PREOPERATIONAL STUDIES OF THE SUSQUEHANNA RIVER IN THE VICINITY OF THE SUSQUEHANNA STEAM ELECTRIC STATION, 1971-1982

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PHYSICOCHEMICAL ANALYSES

The water quality of the Susquehanna River was monitored from July 1971 through August 1982 during the preoperational phase of the Susquehanna SES. The objective since 1971 has been to establish baseline values of physicochemical parameters for evaluation of possible effects on the water quality of the river from the construction and operation of the Susquehanna SES.

From 1971 through 1974, water quality was monitored at several locations upriver and downriver from the Susquehanna SES site to determine water quality throughout the Susquehanna River (Fig. B-1). Beginning in 1973, data were also collected at SSES, a control site approximately 250 m upriver from the Susquehanna SES intake (Fig. B-2). In 1978, Bell Bend, an indicator site approximately 700 m downriver from the Susquehanna SES discharge diffuser, was established.

The river at the Susquehanna SES site is in a "recovery" area due to the effects of upriver acid mine effluents. Drainages from abandoned coal mines enter the river in the Wyoming Valley (from 22 km to 48 km upriver) and degrade water quality. Sewage effluents (raw, primary, and secondary) also flow into the river from several upriver towns and cities as near as 6 km upriver from the Susquehanna SES.

The chemistry of oxidizing and neutralizing acid mine drainage in the river is a complex process involving numerous reactions; there are increases of specific conductance, turbidity, iron, sulfate, and residues, and decreases of pH, alkalinity, and oxygen in the river. Water quality at the Susquehanna SES site was most adversely affected during the preoperational period by iron. Ferrous iron from mine drainage is oxidized in the river to form insoluble ferric compounds, mostly ferric hydroxide. Much of this iron precipitates from

the water column, but enough remains suspended in summer to "color" the river brownish-orange at the site. Water temperature is the major factor controlling iron oxidation in the river and differences in ferric/ferrous iron ratios reflect seasonal changes in water temperature (Gale et. al 1976).

The concentration of total iron in 687 of 778 samples collected at the SSES control site exceeded 1.5 mg/l, the Pennsylvania Department of Environmental Resources (Pa DER) water quality criteria for the river. During the preoperational period, concentrations were generally greater than 2.0 mg/l, however, high river flows produced concentrations up to 52.8 mg/l.

During the interim of this report, two major floods occurred in the Susquehanna River Basin. In June 1972, Tropical Storm Agnes produced flooding unequalled in the modern history of the region. The river crest at the Susquehanna SES site on 25 June was 157.69 m above mean sea level at 0300 h and the mean daily flow was 9,340 m^3/s. Hurricane Eloise caused the second flood in September 1975. It was not as severe as "Agnes"; the river crested at 156.36 m above mean sea level on 27 September at 1700 hours. A velocity of 3.1 m/s was recorded during the Eloise flood when the level was 155.60 m above mean sea level.

The "Agnes" flood had a direct impact on water quality throughout the preoperational period. After the flood, the pumping of acid water from abandoned mines in the Wyoming Valley was terminated. Although mine water continues to enter the river through several seeps and gravity discharges, they are controlled to some degree by the water table. Parameters associated with acid mine drainage (iron, sulfate, hydrogen ion concentration, and specific conductance) decreased substantially at SSES after the mine pumping was terminated (Figs. B-3 through B-9). In addition, the quality of water in four

major mine drainages improved since 1972; overall, pH and alkalinity increased while acidity, sulfate, and total iron decreased (Table B-2).

Because of these changes in water quality, the SSES data were analyzed with nonparametric statistics to determine if: 1) year-to-year changes had occurred in each parameter, and 2) a trend among years was present. Friedman's two-way analysis of variance test (S) was used in the first and Page's distribution-free test (L) for ordered alternatives in the second (Hollander and Wolfe 1973). These tests were first applied to data collected from 1973 through 1976 and then sequentially each year thereafter through 1982. Most notable were significant increasing trends for total alkalinity and pH, and significant decreasing trends for turbidity and total iron in each year tested. Other parameters exhibited significant trends during the preoperational period, however, the significance was usually influenced by the physical state of the river (i.e. high flow, drought, low temperature, etc.) during the particular year the trend occurred. It was demonstrated in 1981 that specific conductance, sulfate, and filtrable residue were inversely related to flow and that turbidity and nonfiltrable residue were directly related to total iron (Table B-3).

Water quality at the control site (SSES) and indicator site (Bell Bend) were similar throughout the preoperational period. Annual mean data between the sites were always close, if not identical (Table B-1). The nonparametric Wilcoxon signed ranks test (Siegel 1956) was used to compare data collected at SSES and Bell Bend from 1978 through 1982 to determine if there were significant patterns between the sites. It was found that turbidity, sulfate, total iron, dissolved iron, and fixed total residue were higher at SSES a significantly greater number of times; Secchi disc depth, dissolved oxygen,

total alkalinity, total residue, and filtrable residue were higher at Bell Bend a significantly greater number of times (Table B-4). Specific conductance, pH, and nonfiltrable residue did not exhibit any patterns between the sites. Significance in the Wilcoxon test should be regarded as a pattern between the sites and not as a difference because of the similarity of the data.

Throughout the preoperational phase of the Susquehanna SES, water quality of the Susquehanna River improved. Total iron and turbidity decreased at the site and pH and total alkalinity increased. It is probable that water quality will improve in the operational phase when the Wyoming Valley Sanitary Authority upgrades its sewage treatment to secondary and the town of Mocanaqua begins sewage treatment. At present, however, there are no plans to abate the acid mine drainages which continually flow into the river.