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2011 ANNUAL REPORT

Enclosed is a copy of "Environmental Studies in the Vicinity of the Susquehanna Steam Electric Station, 2011 Water Quality and Fishes" prepared by Ecology III, Inc. for PPL Susquehanna, LLC. The purpose of this report was to assess the environmental impact of the Susquehanna Steam Electric Station on the Susquehanna River water quality and relative abundance of fishes. This was done by evaluating 2011 results and by comparing preoperational and operational data.

If you have any questions regarding this report, please contact us.

Marion Hidlay
Office Manager

Enclosure

ENVIRONMENTAL STUDIES
IN THE VICINITY OF THE
SUSQUEHANNA STEAM ELECTRIC STATION

2011
WATER QUALITY
FISHES

Prepared by

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INTRODUCTION

PPL Susquehanna, LLC (PPL) contracted Ecology III, Inc. to conduct nonradiological monitoring of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (Susquehanna SES) in 2011. The Susquehanna SES is a nuclear power station with two boiling water reactors, each with a net electrical generating capacity of approximately 1,350 megawatts. It is located on about 1,700 acres on the west side of the Susquehanna River in Salem Township, Luzerne County, 5 miles northeast of Berwick, Pennsylvania. In addition, approximately 700 acres of mostly undeveloped and recreational lands owned by PPL are located on the east side of the Susquehanna River in Conyngham and Hollenback Townships. PPL owns 90% of the station and Allegheny Electric Cooperative, Inc. owns 10%.

The objective of the nonradiological environmental monitoring program is to assess the impact of operating the Susquehanna SES on the Susquehanna River water quality and relative abundance of fishes. This was accomplished in 2011 by comparing data at control and indicator stations and by evaluating results of preoperational (1971-1982) and operational (1983-2010) studies (Ichthyological Associates 1972, Ichthyological Associates, Inc. 1973-1985, Ecology III, Inc. 1986-2011). Monitoring was done at sites within a control station (SSES) upriver from the Susquehanna SES river intake structure and indicator station (Bell Bend) downriver from the discharge diffuser.

To more objectively assess the impact of operating the Susquehanna SES on the Susquehanna River, a statistical procedure called BACI (Before-After:Control-Impact) analysis was applied to preoperational and operational fishes monitoring data.

2011 was an extraordinary year hydrologically for the Susquehanna River. Three-quarters of the monthly mean flows exceeded the 50-year average, and 33% of those months had the highest averages measured since 1961. Topping off the year was the historic flooding that occurred in September as a result of Tropical Storm Lee. While the overall flooding from this storm did not exceed that of the Agnes Flood of 1972, the height of the water in the Shickshinny-Berwick areas was greater than that measured in 1972. Furthermore, the overall cumulative volume of water flowing past Susquehanna SES during 2011 was the largest measured in the past 51 years. As a result of the consistent high water and flooding, the third quarter water quality sample could not be collected and the number of sampling opportunities for fishes was greatly reduced.

This report presents results of water quality and fishes studies for 2011.

WATER QUALITY

PROCEDURES

Water quality of the Susquehanna River relative to operation of the Susquehanna SES was monitored throughout 2011 at four locations (Table 1, Fig. 1). Susquehanna River water samples were collected quarterly at SSES (control) and Bell Bend (indicator), with the exception of the third quarter due to hazardous river conditions. In addition, Susquehanna SES cooling tower blowdown water samples were collected quarterly. River depth and temperature were monitored continuously at the Environmental Laboratory.

Most of the water sample parameters were analyzed by the Chemical Laboratory personnel at the PPL System Facilities Center, Hazleton, Pennsylvania. This laboratory has state accreditation with the Pennsylvania Department of Environmental Protection (PADEP; Commonwealth of Pennsylvania 2010), identified as Lab #40-00568 (www.dep.state.pa.us). Water temperature and dissolved oxygen were measured by Ecology III personnel and river level was recorded with the SSES data (Table 2).

River flow was calculated from river level using two equations based on historical U.S. Geological Survey (USGS) flow data and direct flow measurements made by Ecology III (Table 2). Data supplied by the USGS were used to calculate the 22 February and 28-30 August flows due to equipment failure at the Environmental Laboratory. PPL Susquehanna, LLC personnel provided data for Susquehanna River water withdrawal. River temperature was monitored at the Environmental Laboratory until 24 July when a lightning strike during a thunderstorm caused the recorder to malfunction.

RESULTS AND DISCUSSION

River Flow, River Water Withdrawal, and River Temperature

In 2011, daily mean Susquehanna River flow ranged from 1,940 to 370,000 cubic feet per second (cfs; Table 3, Fig. 2). The 370,000 cfs was a result of Tropical Storm Lee in September. The monthly mean Susquehanna River flow was above the 50-year average for every month except January, February, and July (Fig. 3). The months of March, May, and September were the highest monthly mean flows since 1961. April and October were the third highest monthly mean flows in the 51-year database. PADEP did not issue any drought watches or warnings for Luzerne County in 2011 (www.depweb.state.pa.us keyword: Drought, accessed 8 March 2012). The annual precipitation at Avoca, PA (about 30 miles upriver from the Susquehanna SES) was 60.00 inches. This is the highest annual total on record since 1955, exceeding the previous record set in 2003 by 10.55 inches and was 21.74 inches above normal (www.erh.noaa.gov/bgm/climate/avp.shtml, accessed 8 March 2012). Cumulatively, an estimated 924 billion cubic feet of water flowed through this section of the Susquehanna River during 2011 (Fig. 4). This was 175 billion cubic feet more than the previous record set in 1972.

Tropical Storm Lee in September caused flooding throughout the Susquehanna Basin. The river crest at the Environmental Laboratory, 518.26 feet above mean sea level (ft above msl), occurred at 0800 hours on 8 September. This is the highest river crest in the 40-year history of the Environmental Laboratory, surpassing the previous record crests set in 1972, 1975, and 1996 (517.36 ft above msl, 512.99 ft above msl, and 512.23 ft above msl, respectively).

Susquehanna SES river water withdrawal of river flow ranged from 0.0% on 20 and 21 May (dual unit outage) to 5.27% on 5 August (Fig. 5). Daily river water withdrawal of the plant was ≤2% of river flow for 329 days in 2011. On 10 days in 2011, daily river water withdrawal exceeded 4% of river flow.

Of the months recorded, daily mean river temperature ranged from 0.5 C on numerous days in January and February to 30.1 C on 23 July (Table 4, Fig. 6). The hourly minimum river temperature of 0.2 C occurred at 0500 h on 31 January. The hourly maximum river temperature of 31.6 C occurred from 1600 h to 1800 h on 22 July. River temperature was below average every month except June and July (Fig. 7). However, these temperature comparisons did not take into account variations in river flow among the months.

River Water Quality at the Susquehanna SES

Control and indicator data were compared to PADEP specific water quality criteria (Commonwealth of Pennsylvania 2009; Table 5). The parameters with published specific water quality criteria for the critical use of the Susquehanna River in the vicinity of the Susquehanna SES include alkalinity, ammonia nitrogen, dissolved oxygen, total iron, pH, and temperature. In 2011, Susquehanna River water met the published criteria for all collected samples at the control and indicator sampling sites (Table 6).

There have been significant decreases over time in certain indicators of abandoned mine discharge such as total iron and sulfate concentrations (Table 7, Fig. 8), and Ecology III, Inc. has long reported the biotic recovery in the river associated with these improvements.

Control and Indicator Site Comparisons

Control and indicator water quality data were similar on most of the sampling dates during 2011 (Table 6). Since most of the water taken from the river for plant operation evaporates in the cooling process, the remaining cooling water returned to the river subsequently contains concentrated mineral solids. Total mineral solids (TMS) concentrations in the blowdown sample were 1.1 to 3.4 times greater than those of the river control (Table 6). However, the dilutive effect of high river flow tends to equalize values at the control and indicator sites. This is evident when TMS values of the blowdown are compared to the control and indicator TMS results (Tables 8 and 9). It has been previously demonstrated that TMS concentrations at SSES are the best predictor of TMS concentrations at Bell Bend at most river flows. In addition, if operation of the Susquehanna SES is to influence the water quality at the indicator site, then the probability of that occurring should be greatest at low river flows (Ecology III, Inc. 2008).

Conclusion

Susquehanna River flow exceeded the 50-year average during nine months in 2011 and was below average for the remaining months. The highest river crest (518.26 ft above msl) in the 40-year history of the Environmental Laboratory occurred on 8 September. The maximum river water withdrawal of river flow by Susquehanna SES was 5.27% on 5 August. However, on most days during 2011 river water withdrawal was ≤2% of river flow. Of the months recorded, river temperature was below normal except for June and July.

Water quality data demonstrated that river samples met the published specific water quality criteria for six common parameters. Overall, water quality of this section of the Susquehanna River continues to improve.

Our data analyses demonstrate that effects of the operation of Susquehanna SES on water quality of the Susquehanna River will likely occur at the lowest range of river flows. This is reasonable because the dilutive power of the river against plant discharge would then be minimized.

FISHES

PROCEDURES

As a result of the consistent high water and flooding in 2011, the number of sampling opportunities for fishes was greatly reduced. In addition, the seining sampling site on the eastern shore upriver from Susquehanna SES was scoured away by water and another site had to be established for 2012. This report reflects the results of the reduced number of samples collected in 2011.

Electrofishing

Electrofishing samples were collected once each month in June and July in 2011. Sampling was done at four sites, and each site was approximately 1,100-yards long and parallel to the river shoreline. These sites have been consistently sampled by boat electrofishing since 1976. Two sites were located upriver from the Susquehanna SES river intake structure along each bank of the river, and two sites were downriver from the intake (referred to as SSES and Bell Bend locations, respectively; Table 10, Fig. 1).

The 18-foot electrofishing boat was outfitted with a 5-KW generator (direct current). Electrical output was controlled by a variable-voltage pulsator, with a target of 5-6 amps delivered to the water.

During sampling, the boat was driven downstream parallel to the shoreline, usually within 30 feet of the riverbank. For both safety purposes and sampling efficiency, electrofishing was done at river levels less than 493.1 feet above mean sea level (msl; equivalent to 10.1 feet as measured by the Environmental Laboratory level gauge).

Sampling was done in the evening and began about one hour after sunset. Two observers stood in the bow of the boat and identified and counted fish during each sample. Data were recorded using a cassette tape recorder.

Seining

Shoreline fishes were collected by seine during August. Sampling was done when river levels were less than 490.2 feet above msl (equivalent to 7.2 feet at the Environmental Lab gauge). Similar to the electrofishing sampling sites, two shoreline seine sites were above the Susquehanna SES river intake structure and two were below (Table 10, Fig. 1).

To seine, one end of the 25-foot bag seine (0.25-inch mesh) was kept stationary on the riverbank while the other end was extended about 20 feet into the river or as far as depth of the water allowed. The seine was then pulled upriver and onto shore. Two hauls were made in the same location at each site and the catches from both hauls were combined and considered one unit of effort. Captured fish were placed in 10% formalin in the field and returned to the laboratory. After at least two weeks in the formalin, the fish were rinsed with water, identified, and enumerated before final preservation in 40% isopropyl alcohol.

Statistical Analysis

A statistical analysis known as the Before-After:Control-Impact (BACI), was applied to the electrofishing (1976-2011) and seining data (1978-2011; Ecology III, Inc. 1990). Twenty species or categories of fish were analyzed from the electrofishing data, as were

12 species from the seining data. These species or groups were chosen based on their abundance during the years before Susquehanna SES operation.

Two different electrofishing data sets were analyzed. The first set included all months sampled by electrofishing through the years, and is referred to as the All Data set. The second set, named the Summer Data set, included only the months from June through October to reflect the reduced monitoring effort in place since1986. The seining data set analyzed by the BACI represents all of the months sampled by this method through the years.

RESULTS AND DISCUSSION

Electrofishing

Electrofishing at the SSES and Bell Bend locations in 2011 resulted in the observation of 470 fish of 19 species (Tables 11 through 13). The total numbers of fish collected above and below the SSES intake and discharge for the year were generally similar, with 264 fish at the upriver sites and 206 fish at the downriver sites. Differences in monthly totals between upriver and downriver sites ranged from as few as 80 fish in July at Bell Bend to as many as 144 fish in July at SSES. Comparatively, differences in fish totals between the east and west banks tended to be greater at the downriver locations during both June and July (18 and 38 fish, respectively). Maximum monthly sample sizes occurred during July at SSES (144) and June at Bell Bend (126).

Smallmouth bass was the most abundant species observed at SSES and Bell Bend in 2011 (19% and 18% of the totals, respectively), but northern hog sucker was tied with smallmouth at SSES. Smallmouth bass, together with northern hog sucker and rock bass,

represented 53% of the fish observed at SSES and 50% of those at Bell Bend. Smallmouth bass was also the most abundant species during June at SSES (tied with rock bass) and during June and July at Bell Bend (tied with northern hog sucker in June). Overall, 5-14% of fish observed were placed in the unidentified fish category at both sites during 2011.

Seventeen species were observed at SSES, as were 15 at Bell Bend. Species richness in monthly samples ranged from 12 to 13 species at SSES and 12 to 14 species at Bell Bend. Sucker and sunfish species dominated richness in all months during 2011.

Seining

Seining at the SSES and Bell Bend locations in 2011 resulted in the capture of 384 fish of 12 species (Tables 11 and 14). Spotfin shiner was the most abundant species captured at SSES (56%) and at Bell Bend (87%). Spotfin shiner and spottail shiner comprised 89% of the fishes collected at SSES and 94% of the fishes collected at Bell Bend.

Contrary to previous years, the number of fishes captured at Bell Bend (119) was a fraction (45%) of those collected at SSES (265). Ten species were collected at SSES and six species were collected at Bell Bend. At both stations, species in the minnow and sunfish families predominated.

BACI Results: Electrofishing

Of the 20 species or categories of fish that were tested with the BACI analysis, eight species from the All Data set and eight species from the Summer Data set showed

significant differences in the numbers of fishes above versus below the power plant discharge ($P \leq 0.05$, Table 15). Species in the All Data set that indicated decreases in abundance below the power plant discharge included quillback, northern hog sucker, shorthead redhorse, muskellunge, rock bass, smallmouth bass, and unidentified fish. Brown bullhead was also significantly different; however, its numbers increased at Bell Bend compared to the upriver sites. The Summer Data set demonstrated decline or increase in all of the same species.

BACI Results: Seining

The results of the 12 seined species tested by BACI analysis indicated marginally significant differences in the numbers of spotfin shiner ($P=0.099$) and rock bass ($P=0.073$) above versus below the plant discharge. The point estimates for these species indicated that more spotfin were collected at the downriver sites versus upriver, while fewer rock bass were collected at the downriver locations.

Fisheries Concerns in the Susquehanna River Basin

A number of concerns have been raised over the past year by officials of the Pennsylvania Fish and Boat Commission (PAFBC) regarding the health and abundance of smallmouth bass in the Susquehanna River. They offer at least three lines of evidence to support their concerns. First, the catch rates of smallmouth bass in the lower reaches of the river have significantly declined. In response the Commission has declared the river from south of Sunbury to be "catch and release only" for bass. Second, young bass have shown outbreaks of an infection known as columnaris that, in some years, has been

associated with significant mortality of young fish. Third, 90% or more of the male bass sampled from the river have demonstrated a condition known as "intersex" where males are developing eggs in their testes. Research has indicated that this condition results from fish exposure to endocrine disrupting compounds in water. It is not yet known, however, if this condition causes population-level changes on river bass.

As a result of this evidence, the executive director of the Fish and Boat Commission has called upon Department of Environmental Protection (PADEP) to list the Susquehanna River as an "impaired" river (Arway 2012). It is thought that this designation could focus federal research monies on the river and bring about limits on pollutants received by the river. So far, the officials at the PADEP have resisted such a listing (Krancer 2012).

The concern about smallmouth bass populations downriver from Susquehanna SES and the disagreement at present between the state agencies mandated to address these issues, highlight the importance of the river data collected in this area of the Susquehanna. For example, PADEP and PAFBC personnel have already consulted temperature data collected at the Environmental Lab. Furthermore, the information collected on the relative abundance of fishes in the vicinity of Susquehanna SES is the only long-term fisheries dataset in this area of the Susquehanna and one of the few bellwethers of changes that might be occurring in the river. Therefore, it continues to be in the best interest of PPL to monitor and report the status of fishes near the plant.

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Table 1

Descriptions of water quality sampling sites in the vicinity of the Susquehanna SES, 2011.

SITE	LOCATION
Susquehanna SES Environmental Laboratory	West bank of the Susquehanna River: 1,620 feet (ft) upriver from the Susquehanna SES intake structure, sensors for river depth and temperature are located on river bottom within 100 ft of the bank
SSES (control)	Susquehanna River: 750 ft upriver from the center of the Susquehanna SES intake structure, 130 ft from the west bank
Blowdown	Since November 1996: Susquehanna SES Cooling Tower Blowdown Discharge Line 2S7 automatic composite sampler (ACS) about 750 feet downstream from the cooling tower basin, 0.1 air miles NNE from the stand-by gas treatment vent at 44200/N34117 (PA Grid System) December 1990-October 1996: 6S7 ACS at the Susquehanna SES sewage treatment plant about 2,880 feet downstream from the cooling tower basin
Bell Bend (indicator)	Susquehanna River: 2,260 ft downriver from the Susquehanna SES discharge diffuser, 130 ft from the west bank

Table 2

Water quality parameters and methods of analyses utilized by the Susquehanna SES Environmental Laboratory, 2011.

PARAMETER	METHOD	REFERENCE [a]
River depth (ft)	Seven-day continuous recording from an Acco Bristol, Model No. G500-15 bubbler-type water level gauge.	ACCO (1971)
River level (ft above msl)	$Level = Depth + 482.96$	Soya (1991)
River flow (cfs)	Insert river level into the appropriate regression equation. At level <486.0 ft, $\log flow = -0.05251(level)^2 + 51.478501(level) - 12612.85672$ At level ≥486.0 ft, $flow = 319.96989(level)^2 - 309316.24395(level) + 74753300$	Soya (1991)
River flow (cfs)	Calculation from U.S. Geological Survey gauging stations: $flow = 0.222(a - b) + b$ Where: a = Susquehanna River daily mean flow at Danville, PA b = Susquehanna River daily mean flow at Wilkes-Barre, PA	Ecology III, Inc. (1998)
Temperature (°F)	Constant monitor of river temperature: Seven-day continuous recording from an Omega RD-MV106-3-2-1D temperature recorder.	Omega (2001)
(°C)	River and blowdown temperature of samples collected: Calibrated, mercury-filled thermometer. Method 2550 B. Convert Fahrenheit to Celsius for tabulation: $^{\circ}C = (^{\circ}F - 32) \div 1.8$ or $\frac{^{\circ}C}{^{\circ}F - 32} = 5/9$	APHA (1995) [b] Internet site
Dissolved oxygen (mg/L)	Membrane electrode. Method 4500-O G.	APHA (1995)

[a] Listed in references cited.
[b] http://mathforum.org/library/drmath/view/58393.html. Accessed: 19 February 2009.

Table 3

Daily mean flow (cfs) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2011.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	6800	5300	40200	22300	97500	38000	13500	2560	25700	71400	22300	37300
2	7120	5020	61200	24000	72400	25700	11500	2350	19700	55100	20200	38700
3	7780	5020	47800	24000	54300	19700	11500	2350	14400	54300	18700	31300
4	9540	5020	34600	24000	62100	15300	12700	2140	11500	52600	17200	25200
5	10300	4740	26900	28100	87700	13100	8820	1940	12300	42400	15800	21800
6	9910	4480	37300	73400	73400	11500	7780	2140	15300	31900	14400	20200
7	7780	4480	116000	85500	57700	10700	9180	7120	53400	25200	13500	21800
8	6490	5020	106000	74300	43900	9540	7450	5020	231000	21300	12300	40200
9	6490	5880	78300	57700	35200	8820	6800	4740	370000	18200	11100	38000
10	5880	7450	66700	44600	28800	8120	6490	6800	245000	16200	11100	33900
11	5590	6800	133000	36600	24600	7450	5880	5300	145000	14400	10700	28800
12	5880	6180	178000	33200	21300	9910	5590	4740	93100	12700	9910	24000
13	6180	5300	139000	35200	18200	19200	5020	4740	60300	12300	9910	21300
14	5020	5590	108000	47000	16200	19200	4480	4210	42400	14400	9540	18200
15	4740	5590	84500	47800	14900	15800	3710	3960	34600	26300	9540	17200
16	4740	5590	67600	38000	14900	11900	3460	4210	30000	35900	9540	17200
17	5020	5880	63000	68600	24000	9910	3230	4480	27500	30600	14000	17700
18	4740	7120	66700	96400	26300	9180	3000	4740	23500	26900	15800	19200
19	5020	22300	74300	69500	24600	8470	3000	4210	19700	25200	15300	17700
20	5590	39500	82400	59400	31300	7780	3000	3710	16200	22900	13500	15800
21	5590	33200	71400	54300	51000	7120	2770	4210	14000	31300	12700	14400
22	6180	25200 [a]	67600	44600	54300	6800	2560	3960	11900	35200	11500	16200
23	5880	20700	65800	37300	42400	8120	2350	3460	11900	26900	19200	30000
24	6490	17700	55100	47800	33200	10300	2350	3000	19700	22300	43100	52600
25	6180	18700	46200	56800	30600	14400	2770	2770	17700	19200	51000	50200
26	5020	21300	38700	64800	29400	25200	3710	2560	18700	17200	40200	38000
27	5020	18200	31900	115000	27500	19200	2770	2560	18700	15800	30600	30600
28	5590	19700	27500	148000	40900	15800	2560	20700 [a]	53400	16700	25200	31300
29	5880		24600	181000	54300	13100	2350	48500	80300	22300	22300	35200
30	5590		22300	139000	40900	11900	2140	50200	106000	24600	27500	31900
31	5300		21300		43900		2350	35900		24000		26900
MEAN	6240	12000	67200	62600	41200	13700	5320	8360	61400	27900	18600	27800

[a] Calculated 22 February and 28-30 August flows using USGS data.

Table 4

Daily mean temperature (C) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2011.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.7	0.5	1.7	5.4	13.7	22.3	23.3	--	--	--	--	--
2	1.0	0.5	1.3	5.5	13.6	22.3	23.7	--	--	--	--	--
3	0.8	0.6	1.3	5.9	14.0	21.6	24.0	--	--	--	--	--
4	0.7	0.5	1.4	6.6	13.8	20.7	23.4	--	--	--	--	--
5	0.7	0.5	2.1	7.0	12.2	19.9	24.5	--	--	--	--	--
6	0.6	0.7	3.3	6.5	11.9	20.4	25.3	--	--	--	--	--
7	0.6	1.1	1.6	5.5	12.3	21.3	25.9	--	--	--	--	--
8	0.5	1.1	1.0	5.3	12.8	22.4	26.0	--	--	--	--	--
9	0.5	0.6	1.4	5.8	13.6	24.1	26.0	--	--	--	--	--
10	0.6	0.5	1.9	6.8	14.3	24.7	26.1	--	--	--	--	--
11	0.6	0.6	2.6	8.4	15.1	25.0	26.3	--	--	--	--	--
12	0.6	0.6	2.3	10.0	16.2	24.4	26.9	--	--	--	--	--
13	0.5	0.7	2.6	10.2	16.7	23.2	26.7	--	--	--	--	--
14	0.5	0.8	2.9	10.2	16.5	21.7	26.5	--	--	--	--	--
15	0.6	1.1	2.7	10.2	16.7	20.7	26.3	--	--	--	--	--
16	0.5	1.2	3.2	9.9	17.1	20.5	26.6	--	--	--	--	--
17	0.5	1.8	4.1	9.1	16.2	20.7	26.8	--	--	--	--	--
18	0.6	2.2	5.0	8.3	15.1	21.4	26.9	--	--	--	--	--
19	0.7	1.3	5.9	8.2	14.9	22.0	27.5	--	--	--	--	--
20	0.8	0.6	5.6	8.3	15.4	23.0	28.1	--	--	--	--	--
21	0.6	0.5	4.9	9.0	16.0	23.6	29.1	--	--	--	--	--
22	0.6	0.6	4.9	9.1	16.3	24.5	30.0	--	--	--	--	--
23	0.6	0.5	4.5	8.6	16.6	24.7	30.1	--	--	--	--	--
24	0.5	0.5	3.9	8.7	16.8	23.8	-- [a]	--	--	--	--	--
25	0.5	0.7	3.7	9.2	17.8	23.3	--	--	--	--	--	--
26	0.6	0.9	3.8	10.7	19.0	23.1	--	--	--	--	--	--
27	0.6	1.3	4.0	12.6	20.1	22.3	--	--	--	--	--	--
28	0.6	1.9	4.0	14.2	20.2	22.7	--	--	--	--	--	--
29	0.5		4.3	14.9	19.9	22.9	--	--	--	--	--	--
30	0.6		4.8	14.2	20.7	23.1	--	--	--	--	--	--
31	0.6		5.3		21.8		--	--		--		--
MEAN	0.6	0.9	3.3	8.8	16.0	22.5	26.3	--	--	--	--	--

[a] Equipment Failure

Table 5

Pennsylvania Department of Environmental Protection specific water quality criteria for the Susquehanna River in the vicinity of the Susquehanna SES, 2011.

PARAMETER	UNIT	PERIOD	CRITERIA		AVERAGE
			Minimum	Maximum	
Alkalinity as CaCO3	mg/L		20		
Ammonia Nitrogen	mg/L			4.56	
Dissolved Oxygen	mg/L		4.0		
		Daily Average	5.0		
Iron Total	mg/L	30-Day			1.5
pH			6.0	9.0	
Temperature	C	January 1-31		4.4	
		February 1-29		4.4	
		March 1-31		7.8	
		April 1-15		11.1	
		April 16-30		14.4	
		May 1-15		17.8	
		May 16-31		22.2	
		June 1-15		26.7	
		June 16-30		28.9	
		July 1-31		30.6	
		August 1-15		30.6	
		August 16-31		30.6	
		September 1-15		28.9	
		September16-30		25.6	
		October 1-15		22.2	
		October 16-31		18.9	
		November 1-15		14.4	
		November 16-30		10.0	
		December 1-31		5.6	

Table 6

Water quality data collected quarterly from the Susquehanna River and the Susquehanna SES blowdown, 2011. River sites were SSES (control) and Bell Bend (indicator). Analyses were performed at the PPL Chemical Laboratory, Hazleton, PA. N.D. = Not Detected; N.R. = Not Recorded; N.A. = Not Analyzed

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		3/30/2011	3/30/2011	3/30/2011	6/9/2011	6/9/2011	6/9/2011
Time		827	828	830	720	935	726
River level	ft	492.0			488.9		
Temperature	C	2.8	12.6	2.8	21.7	24.0	21.6
Dissolved oxygen	mg/L	20.6	19.1	19.7	8.8	8.2	8.7
pH, lab		7.48	8.53	7.5	8.61	8.16	8.7
Conductivity, lab	µmho	229	728	230	293	301	292
Total alkalinity	mg/L	52.5	168	53	76.5	86	76.6
Phenolphthalein alkalinity	mg/L	0	5.9	0	8	0	5
Total suspended solids	mg/L	11.7	47	11.7	18	10.4	19
Ammonia as N	mg/L	<0.20	<0.20	<0.20	N.D.	N.D.	N.D.
Silicon dioxide	mg/L	5.09	17.6	4.92	1.45	1.7	1.43
Bicarbonate as CaCO3	mg/L	52.5	156	53	60.5	86	66.6
Carbonate as CO3	mg/L	0	11.8	0	16	0	10
Chloride	mg/L	25.3	93.8	25.6	29	31.2	29
Fluoride	mg/L	0.058	0.218	0.065	0.115	0.423	0.106
Nitrate as NO3	mg/L	3.05	10.6	3.06	0.88	<3.00	0.89
Nitrate ion as N	mg/L	0.69	2.41	0.691	0.2	<0.678	0.201
Phosphorus as PO4	mg/L	0.147	3.672	0.175	0.04	1.396	0.034
Sulfate	mg/L	15.8	54.1	15.9	23.4	24.9	23.3
Aluminum, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Aluminum, total	ug/L	253	1070	204	236	158	226
Barium, total	ug/L	26.6	81.3	26.8	29.4	36	28.7
Calcium, dissolved	mg/L	22.7	72.3	22.4	29.5	30.7	29.3
Calcium, total	mg/L	22.9	73.3	23	29.8	31	29.7
Copper, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Copper, total	ug/L	N.D.	<20.0	N.D.	N.D.	N.D.	N.D.
Iron, dissolved	mg/L	0.11	0.318	0.108	0.033	0.093	0.033
Iron, total	mg/L	0.755	2.86	0.683	0.906	0.606	0.864
Magnesium, dissolved	mg/L	5.22	14.1	4.47	6.7	6.45	6.65
Magnesium, total	mg/L	4.63	14.6	4.63	6.84	6.59	6.83
Manganese, dissolved	ug/L	62.2	30	61.8	4.06	10.4	2.87
Manganese, total	ug/L	76.8	156	76.8	118	98.6	116
Nickel, total	ug/L	N.D.	<20.0	N.D.	N.D.	N.D.	N.D.
Potassium, dissolved	mg/L	1.38	3.86	1.17	1.43	1.39	1.45
Potassium, total	mg/L	1.25	4	1.22	1.53	1.52	1.51
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	14.4	54.1	14.1	17.9	19.4	17.9
Sodium, total	mg/L	14.4	54.7	14.4	18	19.4	18
Strontium, total	ug/L	69.3	216	69.6	101	108	103
Vanadium, total	ug/L	N.D.	<10.0	N.D.	N.D.	N.D.	N.D.
Zinc, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10.0	N.D.	N.D.	N.D.	N.D.
Lead, total	ug/L	N.D.	<5.00	N.D.	N.D.	N.D.	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	N.D.	<2.00	<2.00	<2.00	<2.00	<2.00
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	124	421	123	156	170	156
Calcium hardness (C)	mg/L	56.7	181	55.9	73.7	76.7	73.2
Total hardness (C)	mg/L	76.2	243	76.5	103	105	102

Table 6 (cont.)

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		9/29/2011	9/29/2011	9/29/2011	11/10/2011	11/10/2011	11/10/2011
Time		[a]	849	[a]	910	814	915
River level	ft	498.3			489.5		
Temperature	C		N.R.				
Dissolved oxygen	mg/L		N.R.				
pH, lab		--	7.81	--	7.65	8.88	7.64
Conductivity, lab	µmho	--	846	--	251	661	251
Total alkalinity	mg/L	--	55	--	67.5	194	72
Phenolphthalein alkalinity	mg/L	--	0	--	0	39.6	0
Total suspended solids	mg/L	--	280	--	<4.00	25.5	<4.00
Ammonia as N	mg/L	--	<0.20	--	N.D.	N.D.	N.D.
Silicon dioxide	mg/L	--	34.2	--	2.42	9.26	2.48
Bicarbonate as CaCO3	mg/L	--	55	--	67.5	115	72
Carbonate as CO3	mg/L	--	0	--	0	79.2	0
Chloride	mg/L	--	79.6	--	20.8	63.4	20.8
Fluoride	mg/L	--	0.255	--	<0.050	<0.300	<0.050
Nitrate as NO3	mg/L	--	10.5	--	1.75	6.08	1.81
Nitrate ion as N	mg/L	--	2.36	--	0.395	1.37	0.408
Phosphorus as PO4	mg/L	--	7.466	--	0	2.755	0.046
Sulfate	mg/L	--	256	--	21.8	62	21.7
Aluminum, dissolved	ug/L	--	-- [b]	--	N.D.	N.D.	N.D.
Aluminum, total	ug/L	--	6070	--	<100	424	N.D.
Barium, total	ug/L	--	163	--	26.5	81.5	27.1
Calcium, dissolved	mg/L	--	--	--	26.2	74	26.9
Calcium, total	mg/L	--	92.1	--	26.7	76.4	26.6
Copper, dissolved	ug/L	--	--	--	N.D.	<20.0	N.D.
Copper, total	ug/L	--	28.9	--	N.D.	<20.0	N.D.
Iron, dissolved	mg/L	--	--	--	0.219	0.34	0.227
Iron, total	mg/L	--	12.4	--	0.496	1.92	0.494
Magnesium, dissolved	mg/L	--	--	--	6.32	15.8	5.91
Magnesium, total	mg/L	--	19.7	--	5.86	16.5	5.83
Manganese, dissolved	ug/L	--	--	--	80.7	24.9	83.5
Manganese, total	ug/L	--	833	--	87.4	121	89.9
Nickel, total	ug/L	--	<20.0	--	N.D.	N.D.	N.D.
Potassium, dissolved	mg/L	--	--	--	1.51	3.89	1.38
Potassium, total	mg/L	--	7.64	--	1.37	4.06	1.36
Silver, total	ug/L	--	N.D.	--	N.D.	<10.0	N.D.
Sodium, dissolved	mg/L	--	--	--	13.8	41.1	14.1
Sodium, total	mg/L	--	51.8	--	14	42.1	13.9
Strontium, total	ug/L	--	339	--	96.4	270	96.7
Vanadium, total	ug/L	--	<10.0	--	N.D.	N.D.	N.D.
Zinc, dissolved	ug/L	--	--	--	<20.0	<20.0	<20.0
Zinc, total	ug/L	--	60.3	--	N.D.	<20.0	<20.0
Beryllium, total	ug/L	--	<1.00	--	N.D.	N.D.	N.D.
Cadmium, total	ug/L	--	N.D.	--	N.D.	N.D.	N.D.
Chromium, total	ug/L	--	<10.0	--	N.D.	N.D.	N.D.
Lead, total	ug/L	--	13.2	--	N.D.	N.D.	N.D.
Thallium, total	ug/L	--	N.D.	--	N.D.	N.D.	N.D.
Arsenic, total	ug/L	--	7.25	--	<2.00	<2.00	<2.00
Selenium, total	ug/L	--	N.D.	--	N.D.	N.D.	N.D.
Antimony, total	ug/L	--	N.D.	--	N.D.	N.D.	N.D.
Total mineral solids	mg/L	--	N.A.	--	135	392	138
Calcium hardness (C)	mg/L	--	N.A.	--	65.4	185	67.2
Total hardness (C)	mg/L	--	311	--	90.8	259	90.4

[a] Hazardous river conditions prevented sample collection.

[b] Dissolved metals sample was not collected.

Table 7

Total iron concentrations from the Susquehanna River at the SSES sampling site, 1975-2011.
Samples were collected monthly from 1975 through 1996 and quarterly from 1997 through 2011.
PA DEP specific water quality criteria for total iron is 1.5 mg/L for a 30-day average.
Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

YEAR	NO. SAMPLES Collected	NO. SAMPLES <1.50 mg/L	% SAMPLES <1.50 mg/L	ANNUAL MEAN
1975	12	2	16.7	3.55
1976	12	3	25.0	3.08
1977	11	5	45.5	1.71
1978	12	5	41.7	1.48
1979	12	5	41.7	3.13
1980	12	5	41.7	1.74
1981	12	9	75.0	1.31
1982	12	7	58.3	2.37
1983	11	6	54.5	1.41
1984	12	4	33.3	1.71
1985	12	5	41.7	1.61
1986	12	7	58.3	1.82
1987	12	8	66.7	1.96
1988	12	7	58.3	1.28
1989	12	9	75.0	1.45
1990	12	10	83.3	1.41
1991	12	10	83.3	0.98
1992	12	12	100.0	0.92
1993	12	8	66.7	1.55
1994	11	8	72.7	1.46
1995	12	12	100.0	0.89
1996	12	9	75.0	1.42
1997	4	4	100.0	0.55
1998	4	4	100.0	0.65
1999	4	4	100.0	0.60
2000	4	4	100.0	0.70
2001	4	4	100.0	0.74
2002	4	4	100.0	0.62
2003	4	3	75.0	1.43
2004	4	3	75.0	0.94
2005	4	4	100.0	0.57
2006	4	4	100.0	0.62
2007	4	3	75.0	2.00
2008	4	3	75.0	0.98
2009	4	2	50.0	2.98
2010	4	4	100.0	0.53
2011	3	3	100.0	0.72

Table 8

Comparison of total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 2011. River sites were SSES (control) and Bell Bend (indicator).

DATE	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
30 Mar	22300	124	20.3	421	123	-1.0
09 Jun	8820	156	10.8	170	156	0.0
29 Sep [a]	80300	--	17.9	--	--	--
10 Nov	11100	135	34.0	392	138	3.0

[a] Hazardous river conditions prevented sample collection.

Table 9

Comparison of annual average total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 1991-2011. River sites were SSES (control) and Bell Bend (indicator).

YEAR	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
1991	12600	197.3	14.6	711.8	203.7	6.4
1992	13400	155.3	7.5	600.3	156.4	1.1
1993	23700	202.8	13.1	636.2	204.4	1.6
1994	19200	174.9	13.9	660.9	175.3	0.4
1995	10200	196.7	12.9	643.9	198.8	2.1
1996	24000	151.8	19.5	438.4	152.6	0.8
1997	6490	239.0	16.9	787.7	248.6	9.6
1998	11200	242.2	19.2	649.3	247.9	5.7
1999	9120	204.1	11.2	585.1	212.0	7.9
2000	21200	160.4	12.6	449.5	163.5	3.1
2001	7190	180.2	20.8	572.5	183.9	3.7
2002	12200	136.2	17.7	523.4	142.5	6.3
2003	26900	131.3	18.7	459.0	132.5	1.2
2004	12200	134.1	18.3	446.6	136.3	2.2
2005	13500	157.1	16.2	584.0	165.4	8.3
2006	14400	137.6	17.9	522.8	138.0	0.4
2007	20800	145.7	20.4	455.1	147.9	2.2
2008	10700	164.1	23.2	505.0	165.1	1.0
2009	30900	99.9	22.4	393.8	100.2	0.3
2010	11700	136.7	23.1	546.1	138.0	1.3
2011	30630	103.8	20.8	245.8	104.3	0.5
MEAN	16300	164.3	17.2	543.7	167.5	3.1

Table 10

Descriptions of electrofishing (EL) and seining (SN) sites at SSES and Bell Bend on the Susquehanna River, 2011.

SITE	LOCATION
	SSES (Control)
EL-1	East bank, 426 feet upriver from gas-line crossing to 1,082 feet upriver from a point opposite the center of the Susquehanna SES intake structure
EL-2	West bank from gas-line crossing to a point 820 feet upriver from the center of the Susquehanna SES intake structure
SN-1	East bank, 1,837 feet upriver from a point opposite the center of the Susquehanna SES intake structure (33 feet upriver from the mouth of Little Wapwallopen Creek)
SN-2	West bank, 1,312 feet upriver from the center of the Susquehanna SES intake structure (328 feet downriver from the boat ramp at the Susquehanna SES Environmental Laboratory)
	BELL BEND (Indicator)
EL-3	East bank, 1,279 feet downriver from a point opposite the center of the Susquehanna SES intake structure to a point 1,640 feet upriver from the mouth of Wapwallopen Creek
EL-4	West bank, 1,246 feet downriver from the center of the Susquehanna SES intake structure (558 feet downriver from the discharge diffuser) to a point near the southeastern boundary of PPL's Wetlands Nature Area
SN-3	East bank, 8,528 feet (1.6 miles) downriver from a point opposite the center of the Susquehanna SES intake structure, at the launching ramp of the Berwick Boat Club
SN-4	West bank, 4,264 feet (0.8 miles) downriver from the center of the Susquehanna SES intake structure, near the southeastern boundary of PPL's Wetlands Nature Area

Table 11

Fish species that were observed while electrofishing or collected by seining at SSES and Bell Bend on the Susquehanna River, 2011. Names of fishes and order of listing conform to Nelson et al. (2004).

COMMON NAME	SCIENTIFIC NAME
Carps and Minnows	Cyprinidae
Spotfin shiner	*Cyprinella spiloptera*
Common carp	*Cyprinus carpio*
Spottail shiner	*Notropis hudsonius*
Bluntnose minnow	*Pimephales notatus*
Creek chub	*Semotilus atromaculatus*
Fallfish	*Semotilus corporalis*
Suckers	Catostomidae
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersonii*
Northern hog sucker	*Hypentelium nigricans*
Shorthead redhorse	*Moxostoma macrolepidotum*
North American Catfishes	Ictaluridae
Brown bullhead	*Ameiurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Pikes	Esocidae
Muskellunge	*Esox masquinongy*
Chain pickerel	*Esox niger*
Sunfishes	Centrarchidae
Rock bass	*Ambloplites rupestris*
Redbreast sunfish	*Lepomis auritus*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Perches	Percidae
Tessellated darter	*Etheostoma olmstedi*
Yellow perch	*Perca flavescens*
Walleye	*Sander vitreus*

Table 12

Number, mean, and percent total of fish observed while electrofishing at SSES on the Susquehanna River, 2011.

SPECIES	21 Jun				21 Jul				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Fallfish	0	1	0.5	0.8	1	1	1.0	1.4	0.8	1.1
Quillback	2	21	11.5	19.2	3	19	11.0	15.3	11.3	17.0
White sucker	0	1	0.5	0.8	0	0	0.0	0.0	0.3	0.4
Northern hog sucker	14	7	10.5	17.5	14	15	14.5	20.1	12.5	18.9
Shorthead redhorse	1	0	0.5	0.8	0	2	1.0	1.4	0.8	1.1
Brown bullhead	0	1	0.5	0.8	0	0	0.0	0.0	0.3	0.4
Channel catfish	0	0	0.0	0.0	8	5	6.5	9.0	3.3	4.9
Muskellunge	0	0	0.0	0.0	1	1	1.0	1.4	0.5	0.8
Chain pickerel	0	1	0.5	0.8	0	0	0.0	0.0	0.3	0.4
Rock bass	13	11	12.0	20.0	6	9	7.5	10.4	9.8	14.8
Redbreast sunfish	0	1	0.5	0.8	0	0	0.0	0.0	0.3	0.4
Green sunfish	0	0	0.0	0.0	1	0	0.5	0.7	0.3	0.4
Pumpkinseed	0	0	0.0	0.0	1	0	0.5	0.7	0.3	0.4
Bluegill	3	1	2.0	3.3	3	4	3.5	4.9	2.8	4.2
Smallmouth bass	15	9	12.0	20.0	14	12	13.0	18.1	12.5	18.9
White crappie	0	0	0.0	0.0	1	0	0.5	0.7	0.3	0.4
Sunfish spp.	1	0	0.5	0.8	4	3	3.5	4.9	2.0	3.0
Walleye	3	3	3.0	5.0	1	4	2.5	3.5	2.8	4.2
Fish (unidentified)	7	4	5.5	9.2	10	1	5.5	7.6	5.5	8.3
TOTAL	59	61	60.0		68	76	72.0		66.0	

Table 13

Number, mean, and percent total of fish observed while electrofishing at Bell Bend on the Susquehanna River, 2011.

SPECIES	21 Jun				21 Jul				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Common carp	1	3	2.0	3.2	0	0	0.0	0.0	1.0	1.9
Fallfish	0	4	2.0	3.2	3	1	2.0	5.0	2.0	3.9
Quillback	5	0	2.5	4.0	2	0	1.0	2.5	1.8	3.4
White sucker	1	0	0.5	0.8	1	0	0.5	1.3	0.5	1.0
Northern hog sucker	13	8	10.5	16.7	5	6	5.5	13.8	8.0	15.5
Shorthead redhorse	0	1	0.5	0.8	0	1	0.5	1.3	0.5	1.0
Channel catfish	3	1	2.0	3.2	1	2	1.5	3.8	1.8	3.4
Muskellunge	1	0	0.5	0.8	0	0	0.0	0.0	0.3	0.5
Rock bass	10	9	9.5	15.1	13	2	7.5	18.8	8.5	16.5
Redbreast sunfish	2	2	2.0	3.2	1	0	0.5	1.3	1.3	2.4
Bluegill	2	3	2.5	4.0	4	1	2.5	6.3	2.5	4.9
Smallmouth bass	12	9	10.5	16.7	13	3	8.0	20.0	9.3	18.0
White crappie	0	1	0.5	0.8	0	0	0.0	0.0	0.3	0.5
Sunfish spp.	3	1	2.0	3.2	9	3	6.0	15.0	4.0	7.8
Yellow perch	0	0	0.0	0.0	1	0	0.5	1.3	0.3	0.5
Walleye	8	6	7.0	11.1	3	1	2.0	5.0	4.5	8.7
Fish (unidentified)	11	6	8.5	13.5	3	1	2.0	5.0	5.3	10.2
TOTAL	72	54	63.0		59	21	40.0		51.5	

Table 14

Number, mean, and percent total of fish captured by seining at SSES and Bell Bend on the Susquehanna River, 2011.

SPECIES	25 Aug				OVERALL	
	East	West	Mean	% Total	Mean	% Total
SSES						
Spotfin shiner	147	1	74.0	55.8	74.0	55.8
Spottail shiner	22	66	44.0	33.2	44.0	33.2
Bluntnose minnow	2	8	5.0	3.8	5.0	3.8
Northern hog sucker	2	0	1.0	0.8	1.0	0.8
Shorthead redhorse	0	1	0.5	0.4	0.5	0.4
Rock bass	1	3	2.0	1.5	2.0	1.5
Redbreast sunfish	2	0	1.0	0.8	1.0	0.8
Bluegill	0	7	3.5	2.6	3.5	2.6
Smallmouth bass	0	2	1.0	0.8	1.0	0.8
Largemouth bass	0	1	0.5	0.4	0.5	0.4
TOTAL	176	89	132.5		132.5	
BELL BEND						
Spotfin shiner	61	43	52.0	87.4	52.0	87.4
Spottail shiner	1	7	4.0	6.7	4.0	6.7
Bluntnose minnow	0	1	0.5	0.8	0.5	0.8
Creek chub	1	1	1.0	1.7	1.0	1.7
Redbreast sunfish	0	2	1.0	1.7	1.0	1.7
Tessellated darter	0	2	1.0	1.7	1.0	1.7
TOTAL	63	56	59.5		59.5	

Table 15

P-values for fish species deemed significant by the BACI analysis, 1976-2011($\alpha = 0.05$). Species listed decreased in number at the downriver locations, except for brown bullheads which increased at the downriver sites. Columns depict the p-values associated with the two temporal categories of data analyzed; *All Data* represents all months sampled, *Summer Data* denotes samples collected from June through October.

SPECIES	ALL DATA	SUMMER DATA
Quillback	0.005	0.001
Northern hog sucker	0.001	0.012
Shorthead redhorse	<0.001	<0.001
Brown bullhead	0.012	0.087
Muskellunge	<0.001	0.002
Rock bass	<0.001	0.004
Smallmouth bass	0.028	0.001
Unidentified fish	0.023	0.001

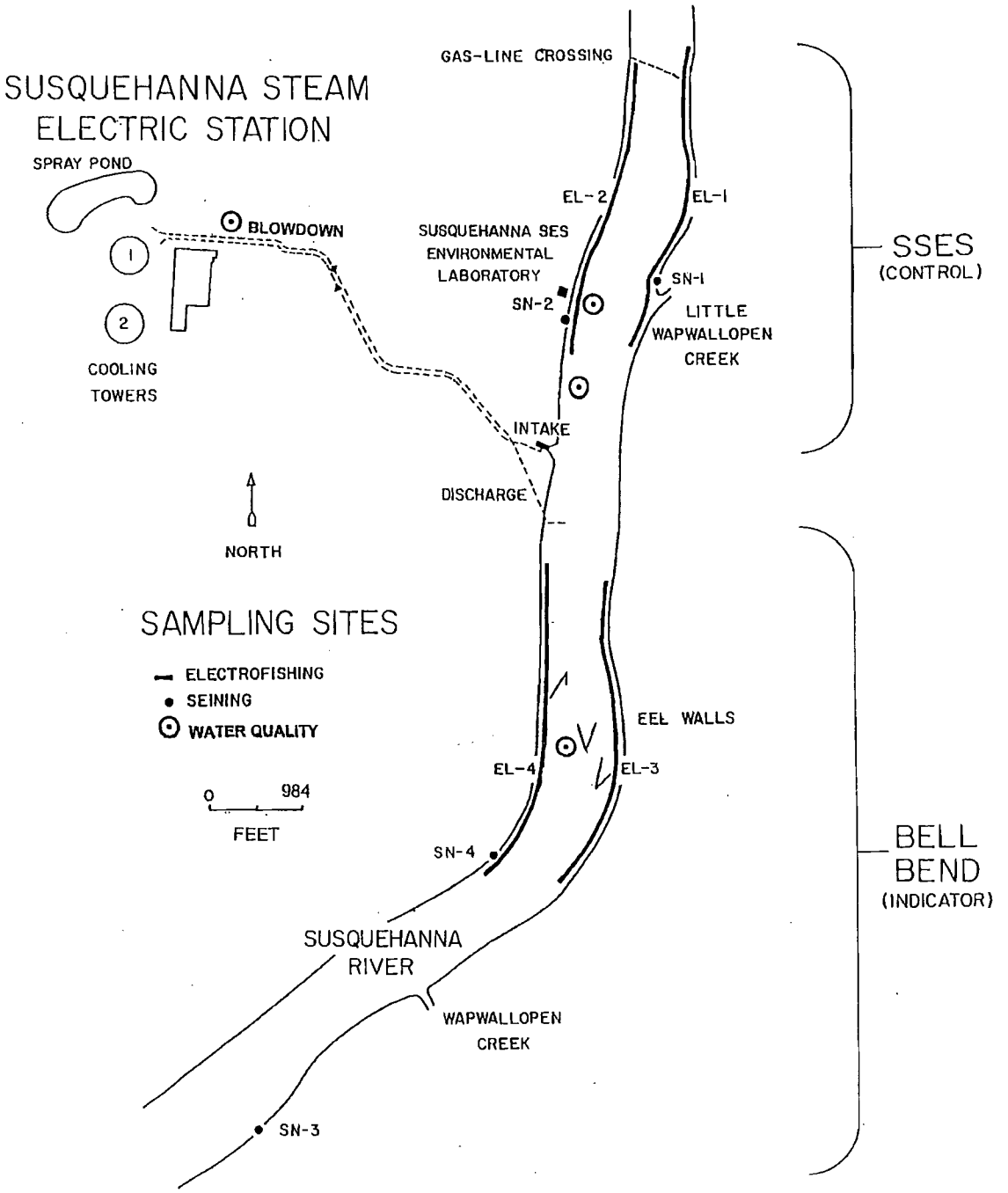

Fig. 1

Sampling sites for water quality, electrofishing (EL), and seining (SN) at SSES and Bell Bend on the Susquehanna River, 2011.

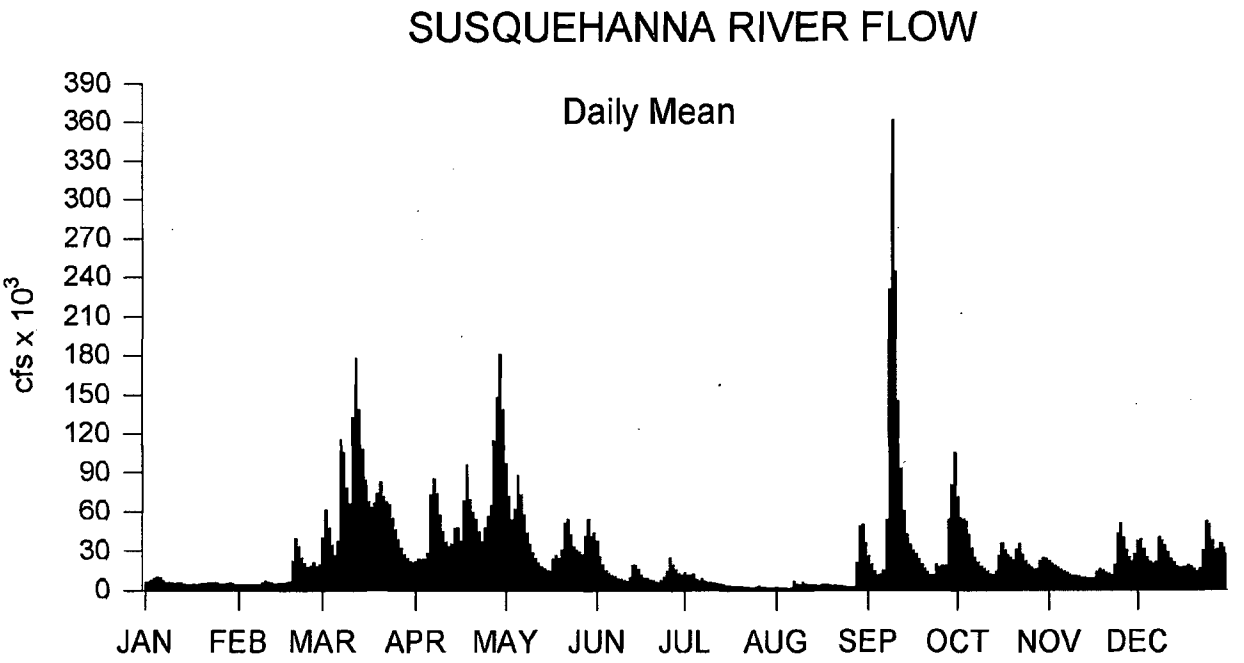

Fig. 2

The 2011 daily mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory. The means were calculated from U.S. Geological Survey and Environmental Laboratory data.

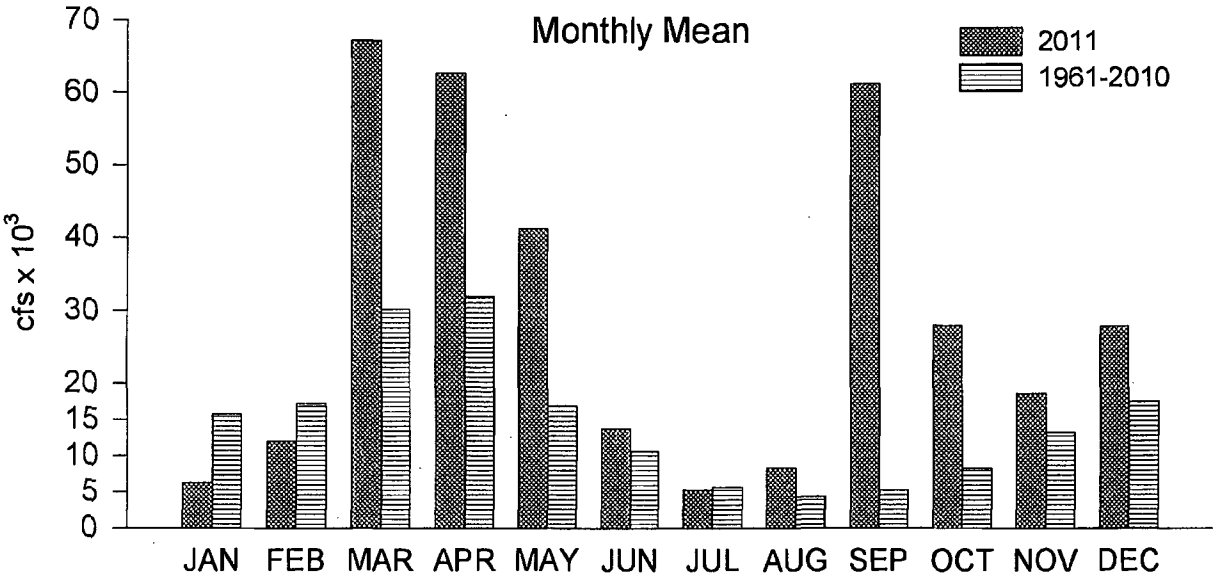

Fig. 3

The 2011 monthly mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the 50-year (1961-2010) mean. The means were calculated from U.S. Geological Survey and Environmental Laboratory data.

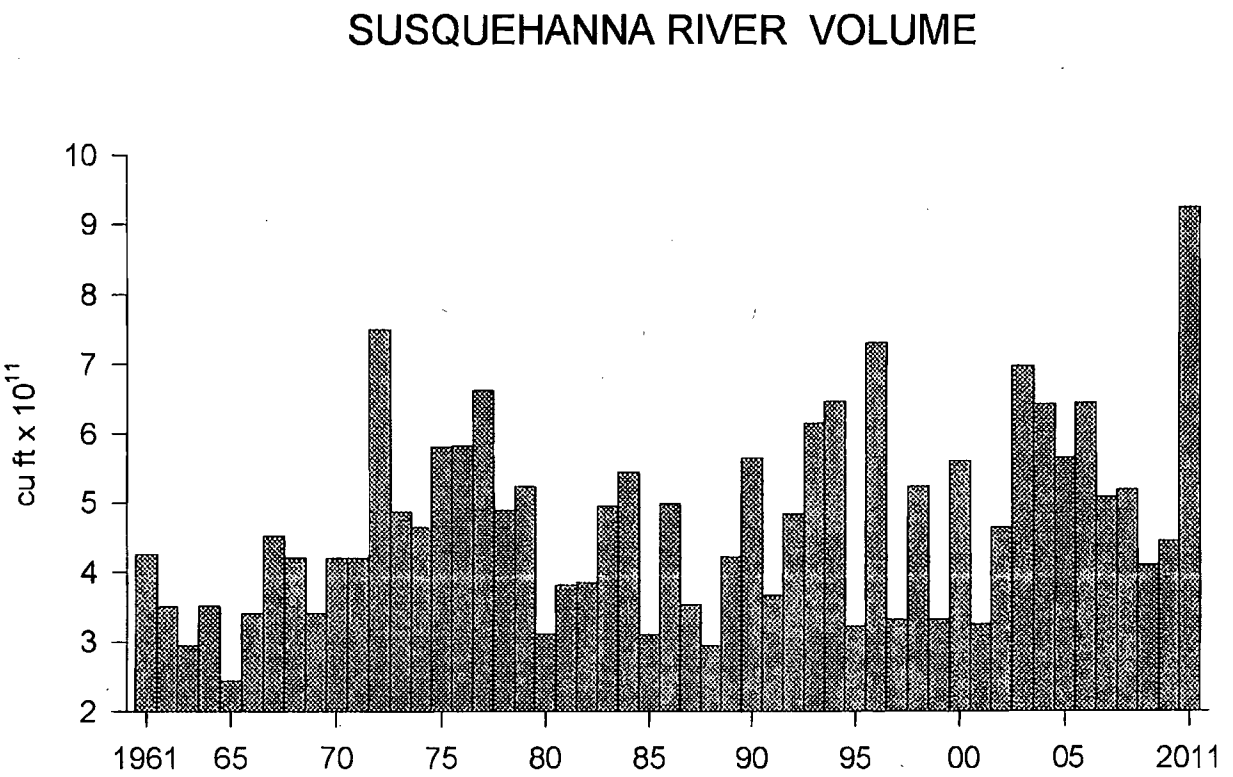

Fig. 4

Volume of Susquehanna River flow at the Susquehanna SES Environmental Laboratory, 1961-2011. The volumes were calculated from U.S. Geological Survey and Environmental Laboratory data.

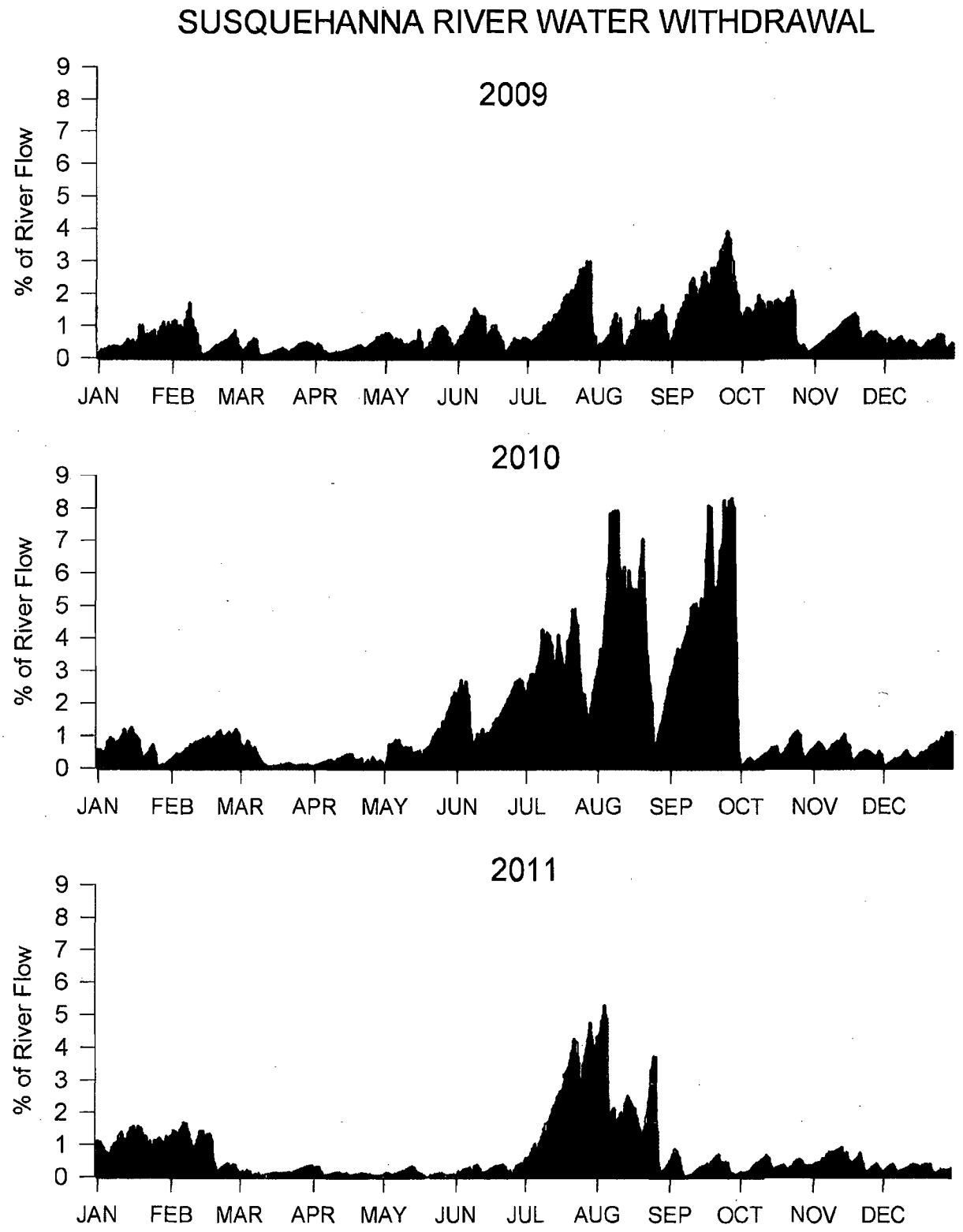

Fig. 5

Daily Susquehanna River water withdrawal by Susquehanna SES, 2009-2011.
Data provided by PPL Susquehanna, LLC personnel.

SUSQUEHANNA RIVER TEMPERATURE

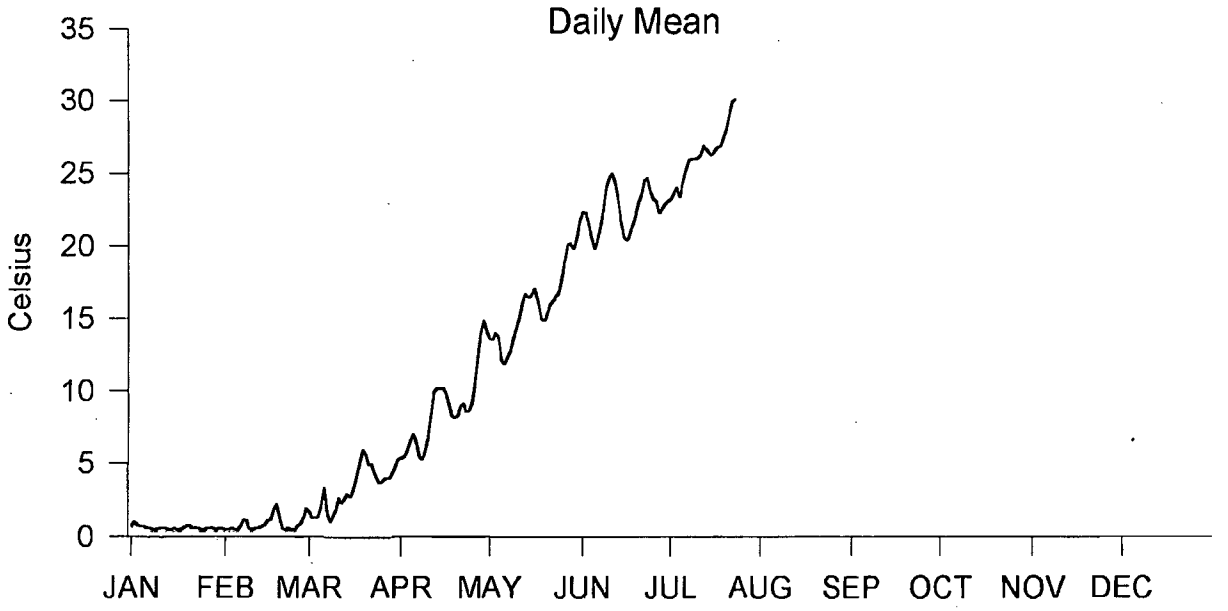

Fig. 6

The 2011 daily mean temperature of the Susquehanna River at the Susquehanna SES Environmental Laboratory. Due to equipment failure, there are no data after 23 July.

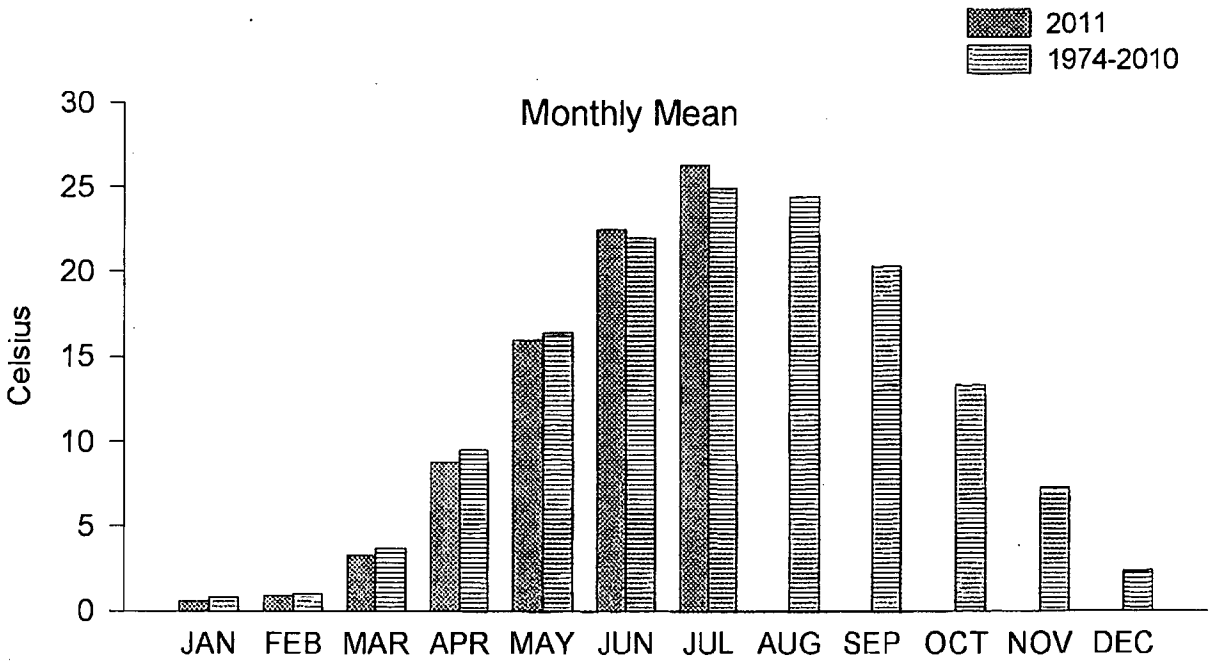

Fig. 7

The 2011 monthly mean temperature of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the 37-year (1974-2010) mean. Due to equipment failure, no data were collected after July.

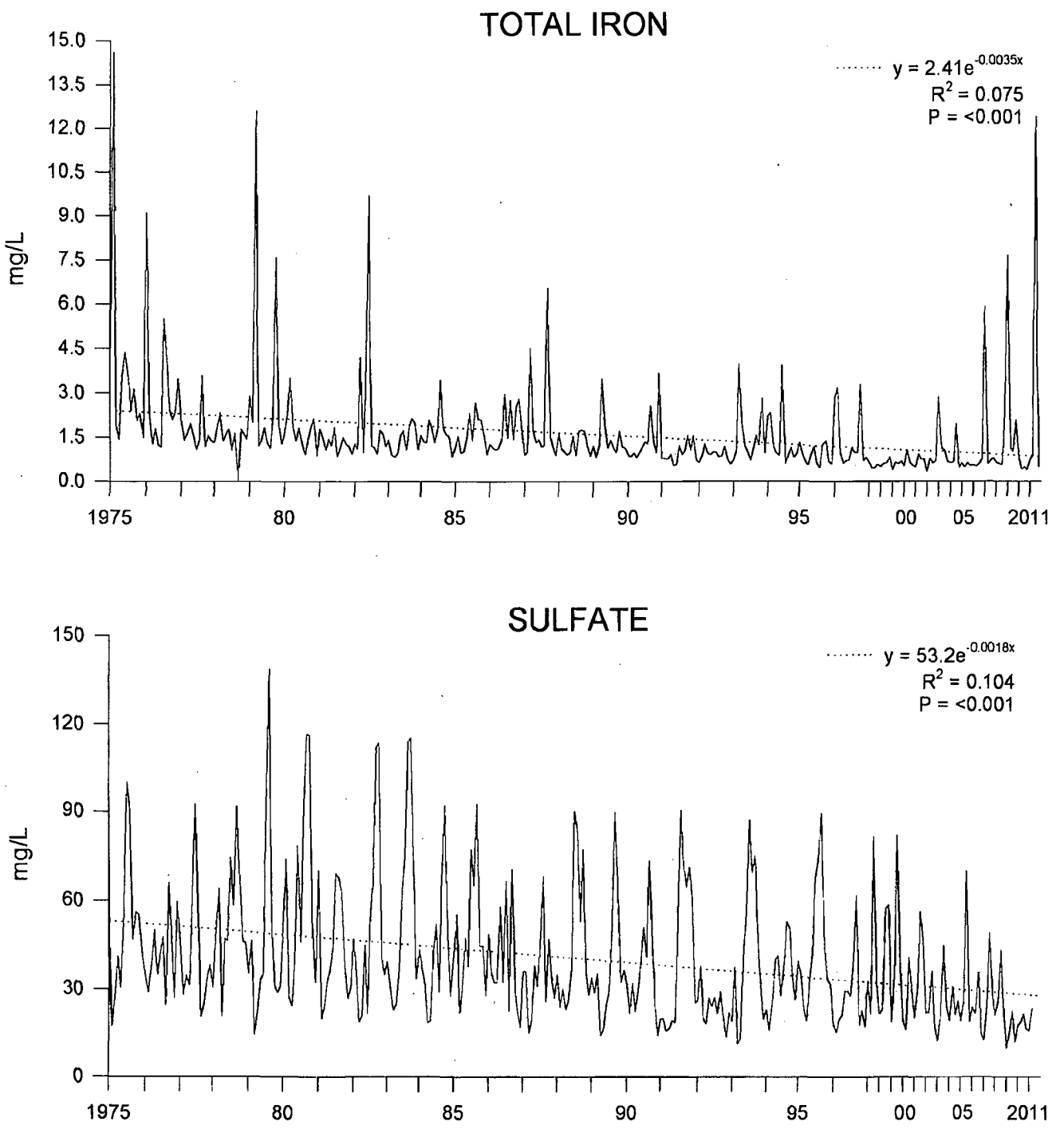

Fig. 8

Total iron and sulfate of the Susquehanna River at the SSES sampling site, 1975-2011. Samples were collected monthly 1975-1996 and quarterly 1997-2011. Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.