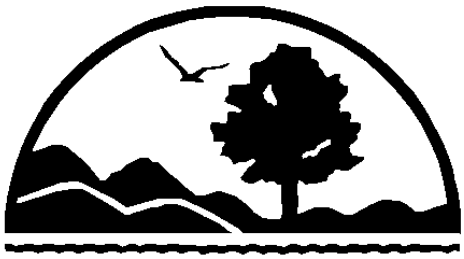
WATER QUALITY STUDY
OF
FLOYDS FORK



Natural Resources and
Environmental Protection Cabinet
Kentucky Division of Water

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WATER QUALITY STUDY OF FLOYDS FORK

KENTUCKY DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
WATER QUALITY BRANCH

Frankfort, Kentucky

This report has been approved for release:

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Dec. 20, 1991
Date

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WATER QUALITY SURVEY OF FLOYDS FORK

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INTRODUCTION

Floyds Fork begins in Oldham County and flows 67 miles through Jefferson and Bullitt Counties to its confluence with the Salt River. A small portion of Shelby and Spencer counties also drain into this watershed. Within its drainage basin are areas that are experiencing rapid growth and development. Only a small part of the watershed is served by a centralized sewage disposal system. Instead, package sewage treatment systems have been installed to meet the wastewater needs of individual developments. In addition to problems caused by package wastewater plants, known water withdrawals are having water quality impacts during low-flow conditions.

For several years the Division of Water (Division) has been notifying county governments and developers of problems occurring in the basin. Wastewater treatment plant proposals have been denied in some areas, while requests for expansions of existing facilities are carefully considered. Both approvals and denials are based on provisions contained in Kentucky Water Quality Regulations, Title 401, Chapters 5:005, Section 7(3) and 5:055, Section 2(3). County governments are being urged to formulate regional wastewater plans and eliminate the proliferation of package facilities. Oldham and Jefferson counties are proceeding with these activities, while Bullitt County has yet to begin this process. These counties have been notified that future development will need regional wastewater facilities. Water withdrawal facilities are being issued permits that will allow withdrawal only

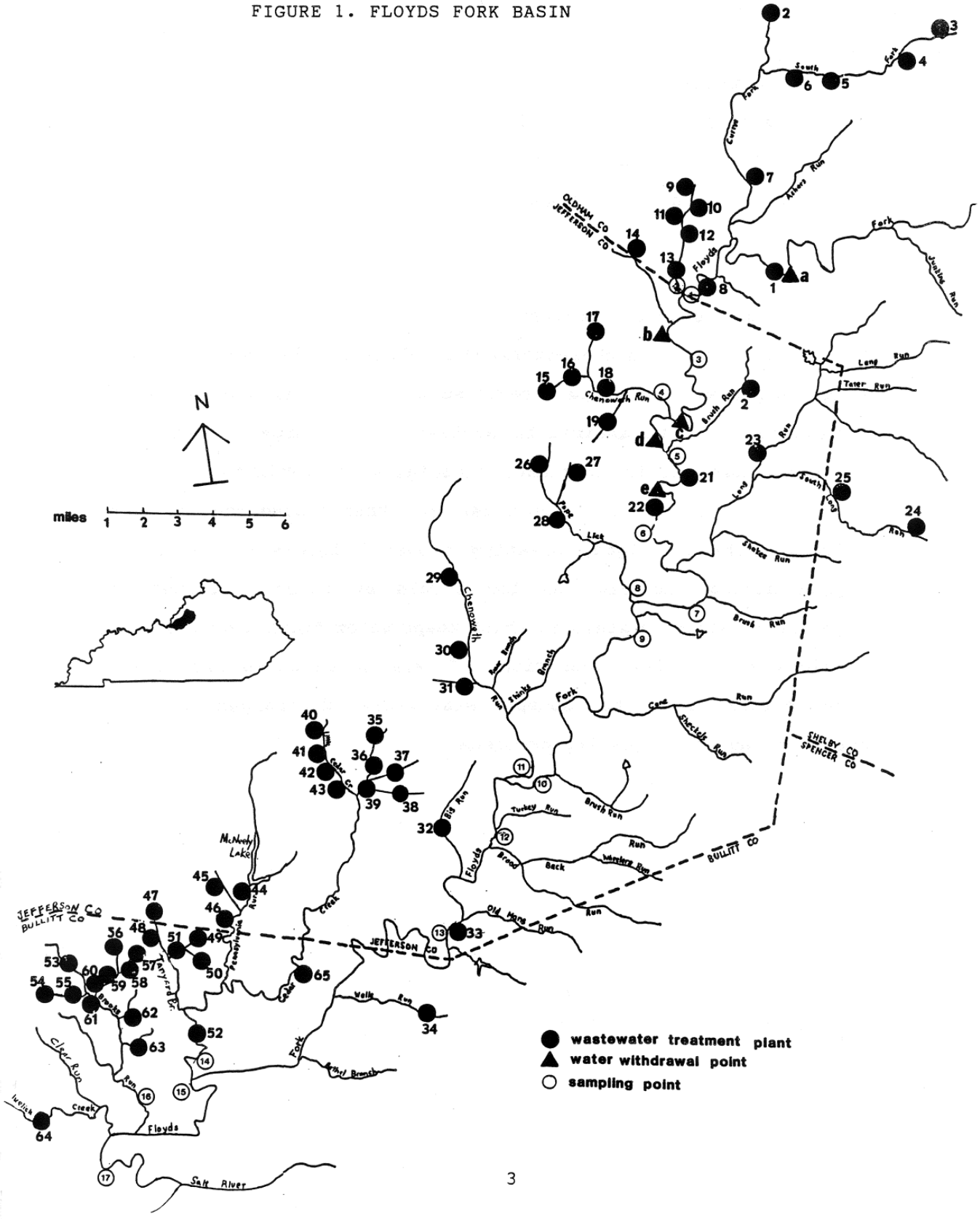
when adequate streamflow is present. These facilities will need on-site storage or other sources to meet their water needs during low-flow conditions During this study, a previously unknown withdrawal for a tree nursery was discovered. Steps are underway to bring this facility into compliance with Kentucky regulations.

From July 24 through 27, 1991, the Division conducted a water quality survey of Floyds Fork. The purpose was primarily to determine dissolved oxygen and streamflow levels in Floyds Fork during hot summertime weather conditions and low streamf lows. These are the conditions when a stream is most stressed. This report presents the results of the study.

DESCRIPTION OF STUDY AREA

Floyds Fork drains 284 square miles of land, primarily in Oldham, Jefferson, and Bullitt Counties (Figure 1). Short sections of tributary streams also drain small areas of Henry, Shelby, and Spencer counties, and a section of Floyds Fork forms part of the county boundary between Oldham and Shelby counties. Major tributaries are Curry's Fork, Chenoweth Runs (upper and lower), Long Run, Pope Lick, Cane Run, Cedar Creek, and Brooks Run. There are 65 discharge outfalls in the basin serving schools, small industries, subdivisions, mobile home parks, and the cities of LaGrange, Jeffersontown, and Hillview (Figure 1). Five wastewater facilities above McNeely Lake in Jefferson County discharge to a

FIGURE 1. FLOYDS FORK BASIN



combined outfall below the lake. There are four known withdrawals within close proximity to each other in Jefferson County and one withdrawal in Oldham County. Locations of the outfalls and withdrawals are noted on Figure I and described in Tables I and 2.

Stream slopes are moderate to nearly flat on the mainstem of Floyds Fork, which is characterized by short riffles between long,, sluggish pools. Low slope streams such as Floyds Fork do not have a high capacity to assimilate wastewater discharges. Water in pools becomes nearly stagnant, especially in conditions of low flow. Pools in nutrient-rich waters can then become covered with thick growths of algae, creating elevated levels of dissolved oxygen during the day and low levels at night. Slopes on tributaries are much steeper, which keeps water flowing quickly and provides substantial reaeration. Streams with steep slopes are much better able to accept wastewater discharges without experiencing water quality problems.

TABLE 1. WASTEWATER FACILITIES IN THE FLOYDS FORK BASIN

MAP #	NAME	DESIGN FLOW (MGD)	STREAM NAME
1	PERSIMMON RIDGE	0.01300	FLOYDS FORK
	(FLOW USED FOR GOLF COURSE IRRIGATION MOST OF THE TIME)		
2	LAGRANGE, CITY OF	0.77500	CURRYS FK
3	GREEN VALLEY	0.07000	TRIB. OF SOUTH CURRYS FK
4	LAKEWOOD VALLEY	0.10000	TRIB. OF SOUTH CURRYS FK
5	CENTERFIELD ELEMENTARY	0.01000	SOUTH CURRYS FK
6	LOCKWOOD ESTATES	0.04500	SOUTH CURRYS FK
7	COUNTRY VILLAGE	0.06000	TRIB. OF CURRYS FK
8	KY DOJ-WOMENS PRISON	0.06500	FLOYDS FORK
9	CRESTWOOD ELEMENTARY	0.01500	TRIB. OF FLOYDS FK
10	MAPLE SPRING APTS	0.02500	TRIB. OF FLOYDS FK
11	THORNHILL MHP	0.00200	TRIB. OF FLOYDS FK
12	CHERRYWOOD	0.00750	TRIB. OF FLOYDS FK
13	ASH AVENUE SEWER CO	0.30000	TRIB. OF FLOYDS FK
14	FRIENDSHIP MANOR	0.08000	TRIB. OF FLOYDS FK
15	FURNITURE SHOWROOMS	0.02000	CHENOWETH RUN
16	STARVIEW ESTATES	0.10000	CHENOWETH RUN
17	MSD BERRYTOWN	0.07500	TRIB. OF CHENOWETH RUN
18	MIDDLE INDUSTRIAL	0.21000	CHENOWETH RUN
19	BECKLEY WOODS SUBDIV	0.90000	TRIB. OF CHENOWETH RUN
20	SOUTHFIELD TRAINING	0.00200	BRUSH RUN
21	ENGLISH STATION	0.03300	FLOYDS FORK
22	COPPERFIELD SUBDIV	0.16000	FLOYDS FORK
23	ASHMOOR WOODS	0.02700	LONG RUN
24	WHITNEY YOUNG JOBS	0.04000	TRIB. TO SOUTH LONG RUN
25	1-64 EASTBOUND REST	0.00300	TRIB. TO SOUTH LONG RUN
26	CROSS CREEK SUBDIV	0.27200	POPE LICK
27	RUNNING CREEK SUBDIV	0.11000	TRIB. TO POPE LICK
28	TUCKER STATION DISP	0.06000	POPE LICK
29	JEFFERSONTOWN, CITY	4.00000	CHENOWETH RUN
30	CHENOWETH HILLS	0.20000	CHENOWETH RUN
31	LAKE OF THE WOODS	0.04400	TRIB. TO CHENOWETH RUN
32	GLENMARY	0.08000	BIG RUN
33	FAIRMONT GARDENS LIQ	0.00600	FLOYDS FORK
34	OAKS MHP	0.02600	WELLS RUN
35	IDLEWOOD	0.60000	CEDAR CREEK
36	FERN CREEK SEWER	0.02000	CEDAR CREEK
37	CEDAR LAKE PARK	0.20000	TRIB. TO CEDAR CREEK
38	BIRCHWOOD SUB.	0.25000	TRIB. TO CEDAR CREEK
39	CEDAR HEIGHTS MHP	0.03100	CEDAR CREEK
40	FARMGATE	0.15000	LITTLE CEDAR CREEK
41	GAINSEOROUGH	0.09000	LITTLE CEDAR CREEK
42	ZELMA FEILDS	0.12500	LITTLE CEDAR CREEK
43	BEULAH LAND ESTATES	0.15000	LITTLE CEDAR CREEK

TABLE 1. WASTEWATER FACILITIES IN THE FLOYDS FORK BASIN (Continued)

MAP #	NAME	DESIGN FLOW (MGD)	STREAM NAME
44	MCNEELY LAKE BYPASS		PENNSYLVANIA RUN
	PLEASANT VALLEY	0.22500	
	APPLE VALLEY SUBDV.	0.20000	
	THE PINES	0.20000	
	JEFFERSON SQUARE DEV	0.12000	
	MAPLE GROVE	0.20600	
45	MCNEELY LAKE VILLAGE	0.20500	TRIB. TO PENNS. RUN
46	LARKGROVE	0.12000	PENNSYLVANIA RUN
47	TREASURE ISLAND EAST	0.50000	TRIB. TO TANYARD BRANCH
48	OVERDALE ELEM.	0.01000	TANYARD BRANCH
49	PRESTON PARKWAY	0.05500	TRIE. TO TANYARD BRANCH
50	BULLIT HILLS	0.20000	TRIB. TO TANYARD BRANCH
51	MARYVILLE #1	0.23000	TRIB. TO TANYARD BRANCH
52	CAMP SHANTITUCK	0.01000	CEDAR CREEK
53	L&N GOLF CLUB	0.00500	BROOKS RUN
54	BROOKS ELEMENTARY	0.01000	TRIB. TO BROOKS RUN
55	INTERSTATE FACILITIES	0.04000	TRIB. TO BROOKS RUN
56	MARYVILLE #2	0.31700	TRIB. TO BROOKS RUN
57	WHEEL ESTATES	0.05000	TRIB. TO BROOKS RUN
58	BRIARWOOD VILLAGE	0.01500	TRIB. TO BROOKS RUN
59	HUNTERS HOLLOW	0.24000	TRIB. TO BROOKS RUN
60	MARYVILLE #3	0.14800	TRIE. TO BROOKS RUN
61	WILLOWBROOK	0.05000	BROOKS RUN
62	MARYVILLE #4	0.24000	TRIB. TO BROOKS RUN
63	HEBRON JUNIOR HIGH	0.02000	TRIB. TO BROOKS RUN
64	BIG VALLEY MHP	0.07500	BLUELICK CREEK
65	LAKE COLUMBIA ESTATES	0.01200	TRIB. TO CEDAR CREEK

TABLE 2. WATER WITHDRAWALS IN THE FLOYDS FORK BASIN

Map #	Name	Withdrawal (mgd)	Stream	County
a	Persimmon Ridge*	0.3	Floyds Fork	Oldham
b	NTS Lake Forest Golf Course	1.0	Floyds Fork	Jefferson
c	Piercy Mill Tree Nursery	0.2	Floyds Fork	Jefferson
d	Valhalla Golf Course	0.5	Floyds Fork	Jefferson
e	Midland Trail Golf Course	0.8	Floyds Fork	Jefferson

* Floyds Fork is often zero flow at this location. Most irrigation water comes from on-site storage ponds and effluent from the Persimmon Ridge wastewater facility.

(Permits for withdrawers b, d, and e in Jefferson County are being modified to provide in-stream flow protection. A legal opinion is being investigated concerning issuing a permit to the Tree Nursery, which has claimed exemption to withdrawal regulations based on its agricultural status.)

DATA COLLECTION

Streamflow and water quality measurements were made at 17 sites in the Floyds Fork basin beginning at the Oldham-Jefferson county line and extending to Bullitt County near the mouth of Floyds Fork, during relatively low-flow conditions from July 24 to July 27, 1991 (Figure 1, Table 3). Measurements were also made near the mouth of the more significant tributaries. Weather conditions were warm and sunny to partly cloudy. No significant measurable rainfall occurred for two weeks prior to or during the study. Instantaneous measurements for dissolved oxygen (DO), water temperature, specific conductance, and pH were made using a Hydrolab model 4041 portable water quality meter that had been calibrated the day prior to the study. Quality control measurements of DO using the Winkler Titration method were done at the first site each morning and periodically during the day to ensure meter accuracy. Dissolved oxygen and water temperature were also measured hourly for periods ranging from 21 to 25 hours at six locations in Floyds Fork using two Hydrolab automatic Datasonde I units. These were calibrated in the office the day prior to deployment. The locations were Floyds Fork at Hwy 362 (site I on Figure 1), Floyds Fork at Fisherville (site 7), Floyds Fork at Seatonville Road (site 10), Floyds Fork at Bardstown Road (site 13), Floyds Fork at Hwy 1526 (site 15), and Floyds Fork at mile 2.5, behind a subdivision off Hwy 44 (site 17). Instantaneous DO measurements were made when setting and removing the sonde units to ensure data accuracy. Data from the sonde units were downloaded to an IBM PC and compared to the instantaneous field measurements.

TABLE 3. STATION LOCATIONS

Map	Location
1	Floyds Fork at Hwy 362, mile 45.7 (above site 2)
2	Unnamed tributary at Hwy 362, mile 0.1
3	Floyds Fork at Aiken Road, mile 43.2
4	Chenoweth Run (upper) at Beckley St. Road, mile 0.4
5	Floyds Fork at Shelbyville Road, mile 38.7
6	Floyds Fork at end of Beckley St. Road, mile 36.2
7	Floyds Fork at Fisherville, mile 32.8
8	Pope Lick Creek near mouth, mile 0.1
9	Floyds Fork at Floyds Fork Park, mile 30.4
10	Floyds Fork at Seatonville Road, mile 24.6
11	Chenoweth Run (lower) at Seatonville Road, mile 0.3
12	Floyds Fork at Broad Run Road, mile 21.6
13	Floyds Fork at Bardstown Road, mile 18.7
14	Cedar Creek near mouth, mile 0.1
15	Floyds Fork at Hwy 1526, mile 7.4
16	Brooks Run at Hwy 61, mile 1.7
17	Floyds Fork behind subdivision off Hwy 44, mile 2.5

Streamflow was measured using Teledyne-Gurley flow meters that were spin tested prior to use.

Although conditions for this study were considered low-flow, comparison to measurements made by the U. S. Geological Survey (USGS) in 1988 indicate that flow can be considerably lower than that measured for this study, especially in the lower reaches of the basin (9). The USGS has measured flow as low as 1.2 cubic feet per second (cf s), and numerous measurements between 3 and 4 cf s, in Floyds Fork at Bardstown Road, while 7.1 cfs was measured during this study at that location. Similarly, the USGS has measured 1.1 cfs in lower Chenoweth Run and 0.09 cfs in Pope Lick, while 2.1 and 0.51 cfs, respectively, were measured during this study (9).

WATER QUALITY IN FLOYDS FORK

Measurements and observations made during this study demonstrate that at least 13 miles of Floyds Fork, primarily in Jefferson County below the Oldham/Shelby County line, do not meet Kentucky's criteria for dissolved oxygen, which stipulates that the daily average DO cannot be less than 5.0 milligrams per liter (mg/L), with no instantaneous levels below 4.0 mg/L. other areas of Floyds Fork also exhibited problems, mostly with algal blooms in quiescent pools, but were not as severe as these 13 miles.

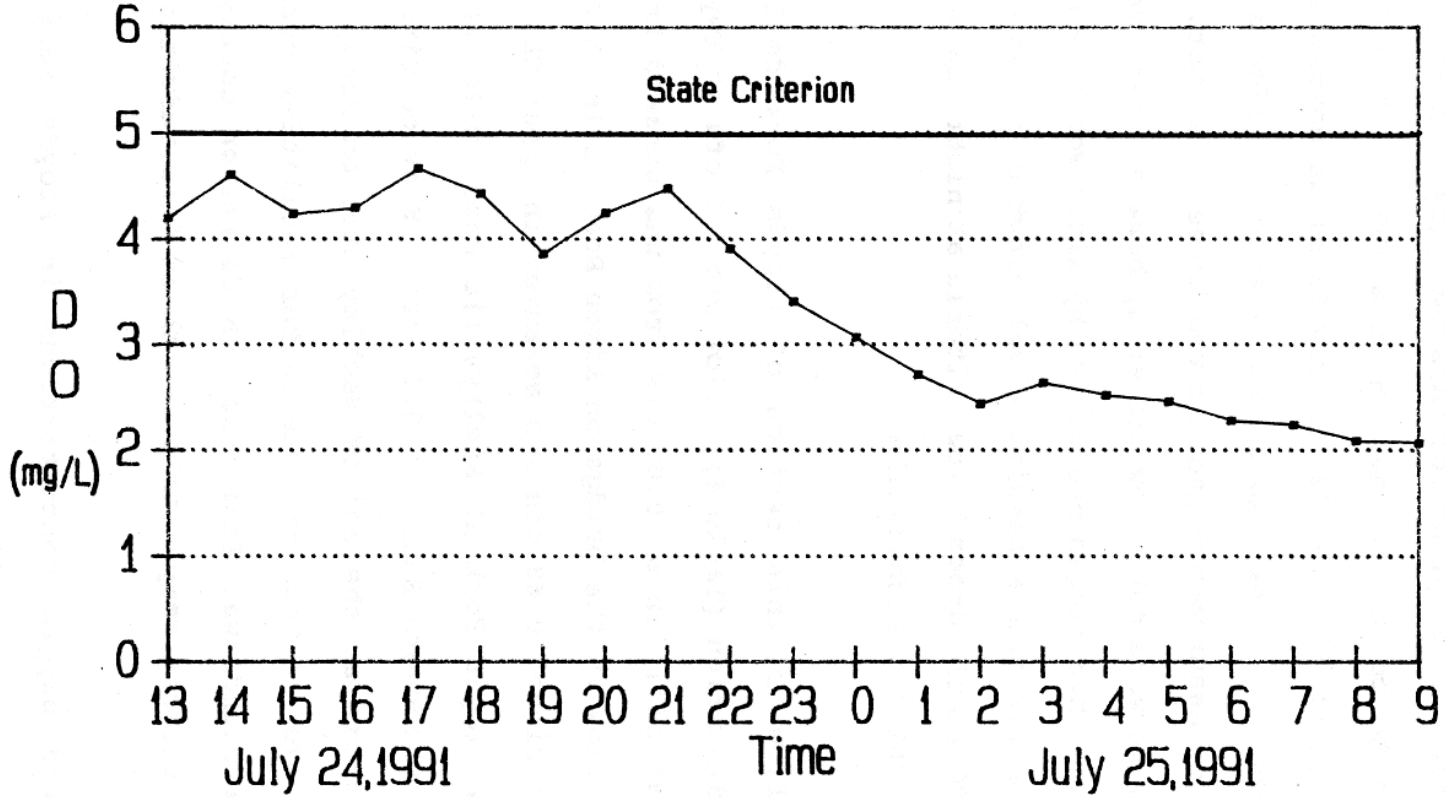
Dissolved oxygen violations within this reach are primarily the result of two activities that impact water quality: inputs from wastewater treatment plants and reductions in streamflow caused by water withdrawals. Wastewater plants add oxygen-consuming carbonaceous and nitrogenous substances and other nutrients that promote algal growth. Excessive water withdrawals can reduce streamflow to a level where the stream can no longer assimilate wastewater inputs. Pools become nearly stagnant, and algal blooms occur. These conditions were observed throughout this section of Floyds Fork.

Dissolved oxygen in Floyds Fork at Hwy 362, mile 45.7, did not exceed 5 mg/L an July 24 or 25, and was below 4 mg/L much of the time (Table 4, Figure 2). These problems are believed to be caused by the malfunctioning wastewater treatment plant serving the State Correctional Institute for Women, just above the Jefferson County

TABLE 4. WATER QUALITY CONDITIONS IN FLOYDS FORK

MAP #	STATION	DATE	TIME	FLOW (CFS)	DISSOLVED OXYGEN (MG/L)	WATER TEMP. (DEG. F)	SPECIFIC CONDUCTANCE (uS/CM)	pH (UNITS)
1	FLOYDS FORK AT HWY 362	7-24-91	11:40 A.M.	0.50	3.40	79.0	532	7.2
		7-25-91	9:30 A.M.		2.90	76.0	534	7.2
2	UNNAMED TRIB. AT HWY 362	7-24-91	12:07 P.M.	0.06	5.6	77.5	727	7.3
3	FLOYDS FORK AT AIKEN ROAD	7-24-91	2:15 P.M.	0.39	7.3	82.5	440	7.6
4	CHENOWETH RUN AT BECKLEY STATION ROAD	7-24-91	3:10 P.M.	0.68	11.1	82.5	802	8.2
5	FLOYDS FORK AT SHELBYVILLE ROAD	7-24-91	4:20 P.M.	0.27	9.5	83.0	696	7.6
6	FLOYDS FORK AT END OF BECKLEY STATION ROAD	7-24-91	5:15 P.M.	0.24	6.7	82.5	547	7.4
7	FLOYDS FORK AT FISHERVILLE	7-24-91	10:35 A.M.		4.2	82.0	453	7.2
		7-25-91	8:20 A.M.		4.3	79.5	457	7.2
8	POPE LICK CREEK NEAR MOUTH	7-24-91	6:25 P.M.	0.51	10.6	81.0	618	8.5
9	FLOYDS FORK AT FLOYDS FK PARK	7-24-91	7:15 P.M.	1.88	12.0	83.3	460	8.2
10	FLOYDS FORK AT SEATONVILLE ROAD	7-25-91	11:45 A.M.	2.50	6.3	76.5	452	7.4
		7-26-91	7:45 A.M.		5.1	74.5	455	7.4
11	CHENOWETH RUN AT SEATONVILLE ROAD	7-25-91	12:15 P.M.	2.09	9.6	74.5	628	8.4
12	FLOYDS FORK AT BROAD RUN ROAD	7-25-91	1:50 P.M.	5.36	5.7	79.0	580	7.6
13	FLOYDS FORK AT BARDSTOWN ROAD	7-25-91	10:30 A.M.	7.08	5.3	78.0	549	7.4
		7-26-91	8:40 A.M.		5.1	75.5	556	7.4
14	CEDAR CREEK AT MOUTH	7-26-91	12:40 P.M.	2.91	7.4	74.5	670	7.5
15	FLOYDS FORK AT HWY 1526	7-26-91	12:05 P.M.	10.4	6.0	76.0	545	7.3
		7-27-91	1:05 P.M.		7.4			
16	BROOKS RUN AT HWY 61	7-25-91	4:15 P.M.	0.92	7.7	73.0	741	7.5
17	FLOYDS FORK AT MILE 2.5	7-26-91	10:40 A.M.	11.8	5.4	77.5	564	7.4
		7-27-91	12:07 P.M.		5.8			

Figure 2: Floyds Fork at Hwy 362
DO vs. Time

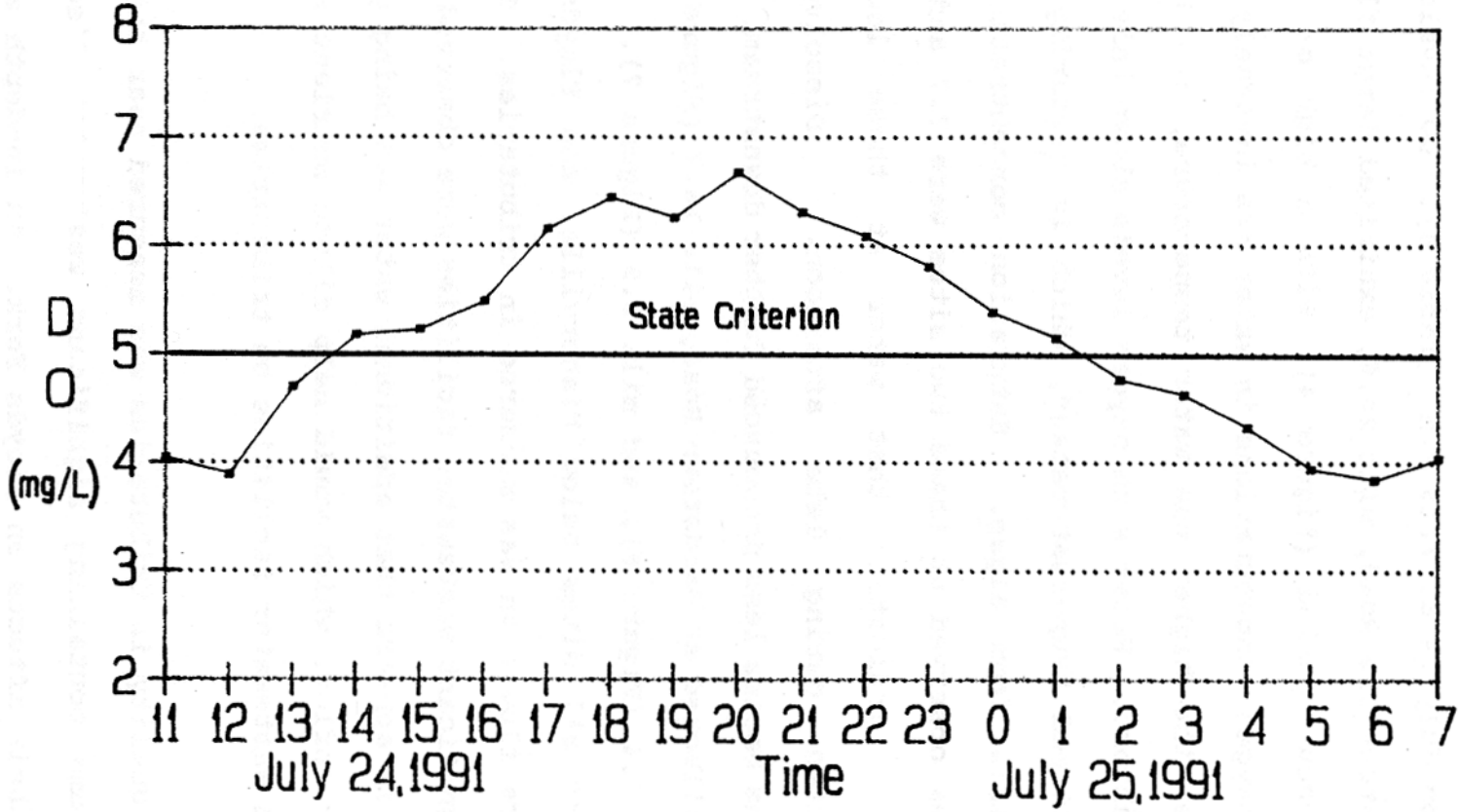


line in Shelby County. This conclusion is based on an inspection of the facility conducted by the Division shortly after this study was conducted. (A new plant for this facility is nearly completed and expected to be operational in late 1991). Dissolved oxygen data collected at Fisherville, nearly 13 miles downstream at mile 32.8, continue to show violations (Table 4, Figure 3). The instantaneous measurements made at the three sites between Hwy 362 and Fisherville were not below criteria, however these were made in late afternoon when oxygen production by algae would be high (Table 4). Considering the extensive algal growths observed at these locations, DO likely drops below criteria at night, as was observed at both Hwy 362 and Fisherville.

Streamflow in this section of Floyds Fork declined in a downstream direction (Table 4). Flow was 0.5 cfs at Hwy 362, mile 45.7, with an addition of 0.06 cfs from the unnamed tributary at mile 45.5. Flow at the bridge on Aiken Road, mile 43.2, was 0.39 cfs. An additional 0.68 cfs was measured in upper Chenoweth Run, yet flow in Floyds Fork at Shelbyville Road, mile 38.7 and 1.3 miles below Chenoweth Run, was 0.27 cfs. Flow continued to drop and was 0.24 cfs at the end of Beckley Station Road, mile 36.2, despite the inflow from two wastewater facilities between.these sites. The withdrawal facilities in Jefferson County noted in Table 2 are largely responsible for these flow reductions.

Dissolved oxygen concentrations in Floyds Fork are much improved below Fisherville, largely due to increasing flow, but

Figure 3: Floyds Fork at Fisherville
DO vs. Time



some areas exhibited problems indicating nutrient enrichment. The DO concentration in Floyds Fork at Floyds Fork Park, mile 30.4, was 12.0 mg/L on July 24 at 7:15 P.M. (Table 4). DO levels in Floyds Fork at Seatonville Road, mile 24.6, exhibited large fluctuations over a 24-hour period (Figure 4), with a high of 11.5 mg/L. Dissolved oxygen concentrations in water are inversely related to temperature; the higher the water temperature, the less oxygen water can absorb. Water with oxygen levels above this saturation point is termed "supersaturated", which is primarily caused by photosynthesis from algae. Saturation concentrations at the temperatures observed at these two sites were 7.7 and 7.9 mg/L, respectively, indicating that water at these locations is supersaturated during late afternoon. Dissolved oxygen fluctuations became less pronounced further downstream, as noted by the data collected at Bardstown Road, mile 18.7 (Figure 5), at Hwy 1526, mile 7.4 (Figure 6), and mile 2.5 (Figure 7). Streamflow increased at all sites below Fisherville, and Floyds Fork was gaining more flow than was measured-in tributaries. Tributaries without significant wastewater facilities were observed to be dry. Therefore, it appears that additional water was being gained from groundwater inflow, which would help dilute nutrient rich waters coming from wastewater facilities on tributaries.

Water quality in tributaries was measured near the mouths of those streams containing significant wastewater discharges to determine their affects on Floyds Fork. An in-depth analysis of these tributaries was not conducted for this study. Most of these

Figure 4: Floyds Fork at Seatonville Rd
DO vs. Time

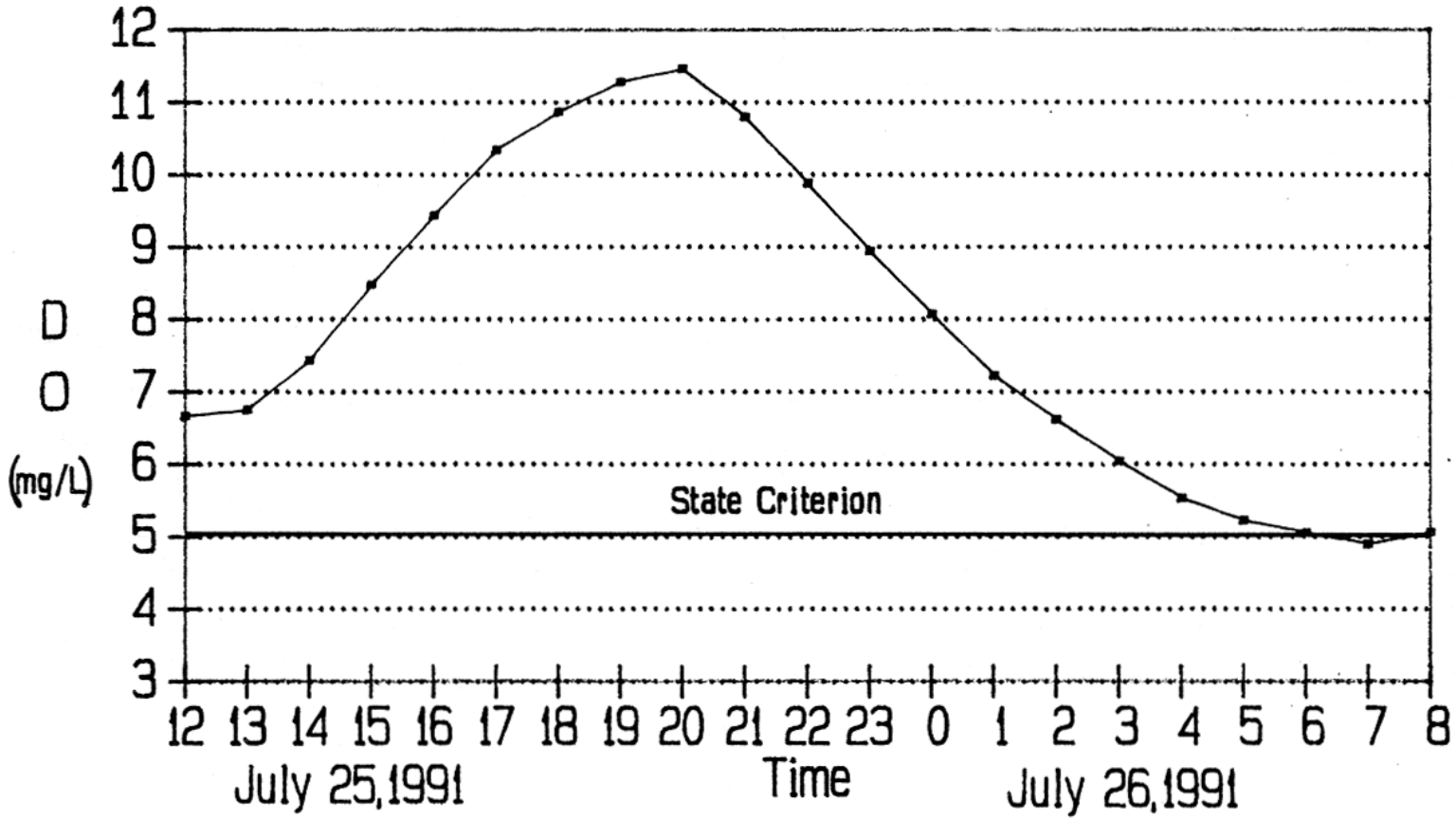


Figure 5: Floyds Fork at Bardstown Rd
DO vs. Time

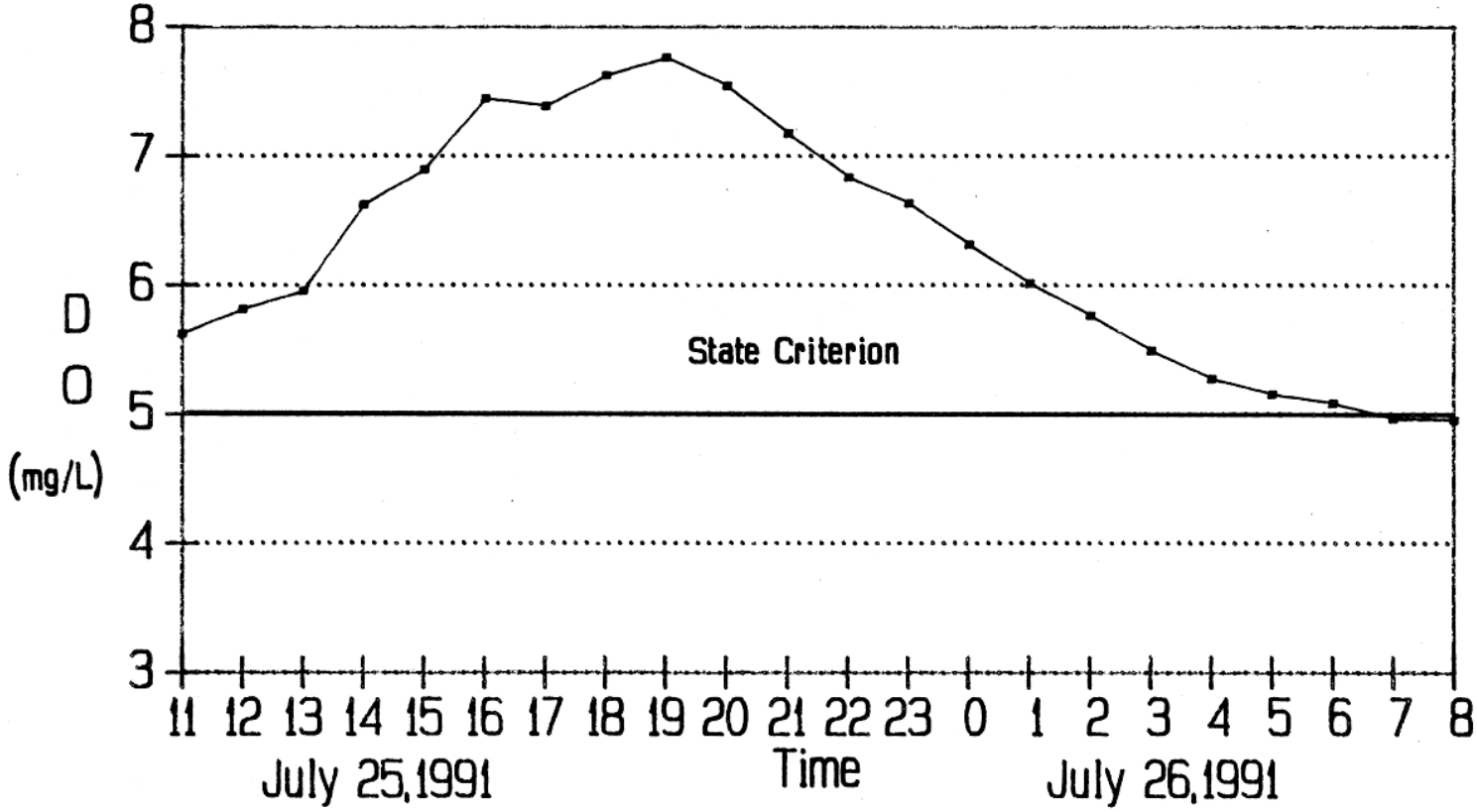


Figure 6: Floyds Fork at Hwy 1526
DO vs Time

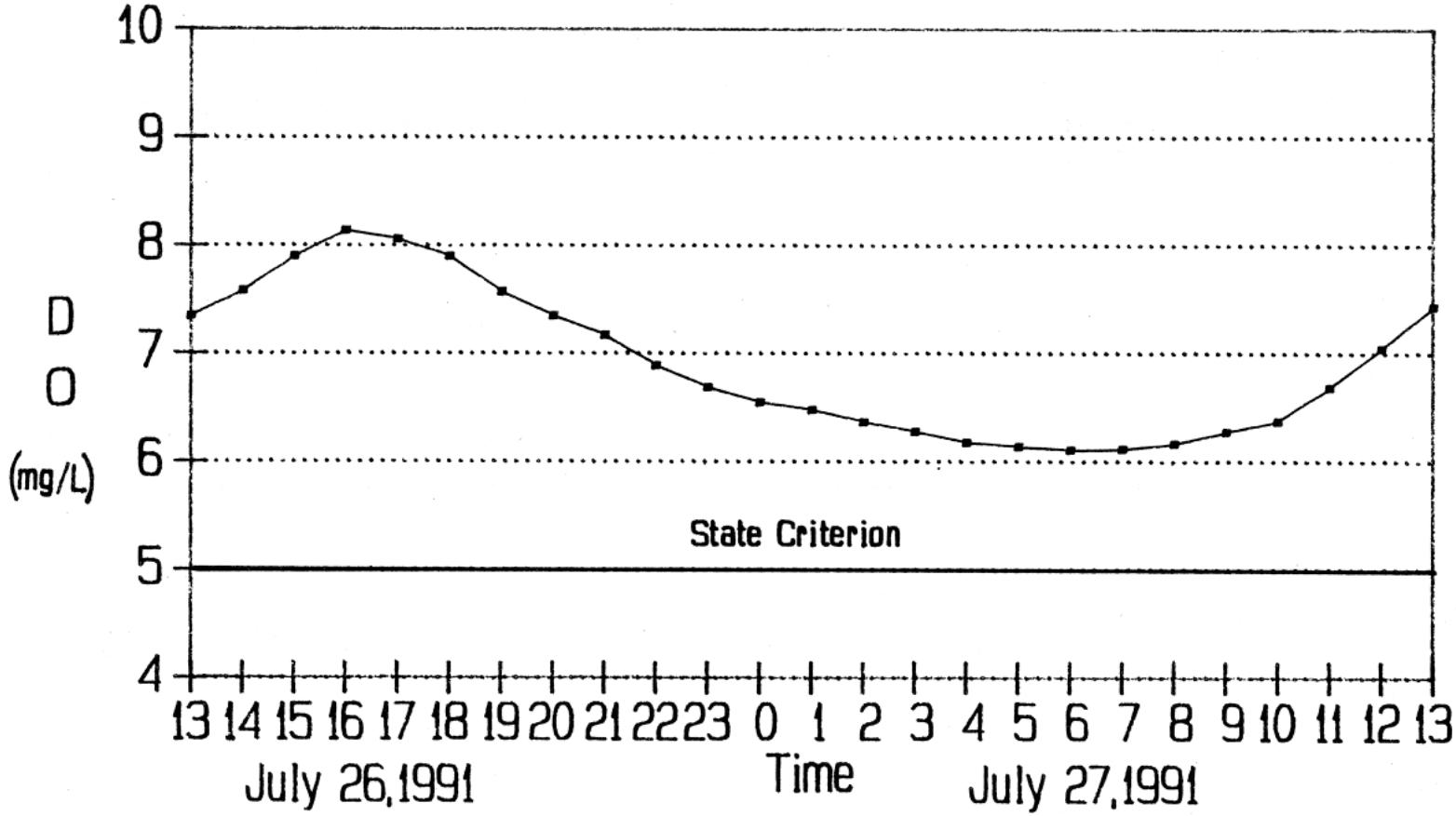
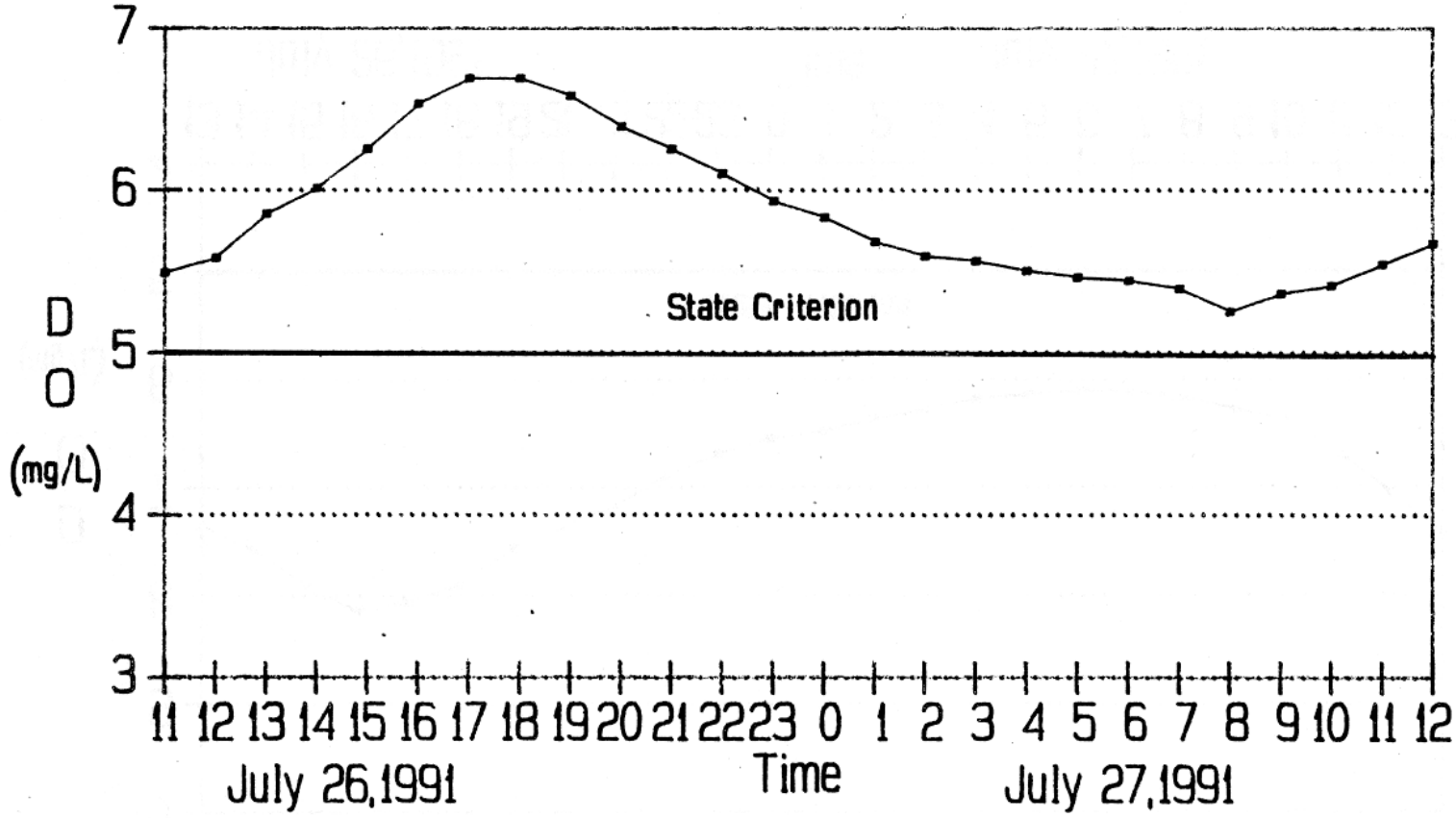


Figure 7: Floyds Fork at mile 2.5
DO vs Time



streams have fairly steep slopes, providing natural reaeration in riffles and allowing for fewer pools where effluents cause more siqnificant problems. None of the tributaries violated the DO criteria near their confluence with Floyds Fork, but upper Chenoweth Run, Pope Lick, and lower Chenoweth Run exhibited supersaturated conditions and algal growth indicating nutrient enrichment. Cedar Creek and Brooks Run did not exhibit supersaturated conditions, which may be attributable to the heavy tree canopy reducing photosynthesis at the sampling stations rather than lower nutrient levels. Both Cedar Creek and Brooks Run have numerous wastewater facilities, but their locations are three to four stream miles above the confluence with Floyds Fork, which helps reduce their impact to Floyds Fork.

Two other parameters were measured during this study, specific conductance and pH. Specific conductance is a measure of the dissolved solids content, which includes calcium, sodium, magnesium, potassium, chloride, nitrate, sulfate, carbonate and bicarbonate ions. A measure of the hydrogen ion activity is called pH, where 7 is neutral, less than 7 is acidic, and above 7 is basic. Specific conductance values generally range from 100 to 600 microsiemans per centimeter (uS/cm), and pH from 6.5 to 7.5 units in streams in Kentucky. Specific conductance values on tributaries measured during this study were elevated, ranging from 618 uS/cm in Pope Lick to 802 uS/cm in upper Chenoweth Run (Table 4). The components of specific conductance are common in wastewater effluents, which dominates the flow in these streams. Specific

conductance values in Floyds Fork ranged from 440 uS/cm to 696 uS/cm (Table 4). It is interesting to note how wastewater discharges affect specific conductance values in Floyds Fork. For example, there are three wastewater facilities in upper Chenoweth Run, the largest being the Beckley Woods facility that serves the Lake Forest subdivision. Specific conductance in Floyds Fork at Shelbyville Road, about 2 miles below the site on Chenoweth Run, was 696 uS/cm. The value was 547 in Floyds Fork at the end of Beckley Station Road, about 2.5 miles further downstream, and 453 at Fisherville, another 3.5 miles downstream. Two factors which could have affected the change in conductance were dilution from water with lower conductivity, or uptake of various components by algae (8). Since streamflow was being reduced in this area, the most likely cause of this reduction is uptake by the extensive algal growth in Floyds Fork. Algal growth can also affect pH. The pH will increase as algae increase their photosynthetic activity during daylight hours, and decrease at night when algae are not carrying on photosynthesis (8). The pH at several locations in the basin was greater than 8. 0 units (Table 4), again demonstrating algal activity. Specific conductance and pH data indicate that Floyds Fork is experiencing significant nutrient enrichment.

WATER QUALITY MODELING

Water quality modeling using U.S. EPA-approved methodology is commonly used by regulatory agencies in the United States to make permit decisions and set effluent limits for wastewater facilities.

These decisions are designed to maintain a daily average DO concentration of 5.0 mg/L in the receiving stream and control ammonia toxicity associated with the Warmwater Aquatic Habitat use as contained in Kentucky water quality regulations.

The QUAL2E-U water quality model is used as the basic tool for calculating in-stream DO and ammonia concentrations. This model is fully supported and documented by the U.S. EPA, and is used worldwide for this purpose. Inputs to the model include stream flow, stream slope, wastewater facility flows, and water withdrawals. Average stream temperature and pH for summer and winter conditions are also model inputs. The stream flow used to determine effluent limits is the low flow occurring for a period of 7 consecutive days once every 10 years, termed the 7QIO. These values are determined from long-term data collected by the USGS. Streamflow contributions from wastewater dischargers are also added to this flow. Reliable values of 7QIO are not available for much of Floyds Fork because streamflow during low-flow conditions is partly controlled by wastewater inputs and has been significantly affected by water withdrawals. The location and effects of one previously unknown withdrawal, the Piercy Mill Tree Nursery, was discovered during the course of this study.

Water quality modeling of the section of Floyds Fork between mile 45.7 (Hwy 362) and mile 32.8 (Fisherville) indicate a steady flow of 2.0 cfs is needed to maintain a DO concentration of 5.0 mg/L. Design flows from wastewater facilities above mile 45.7 are

1.76 cfs, and above mile 32.8 total 4.4 cfs. Wastewater facilities do not generally operate at design flow during dry weather conditions, and some flow is naturally lost in streams. These amounts, therefore, would not consistently be available in this section of Floyds Fork, even without the water withdrawals. Statistical analysis of flow data from the USGS station near Crestwood, mile 50.5, shows that streamflow is greater than 2.0 cfs about 65 percent of the time and about 78 percent of the time at the station at Fisherville.

Streamflow values used in modeling below Fisherville are based on measurements made by the USGS at several locations in the basin during low-flow conditions. The lowest flows measured by the USGS are not used in modeling to determine effluent limits because these values were measured in the summer of 1988 and are considered the result of exceptionally dry conditions. A value of 0.26 cfs is used at the mouth of Pope Lick Creek, which was noted by the USGS from several measurements made during low-flow conditions. The lowest measurement made at this location was 0.09 cfs. A value of 1.5 cfs is used at the mouth of lower Chenoweth Run, and 3.0 cfs in Floyds Fork at mile 18.7 (Bardstown Road). The lowest flow measured at mile 18.7 was 1.15 cfs; however, numerous other measurements made during low-flow conditions ranged between 3 and 4 cfs. Results from modeling show that Floyds Fork experiences reductions and some violations of DO below the large tributaries with significant wastewater flows. These are areas below lower Chenoweth Run, Cedar Creek, and Brooks Run. These violations are

more acute if the lowest flows measured by the USGS are used in modeling.

Water quality modeling of the tributaries does not indicate Do violations within these streams. These streams have relatively steep slopes, where wastewater effluents are aerated and not likely to cause low DO conditions. It is possible that pools exist at various locations in these streams, where oxygen levels would likely be reduced. This situation was not investigated as part of this study.

OTHER STUDIES

Water quality data in Floyds Fork has been collected and reported by several agencies. Currently, the Louisville and Jefferson County Metropolitan Sewer District (MSD), in cooperation with the USGS, collects data on a monthly basis at sites throughout Jefferson County. Dissolved oxygen concentrations less than 5 mg/L have been measured in Pope Lick, Floyds Fork at Fisherville, Floyds Fork at Bardstown Road, and Pennsylvania Run just above the Bullitt County line. MSD reports that all streams being tested in Jefferson County are severely stressed, and that suspended solids, nitrogen, and phosphate levels were generally high and indicative of pollution problems (6). In addition to wastewater inputs, MSD notes these problems are also caused by soil erosion and urban runoff. Soil erosion from poorly managed construction activities can cause excess siltation in streams, and excess fertilization and

chemical application to lawns, golf courses, and other areas can cause nutrient enrichment and other problems.

The Division conducted a study of the Floyds Fork basin in 1981 to determine the stream-use designation that should be applied to this system. The study recommended that Floyds Fork and its tributaries should be classified under the Kentucky water quality standards for Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation. Kentucky water quality standards were violated during this study for DO, pH, cadmium, iron and mercury at various places in the basin. Elevated nutrient levels were found to have stimulated dense growths of filamentous algae, which had created localized nuisances and degradations in water quality. In addition to wastewater inputs, it also noted that land disturbances and intensive fertilization practices increase the potential for soil erosion and nutrient runoff. Elevated DO and pH values were noted at several sites, and was partially attributed to dense algal growths (5).

Data were also collected by the Jeff erson County Dept. of Public Health from 1975 to 1982. Violations of the DO standard were observed at several locations, and elevated levels of nutrients were reported (5).

CONCLUSIONS AND RECOMMENDATIONS

Water quality of some areas of Floyds Fork is very poor. Data

collected for this study and during previous studies have consistently found violations of Kentucky's dissolved oxygen standards and signif icant nutrient enrichment. The area of most concern found during this study is the nearly 13 miles between the Hwy 362 bridge and Fisherville. The primary causes for the problems in this reach are the malfunctioning wastewater facility serving the Kentucky Correctional Institute for Women and the four water withdrawals within this reach. Water quality was found to be much improved in the lower reaches of Floyds Fork primarily because streamflow increased significantly. However, water quality modeling of the lower reaches demonstrate that during conditions of lower flows, such as those previously measured by the USGS, DO reductions and violations would occur below lower Chenoweth Run, Cedar Creek, and Brooks Run.

A number of actions have been initiated to begin improving this situation. These are:

- A new wastewater plant is nearly complete for the Kentucky Correctional facility.

- Restrictions to the water withdrawals are being implemented. A new USGS gaging station has been installed at the Hwy 362 bridge. Automatic equipment will be installed that will allow the withdrawal facilities to monitor flow. When flow is 2 cfs or less, withdrawals must cease.

- Based on Kentucky Water Quality Regulations, Title 401 Chapters 5:005 Section 7(3) and 5:055, Section 2(3), and the results from this study, it is recommended that no new wastewater treatment plants be approved on the main stem of Floyds Fork in Jefferson or Bullitt Counties. An exception to this would be approval of a regional facility that would provide for the removal of numerous existing package facilities. Proposals for new wastewater facilities have already been denied in certain locations.

- It is also recommended that no new wastewater facilities be approved on several tributaries, including upper Chenoweth Run, lower Chenoweth Run, Cedar Creek and its tributaries, and Brooks Run and its tributaries. (Three approvals, one to a tributary of Brush Run, one to lower Chenoweth Run, and one to Brooks Run, have previously been granted, but construction has not yet begun. The facility on Chenoweth Run will replace an existing facility).

- Expansions of existing facilities will be examined on a case by case basis and may be allowed depending on location, size of expansion, and existing effluent limits.

- The Division supports the regional plans being developed for Oldham and Jefferson Counties and recommends the plans be implemented as soon as possible. Bullitt County is being urged to develop a plan to eliminate the numerous wastewater facilities in the Brooks Run and Cedar Creek drainage areas within Bullitt County.

The above actions do not address other issues noted from previous studies that also significantly affect water quality in developing areas; soil erosion and urban runoff. Regulatory programs to control stormwater and other sources of nonpoint source pollution have not yet been implemented. On May 23, 1991, Jefferson County Judge/Executive David L. Armstrong directed his Planning Commission to take action to preserve Floyds Fork by applying the county's Development Review Overlay regulations for additional protection of the stream beds and banks from encroachment by excavation and clearing of natural vegetation. In addition, the Planning Commission conducted public hearings in the fall of 1991 to receive citizen input regarding long-term goals for the protection of Floyds Fork. These activities plus the actions of individuals responsible for construction projects, golf course maintenance, and even the homeowner's decisions regarding lawn care, can and will affect the ability of Floyds Fork to recover and once again become a healthy stream system.

REFERENCES

1) Bowie, G. L., W. B. Mills, D. B6 Porcella, C. L. Campbell, J. R. Pagenkopt, G. L. Rupp, K. M. Johnson, P. W. H. Chan, and S. A. Gherini, Rates, Constants and Kinetics Formulations in Surface Water Ouality Modeling, 2nd ed., EPA/600/3-85/040, U.S. Environmental Protection Agency, Athens, GA, 1985.

2) Brown, L. C. and T. 0. Barnwell, Jr., The Enhanced Stream Water Quality Models OUAL2E and OUAL2E-UNCAS: Documentation and User Manual, EPA/600/3-87/007, U. S. Environmental Protection Agency, Athens, GA, 1987.

3) Buchanon, T. J., and Somers, W. P. Techniques of Water-Resources Investigations; Discharge Measurements at Gagring Stations, USGS TWRI Book 3, Chapter A-8, 1976.

4) Driscoll, E. D. (E. D. Driscoll & Assoc., Inc.), J. L. Mancini (Mancini and DiToro Consulting Inc.), and P. A. Mangarella (Woodward - Clyde Consultants), Technical Guidance Manual for Performing Wasteload Allocations, Book II, Chapters I & 2. EPA-440/4-84-020, U. S. Environmental Protection Agency, 1983.

5) Logan, Robert W., et al, Floyds Fork Drainage Biological and Water Quality Investigation for Stream Use Designation, Kentucky Division of Water, 1986.

6) Louisville and Jefferson County Metropolitan Sewer District, Stream Ouality Monitoring, an Appraisal of Water Ouality Conditions in Streams of Jefferson County, January - December 1989.

7) Mills, W. B., G. L. Bowie, T. M. Grieb and K. M. Johnson (Tetra Tech., Inc.) , and R. C. Whittemore (NCASI), Stream Sampling for Wasteload Allocation Applications EPA/625/6-86/013, U. *S.* Environmental Protection Agency, 1986.

8) Palmer, C. Mervin, Algae in Water Supplies, U. S. Dept. of Health, Education, and Welfare, 1959.

9) U.S. Geological Survey, Water Resources Data, Kentucky, Water Year 1988.