DEVELOPMENT OF A TOTAL PHOSPHORUS TMDL FOR CHENOWETH RUN (PHASE I)

Problem Identification

Chenoweth Run, a tributary of Floyd's Fork lies entirely within Jefferson County, Kentucky. The stream flows through a densely developed industrial park, past the City of Jeffersontown, then through a lower-density urban area, and the last three miles through a mostly rural area.

Nutrient enrichment has been a problem in Chenoweth Run and in Floyds Fork below Chenoweth Run. Chenoweth Run was placed on the 1992 and 1994 303(d) lists as a water body not meeting water quality uses. Organic enrichment and nutrients were identified as causes of use impairment. Dense algal mats have formed in Chenoweth Run and in downstream water bodies as a result of excessive phosphorus discharge to the stream acting as a fertilizer and promoting algal growth. 401 KAR 5:031 Section 2 states that"...surface waters shall not be aesthetically or otherwise degraded by substances that produce undesirable aquatic life or result in the dominance of nuisance species." Algal activity also affects the pH of a stream. The pH of a stream is important because of its relationship to ammonia toxicity. At high summer temperatures and high pH (considered greater than about 8.5 units), ammonia becomes toxic to aquatic life. This again points to the importance of nutrient control to reduce algal biomass.

Endpoint Identification

Chenoweth Run is classified as a surface water supporting warmwater aquatic habitats. This use (and other uses) specify that "... surface waters shall not be aesthetically or otherwise degraded by substances that produce undesirable life, or result in the dominance of nuisance species."

Source Analysis

In a riverine water body such as Chenoweth Run, the growth of nuisance algal mats has been observed during summertime conditions. Generally, stream flow is low to moderate and temperatures are warm making conditions suitable for stimulating algal production. Under low-flow conditions most of the stream flow comes from wastewater discharge. An analysis of in-stream water quality data showed a significant increase in TP concentration downstream of the major discharger, Jeffersontown WWTP. At moderate stream flows, stormwater runoff contributes nutrients to the receiving waters.

Other factors exacerbating the problem is the fact that development in the watershed has resulted in the clear-cutting of trees in the riparian zone around Chenoweth Run. Also, stormwater runoff has increased dramatically.

Linkage of Endpoints and Sources

A water quality assessment of Chenoweth Run resulted in the recommendation of limiting total phosphorus (TP) to 1 mg/l at the Jeffersontown WWTP. The critical period of time where algal production occurs is during summer months when stream flows are low and dominated by effluent discharge. Thus, this recommendation of limiting the Jeffersontown WWTP, the major point source discharging to Chenoweth Run, to 1 mg/l TP constitutes Phase I of this TMDL. Phase II will entail more in-depth study of Chenoweth Run including development of a computerized watershed-simulation model that can be used for optimizing management decisions relating to water quality and quantity in the Chenoweth Run drainage basin. Both point and non-point sources of pollution will be fully evaluated for their effects during low-flow and storm flow scenarios.

Allocation of Responsibilities

Wasteload Allocation (Phase I)

Facility	Flow (MGD)	TP Concentration (mg/l)	TP Loading (lbs/day)
Jeffersontown	4.0	1	33.38

The TP concentration limit will be placed in the KPDES permit at permit reissuance (June 2000) unless the Phase II study documents another limit.

Load Allocation (Background Stream Loading):

The Phase I study of Chenoweth Run evaluated the low flow event in Chenoweth Run as the critical period for algal production. The 7Q10 (low flow event) for Chenoweth Run is 0 cfs. The Phase II study will evaluate storm flow events and determine if additional controls are needed during rainfall events. Thus, the load allocation for Chenoweth Run during the low flow event is:

Total Phosphorus: 0 lbs/day

Margin of Safety (MOS):

The margin of safety will be incorporated into Phase II of this study.

Total Maximum Daily Load @ 7Q10 = 0 cfs:

Total Phosphorus = 33.38 lbs/day + 0 lbs/day = 33.38 lbs/day

Reduction of TP discharged to the stream will result in a reduction of algal biomass produced in Chenoweth Run and at the confluence with Floyd's Fork.

Additional measures are needed to achieve solutions to these problems. Along with point source controls creation of riparian zones and tree planting to provide shade along Chenoweth Run will aid in water quality recovery. Storm water runoff controls would also be helpful.

Public Availability

A community workgroup was formed as a public outreach component for the project. Membership on this workgroup consisted of concerned citizens, local agencies, state and federal agencies, and environmental groups. The initial plan of study was developed with their assistance and the final work product was reviewed by the workgroup.

Approval

This TMDL is hereby approved as meeting the requirements of Section 303(d) of the Clean Water Act.

Virginia Buff 8-27-97

Virginia Buff
Technical Reviewer

9/2/97

Jim Greenfield
Technical Approver

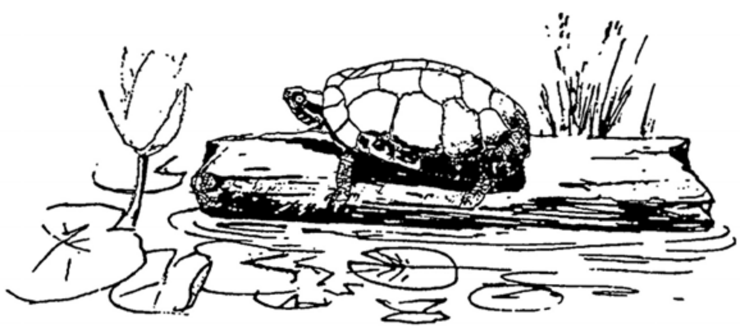
9/4/97

Robert F. McGhee, Director
Water Management Division

9-4-97

Date

Water Quality Study of Chenoweth Run



Kentucky Natural Resources and Environmental Protection Cabinet
Department for Environmental Protection
Division of Water
June 1996

WATER QUALITY STUDY OF CHENOWETH RUN

Kentucky Department for Environmental Protection
Division of Water
KPDES Branch

June 1996

This report has been approved for release:

Jack A. Wilson

Jack A. Wilson, Director
Division of Water

June 28, 1996

Date

WATER QUALITY STUDY OF CHENOWETH RUN

BY
DAVID LEIST, P.E.
DIVISION OF WATER

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WATER QUALITY STUDY OF CRENOWETH RUN

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ACKNOWLEDGMENTS

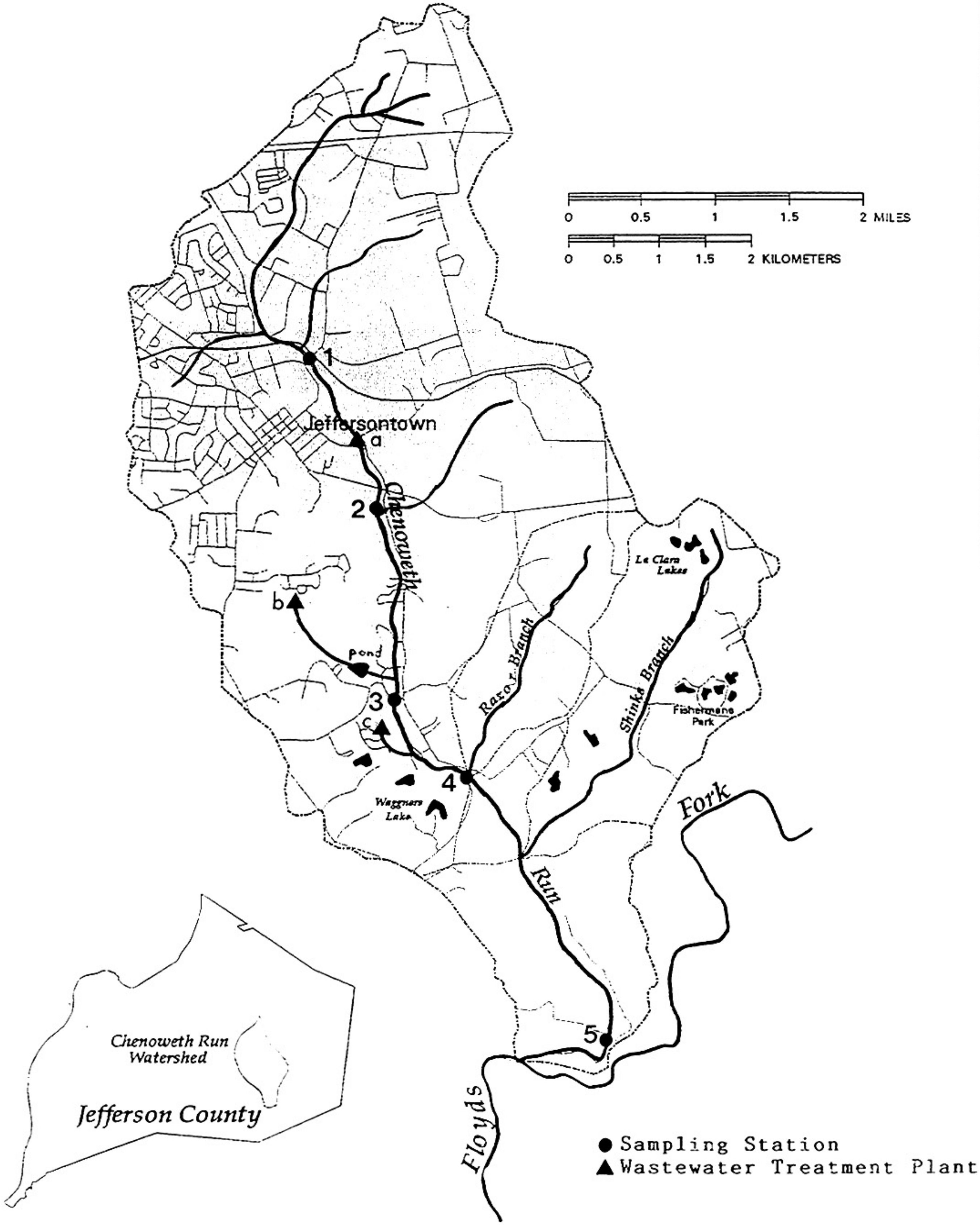
This report represents the work of numerous individuals involved with planning, data collection, and laboratory analysis. The U.S. Environmental Protection Agency made the project possible with a grant that provided much of the funding. A planning meeting included input from Bob Butler, Jefferson County Planning and Environmental Management Office; Clark Bledsoe, Jefferson County Health Department; Harry Rollins and Dennis McClain, U.S. Geological Survey (USGS); Teena Halbig, Floyds Fork Environmental Association; Winston Shelton and Kathy Lowry, Association of Chenoweth Run Environmentalists; and Jeff Frank, Audubon Society. Ed Puckett and other staff with the USGS collected most of the samples and field data, and Gordon Garner, Metropolitan Sewer District, volunteered the district's laboratory services. Bob Forbes, USGS, prepared the base map of the basin shown in Figure 1. The Division of Water wishes to thank all these individuals and agencies for their participation in this project.

INTRODUCTION

Chenoweth Run, a tributary of Floyds Fork, lies entirely within Jefferson County, Kentucky. The headwater is just north of Interstate 64, and the stream flows nine miles to its confluence at mile 24.2 of Floyds Fork. Chenoweth Run flows through a densely developed area in the Bluegrass Industrial Park, past the city of Jeffersontown, then through a lower-density urban area, and the last three miles through a mostly rural area. Additional development is occurring throughout the entire watershed. The Jeffersontown Wastewater Treatment Plant (J-town WWTP), with a design flow of 4 million ga11ons per day (mgd), is located on Chenoweth Run at mile 5.2. Two other relatively sma11 treatment plants serve individual developments and are located on tributaries (Figure 1, Table 1.).

In late 1992, the Kentucky Division of Water (KDOW) became increasingly concerned about water quality conditions in Chenoweth Run and its impacts on Floyds Fork. A proposed new wastewater treatment plant at mile 1.8 to serve a planned development, plus the concern of two local environmental groups, prompted the KDOW to further investigate water quality conditions. County government also became increasingly concerned about these conditions and formed a task force of local officials and citizens to delineate ideas and suggestion for improvement. A report that covers guidelines for new development in the basin is currently being drafted by a consulting firm for Jefferson County.

CHENOWETH RUN WATERSHED
Jefferson County, Kentucky



Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection, zone 16

TABLE 1. WASTEWATER TREATMENT PLANTS IN CHENOWETH RUN	
Map	Design Flow (mgd)*
a) Jeffersontown	4.0
b) Chenoweth Hills	0.20
c) Lake of the Woods	0.04
* Million gallons per day	

TABLE 2. SAMPLING STATIONS IN CHENOWETH RUN
Map
1. Chenoweth Run at Watterson Trail, above the J-town WWTP
2. Chenoweth Run at Taylorsville Road
3. Chenoweth Run at Easum Road
4. Chenoweth Run at Gelhaus Lane
5. Chenoweth Run at Seatonville Road

Various data have been collected previously in Chenoweth Run and streams throughout Jefferson County. In 1986, the KDOW published a report on conditions in the Floyds Fork basin. This report included information from a sampling station on Chenoweth Run. In 1988, the Metropolitan Sewer District (MSD), in cooperation with the U.S. Geological Survey (USGS), began collecting water quality data throughout the county. Both agencies have published a series of reports describing water quality conditions. Water quality problems were found in every stream in the county, including Chenoweth Run. The most significant problems in Chenoweth Run and Floyds Fork downstream of Chenoweth Run were with dense nuisance growths of algae, causing both aesthetic problems and water quality criteria violations of dissolved oxygen, pH, and ammonia toxicity. Fueling this algal growth was an excess of nutrients, with phosphorus considered the nutrient of most concern. In 1989, Chenoweth Run had the highest average total phosphorus concentration collected from 26 sites in Jefferson County, with a value of 1.58 mg/L (MSD, 1990).

As a result of this existing information, the KDOW placed a phosphorus removal requirement for a proposed facility, began requiring phosphorus monitoring at the J-town WWTP, and applied for a U.S. Environmental Protection Agency (EPA) grant to further determine the sources and extent of the problems in Chenoweth Run. (The plans for the proposed facility have since been canceled. The development, if built, will connect to an existing MSD facility on

Cedar Creek, outside of the Chenoweth Run watershed). The EPA awarded the grant in 1994, and a meeting was held with local government and concerned citizens to refine the study plan. Sampling began in January 1995.

DESCRIPTION OF STUDY AREA

Chenoweth Run drains about 17 square miles of Jefferson County and flows about 9 miles to its confluence with Floyds Fork. The location of the J-town WWTP represents a dividing point in land use. The drainage area above the facility, about 7 square miles, is intensely developed by both residential areas and the Bluegrass Industrial Park. Much of the downtown area of Jeffersontown is within this drainage area. The industrial park consists primarily of light industry, office, and warehouse areas. A new church complex, including a 50-acre parking lot and associated buildings, is currently under construction at the very headwaters. The stream channel through much of the area above the J-town WWTP lies within very steep, tree-lined banks. Large drain pipes carry storm runoff from parking lots, rooftops, and other areas directly to the creek. Buffer zones, or areas of vegetation beyond the stream banks are sparse. Stream slope is moderate and averages about IS feet per mile. The area downstream of the J-town WWTP is much less developed, with some areas of rural and agricultural use. Subdivision development has occurred in this area, and more is either planned or under construction. Stream banks are much less steep, and buffer zones still remain in much of the area. A significant tree canopy, however, does not exist in much of this length, and the stream is exposed to direct sunlight in many places. Stream slopes are again moderate, averaging about 13 feet per mile.

Fish are observed throughout the basin. Pools exist at several locations below the J-town WWTP, and larger sport fish can be seen in these pools, including bass and bluegill. Similar fish observations were also noted in the 1986 KDOW report. Ducks are routinely present in Chenoweth Run and during winter months are seen at the J-town WWTP outfall. Presumably the ducks favor the warmer effluent waters.

DATA COLLECTION

Five sampling stations were used for this study (Figure I and Table 2). Samples were collected monthly from January 1995 to January 1996, with additional samples collected during both extreme low-flow and high-flow conditions. Samples were also collected from the effluent of the J-town WWTP. The USGS measured streamflow and collected the samples under contract with the KDOW as part of the EPA grant. MSD staff continued to collect their normal samples at the Gelhaus Lane station. Coordination between the USGS and MSD was accomplished, and the samples at Gelhaus Lane and the two Floyds Fork stations in MSD's network were collected on the same days. Data collected by MSD at their stations are undergoing MSD internal review and.are not published in this report. Samples were analyzed by MSD in its laboratory. Staff from KDOW also conducted some additional sampling and algal collection. A separate report is being prepared by the KDOW for the algal analysis.

Water samples were analyzed for BOD, ammonia, dissolved oxygen, temperature, pH, total phosphorus, nitrite plus nitrate nitrogen, suspended solids, and fecal coliform bacteria. An error was discovered with the holding times for the fecal coliform bacteria samples, and the results were found to be invalid and are not reported. Metals data were collected twice for this study, once for low-flow conditions and once after a heavy rainfall event. Samples for metals were analyzed by the Kentucky Division of Environmental Services lab in Frankfort.

Dissolved oxygen, pH, and water temperature were measured every 30 minutes for periods ranging from 22 to 24 hours at three sampling stations during one low-flow period. Hydrolab automatic datasonde units were used. These had been calibrated in the office the day prior to deployment, and instantaneous stream measurements were made when setting and removing the units to ensure data accuracy.

Streamflow conditions were variable for this study, ranging from a low of 0.13 cubic feet per second (cfs) above the J-town WWTP during low flows to 331 cfs at the Seatonville Road station after a heavy storm event. These conditions met the study goal of sampling a variety of hydrologic events.

NUTRIENT PROBLEMS AND CONTROL

Nutrients, primarily phosphorus and nitrogen, stimulate the growth of aquatic plants just as they do for land plants. The chlorophyl-bearing algae and rooted aquatic plants cause the most concern. Algae can proliferate where nutrient concentrations and light intensities are sufficient. The definition of 'sufficient' varies from stream to stream and is the focus of national research by the EPA and others. This algal proliferation can be greatly accelerated in streams and lakes with excess nutrients and sunlight. Algal blooms may occur, creating water quality problems with dissolved oxygen, pH, ammonia toxicity, aesthetics, and taste and odor in the water if used for public consumption. As algae die, decomposition can release foul odors and deplete dissolved oxygen to the point of causing fish kills. As algae respire at night or during extended periods of cloud cover, dissolved oxygen depletion can also become severe. These problems most often occur in lakes, but can also occur in streams. Streams with low slopes and little riparian tree cover have the greatest potential for algal blooms.

Aquatic plant growth can be inhibited by eliminating one or more of the critical elements. Velz (1970) notes that phosphorus is the most likely nutrient to be controlled. He says, however, that "the critical concentration level of phosphorus to inhibit algal growth remains in question. It has been considered as 0.1 milligrams per liter (mg/L), yet growth in lakes has persisted with no change in the amount of bloom when concentration in the receiving waters was reduced from 0.5 to 0.07 mg/L." He further states, "Nutrient control is highly complex. To some authorities it is conceivable that the uncontrollable sources from the urban, agricultural, and natural environments in general may maintain nutrients above critical levels even though all nutrients were to be removed from wastewater effluents."

Perhaps of equal importance to nutrient reduction is the protection or re-establishment of stream riparian zones. The following is an article from the December 1995 issue of "Water Environment & Technology" magazine.

> Shade Clears Streams
> When watersheds are developed and trees are cut down, streams that should be recreational resources often become clogged with thick blankets of algae. Working at the University of Michigan's Stream Research Facility near Pellston, Mich., R. Jan Stevenson, Professor of Biology at the University of Louisville, Kentucky, has found that when a stream loses its shade, the type of algae in the stream changes from species that insect larvae and snails eat to those that have no natural predators. Restoring vegetation and shade in riparian areas reverses this process, allowing edible algae, whose numbers are kept down by snails and insect larvae, to once again dominate, and the streams to once again become community recreational assets.

Because of the complexities of algal blooms, nutrient contribution, and stream dynamics (stream slope, flow, shade, etc.) there is no federal or state standard for phosphorus. The EPA, as well as the states, recognizes the need for nutrient control. As reported in the December 1994 "Inside EPA's Water Policy Report," the EPA is forming a nutrients water quality work group as part of its efforts to develop nutrient criteria. Director Robert Wayland, of EPA's Office of Wetlands, Oceans, and Waterbodies, notes his office will be working on "some badly needed criteria for nutrients in different types of waterbodies, including rivers, streams, lakes, and estuaries." The effort is to try to avoid eutrophication and nutrient enrichment that causes algal blooms. This is reflected in narrative form in KDOW Regulation 5:031, Section 1, which states: "Nutrient Limits. In lakes, surface impoundments and their tributaries, and other surface waters where eutrophication problems may exist, nitrogen, phosphorus, carbon, and contributing trace elements discharges will be limited as appropriate by the cabinet."

Nutrient control is obviously not a problem unique to Chenoweth Run, but has a national focus. Although algal blooms are nothing new, research into controlling the problem is relatively recent. Solutions found from this effort will ultimately address this aspect of stream degradation.

WATER QUALITY IN CHENOWETH RUN IN 1995

The primary focus of data collection in 1995 was on phosphorus concentrations in Chenoweth Run and the source(s) of this phosphorus. Median total phosphorus concentrations in 1995 were found to be 0.04 mg/L above the J-town WWTP, 2.5 mg/L in the plant effluent, 1.4 mg/L a short distance downstream, and concentrations remained elevated throughout Chenoweth Run to its confluence with Floyds Fork (Table 3, Figure 2). The value commonly recommended by the EPA for flowing streams is 0.1 mg/L (EPA, 1986), but as previously discussed, there is no stream standard for phosphorus. A further analysis of these data (Figure 3) shows that the J-town WWTP has the greatest impact on phosphorus concentrations in Chenoweth Run during low to normal streamflow. During high streamflow events, the plant has little impact on concentrations in the stream. During storms, the nonpoint source contribution is much more significant, and concentrations are essentially the same (about 0.3 mg/L) above the plant as below. The most likely source during storm runoff is from fertilizers used on lawns, both for homes and in the industrial park. Most of the industries have well-maintained "lawns" around buildings and parking lots. During normal summertime conditions when algal blooms are prevalent, the primary source of the phosphorus is the J-town WWTP.

Perhaps the most interesting facet of the 1995 study is that the thick algal blooms that have been observed in previous summers

Table 3. Water Quality Data in Chenoweth Run in 1995

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Stream Flow (cubic feet per second)					
Above Treatment Plant	16	0.13	0.26	0.81	2.41	15.70	155.87	293.00
Treatment Plant Effluent *	12	3.47	3.48	3.58	3.95	4.81	7.53	7.55
At Taylorsville Road	15	4.02	4.16	5.05	10.20	29.60	140.26	211.00
At Easum Road	15	3.58	4.22	6.11	11.10	40.90	171.60	252.00
At Seatonville Road	15	1.81	2.58	5.65	14.90	53.70	217.60	331.00
			Dissolved Oxygen (mg/L)					
Above Treatment Plant	19	6.0	7.2	7.7	9.1	12.3	13.8	14.2
Treatment Plant Effluent	15	4.0	5.0	7.1	8.0	8.5	9.6	9.9
At Taylorsville Road	18	7.4	7.8	8.4	10.4	12.4	14.1	14.2
At Easum Road	14	7.7	7.8	9.6	12.5	14.5	18.5	20.0
At Seatonville Road	16	8.2	8.6	10.0	12.4	15.3	18.9	23.9
			pH (standard units)					
Above Treatment Plant	19	6.2	6.3	6.6	7.6	7.9	8.1	8.2
Treatment Plant Effluent	16	6.5	6.6	6.8	7.4	7.7	8.7	8.8
At Taylorsville Road	19	6.6	6.8	7.0	7.4	7.8	8.2	9.2
At Easum Road	15	6.5	6.9	7.4	7.9	8.6	8.8	8.8
At Seatonville Road	19	6.6	7.1	7.4	8.2	8.7	9.1	10.6
			BOD (mg/L)					
Above Treatment Plant	17	1.	1.	1.	2.	4.	4.	5.
Treatment Plant Effluent	16	1.	2.	2.	3.	8.	10.	10.
At Taylorsville Road	17	1.	1.	2.	2.	5.	5.	5.
At Easum Road	15	1.	1.	1.	2.	4.	5.	6.
At Seatonville Road	17	1.	1.	1.	2.	4.	6.	8.
			Total Phosphorus (mg/L)					
Above Treatment Plant	15	0.01	0.02	0.02	0.04	0.12	0.35	0.36
Treatment Plant Effluent	12	0.86	0.99	1.50	2.50	3.33	3.97	4.00
At Taylorsville Road	15	0.34	0.35	0.68	1.40	2.90	3.27	3.53
At Easum Road	12	0.31	0.32	0.43	0.63	2.15	2.61	2.70
At Seatonville Road	17	0.14	0.24	0.32	0.75	1.55	2.34	2.92

* During high streamflow events, plant flow was not measured.

Table 3. Water Quality Data in Chenoweth Run in 1995 (cont.)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Water Temperature (degrees C)								
Above Treatment Plant	19	1.0	3.5	5.0	14.6	21.0	21.5	22.0
Treatment Plant Effluent	15	5.0	7.1	11.5	17.2	22.5	24.9	25.5
At Taylorsville Road	18	5.0	5.9	8.0	16.8	23.4	25.4	25.5
At Easum Road	15	3.0	3.0	4.0	16.0	23.0	24.9	25.5
At Seatonville Road	19	0.5	2.5	5.0	19.0	23.7	25.5	26.0
Total Suspended Solids (mg/L)								
Above Treatment Plant	19	1.	2.	5.	9.	36.	146.	440.
Treatment Plant Effluent	16	1.	1.	3.	7.	9.	14.	18.
At Taylorsville Road	19	1.	2.	5.	6.	18.	196.	234.
At Easum Road	15	1.	2.	4.	6.	53.	153.	230.
At Seatonville Road	19	1.	2.	3.	6.	26.	118.	124.
Ammonia nitrogen (mg/L as N)								
Above Treatment Plant	19	0.02	0.02	0.04	0.05	0.07	0.20	0.24
Treatment Plant Effluent	16	0.03	0.03	0.06	0.19	0.84	1.49	1.70
At Taylorsville Road	19	0.02	0.02	0.05	0.11	0.39	0.80	0.82
At Easum Road	15	0.01	0.02	0.04	0.10	0.26	0.57	0.60
At Seatonville Road	19	0.01	0.03	0.05	0.08	0.12	0.64	0.69
Nitrite plus Nitrate Nitrogen (mg/L as N)								
Above Treatment Plant	18	0.26	0.44	0.65	1.13	1.32	1.70	1.70
Treatment Plant Effluent	15	0.88	1.19	4.60	9.60	13.00	18.94	19.00
At Taylorsville Road	18	1.20	1.74	3.70	5.60	11.05	12.30	15.00
At Easum Road	15	1.10	1.40	2.80	3.50	6.70	11.60	14.00
At Seatonville Road	18	0.94	1.35	2.17	4.00	7.63	10.16	13.00

Figure 2. Total Phosphorus in Chenoweth Run in 1995

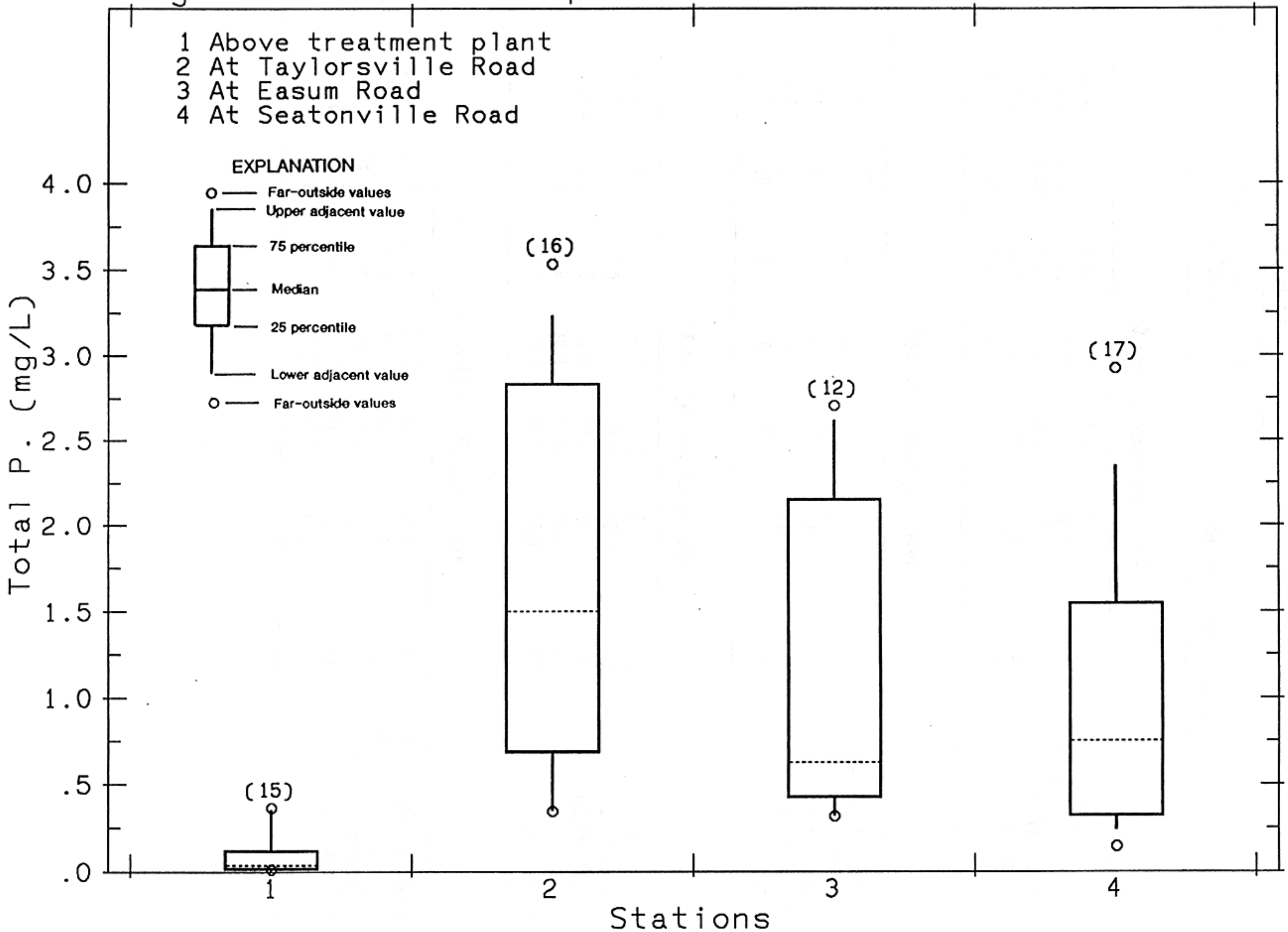
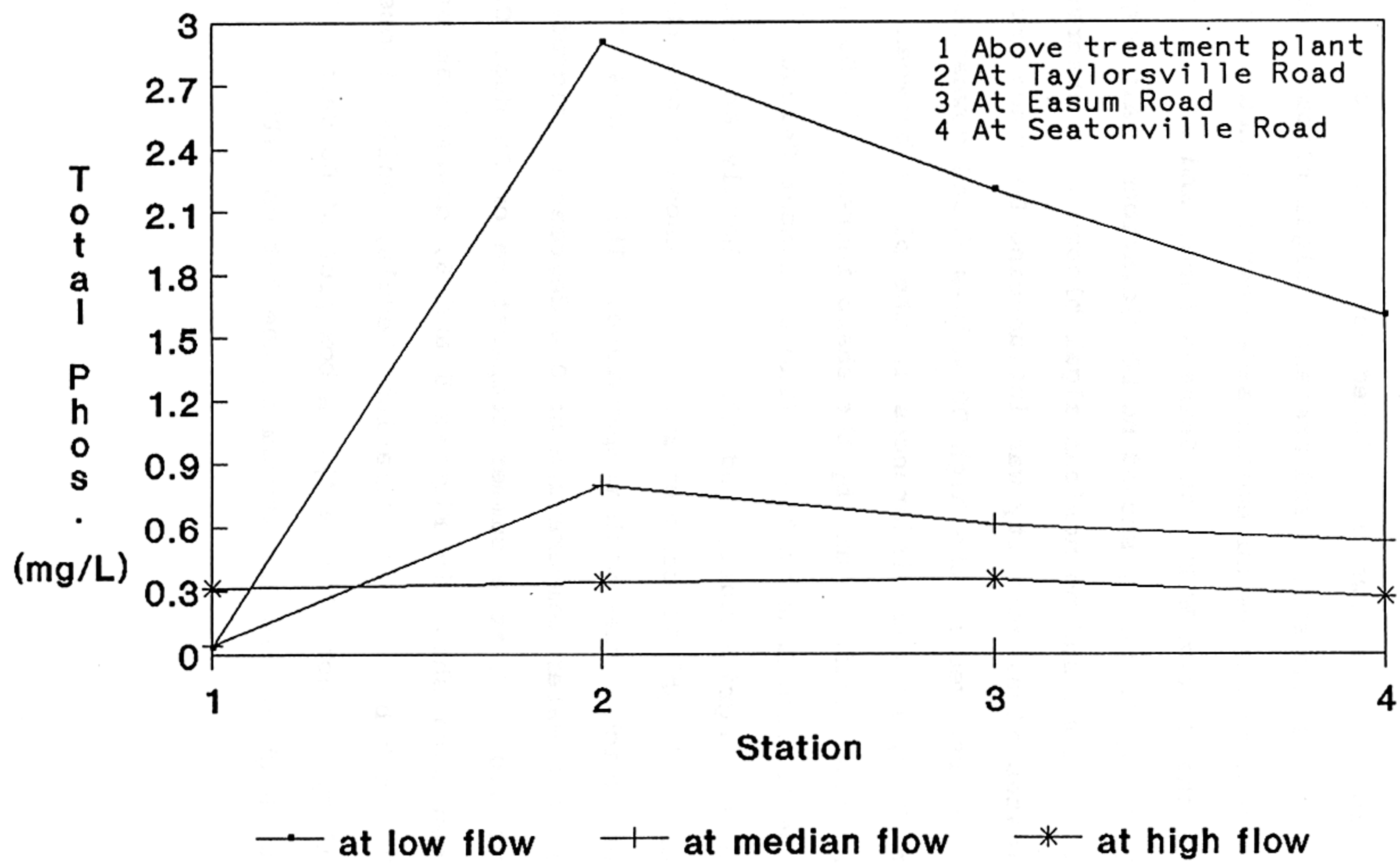


Figure 3. Total Phosphorus in Chenoweth Run During Different Streamflow Conditions



did not occur, and there were no dissolved oxygen (DO) violations measured in Chenoweth Run. Intense storms, especially in May, and the high streamflows associated with these storms, scoured the algae out of the stream and prevented algal blooms from occurring. Dissolved oxygen measurements made over a 24-hour period at sites above the J-town WWTP, at Gelhaus Lane, and at Seatonville Road (Figures 4, 5, and 6) showed no DO violations. Although there were no violations and no noxious algal blooms were observed, the data indicates algal activity was influencing DO concentrations. This can be observed by the high DO values found downstream of the J-town WWTP, by the differences in the plots between upstream and downstream stations, and by the sharp increase in Do after sunrise at the Gelhaus Lane station. (The area near Gelhaus Lane has been used f or agriculture, and there is hardly any remaining tree cover.) "High" DO concentrations are those above the saturation point, which varies with temperature. This ranges from about 14.6 mg/L at a water temperature of 0.0 degrees centigrade (deg. C) to about 8.0 mg/L at a summer temperature of 25 deg. C. Dissolved oxygen data shown in Figures 5 and 6, downstream of the J-town WWTP, exhibit supersaturation levels, while those above the facility did not (Figure 4). A box plot of DO data (Figure 7) also shows high levels downstream of the J-town WWTP.

Figure 4: Dissolved Oxygen above the J-town WWTP

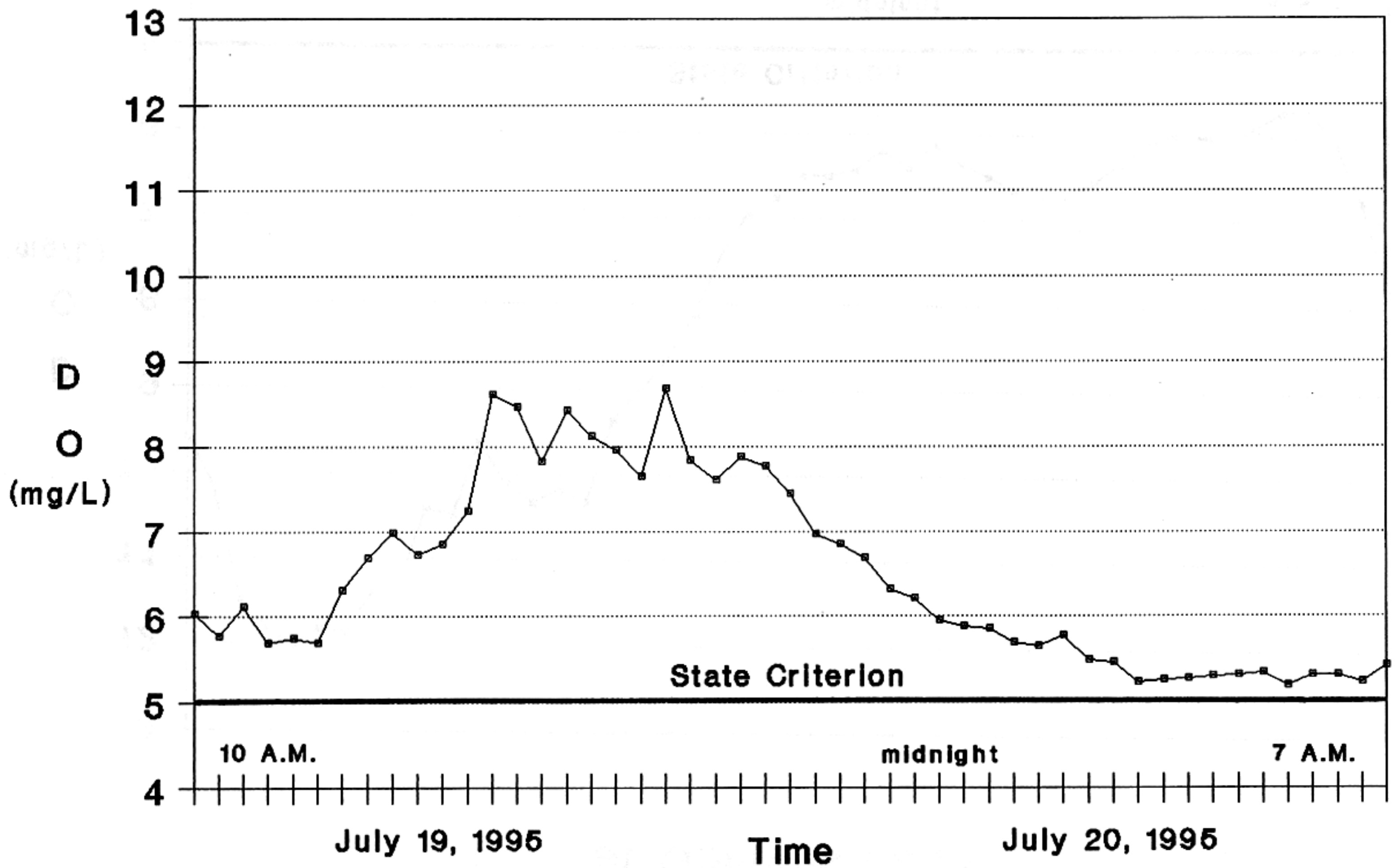


Figure 5: Dissolved Oxygen at Gelhaus Lane

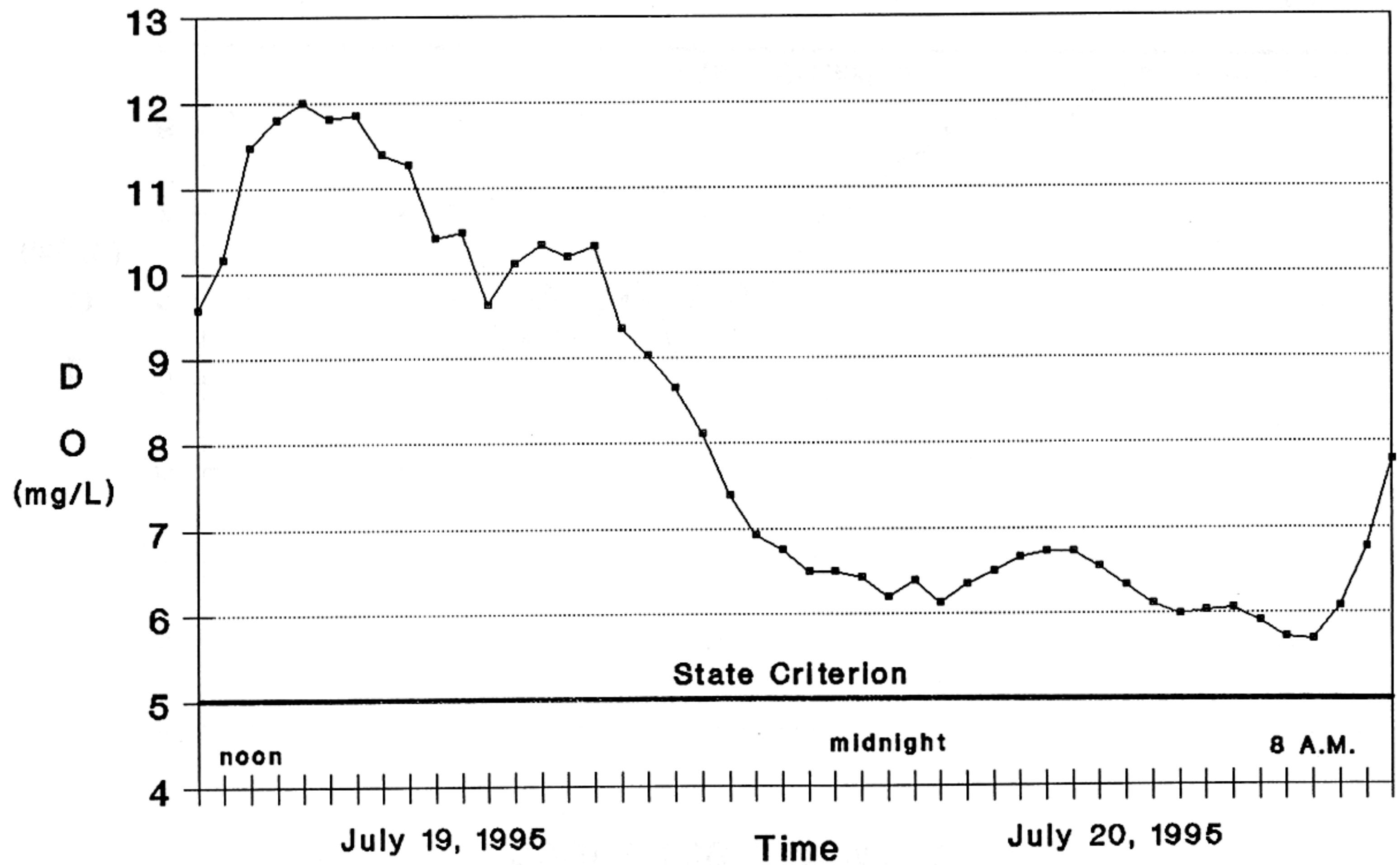


Figure 6: Dissolved Oxygen at Seatonville Road

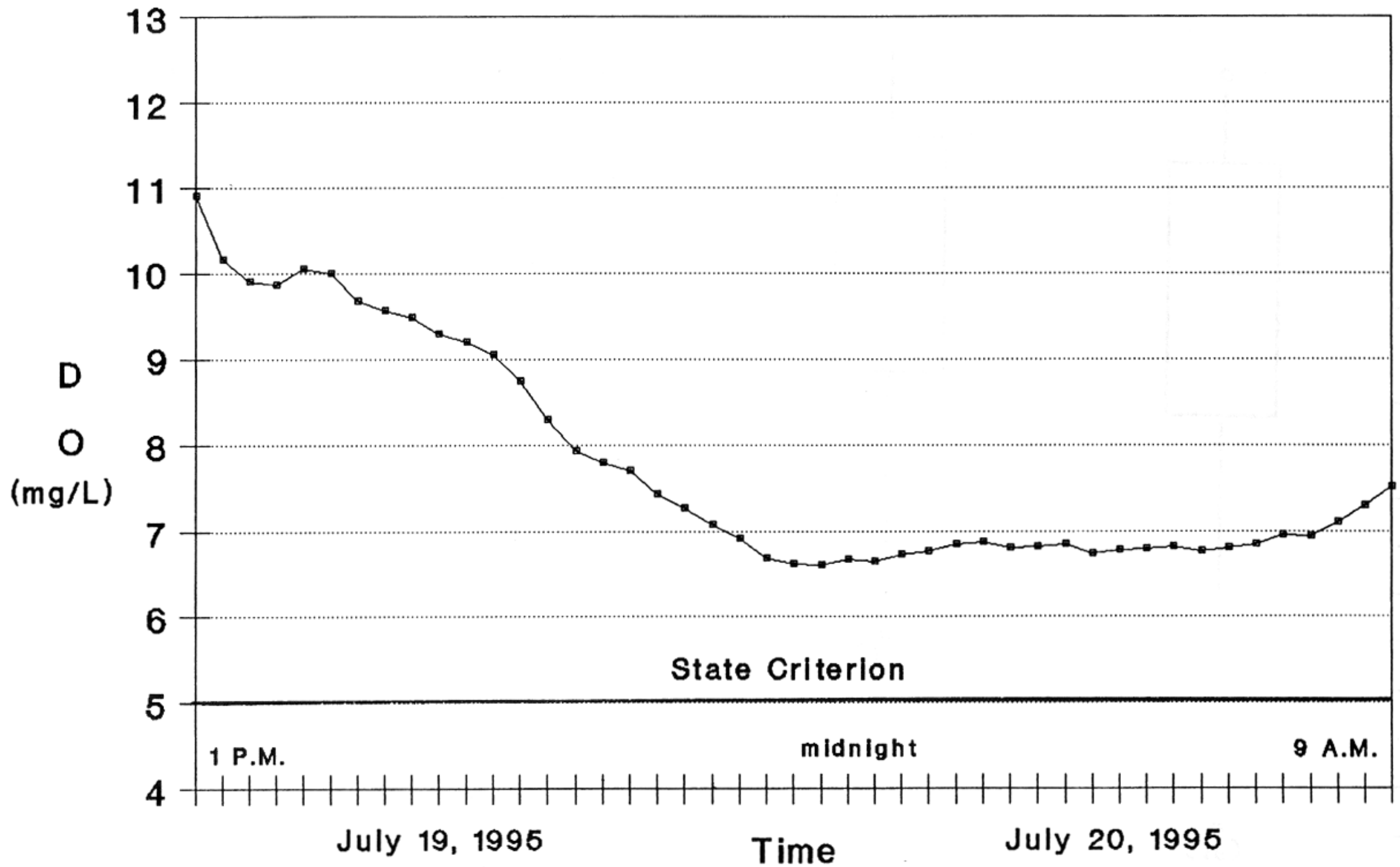
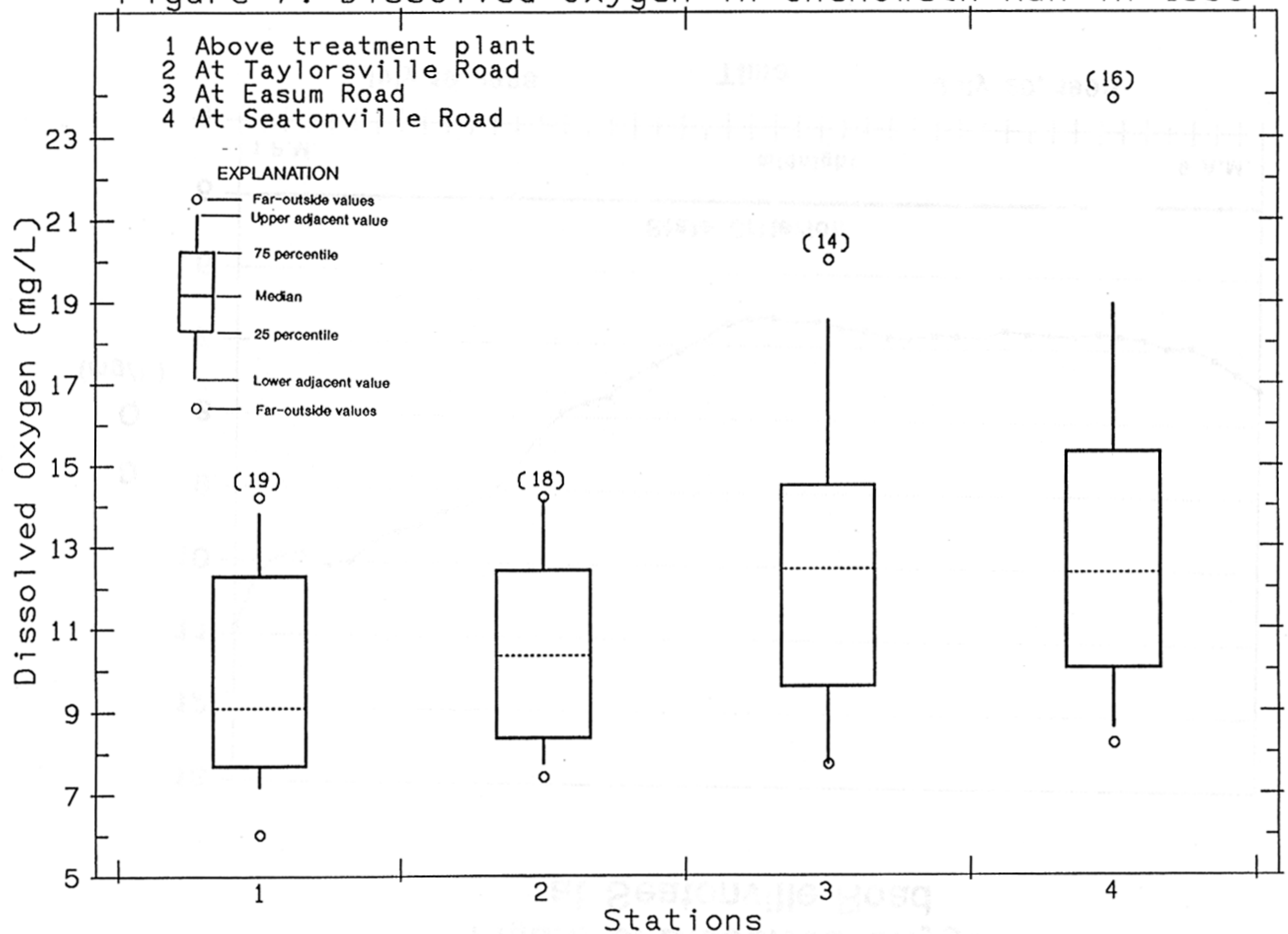


Figure 7. Dissolved Oxygen in Chenoweth Run in 1995



Algal activity also affects the pH of a stream. The pH will increase as algae increase their photosynthetic activity and uptake of carbon dioxide during daylight hours and decrease at night when algae are releasing carbon dioxide in respiration (Palmer, 1959). Over a 24-hour period on July 19 and 20, pH ranged from 8.0 to 8.4 units at the station above the J-town WWTP, 7.8 to 9.5 units at the Gelhaus Lane station, and 8.1 to 9.1 units at the Seatonville Road station. The highest values occurred in late af ternoon and the lowest values at night. This again indicates significant algal activity below the J-town WWTP. A box plot of pH data also indicates elevated levels downstream of the facility (Figure 8). The pH of a stream is important because of its relationship to ammonia toxicity. At high summer temperatures and high pH (considered greater than about 8.5 units), ammonia becomes toxic to aquatic life, even at the relatively low ammonia concentrations found in Chenoweth Run. This again points to the importance of nutrient control to reduce algal biomass and subsequent water quality problems.

The J-town WWTP is consistently in compliance with BOD, ammonia, and total suspended solids (TSS) permit limits. The effluent does not negatively impact Chenoweth Run for these parameters (Table 3, Figures 9, 10, and 11). BOD and ammonia are fairly low throughout the stream. Total suspended solids, however, are high after storm events, with the maximum value of 440 mg/L measured above the treatment plant. This is likely caused by quick

Figure 8. pH in Chenoweth Run in 1995

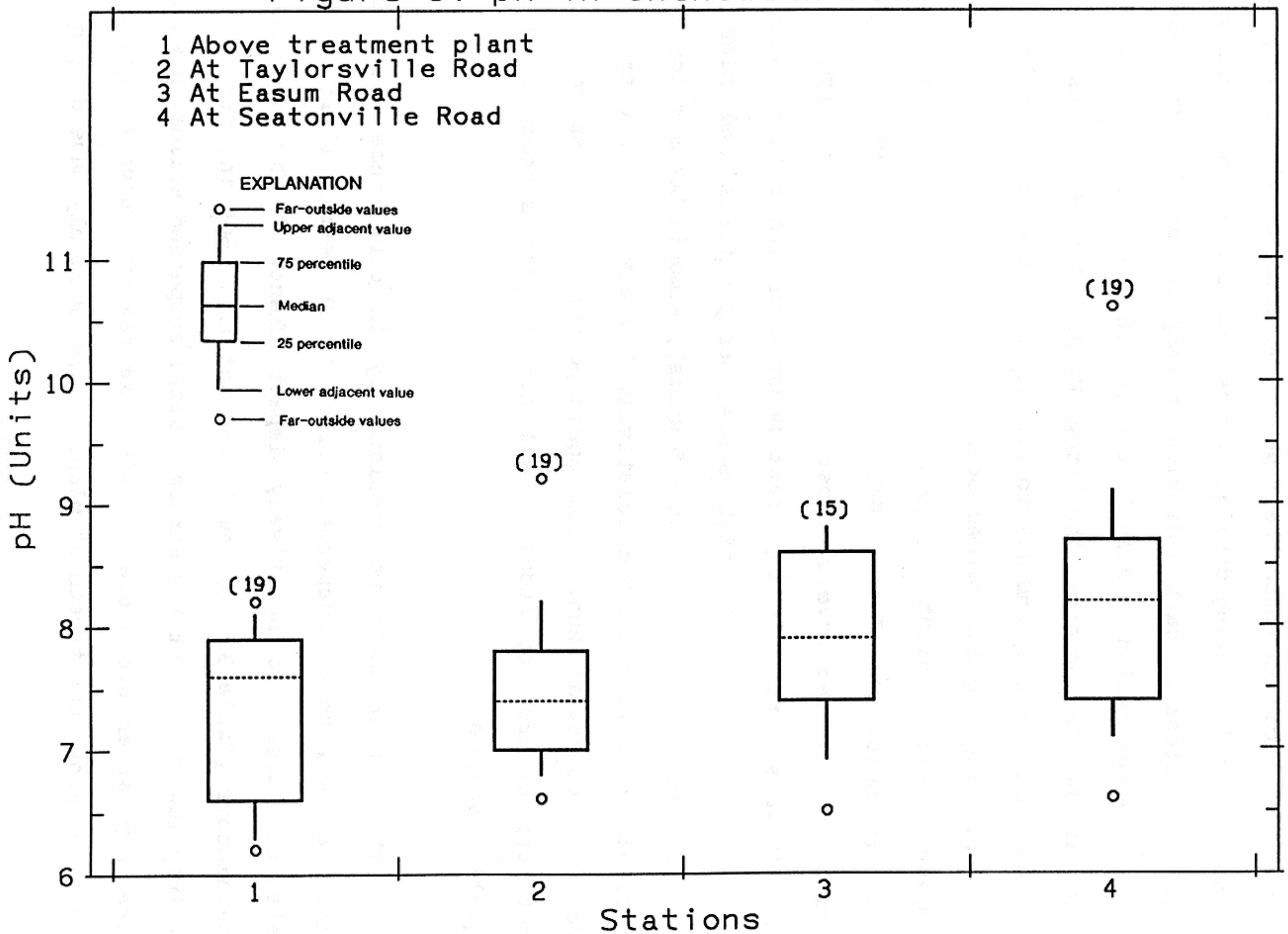
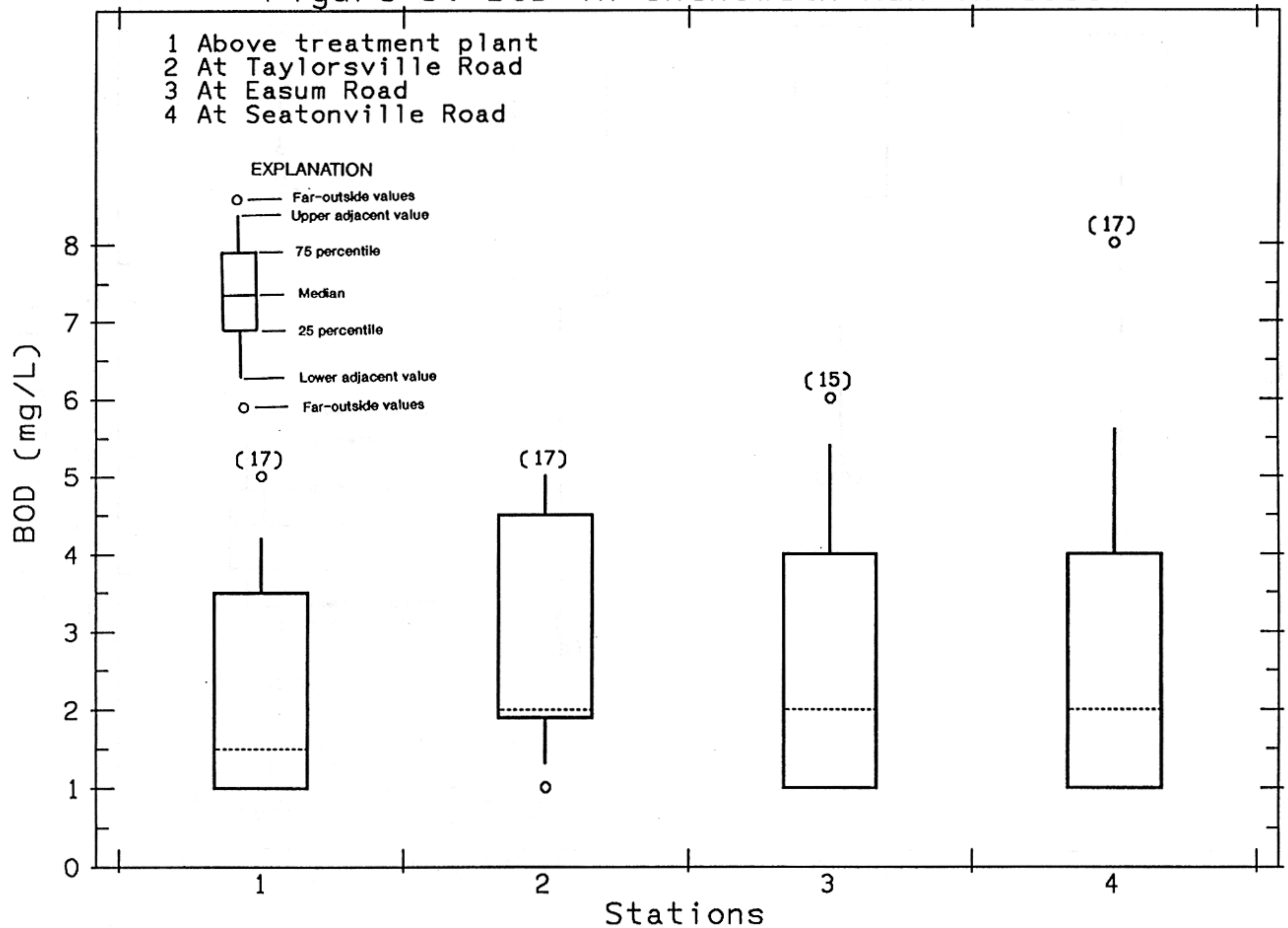


Figure 9. BOD in Chenoweth Run in 1995



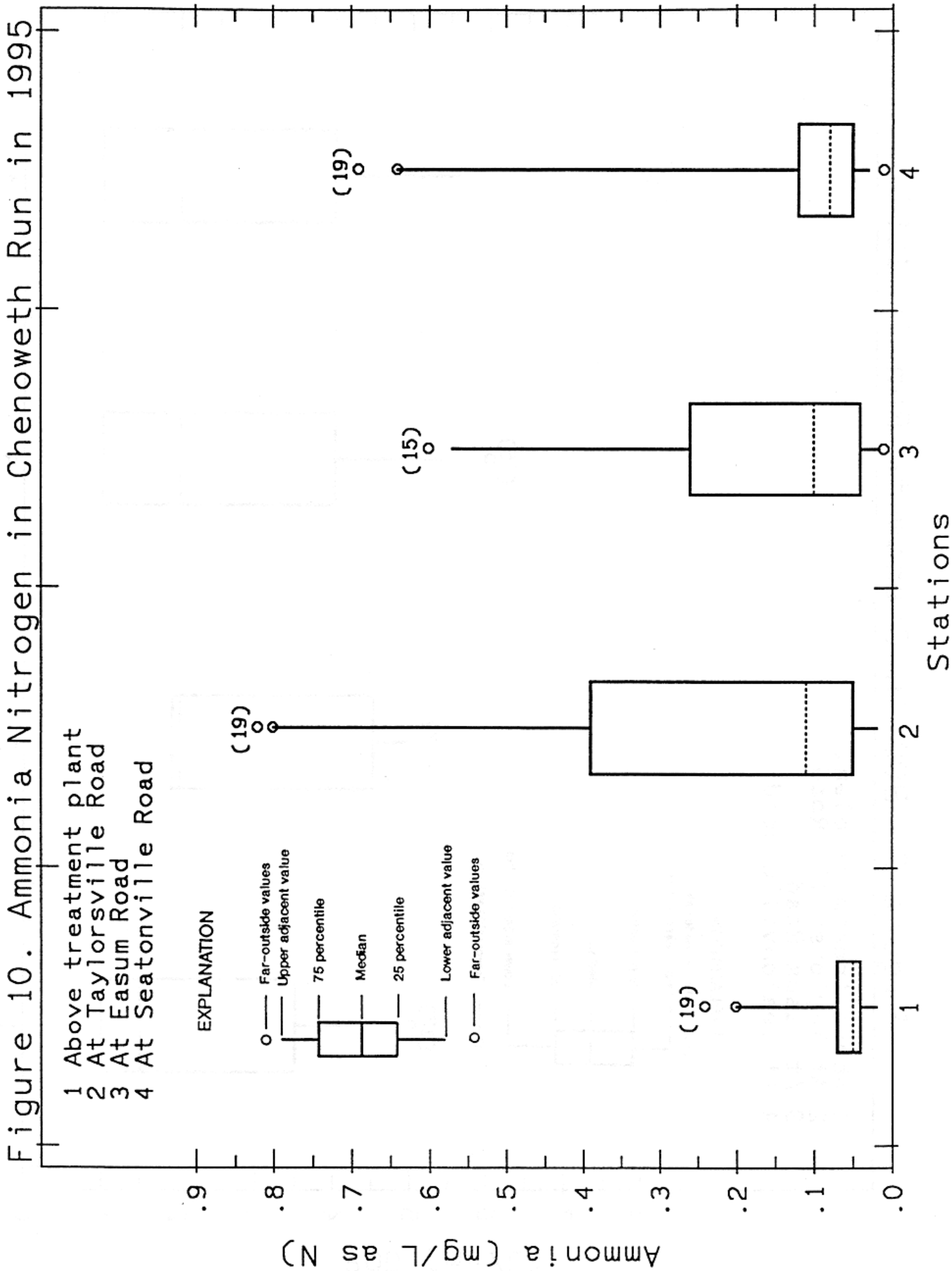
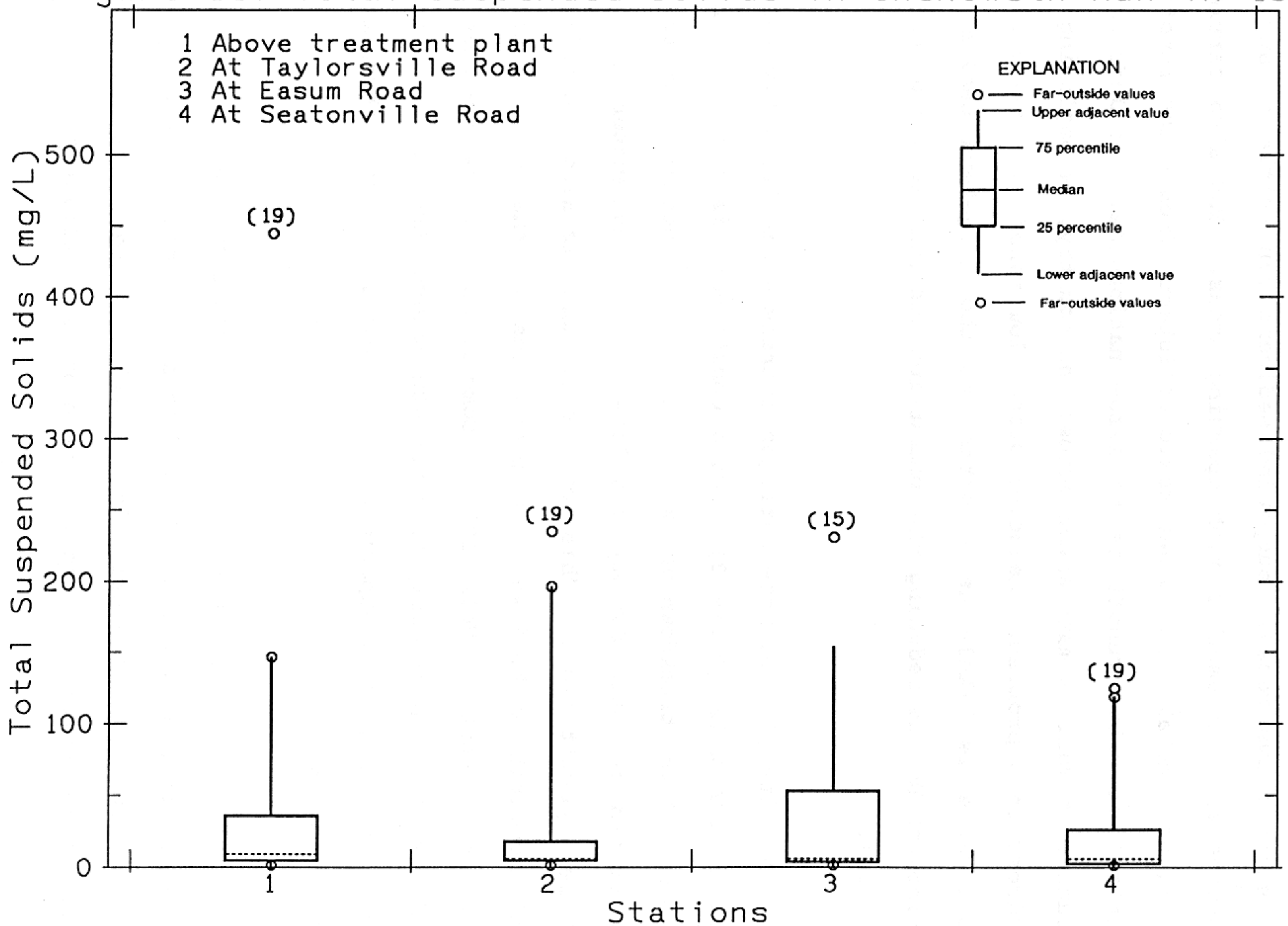


Figure 10. Ammonia Nitrogen in Chenoweth Run in 1995

Figure 11. Total Suspended Solids in Chenoweth Run in 1995



storm load runoff from urban, industrial, and construction sites. As storm flows recede, suspended sediment can settle to stream bottoms and can smother fish spawning areas. TSS also carries nutrients, metals, and other toxic pollutants from urban runoff. Control of urban runoff is an issue nationwide, and Jefferson County, as well as many areas across the country, is beginning to address this problem. Reducing storm-flow runoff and associated pollutants is likely as important to the long-term health of Chanoweth Run as reducing the summertime nutrient load from point sources.

Nitrite plus nitrate nitrogen increases signif icantly below the J-town WWTP (Table 3). This constituent is a natural by-product of the breakdown of ammonia and is not uncommon. There is no stream standard for aquatic life for this parameter, nor is there a permit limit. This form of nitrogen is also a nutrient, but researchers believe that phosphorus is the most critical nutrient to control (Velz, 1970). Some forms of algae are able to utilize nitrogen directly from the atmosphere, thus a stream poor in nitrogen may still experience algal blooms if excess phosphorus is available.

Samples for metals were collected once during a low flow and once during a storm event. These data are presented in Appendix I. No violations of metal criteria were noted during the period of low flow at any stream station or treatment plant effluent. Iron and lead violated chronic stream criteria for these metals (1.0 mg/L and 0.008 mg/L at an average stream hardness of 200 mg/L, respectively) at the high-flow event at all stream stations but not in the effluent. It should be noted that chronic criteria are established to protect aquatic life from long-term exposure and may not be important from short-term exposure found in storm events. Iron also violated the acute criterion of 4 mg/L at all stream stations, but not in the effluent. Iron is associated with soil particles, and sediment-laden runoff is likely the source of high iron concentrations found in high stream flows. This again points out the need to better control urban storm water runoff.

PREVIOUS STUDIES

Other data have been collected previously in Chenoweth Run, and a number of reports have been written. These are listed in the References. Most of these studies did not focus on Chenoweth Run, but include samples f rom Chenoweth Run as part of the overall projects. The KDOW published a study of Floyds Fork in 1986 and included samples from Chenoweth Run at Seatonville Road. MSD, in cooperation with the USGS, began sampling stream sites across Jefferson County in 1988 and continues to sample these today. The MSD station on Chenoweth Run is at Gelhaus Lane.

The 1986 KDOW study found significant nutrient enrichment problems in Chenoweth Run and in Floyds Fork below Chenoweth Run. "The aquatic biota has been adversely impacted in Chenoweth Run and in areas downstream from its conf luence with main stem Floyds Fork" (KDOW 1986). It was noted that Chenoweth Run had dense growths of algae, and tree cover to provide shade was limited. This was stated to contribute to algal growth. Dissolved oxygen was measured as greater than 20 mg/L, and pH was 9.2. Total phosphorus was 1. 44 mg/L. These samples were collected from a one-time sampling trip during low-flow, summertime conditions.

MSD has published reports on overall stream quality throughout Jefferson County for data collected in 1989, 1990, 1991/1992 (three reports), plus a report of data collected in Chenoweth Run from 1991 to 1994. Water quality problems abound in urban areas, and

Jefferson County is no exception. "As streams are relocated (for development) and vegetation is removed, the surrounding terrain loses its ability to hold water, and there is increased runoff and erosion. This results in rapidly fluctuating levels of flow in the streams and usually results in increased amounts of silting, increased numbers of coliforms (bacteria), increased oxygen demand, and other factors that contribute to the general deterioration of water quality in the streams" (MSD 1991).

MSD reported that fecal coliform bacteria violate the primary contact recreation criteria at every sampling station in the county. Nutrient concentrations are elevated in most streams, and metals criteria are violated occasionally at numerous stations. Nuisance algal growths are common in many of the streams in Jefferson County. Biotic Index Values, a measure of the biological integrity of streams, show moderate to severe impact throughout the county. Chenoweth Run at Gelhaus Lane has had violations of copper, mercury, cadmium, lead, zinc, and fecal coliform bacteria with a biotic index value that shows a severe level of impact. Sampling for cyanide, pesticides, and herbicides also has found occasional violations of stream criteria. MSD reported for Chenoweth Run that "extremely abundant growths of filamentous algae develop during warmer periods" (MSD 1996). These problems are considered to be from both point and nonpoint sources.

MSD has undertaken a number of programs to alleviate stream problems in Jefferson County. These include 'storm water permitting programs, point and non-point pollution sources, CSO (combined sewer overflow) impact reduction studies, flow fluctuation abatement programs, flood hydrograph studies, dissolved oxygen model development, development of watershed simulation models, continued construction of a county-wide system of sewers and elimination of small package plants. The impacts of these and other programs will continue to be monitored to assess their eventual impact on stream quality with on-going recovery studies (designed to assess the impacts of MSD management decisions and capital projects) and a continuation of the water quality monitoring program" (MSD 1994).

In an effort to assess the impact that Chenoweth Run may be having on Floyds Fork, a summary of previously published data is presented in Table 4. Of the parameters examined, it appears that phosphorus contribution from Chenoweth Run is having the most impact on Floyds Fork. The median total phosphorus concentration in Floyds Fork at Taylorsville Road, near Fisherville at mile 32.7, was 0.17 mg/L from 86 measurements collected from 1988 to 1992. Chenoweth Run flows into Floyds Fork at mile 24.2. The median phosphorus concentration in Chenoweth Run at Gelhaus Lane during this period was 1.6 mg/L. The median phosphorus concentration in Floyds Fork at Bardstown Road, downstream of Chenoweth Run and at mile 18.7, was 0.35 mg/L. Figure 12 shows total phosphorus

Table 4. Data in Floyds Fork and Chenoweth Run from 1988 to 1992

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Total Suspended Solids (mg/L)					
Floyds Fk at Taylorsville Rd	91	2.	4.2	8.0	16	30	102	1640
Chen. Run at Gelhaus Lane	89	0.7	2.0	5.0	8.0	16	48	502
Floyds Fk at Bardstown Rd	90	<1.	3.1	7.0	15	27	106	302
			Dissolved Oxygen (mg/L)					
Floyds Fk at Taylorsville Rd	95	3.0	6.2	7.5	8.9	12	13	16
Chen. Run at Gelhaus Lane	94	6.6	7.8	9.0	11	13	14	17
Floyds Fk at Bardstown Rd	95	4.2	5.8	7.5	9.0	12	13	16
			pH (standard units) **					
Floyds Fk at Taylorsville Rd	74	6.6	7.6	7.7	7.9	8.2	8.4	9.0
Chen. Run at Gelhaus Lane	74	6.2	7.5	7.7	7.9	8.1	8.6	9.3
Floyds Fk at Bardstown Rd	75	6.9	7.6	7.7	7.9	8.1	8.2	8.6
			BOD (mg/L)					
Floyds Fk at Taylorsville Rd	91	<2.0	(1.1)	2.0	2.0	6.2	9.0	14
Chen. Run at Gelhaus Lane	90	<2.0	(1.2)	2.0	3.0	6.6	13	23
Floyds Fk at Bardstown Rd	90	<2.0	(1.0)	1.6	2.2	4.3	9.3	14
			Total Phosphorus (mg/L)					
Floyds Fk at Taylorsville Rd	86	0.03	0.07	0.11	0.17	0.28	0.48	1.5
Chen. Run at Gelhaus Lane	86	0.15	0.34	0.80	1.6	2.6	3.5	12
Floyds Fk at Bardstown Rd	86	0.05	0.13	0.23	0.35	0.79	1.3	5.8

* Data taken from USGS Water Resources Investigations Report 94-4065, 1988 to 1992

** Data taken from USGS Water Resources Investigations Report 92-4150, 1988 to 1991

( ) Value estimated by USGS log-normal fit program

Table 4. Data in Floyds Fork and Chenoweth Run from 1988 to 1992 (cont) *

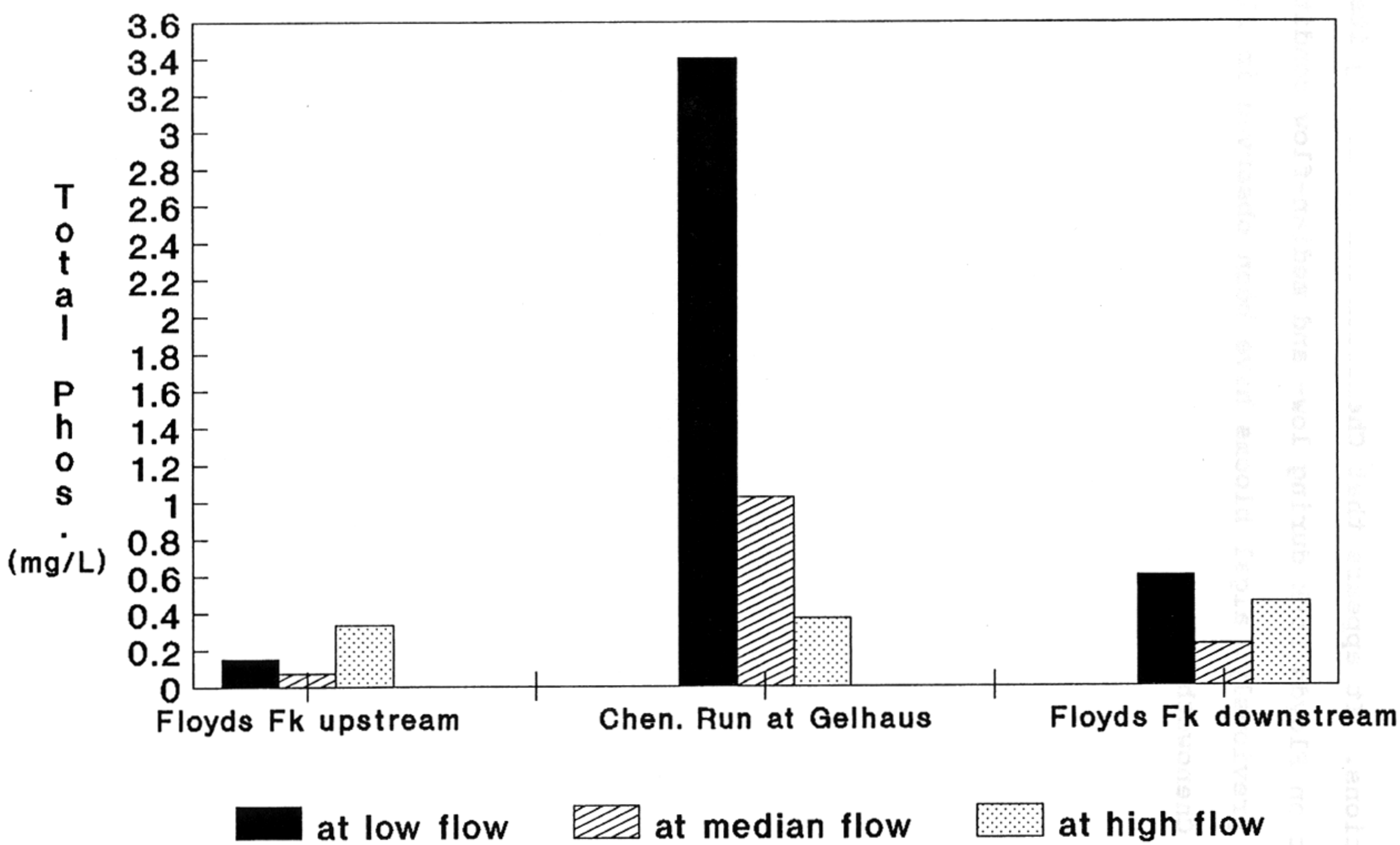
Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Water Temperature (degrees C) **					
Floyds Fk at Taylorsville Rd	74	0.7	3.5	8.1	14	22	27	30
Chen. Run at Gelhaus Lane	73	0.0	4.9	8.0	15	21	25	32
Floyds Fk at Bardstown Rd	75	0.3	3.7	7.8	16	23	27	30
			Ammonia Nitrogen (mg/L as N)					
Floyds Fk at Taylorsville Rd	91	<.01	(<.01)	(<.01)	0.04	0.09	0.37	6.6
Chen. Run at Gelhaus Lane	88	<.01	(<.01)	(0.01)	0.09	0.36	0.76	6.8
Floyds Fk at Bardstown Rd	90	<.01	(<.01)	(0.01)	0.06	0.11	0.35	2.3
			Nitrate Nitrogen (mg/L as N)					
Floyds Fk at Taylorsville Rd	90	<.10	0.27	0.49	0.91	1.8	3.2	9.6
Chen. Run at Gelhaus Lane	89	0.14	1.3	2.1	3.7	5.7	11	21
Floyds Fk at Bardstown Rd	90	<.10	0.33	0.82	1.3	1.8	3.2	9.1

* Data taken from USGS Water Resources Investigations Report 94-4065, 1988 to 1992

** Data taken from USGS Water Resources Investigations Report 92-4150, 1988 to 1991

( ) Value estimated by USGS log-normal fit program

Figure 12. Total Phosphorus
Chenoweth Run & Floyds Fk, 1988 to 1992



concentrations at these locations during different hydrologic conditions. It appears that Chenoweth Run is having its greatest impact on Floyds Fork during low- and median-flow conditions. As noted previously, algal blooms have been observed in Floyds Fork below Chenoweth Run.

CONCLUSIONS AND RECOMMENDATIONS

Data collected for this study and previous studies show a variety of water quality problems in Chenoweth Run. During low to moderate flows, it appears that high phosphorus concentrations are severely impacting both Chenoweth Run and Floyds Fork downstream of Chenoweth Run. The primary source of this phosphorus is the J-town WWTP. At higher flow conditions, runoff from urban, industrial, and construction areas increases sediment concentrations, contributes to metal criteria violations, and adds nutrients and other chemicals.

Three measures are needed to achieve solutions to these problems: 1) phosphorus reduction at the J-town WWTP; 2) creation of riparian zones and tree planting to provide shade; 3) and storm water runoff controls. The specific amount of phosphorus reduction needed from the J-town WWTP cannot be discerned from existing data. MSD, in cooperation with the USGS, is undertaking a modeling study of Chenoweth Run that is expected to provide a more detailed answer to this question. (The study plan is attached as Appendix II.) If results of this study are not available at the next permit issuance (June 2000), or are inconclusive, the KDOW will require a 1 mg/L phosphorus limit for this facility. In the absence of stream criteria, 1 mg/L is the phosphorus value being applied on other Kentucky facilities discharging to flowing streams with documented nutrient problems. A more strict limit may also be applied in the future if nationwide research establishes specific stream criteria.

Follow-up monitoring of Chenoweth Run by the KDOW, or possibly MSD and the USGS, will be used to determine the effectiveness of this limit and other control measures. If algal blooms and associated water quality problems persist, further watershed control measures or additional phosphorus reduction may be necessary.

The KDOW believes that Chenoweth Run and all urban streams have the potential to fully meet state water quality criteria. The task will not be easy or inexpensive and will require the cooperation of both public and private entities. Regulatory controls at the end-of-pipe will not likely be successful without reductions in the use of lawn-care chemicals, effective sediment control structures in areas of construction, riparian zone creation and restoration, and effective storm water management.

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APPENDIX I: METALS DATA IN 1995

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

July 19, 1995

Division of Environmental Services
Report Number: A02-15514
Sample Number: 9501616

To: Division of Water
Frankfort Office Park
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: Sam Lester

County: Jefferson

Facility:

Collected by: Dave Leist — **Date:** 05/17/95 **Time:** 0910

Delivered by: Dave Leist — **Date:** 05/19/95 **Time:** 1500

Received by: Polly Baker — **Date:** 05/19/95 **Time:** 1500

Sample Matrix: Water

Collection Method: Grab

Sample Identification: Chenoweth Run at Watterson Trail

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Arsenic	0.005 mg/L
Barium	0.078 mg/L
Cadmium	ND @ 0.001 mg/L
Chromium	0.007 mg/L
Copper	0.009 mg/L
Iron	10.3 mg/L
Lead	0.023 mg/L
Manganese	0.760 mg/L
Mercury	ND @ 0.0001 mg/L
Nickel	0.022 mg/L
Selenium	ND @ 0.002 mg/L
Silver	ND @ 0.001 mg/L
Zinc	0.050 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

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NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

July 19, 1995

Division of Environmental Services
Report Number: A02-15515
Sample Number: 9501617

To: Division of Water
Frankfort Office Park
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: Sam Lester

County: Jefferson

Facility:

Collected by: Dave Leist — **Date:** 05/17/95 **Time:** 1020

Delivered by: Dave Leist — **Date:** 05/19/95 **Time:** 1500

Received by: Polly Baker — **Date:** 05/19/95 **Time:** 1500

Sample Matrix: Water

Collection Method: Grab

Sample Identification: STP Old Taylorsville Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Arsenic	ND @ 0.002 mg/L
Barium	0.064 mg/L
Cadmium	ND @ 0.001 mg/L
Chromium	0.002 mg/L
Copper	0.008 mg/L
Iron	0.257 mg/L
Lead	0.003 mg/L
Manganese	0.070 mg/L
Mercury	ND @ 0.0001 mg/L
Nickel	0.012 mg/L
Selenium	ND @ 0.002 mg/L
Silver	ND @ 0.001 mg/L
Zinc	0.028 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

July 19, 1995

Division of Environmental Services
Report Number: A02-15516
Sample Number: 9501618

To: Division of Water
Frankfort Office Park
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: Sam Lester

County: Jefferson

Facility:

Collected by: Dave Leist — **Date:** 05/17/95 **Time:** 1205

Delivered by: Dave Leist — **Date:** 05/19/95 **Time:** 1500

Received by: Polly Baker — **Date:** 05/19/95 **Time:** 1500

Sample Matrix: Water

Collection Method: Grab

Sample Identification: Chenoweth Run at Taylorsville Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Arsenic	0.004 mg/L
Barium	0.070 mg/L
Cadmium	ND @ 0.001 mg/L
Chromium	0.005 mg/L
Copper	0.010 mg/L
Iron	9.39 mg/L
Lead	0.016 mg/L
Manganese	0.538 mg/L
Mercury	ND @ 0.0001 mg/L
Nickel	0.013 mg/L
Selenium	ND @ 0.002 mg/L
Silver	ND @ 0.001 mg/L
Zinc	0.038 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

July 19, 1995

Division of Environmental Services
Report Number: A02-15517
Sample Number: 9501619

To: Division of Water
Frankfort Office Park
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: Sam Lester

County: Jefferson

Facility:

Collected by: Dave Leist	**Date:** 05/17/95	**Time:** 1325
Delivered by: Dave Leist	**Date:** 05/19/95	**Time:** 1500
Received by: Polly Baker	**Date:** 05/19/95	**Time:** 1500

Sample Matrix: Water

Collection Method: Grab

Sample Identification: Chenoweth Run at Easum Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Arsenic	0.004 mg/L
Barium	0.059 mg/L
Cadmium	ND @ 0.001 mg/L
Chromium	0.005 mg/L
Copper	0.007 mg/L
Iron	6.94 mg/L
Lead	0.013 mg/L
Manganese	0.391 mg/L
Mercury	ND @ 0.0001 mg/L
Nickel	0.008 mg/L
Selenium	ND @ 0.002 mg/L
Silver	ND @ 0.001 mg/L
Zinc	0.029 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

Gleason L. Wheatley for
William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

July 19, 1995

Division of Environmental Services
Report Number: A02-15518
Sample Number: 9501620

To: Division of Water
Frankfort Office Park
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: Sam Lester

County: Jefferson

Facility:

Collected by: Dave Leist — **Date:** 05/17/95 **Time:** 1500

Delivered by: Dave Leist — **Date:** 05/19/95 **Time:** 1500

Received by: Polly Baker — **Date:** 05/19/95 **Time:** 1500

Sample Matrix: Water

Collection Method: Grab

Sample Identification: Chenoweth Run at Seatonville Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Arsenic	0.004 mg/L
Barium	0.042 mg/L
Cadmium	ND @ 0.001 mg/L
Chromium	0.004 mg/L
Copper	0.005 mg/L
Iron	5.18 mg/L
Lead	0.008 mg/L
Manganese	0.274 mg/L
Mercury	ND @ 0.0001 mg/L
Nickel	0.009 mg/L
Selenium	ND @ 0.002 mg/L
Silver	ND @ 0.001 mg/L
Zinc	0.019 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES

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Permit Review Branch

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NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

August 13, 1995

Division of Environmental Services
Report Number: A37-00005
Sample Number: 9502222

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: David Leist

County: Jefferson

Facility:

Collected by: David Leist — **Date:** 07/11/95 **Time:** 0840

Delivered by: Skip Call — **Date:** 07/12/95 **Time:** 0949

Received by: Polly Baker — **Date:** 07/12/95 **Time:** 0949

Sample Matrix: Water

Collection Method: Grab

Sample Identification: CR5 - Chenoweth Run at Waterson Trail

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Aluminum	0.131 mg/L
Antimony	ND @ 0.028 mg/L
Barium	0.079 mg/L
Beryllium	ND @ 0.001 mg/L
Cadmium	ND @ 0.006 mg/L
Calcium	74.5 mg/L
Chromium	ND @ 0.016 mg/L
Cobalt	ND @ 0.013 mg/L
Copper	ND @ 0.005 mg/L
Iron	0.249 mg/L
Magnesium	31.4 mg/L
Manganese	0.074 mg/L
Molybdenum	ND @ 0.009 mg/L
Nickel	ND @ 0.011 mg/L
Potassium	2.31 mg/L
Silver	ND @ 0.002 mg/L
Sodium	25.2 mg/L
Strontium	0.128 mg/L
Thallium	ND @ 0.048 mg/L
Tin	ND @ 0.015 mg/L
Vanadium	ND @ 0.004 mg/L
Zinc	0.010 mg/L
Arsenic	ND @ 0.002 mg/L
Mercury	ND @ 0.0001 mg/L

TOTAL CONSTITUENTS	**CONCENTRATION**
Selenium	ND @ 0.002 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis
William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
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DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

August 13, 1995

Division of Environmental Services
Report Number: A37-00004
Sample Number: 9502221

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: David Leist

County: Jefferson

Facility:

Collected by: David Leist — **Date:** 07/11/95 **Time:** 0940

Delivered by: Skip Call — **Date:** 07/12/95 **Time:** 0949

Received by: Polly Baker — **Date:** 07/12/95 **Time:** 0949

Sample Matrix: Water — **Collection Method:** Grab

Sample Identification: CR4 - Chenoweth Run at J-Town STP

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Aluminum	ND @ 0.056 mg/L
Antimony	ND @ 0.028 mg/L
Barium	0.026 mg/L
Beryllium	ND @ 0.001 mg/L
Cadmium	ND @ 0.006 mg/L
Calcium	49.7 mg/L
Chromium	ND @ 0.016 mg/L
Cobalt	ND @ 0.013 mg/L
Copper	0.017 mg/L
Iron	0.047 mg/L
Magnesium	17.5 mg/L
Manganese	0.008 mg/L
Molybdenum	0.011 mg/L
Nickel	ND @ 0.011 mg/L
Potassium	11.4 mg/L
Silver	ND @ 0.002 mg/L
Sodium	75.3 mg/L
Strontium	0.223 mg/L
Thallium	ND @ 0.048 mg/L
Tin	ND @ 0.015 mg/L
Vanadium	ND @ 0.004 mg/L
Zinc	0.063 mg/L
Arsenic	ND @ 0.002 mg/L
Mercury	ND @ 0.0001 mg/L

TOTAL CONSTITUENTS	**CONCENTRATION**
Selenium	ND @ 0.002 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

RECEIVED

AUG 2 2 1995

Permit Review Branch

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

August 13, 1995

Division of Environmental Services
Report Number: A37-00003
Sample Number: 9502220

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: David Leist

County: Jefferson

Facility:

Collected by: David Leist — **Date:** 07/11/95 **Time:** 1045

Delivered by: Skip Call — **Date:** 07/12/95 **Time:** 0949

Received by: Polly Baker — **Date:** 07/12/95 **Time:** 0949

Sample Matrix: Water

Collection Method: Grab

Sample Identification: CR3 - Chenoweth Run at Taylorsville Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Aluminum	0.088 mg/L
Antimony	ND @ 0.028 mg/L
Barium	0.035 mg/L
Beryllium	ND @ 0.001 mg/L
Cadmium	ND @ 0.006 mg/L
Calcium	52.5 mg/L
Chromium	ND @ 0.016 mg/L
Cobalt	ND @ 0.013 mg/L
Copper	0.015 mg/L
Iron	0.158 mg/L
Magnesium	19.5 mg/L
Manganese	0.025 mg/L
Molybdenum	0.013 mg/L
Nickel	ND @ 0.011 mg/L
Potassium	9.75 mg/L
Silver	ND @ 0.002 mg/L
Sodium	65.0 mg/L
Strontium	0.202 mg/L
Thallium	ND @ 0.048 mg/L
Tin	ND @ 0.015 mg/L
Vanadium	ND @ 0.004 mg/L
Zinc	0.056 mg/L
Arsenic	ND @ 0.002 mg/L
Mercury	ND @ 0.0001 mg/L

TOTAL CONSTITUENTS	**CONCENTRATION**
Selenium	ND @ 0.002 mg/L

ND = Not Detected

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William E. Davis

William E. Davis, Director
Division of Environmental Services

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DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

August 13, 1995

Division of Environmental Services
Report Number: A37-00002
Sample Number: 9502219

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: David Leist

County: Jefferson

Facility:

Collected by: David Leist — **Date:** 07/11/95 **Time:** 1135

Delivered by: Skip Call — **Date:** 07/12/95 **Time:** 0949

Received by: Polly Baker — **Date:** 07/12/95 **Time:** 0949

Sample Matrix: Water

Collection Method: Grab

Sample Identification: CR2 - Chenoweth Run at Easum Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Aluminum	0.075 mg/L
Antimony	ND @ 0.028 mg/L
Barium	0.047 mg/L
Beryllium	0.001 mg/L
Cadmium	ND @ 0.006 mg/L
Calcium	55.5 mg/L
Chromium	ND @ 0.016 mg/L
Cobalt	ND @ 0.013 mg/L
Copper	0.011 mg/L
Iron	0.128 mg/L
Magnesium	21.7 mg/L
Manganese	0.013 mg/L
Molybdenum	0.009 mg/L
Nickel	ND @ 0.011 mg/L
Potassium	8.02 mg/L
Silver	ND @ 0.002 mg/L
Sodium	55.7 mg/L
Strontium	0.196 mg/L
Thallium	ND @ 0.048 mg/L
Tin	ND @ 0.015 mg/L
Vanadium	ND @ 0.004 mg/L
Zinc	0.035 mg/L
Arsenic	ND @ 0.002 mg/L
Mercury	ND @ 0.0001 mg/L

TOTAL CONSTITUENTS	**CONCENTRATION**
Selenium	ND @ 0.002 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis, Director
Division of Environmental Services

PHILLIP J. SHEPHERD
SECRETARY

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GOVERNOR

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COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
100 SOWER BOULEVARD
SUITE 104
FRANKFORT, KY 40601

August 13, 1995

Division of Environmental Services
Report Number: A37-00001
Sample Number: 9502218

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Chenoweth Run

Attn: David Leist

County: Jefferson

Facility:

Collected by: David Leist — **Date:** 07/11/95 **Time:** 1225

Delivered by: Skip Call — **Date:** 07/12/95 **Time:** 0949

Received by: Polly Baker — **Date:** 07/12/95 **Time:** 0949

Sample Matrix: Water

Collection Method: Grab

Sample Identification: CR1 - Chenoweth Run at Seatonville Road

REPORT OF ANALYSIS

TOTAL CONSTITUENTS	CONCENTRATION
Aluminum	ND @ 0.056 mg/L
Antimony	ND @ 0.028 mg/L
Barium	0.043 mg/L
Beryllium	ND @ 0.001 mg/L
Cadmium	ND @ 0.006 mg/L
Calcium	58.2 mg/L
Chromium	ND @ 0.016 mg/L
Cobalt	ND @ 0.013 mg/L
Copper	0.008 mg/L
Iron	0.197 mg/L
Magnesium	23.6 mg/L
Manganese	0.027 mg/L
Molybdenum	ND @ 0.009 mg/L
Nickel	ND @ 0.011 mg/L
Potassium	9.70 mg/L
Silver	ND @ 0.002 mg/L
Sodium	50.4 mg/L
Strontium	0.194 mg/L
Thallium	ND @ 0.048 mg/L
Tin	ND @ 0.015 mg/L
Vanadium	ND @ 0.004 mg/L
Zinc	0.016 mg/L
Arsenic	ND @ 0.002 mg/L
Mercury	ND @ 0.0001 mg/L

TOTAL CONSTITUENTS	**CONCENTRATION**
Selenium	ND @ 0.002 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis
William E. Davis, Director
Division of Environmental Services

APPENDIX II. MSD/USGS CHENOWETH RUN PROJECT PROPOSAL

(re-printed with permission from MSD and the USGS)

PROJECT PROPOSAL

HYROLOGIC MODELING OF THE CHENOWETH RUN WATERSHED, JEFFERSON COUNTY, KENTUCKY

U.S. Geological Survey
Water Resources Division
Kentucky District

November 1995

INTRODUCTION

The Kentucky District of the U.S. Geological Survey (USGS), Water Resources Division is proposing cooperative development of a computerized watershed-simulation model that can be used for optimizing management decisions relating to water quality and quantity in the Chenoweth Run drainage basin in Jefferson County. The model-development process will require compilation and review of available data and collection of additional data where necessary. These data will be made readily available to other local, state, and federal agencies, as well as concerned citizens.

The data will be used to determine the dominant processes controlling water quality and quantity in the basin, ascertain the rate with which concentrations of key constituents change under different circumstances, and provide a mathematical simulation of these processes using computer-based algorithms. There have been hundreds of modeling applications for this purpose all over the world. These applications have been accomplished for watersheds as small as a few acres and as large as the Chesapeake Bay tributary area, approximately 62,000 square miles. The USGS, in cooperation with the Louisville and Jefferson County Metropolitan Sewer District (MSD), is currently developing such a model for similar purposes in the Beargrass Creek Basin of Jefferson County.

PROBLEM AND NEED

Changes associated with land-development activities, which are anticipated to increase in this basin in the future, can significantly alter the hydrologic character of a drainage basin. Transformation of open farmlands to housing complexes, golf courses, or commercial and/or industrial areas can adversely affect the quality and quantity of downstream water resources. In addition to Chenoweth Run, there are numerous ponds and small lakes in the basin that can be adversely affected by future development undertaken in the absence of sound land-use and water-management decisions.

Water-quality problems in the Chenoweth Run drainage basin have been reported by USGS (*Water Quality of Selected Streams in Jefferson County, Kentucky, 1988-91*, Evaldi and others; *Yields of Selected Constituents in Base Flow and Stormflow in Urban Watersheds of Jefferson County, Kentucky, 1988-92*, Evaldi and Moore), MSD (*MSD Stream Quality Monitoring Report with 1991/1992 Data*), and Kentucky Division of Water (KDOW). Sources of these problems may include wastewater-treatment plants, agriculture (including livestock), construction activities, stream-bank erosion, lawn care, golf courses, and storm runoff from urban and industrial areas. The KDOW (*Water Quality Study of Floyds Fork*, 1991) reported adverse effects on Chenoweth Run resulting from wastewater effluents. During certain periods of the year, wastewater discharges may dominate streamflow in Chenoweth Run resulting in nutrient-enrichment problems. In 1991, KDOW proposed a moratorium on additional wastewater-treatment facilities in the Chenoweth Run drainage basin. The *1994 Kentucky Report to Congress on Water Quality*

(KDOW) listed 9 miles of Chenoweth Run as not meeting either aquatic life or swimming uses because of organic enrichment, nutrients, metals, and pathogens discharged in urban runoff and wastewaters.

An improved understanding of the dominant processes controlling water quantity and quality in streams and impoundments in the Chenoweth Run Basin is needed. A hydrologic-modeling tool is needed for assessing the effectiveness of alternative water-resources-management strategies in the Basin.

OBJECTIVE

The objective of this study is to provide an improved understanding of the hydrology of the Chenoweth Run drainage basin by development and calibration of a comprehensive watershed model for continuous simulation of rainfall-runoff, infiltration and subsurface flow, evapotranspiration, channel hydrology, soil erosion, contaminant wash-off, constituent transport and transformation, and sedimentation and resuspension. The model will simulate processes linking land use to water quantity and quality so as to provide valuable information concerning streamflows and source/transport/fate relations for water-quality constituents. This objective requires: (1) calibration of a hydrologic model that will provide satisfactory prediction of streamflows ranging from base flows to flood flows at key locations in the basin and (2) development of a suitable mass balance budget (loadings) for constituents of interest in the Chenoweth Run Basin.

BENEFITS

This watershed modeling study will provide MSD an improved ability to make water-resources-management decisions and to develop long-term strategies for improving water quality in the basin. The study results and the calibrated model will be provided to MSD for future application in water-resources management in the Chenoweth Run basin. An improved understanding of and the ability to simulate the key processes controlling water quality and quantity will facilitate evaluation of the effects of various future land-development scenarios and alternative management options. The calibrated model can be used to assist in prioritizing problems in the Chenoweth Run drainage basin and assessing the relative effectiveness of Best Management Practice (BMP) or other options.

Application of a well-documented, tested, and scientifically based watershed model developed and calibrated by the USGS, which has no regulatory or resource-management authority, will provide an objective source of information available to all interested parties. The calibrated model can be used to test hypotheses concerning basin hydrologic behavior and water-quality conditions. For example, the model may be applied to quantitatively assess the following:

- The effects and contribution of point and nonpoint sources of contamination
- The effects of increased urbanization (with additional paving of pervious areas and clearing of riparian vegetation) on stream base flows and water temperatures, which are critical factors controlling the health of aquatic communities
- The timing and movement of flood flows from various subbasins of Chenoweth Run, which is important for determining the potential effectiveness of stormwater-detention facilities

This study will also provide additional information for regionalization of the model parameter set to the hydrology of Jefferson County and central Kentucky. This will improve MSD's capability to apply such hydrologic models in other basins in Jefferson County.

APPROACH

This study will be designed to define the relations between present-day land-use activity and water-quality and quantity characteristics. This will be accomplished by applying Geographic Information System (GIS) technology, hydrologic and environmental data collection and analysis, sound ecological theory, and computer modeling codes. Calibration of the continuous watershed model will provide an assessment of how well it simulates those relations.

The continuous watershed model, Hydrologic Simulation Program--Fortran (HSPF) (Bicknell and others, 1993), will be used in this study. This model provides a continuous accounting of soil moisture (antecedent) conditions and thus allows for continuous simulation of the complete flow regime from low to high flow. Some water-quality conditions may be critical during low flows, and the effects of point sources may be most evident during low-flow periods. Maximum constituent loadings, though not necessarily the highest concentrations, often occur during high-flow periods. Thus, continuous modeling of the full range of flow conditions is important for accurate representation of water-quality conditions. Rainfall-runoff simulations and simulation of erosion and wash-off processes provide the basis for nonpoint-source simulation in the basin. Routing of this water and material from the land surface and subsurface to collecting channels and surface streams allows accounting for the fate and transport of materials throughout the hydrologic regime of the basin.

Tasks for implementation of this modeling study are outlined below:

1. **Collect required hydrometeorological data including precipitation, streamflow, and water-quality characteristics.**

Existing hydrometeorological data will be reviewed and utilized to the maximum extent possible for this study. Continuous rainfall and discharge information was collected from 1991-95 at the USGS/MSD flood-hydrograph station on Chenoweth Run in Jeffersontown (stations 03298130 and 03298135). One site in the USGS/MSD stream-monitoring network is located at Chenoweth Run at Gelhaus Lane. Water-quality and streamflow information is being collected in 1995 at several locations in the basin for a KDOW study of the basin.

Field data-collection activities will be required to determine the quantity and physical, chemical, and bacteriological characteristics of streamflow in the basin. Data-collection activities will include discharge measurements, water-quality measurements, water-quality sampling, and gaging-station servicing. Water samples will be collected by use of manual, cross-sectionally integrated sampling techniques and by use of automatic samplers where appropriate. All field activities will be conducted using documented procedures and quality-assurance practices of the USGS.

The proposed continuous-record data-collection network includes stream gages with monitors for water temperature, specific conductance, pH, and dissolved oxygen at two locations (Chenoweth Run at Ruckriegel Parkway and Chenoweth Run at Gelhaus Lane) and at least one rain gage (at or near Chenoweth Run at Ruckriegel Parkway). Rainfall and streamflow will be determined at 5-minute intervals. Temperature, specific conductance, pH, and dissolved oxygen will be measured at 5- to 30-minute intervals.

Stream-water samples will be collected for laboratory analysis in an effort to characterize spatial, flow-related, and seasonal variability of water quality in the basin. Samples will be collected during low, moderate, and high flows. Emphasis will be placed on sampling moderate to high flows, because the greatest variability in stream-water-quality conditions (and consequently the greatest modeling uncertainty) occurs during high flows. Sampling will be conducted during a variety of storm events of differing duration, intensity, and antecedent conditions. Moderate- and high-flow events will be targeted for sampling during the winter, late-spring/early-summer, and late-summer/early-fall time periods.

Stream-water samples may be single discrete samples, one of a series of discrete samples, or a composite of a series of discrete samples. During low flows, single discrete samples will be collected. During storms producing moderate and high flows, a series of discrete water samples will be collected for the duration of the storm hydrograph. Ideally, at least five water samples will be collected over the duration of the hydrograph for a storm event. Streamflow will be measured when samples are collected. The series of discrete samples collected over the storm hydrograph may be analyzed individually to generate observed pollutographs (plots of constituent concentrations over time) and loadographs (plots of constituent loading over time) that provide information on contaminant movement in the basin and storm-event loading. Alternatively, the series of discrete samples may be composited into a single sample for analysis, which can be used to estimate the mean storm-event constituent concentrations and the storm-event loading. Single, discrete storm-event samples may also be collected to supplement available high-flow information.

Water samples for analysis of constituents of interest will be collected over a 2-year period at four locations on Chenoweth Run (Ruckriegel Parkway, Taylorsville Road, Gelhaus Lane, and Seatonville Road). A limited number of supplemental high-flow samples will ideally also be obtained at Easum Road. The types and number of samples proposed for each location are shown in the table below.

Sampling location (station)	Sample type			
	Storm series	Storm composite	Single, discrete high flow	Single, discrete low flow
Ruckriegel Parkway (03298135)	6	---	---	2
Taylorsville Road (03298140)	---	6	---	2
Easum Road (03298145)	---	---	*	2
Gelhaus Lane (03298150)	6	---	---	2
Seatonville Road (03298160)	---	6	---	2

* The extent of sampling required at this location will depend on the adequacy of existing data.

MSD laboratory analysis of water samples will include determinations of all routine parameters currently analyzed for the USGS/MSD stream-monitoring network [pH, alkalinity, total dissolved solids, total suspended solids, total volatile suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, organic nitrogen, ortho-phosphorus, total phosphorus, fecal *Coliform* and *Streptococcus*]. (Water sampling and analysis of metals and pesticides could be added as future model refinements and enhancements.) Field determinations will include streamflow, air and water temperature, barometric pressure, dissolved oxygen, pH, and conductivity.

Data-collection and laboratory-analysis procedures will be reviewed in accordance with the quality-assurance practices of the USGS to ensure that data quality will be consistent with overall project objectives. Quality-assurance samples will be used to ascertain the precision, variability, bias, and representativeness of the project data.

The water-quality data collected during the 2-year calibration period and the available historical data can be related to stream discharge. These relations, used in conjunction with continuous stream-discharge data, provide a means to estimate constituent concentrations and loadings on a continuous basis. The observed and estimated water-quality information will be compared to model simulations during the model calibration/confirmation process.

Project sampling may be accomplished most effectively by redirection of USGS/MSD resources currently used for routine monitoring of stream-water quality. It is assumed that about 5 sites in the stream-monitoring network located elsewhere in the County will be discontinued following an analysis of the network (see companion proposal titled *Probability-Based Evaluation of the Stream-Monitoring Program*), and resources for the discontinued stations will be redirected to storm sampling for this Chenoweth Run modeling study. Thus, one MSD field person will be presumed available to assist in all project sampling activity.

2. **Collect all available information on point- and nonpoint-contaminant sources including wastewater-treatment plants, industrial discharges, paved areas, construction sites, and chemically treated lawns.**

Literature values are typically used in modeling to estimate contaminant wash-off rates from specific land uses. Observed storm-runoff data and techniques for estimating storm-runoff quality for Jefferson County have been published in previous studies (Evaldi and Moore, 1992; and Evaldi and Moore, 1994). Though not budgeted in this study, sampling of runoff from specific land uses in the basin would improve model accuracy.

3. **Determine basin and channel characteristics needed to parameterize the model including drainage areas, land uses, impervious area, soils characteristics, storm sewers, channel shape and length.**

Detailed data collection and analysis to determine critical basin characteristics may be required to adequately parameterize and calibrate the model. The Natural Resource Conservation Service (NRCS) is available to assist the USGS in determination of selected basin characteristics. Field measurement of soils properties including permeability and water-storage characteristics in the basin would provide valuable information for parameterizing the model. Supplementary project funding for this data-collection effort is being pursued.

4. **Develop, calibrate, and confirm the HSPF model.**

Both the historic and the current data collected during the 2-year sampling period will be used to calibrate and confirm the basin model. Additional confirmation of the model parameter set could be accomplished by extending the data collection beyond 2 years and (or) by parameter application in modeling a nearby, similar basin such as Cedar Creek.

REPORTS

A USGS Water-Resources Investigations Report will be published that will contain: (1) a basin map showing important hydrologic features; (2) a description of data-collection methods and results; (3) a description of the model development and simulations; and (4) an uncertainty analysis of the model results.

HUMAN RESOURCES

Hydrologists and biologists familiar with hydrologic data collection and modeling are available in the District to complete the project. Experienced field personnel are available to collect and manage the field data. Technical support will also be provided by the Kentucky District Water-Quality and Surface-Water Specialists, as well as District staff having expertise in specialized areas such as GIS technology. During event-sampling periods, other USGS staff in the Kentucky District may be available to assist in data-collection activities for the project. Other personnel in the District will be assigned as needed to assist the project leaders. The project leaders will coordinate closely with MSD on project execution.

The assistance of MSD personnel will also be needed for project completion. Two-person teams will be needed for much of the collection of field data. It is envisioned that these teams will include both USGS and MSD personnel. It is proposed that the MSD water-quality laboratory perform required sample analyses. Assistance from MSD and/or Louisville and Jefferson County Information Consortium personnel will be needed to provide available GIS coverages for the study area. For the purpose of MSD acquiring an in-house model-application capability, it is assumed that one or more staff from MSD will be available to participate where feasible in the Chenoweth Run model-development process.

SELECTED REFERENCES

Bicknell, B.R., Imhoff, J.C., and Kittle, J.L., Jr., 1993, Hydrologic Simulation Program—Fortran, User's Manual for Release 10: U.S. EPA Environmental Research Laboratory, Athens, Ga., EPA/600/R-93-174.

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