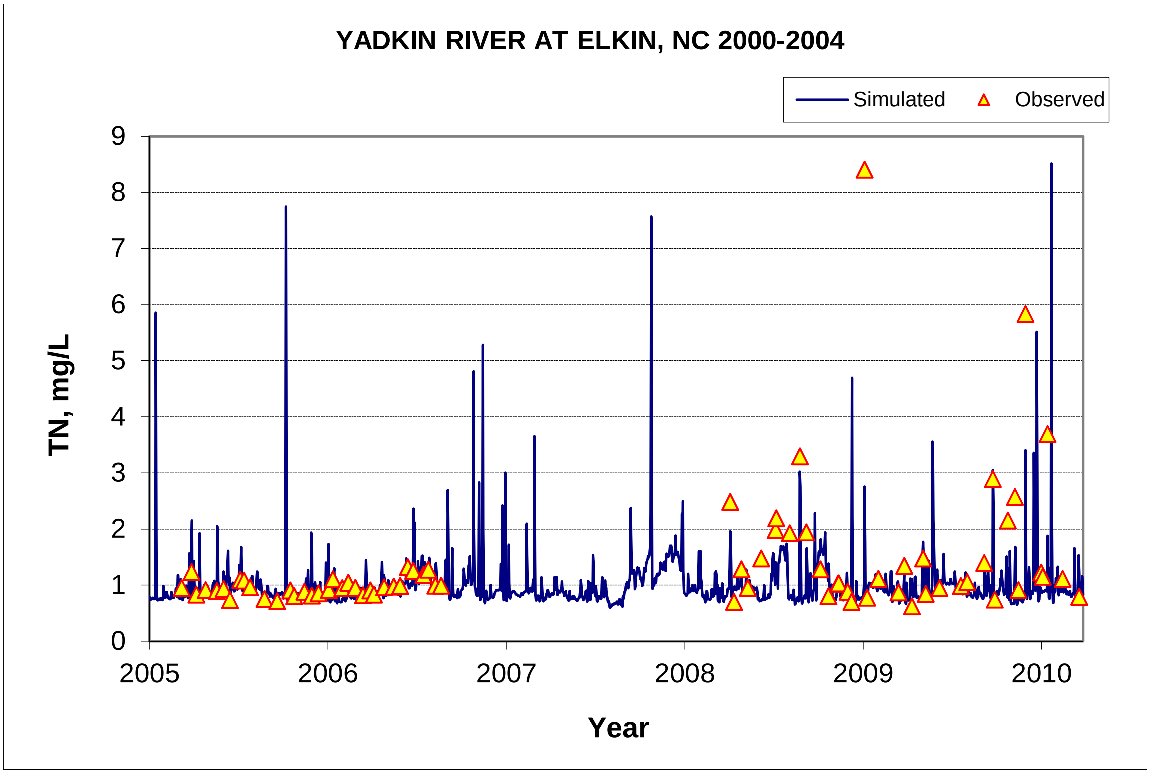

Figure G- 76. Total N Concentration Time Series, Calibration Period, Yadkin River at Elkin

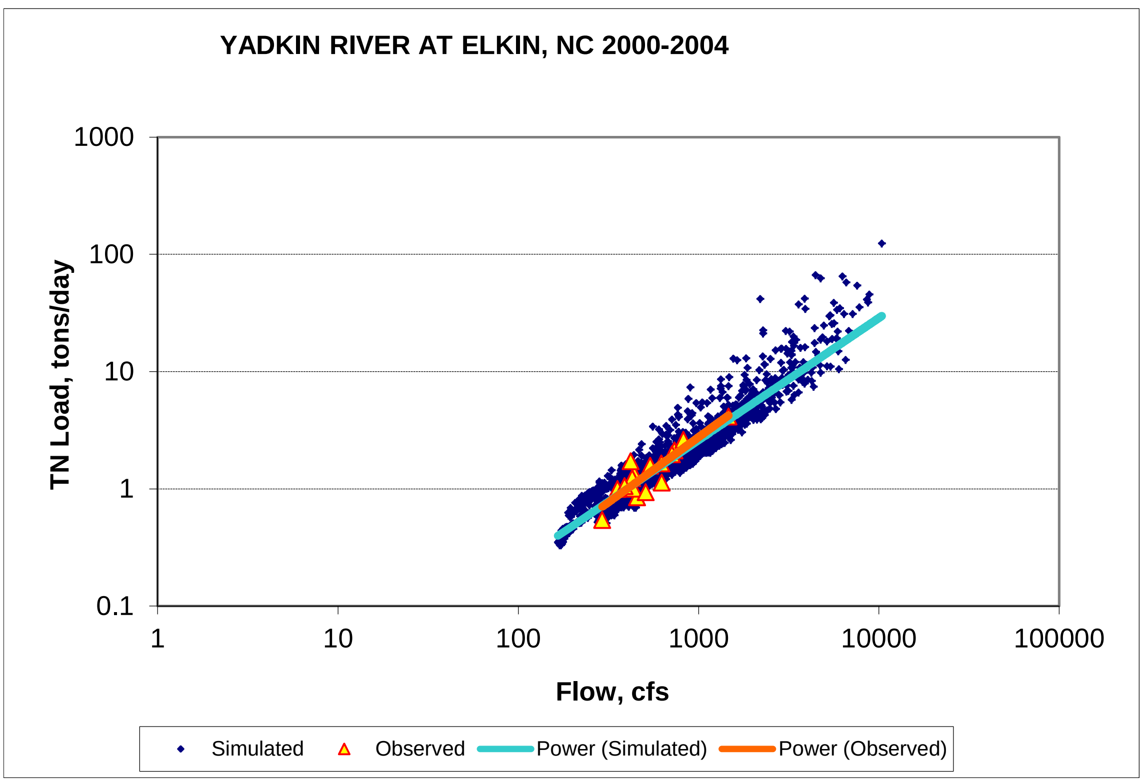

Figure G- 77. Total N Load Power Plot, Validation Period, Yadkin River at Elkin

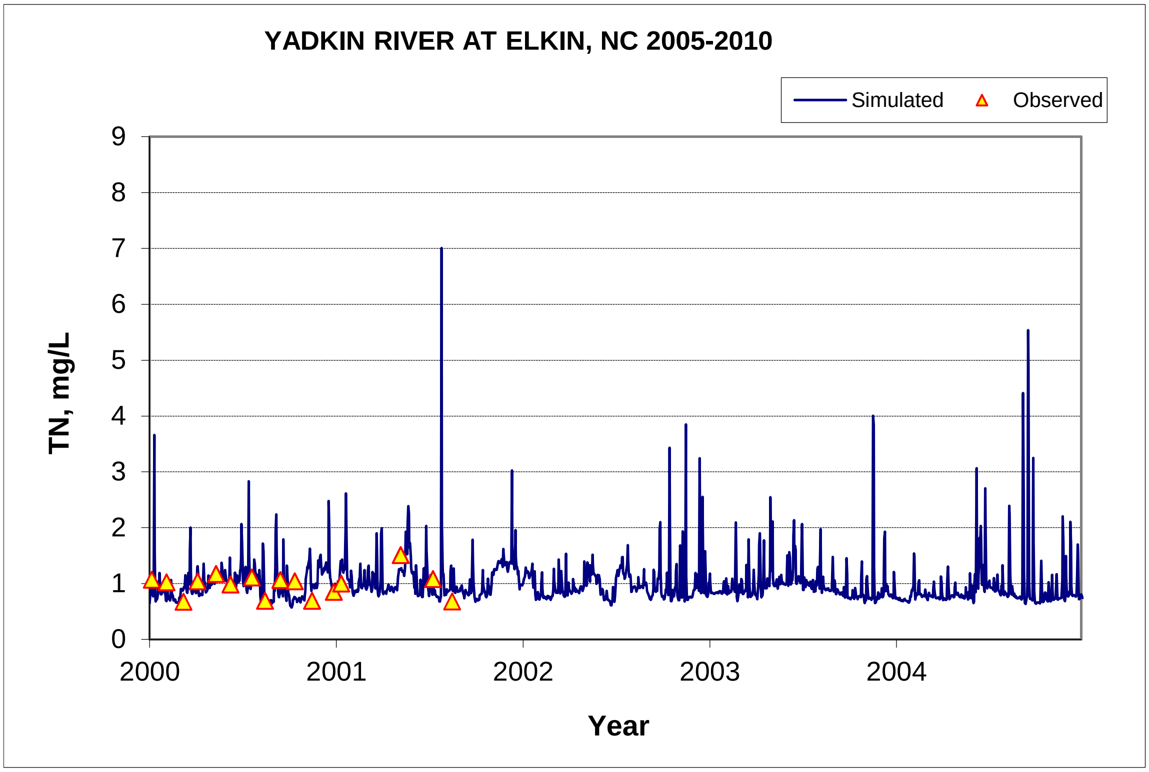

Figure G- 78. Total N Concentration Time Series, Validation Period, Yadkin River at Elkin

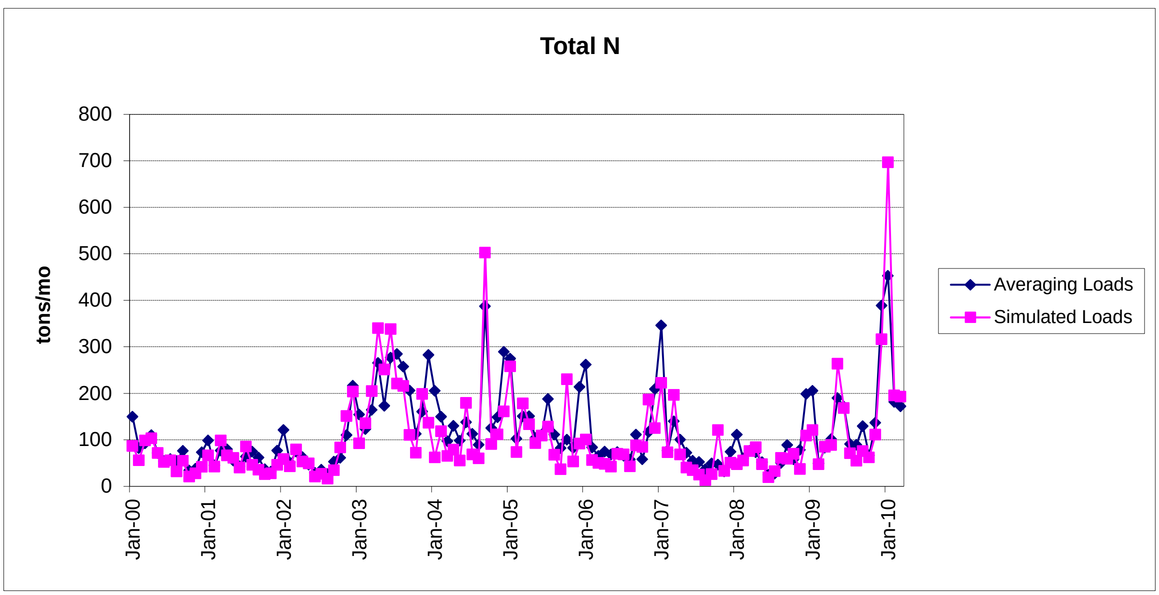

Figure G- 79. Total N Monthly Load Series, Yadkin River at Elkin

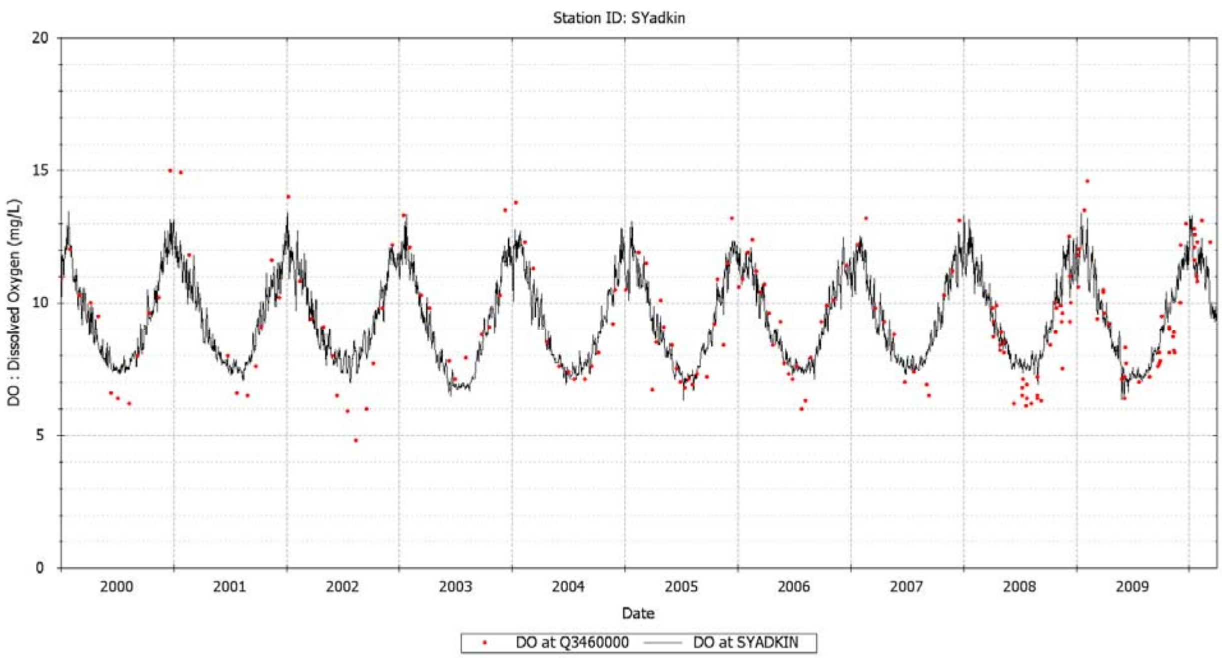

Figure G- 80. DO Simulation, South Yadkin River

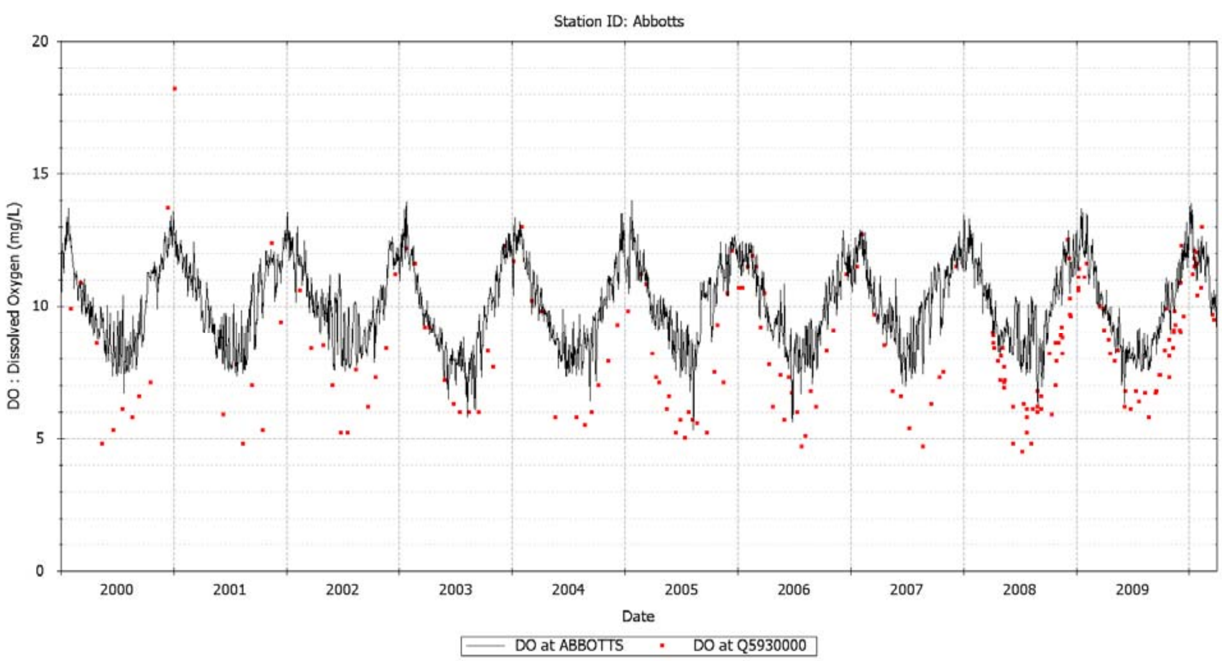

Figure G- 81. DO Simulation, Abbotts Creek

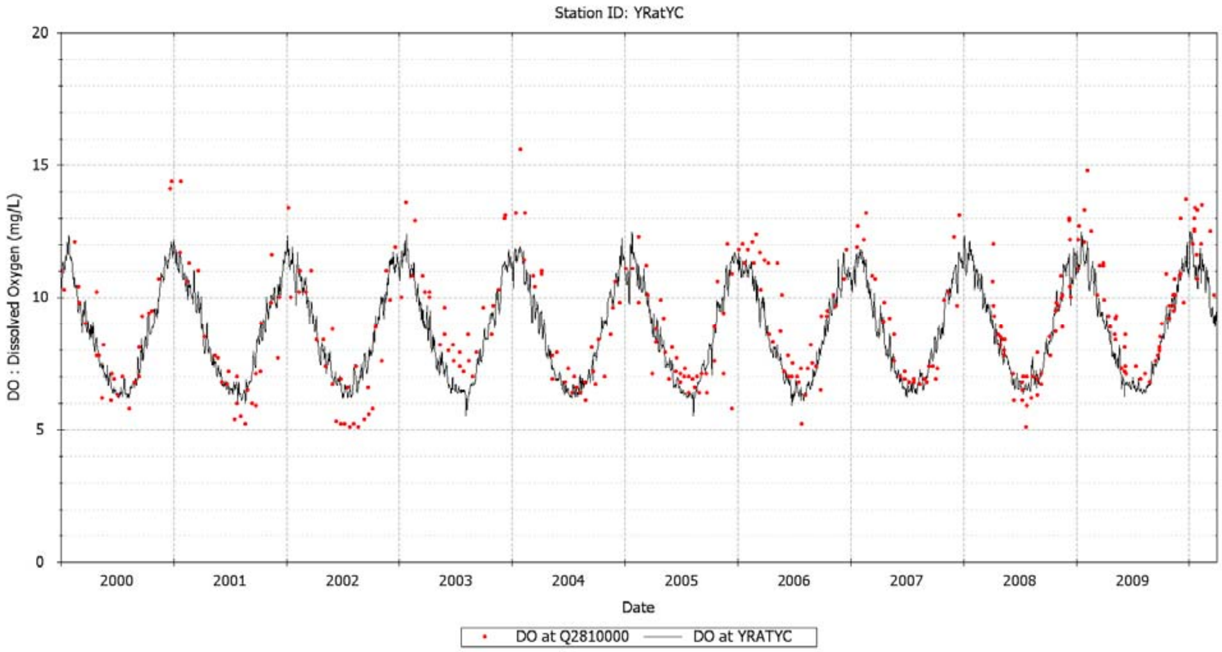

Figure G- 82. DO Simulation, Yadkin River at Yadkin College

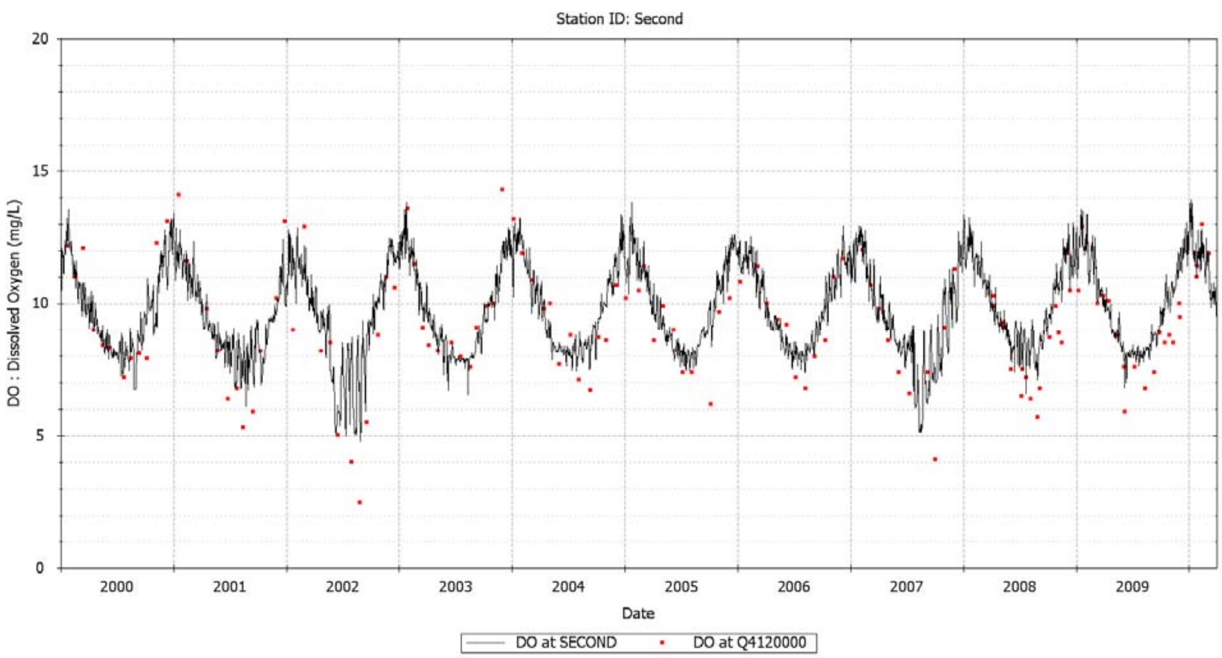

Figure G- 83. DO Simulation, Second Creek

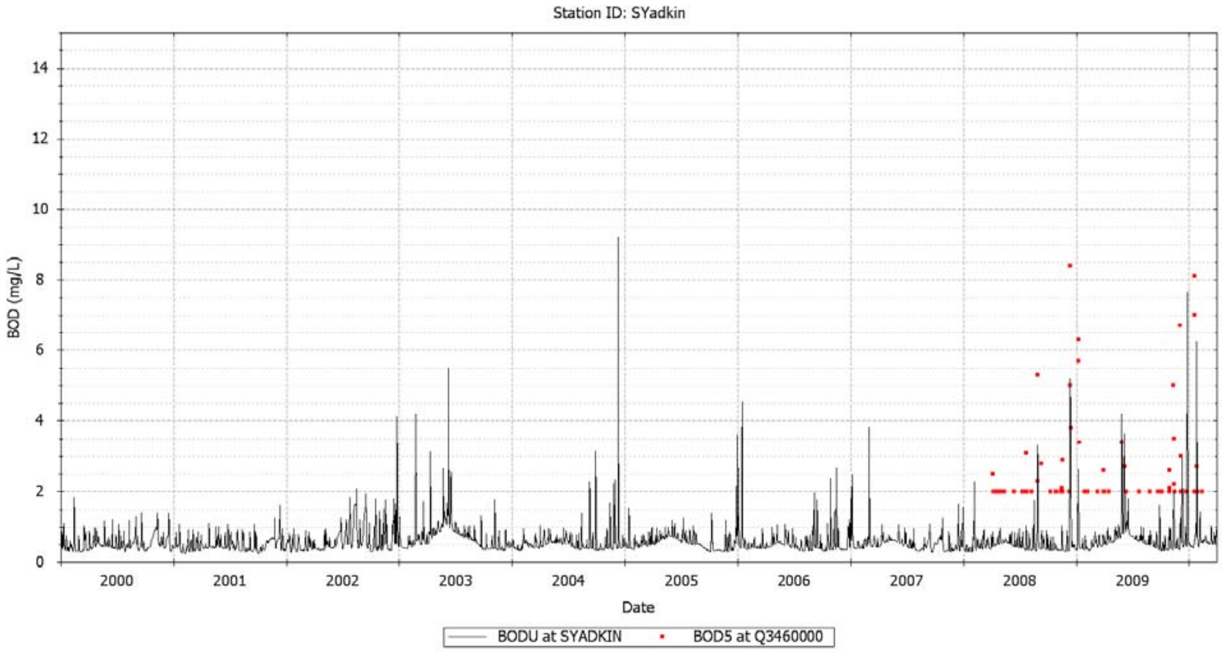

Figure G- 84. BOD Simulation, South Yadkin River

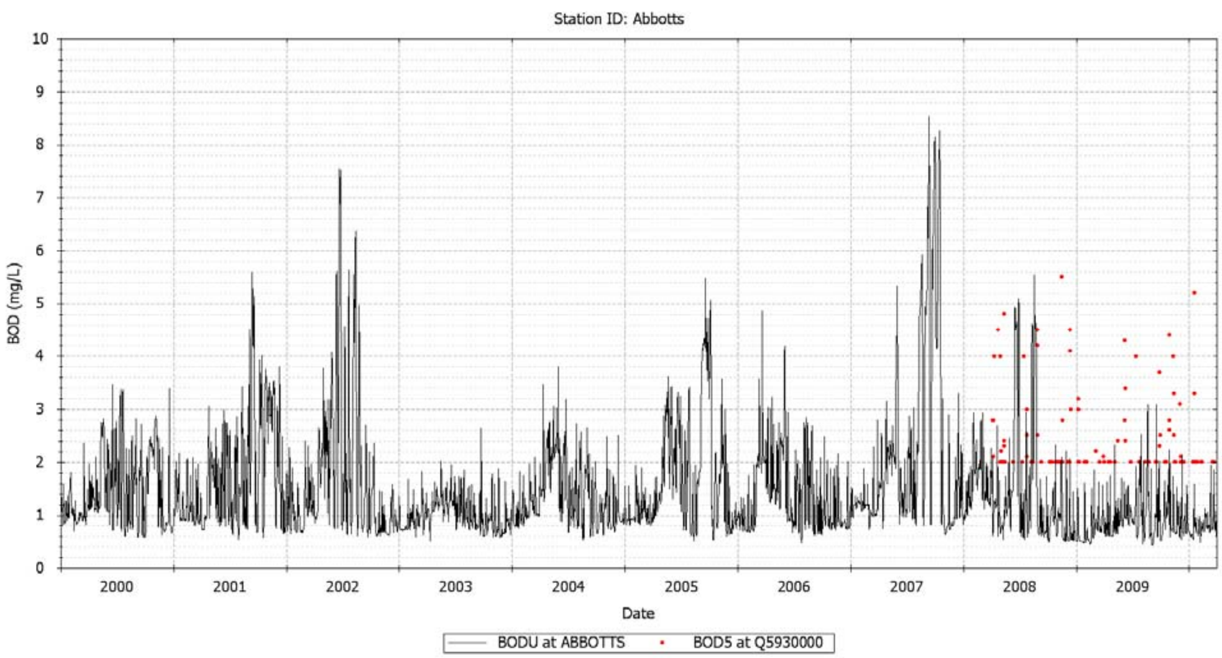

Figure G- 85. BOD Simulation, Abbotts Creek

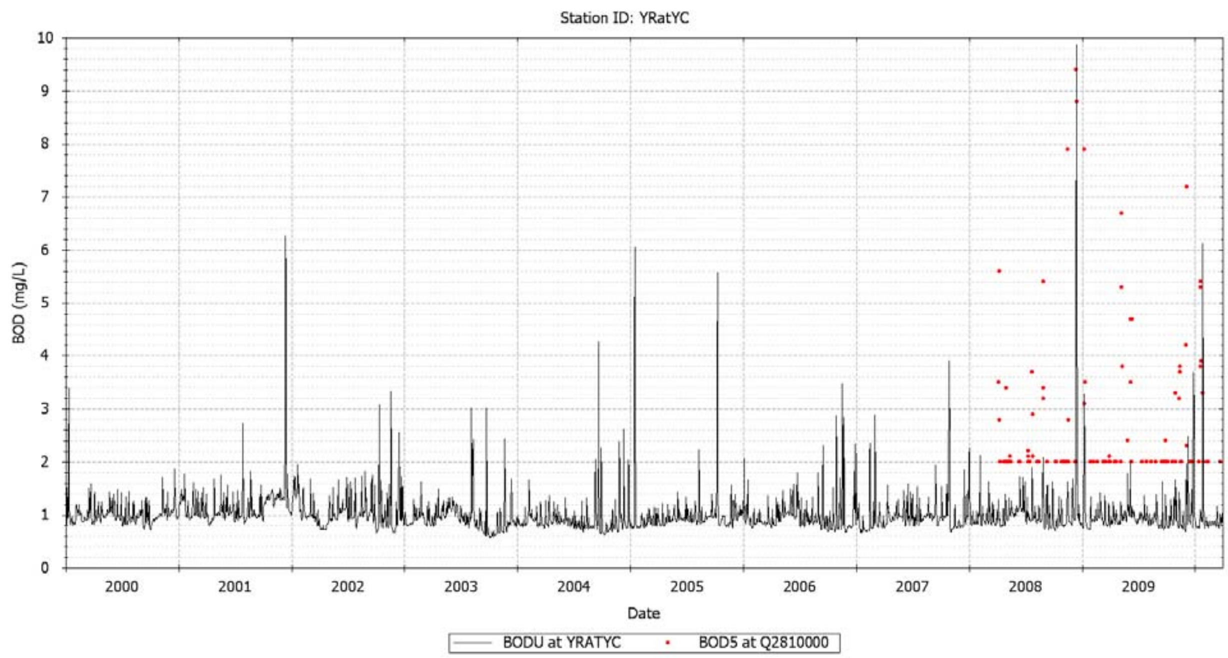

Figure G- 86. BOD Simulation, Yadkin River at Yadkin College