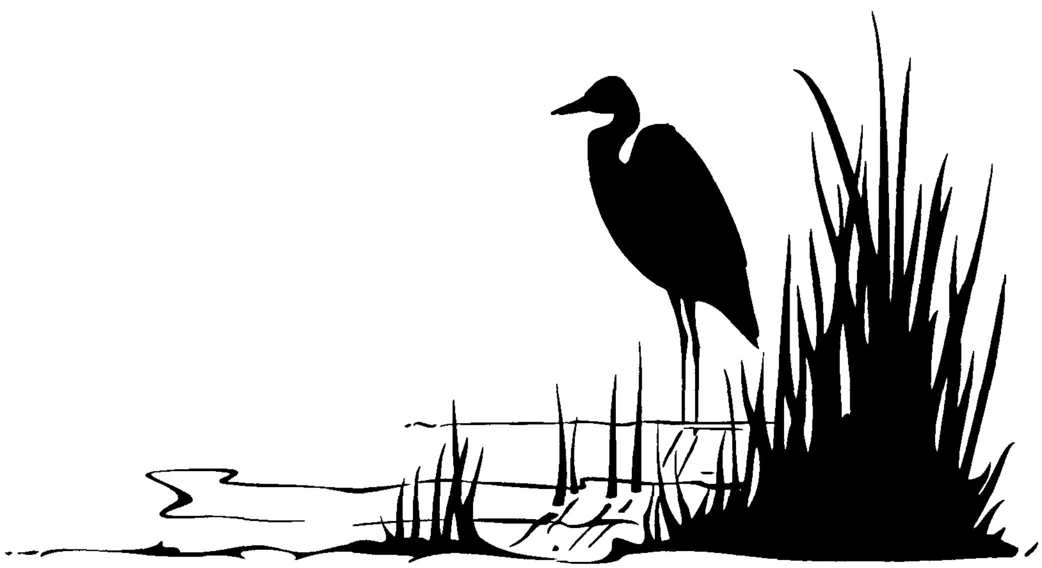
1996 Kentucky Report to Congress on Water Quality

Kentucky Natural Resources and Environmental Protection Cabinet

Division of Water



1996

KENTUCKY
REPORT TO CONGRESS
ON
WATER QUALITY

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND
ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

DIVISION OF WATER

OCTOBER 1996

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report was prepared by the Kentucky Division of Water (DOW) to fulfill requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500) as subsequently amended and commonly known as the Clean Water Act. Section 305(b) requires that states submit to the U.S. Environmental Protection Agency (EPA) on a biennial basis a report assessing current water quality conditions. This report presents an assessment of Kentucky's water quality for the period October 1993 through September 1995. Topics that are discussed in the report are: 1) monitoring programs and data sources; 2) water quality conditions and use support of streams, rivers and lakes; 3) wetland issues; 4) groundwater issues; 5) water pollution control programs; and 6) recommendations on additional actions necessary to achieve the objectives and goals of the Clean Water Act.

Water Quality Assessment

The water quality assessment of rivers and streams in this report is based on the support of designated uses in state waters depicted on U.S. Geological Survey (USGS) 1:100,000 scale topographic maps, excluding the Mississippi River. The maps contain about 49,100 miles of streams, of which approximately 9,219 miles were assessed by the DOW. The 664 miles of the Ohio River bordering Kentucky were assessed by the Ohio River Valley Water Sanitation Commission (ORSANCO). Total miles are based on Reach File 3 data files provided by EPA on 1:100,000 scale USGS maps.

Forty-four primary ambient water quality monitoring stations, characterizing approximately 1,432 stream miles within the state, were operated by the DOW during the reporting period. Also, water quality data from ten stations operated by federal and other state agencies were used. For groundwater, ambient monitoring at 70 sites statewide was begun in 1995. Biological monitoring occurred at 25 stations during 1994 and 1995. In addition, 13 lakes were sampled for eutrophication trends. Seventeen intensive surveys were conducted on 106 miles of streams to evaluate point source and nonpoint agricultural pollution, baseline water quality, and the status of water quality in streams assessed previously. Forty stations are maintained in the Reference Reach program, a recent effort to characterize the state's least impacted waters. A total of 689 miles have been assessed by this program since 1992, including several sites that did not qualify for Reference Reach status. For the first time, finished drinking water data (required of public water systems by the Safe Drinking Water Act) were used for assessing the drinking water use in 1,651 miles of streams and 57 lakes. Water Watch, a citizen's education program, has 270 water testing teams in place, each equipped with field kits that measure dissolved oxygen, pH, temperature, nitrates, chloride, and iron. Also, 160 biological monitoring teams have been placed in the field. The Water Watch Program also supports shoreline cleanup projects, community education, and leadership training. Numerous watershed organizations, particularly in urban areas, have emerged in Kentucky and are dedicated to improving river and riparian management. A total of $100,000, in the form of seed grants of up to $5,000, was again provided by the Kentucky legislature to help these organizations in their conservation efforts. The DOW has become increasingly involved with these organizations by providing them with technical support and information. Also, the DOW has created an international "Sister Rivers" project to link river groups from different countries with Kentucky-based watershed organizations.

Overall use support was assessed by following EPA guidelines that define fully supporting as fully supporting all uses for which data are available. If a segment supported one use but did not support another, it was listed as not supporting. For instance, if a segment supported a warmwater aquatic habitat use but not a primary contact recreation use, it was listed as not supporting. A segment is listed as partially supporting if any assessed use fell into that category even if another use was fully supported. Many waterbodies were assessed for only one use because data were not available to assess other uses.

Aquatic life, swimming, drinking water, and fish consumption uses were assessed. Excluding the Ohio River, full support of uses occurred in 5,982 miles (65 percent), uses were not supported in 2,056 miles (22 percent), and partial use impairment was found in 1,180 miles (13 percent) of the assessed waters (Table I.) This summary does not include ORSANCO's assessment of the mainstem of the Ohio River. ORSANCO reports that none of the 664 miles of the Ohio River bordering Kentucky fully supported swimming, fish consumption, or drinking water supply uses. For aquatic life use, 110 miles fully supported and 80 miles were not assessed. The Mississippi River, which forms 71 miles of Kentucky's western border, is assessed by Missouri.

Swimming use was impaired to a much greater extent than was aquatic life use (Figure I). The major causes of use nonsupport were fecal coliform bacteria contamination (pathogen indicators), which affected swimming use, and siltation and organic enrichment, which impaired aquatic life use (Figure II). Nonpoint sources impacted about three times as many miles as point sources. The major sources of the fecal coliform contamination were sanitary (both municipal and package wastewater treatment plants), agricultural nonpoint sources, septic tanks, and straight pipes. Sanitary wastewater facilities were also the source of the organic enrichment, while mining and agricultural nonpoint sources were the major sources of siltation (Figure III).

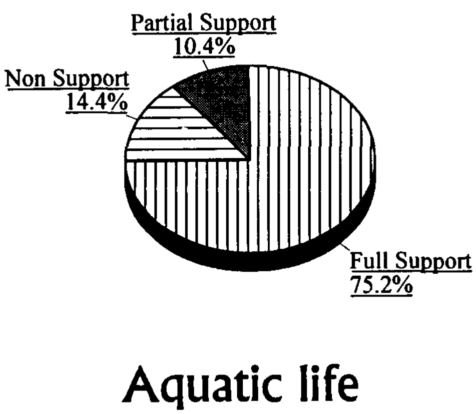
For drinking water use, only 20 of the more than 200 Public Water Supplies dependent on surface waters had violations of maximum contaminant levels (MCL) for the period 1993-95, and follow-up sampling indicated that the

Table I. Summary of Assessed Use Support[a] Miles			
	Assessed Basis		
Degree of Support	Evaluated	Monitored	Total
Fully Supporting	1765.5	4041.4	5806.9
Fully Supporting but Threatened	116.7	58.8	175.5
Partially Supporting	511.6	668.8	1180.4
Miles Not Supporting	859.6	1196.5	2056.1
TOTAL	3253.4	5965.5	9218.9

[a] Excludes mainstems of Ohio and Mississippi rivers; refer to ORSANCO and Missouri 305(b) reports

Figure I

SUMMARY OF INDIVIDUAL USE SUPPORT RIVERS AND STREAMS



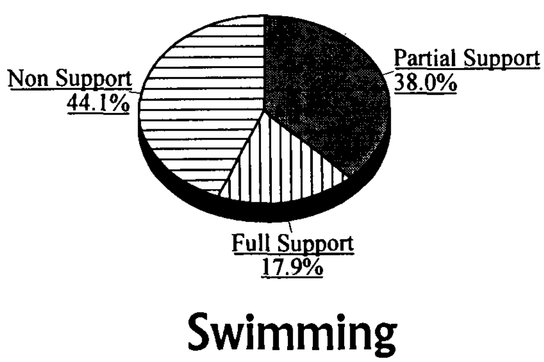


Figure II

CAUSES OF USE NONSUPPORT RIVERS AND STREAMS

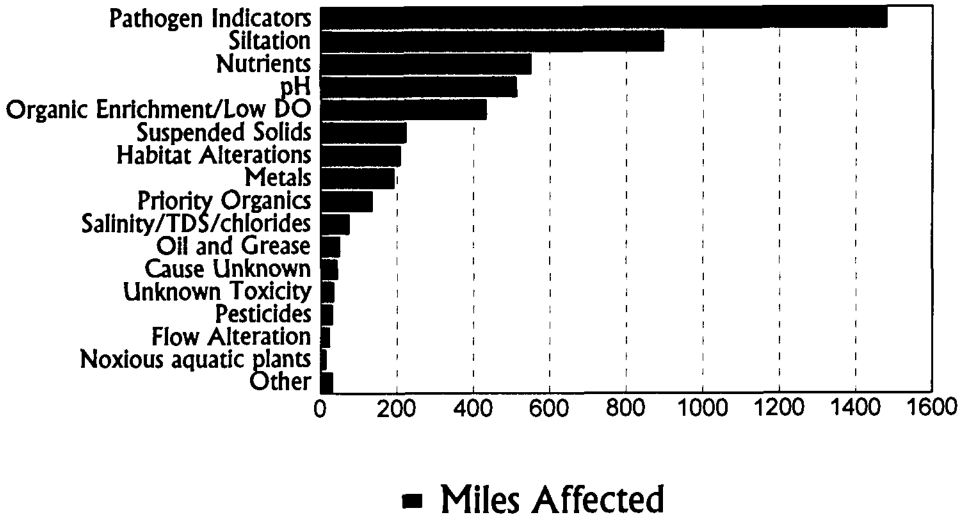
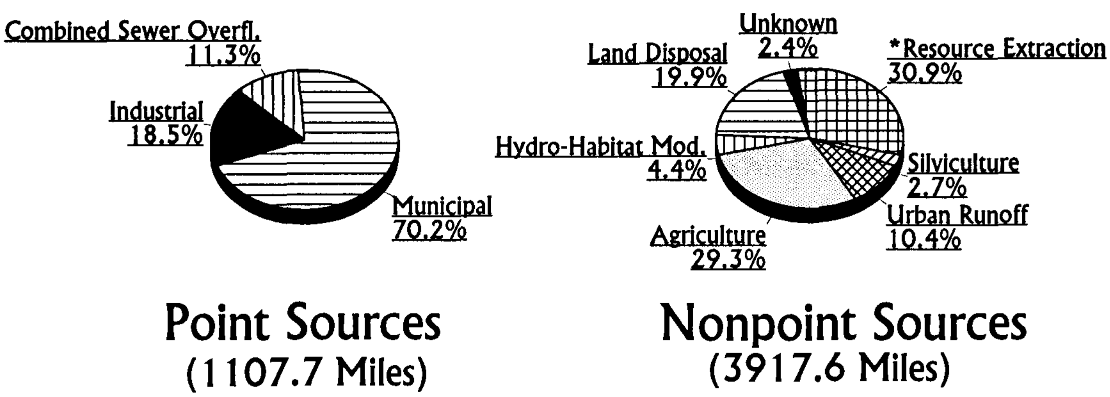


Figure III

SOURCES OF USE NONSUPPORT RIVERS AND STREAMS



* includes pre-1977 Surface Mining Control and Reclamation Act mining operations

initial violations were not significant. For groundwater sources, MCL violations have averaged about five per year for the last three years.

Inadequate sewer collection systems are a major concerns in many towns. Surface waters are impacted by overflows from these systems primarily during and immediately following rainfall events.

Trends were not assessed for the 1996 report because only two years of additional data were available since the previous trend analysis was reported in 1994. The previous trend analysis showed that there had been some notable improvements in water quality. Chloride had decreased significantly at 19 ambient monitoring stations over the past several years. Trend analysis revealed that chloride levels in the Kentucky River had returned to near background levels. The decrease in chlorides was attributed to enforcement of KPDES permit limits on oil and gas production facilities, decreased oil and gas production, and differing stream flows. Nutrients had also exhibited decreasing trends at many stations across the state.

Swimming advisories were in effect in three areas of the state, and citizens have been advised not to swim in streams in and downstream of urban areas following rainfall events. Fecal coliform contamination caused swimming advisories to be re-issued for the Licking River and two tributary streams near Covington, 86 miles of the upper reaches of the North Fork Kentucky River, and several streams in the Upper Cumberland River basin in Bell and Harlan counties.

Bacteriological surveys at Lake Cumberland, Herrington Lake, Taylorsville Lake, and Laurel River Lake indicated that the swimming use was supported in the main lakes and around major marinas and houseboat docking areas. No beaches were closed by the Parks Department during this reporting period.

Fish consumption advisories remain in effect for the Mud River and Town Branch in Logan, Butler, and Muhlenberg counties, the West Fork of Drakes Creek in Simpson and Warren counties, Green River Lake, and Little Bayou Creek in McCracken County because of PCB contamination, and for five ponds on the West Kentucky Wildlife Management Area (McCracken County) because of mercury from unknown sources. The entire length (664 miles) of the Ohio River bordering Kentucky remains posted with fish consumption advisories because of PCB and chlordane contamination. The Ohio River advisories are specifically for the consumption of channel catfish, carp, white bass, paddlefish, and paddlefish eggs. Thirty-two fish kills totaling about 172,000 fish were reported during 1994-1995, affecting 50 miles of streams. The number of fish kills, waterbodies affected, miles affected, and fish killed were the highest since 1989 and disrupted what had been a declining trend since 1986. Fish kills were most commonly attributed to oil and chemical spills.

Wetlands are considered waters of the Commonwealth and are protected from loss and degradation primarily through Water Quality Certifications issued by the DOW under the authority of Section 401 of the Clean Water Act. In 1994-95, certifications were issued for 387 activities, denied for six activities, and either waived or exempted for another 74 activities. Unavoidable impacts to wetlands require mitigation to compensate for lost wetland acreage and function.

The water quality assessment of lakes included more than 90 percent of the publicly owned lake acreage in Kentucky. Eighty-six of 120 lakes (72 percent) fully supported their uses, 28 (23 percent) partially supported uses, and 6 (5 percent) did not support one or more uses. On an acreage basis, more than 91 percent (199,718 acres) of the 218,362 assessed acres fully supported uses, 8 percent (18,192 acres) partially supported uses, and less than one percent (452 acres) did not support one or more uses (Figure IV).

Nutrients were the most frequent cause of uses in lakes not being fully supported (Figure V). Agricultural runoff and septic tanks were the principal sources of the nutrients (Figure V). PCBs affected one lake of considerable size, resulting in a high percentage of lake acres impacted by priority organics (Figure V). Naturally shallow lake basins, which allow the proliferation of nuisance aquatic weeds that impair secondary contact recreation, accounted for the second greatest cause of use nonsupport. Other natural conditions such as manganese releases from anoxic hypolimnetic water and nutrients in runoff from relatively undisturbed watersheds affected domestic water supply and secondary contact uses, respectively. Suspended solids from surface mining activities impaired the secondary contact recreation use in fewer eastern Kentucky reservoirs than in the previous two-year reporting period.

An analysis of lake trophic status indicated that of the 104 lakes assessed, 60 (57.7 percent) were eutrophic (including three that were hypereutrophic), 33 (31.7 percent) were mesotrophic, and 11 (10.6 percent) were oligotrophic. One-half of the lake acres assessed (108,151 acres) were eutrophic. Of the rest, 22 percent were mesotrophic and 29 percent were oligotrophic (Figure VI). The Lily Creek and Pitman Creek embayments of Lake Cumberland changed from a eutrophic state to a mesotrophic state, and Carr Fork Lake changed from a eutrophic to an oligotrophic state. These accounted for the major changes in lake trophic status from the 1994 305(b) report.

The envelope on the back inside cover of this report contains color-coded maps illustrating use support by major river basins. The maps include all streams and all but a few of the smaller lakes that were assessed.

Water Pollution Control Programs

Kentucky's water pollution control programs continued to improve existing and develop new approaches for controlling pollution. Permitting of combined sewer overflows (CSOs) and stormwater outfalls was initiated in the summer and fall of 1991 and proceeded throughout this 305(b) reporting period.

Figure IV

SUMMARY OF LAKE USE SUPPORT

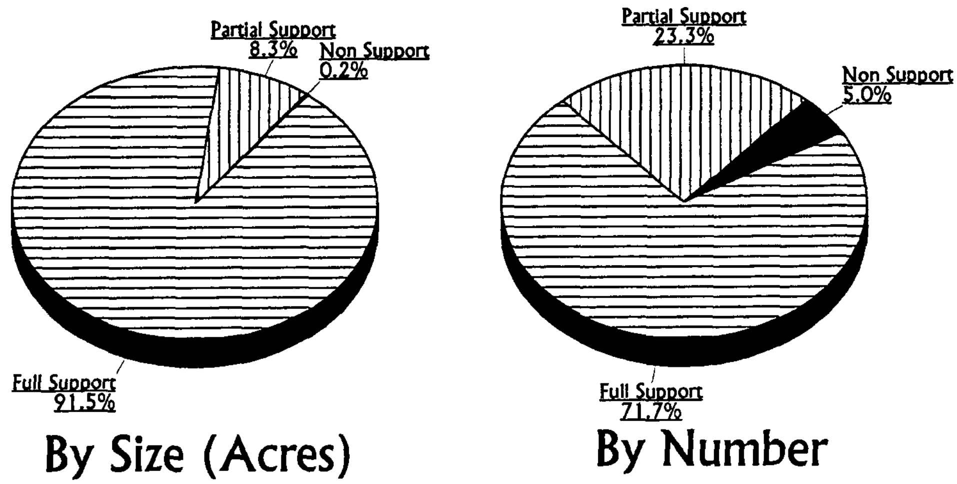


Figure V

USE NONSUPPORT IN LAKES

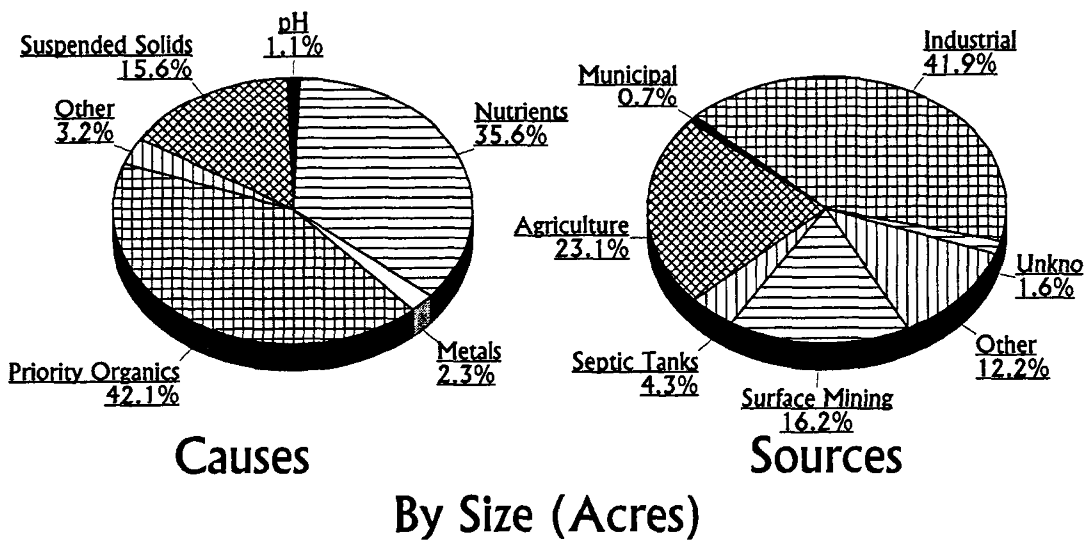
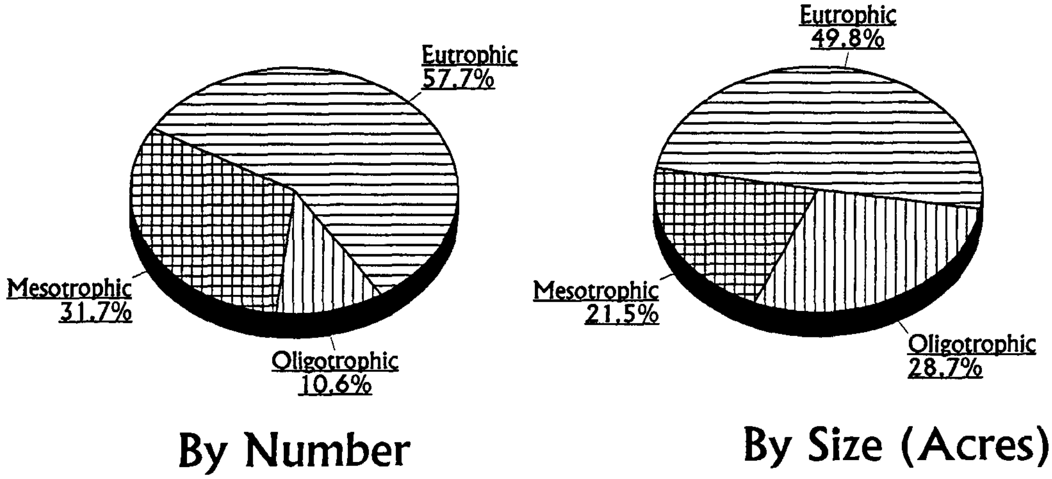


Figure VI

SUMMARY OF LAKE TROPHIC STATE



By the end of 1995, 81 municipal and 43 industrial wastewater treatment facilities had KPDES permit requirements for whole effluent toxicity testing. The DOW conducted acute and chronic toxicity tests on 39 point source discharges in 1994 and 1995. A total of 2,073 tests were conducted by permitted facilities. One hundred and four facilities (84 percent) were in compliance with their toxicity limits, and 20 facilities (16 percent) were conducting toxicity identification/reduction evaluations to reduce the toxicity of their effluents. Twenty-five facilities completed the toxicity reduction/identification process in the two-year period up to the end of 1995.

Pretreatment programs have been approved in 71 cities to better treat industrial wastes flowing into publicly owned treatment works. Sixty-four of the programs are active. New programs were approved and implemented in three municipalities. Four other municipalities needing pretreatment programs are on schedule for obtaining approval.

A state revolving loan fund program has continued to help meet the needs of wastewater treatment plant construction. Twenty-three municipal wastewater treatment projects were completed in 1994-95. These projects have either replaced outdated or inadequate treatment facilities, addressed inflow/infiltration problems, or have provided a centralized collection and treatment system for the first time. Since 1989, Kentucky has received more than $177 million in capitalization grants and has added $35 million in state funds under this program.

The Nonpoint Source (NPS) program is providing oversight and (Clean Water Act) Section 319 grant funds for 55 projects. These projects address watershed remediation, education, training, best management practice evaluation, and technical assistance. Kentucky's NPS program has received a total of more than $7 million through 319 grants from EPA since 1990.

The NPS program continues to monitor water quality in four watersheds with NPS pollution remediation demonstration projects. The Mammoth Cave, Upper Salt River/Taylorsville Lake, and Fleming Creek projects involve agricultural pollution remediation throughout the entire watershed. Biologists in the NPS program are cooperating with personnel in the Tennessee NPS Program by conducting water quality monitoring in the Bear Creek interstate watershed. Acid mine drainage in this watershed of the Big South Fork Cumberland River is being remediated by Tennessee agencies. These are long-term studies to determine nonpoint source impacts and demonstrate water quality improvements from best management practices.

Education efforts in the NPS program are producing several noteworthy achievements. Two video programs on pollution problems from nonpoint sources in Kentucky were produced under contract with Western Kentucky University. One of the videos focuses on abandoned mine lands and water quality. Funding was awarded to the American Cave and Conservation Association to assist in developing NPS-related exhibits at its American Museum of Caves and Karstlands located in Horse Cave. The DOW has contracted with the Kentucky Waterways Alliance to award small grants to local citizen waterway groups for nonpoint source education projects.

Kentucky's groundwater program continues to make advances to strengthen protection strategies and to implement regulations. A new groundwater regulation became effective in August 1994. This regulation requires facilities that conduct activities with the potential to pollute groundwater to develop and implement groundwater protection plans. Other programs have become fully established in recent years (Driller Certification Program) or have been initiated and have begun to show beneficial results (Wellhead Protection Program). Programs and regulations of agencies other than the Division of Water (e.g. State Superfund and RCRA programs) are also continuing to protect groundwater. The Groundwater Branch of the Division of Water began an ambient monitoring network of 70 sites in 1995. Groundwater data have also been collected by public water supplies as required by Phase II/Phase V of the Safe Drinking Water Act. In 1995, eight (2 percent) of these groundwater systems experienced violations of maximum contaminant levels, mostly bacteria and nitrates.

BACKGROUND

BACKGROUND

This report was prepared by the Kentucky Division of Water (DOW) to fulfill the requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500) as amended by the Clean Water Act of 1987 (P.L. 100-4). Section 305(b) requires that every two years states submit to the U.S. Environmental Protection Agency (EPA) a report addressing current water quality conditions. This report generally assesses data collected in 1994 and 1995 using EPA guidelines provided to the states. Items addressed in the report include: 1) monitoring programs and data sources; 2) water quality conditions and use support of streams rivers, and lakes; 3) wetlands issues; 4) groundwater issues; 5) water pollution control programs; and 6) recommendations on actions necessary to achieve the goals and objectives of the Clean Water Act. EPA uses the reports from the states to apprise Congress of the current water quality of the nation's waters and to recommend actions that are necessary to achieve improved water quality. States use the reports to provide information on water quality conditions to the general public and other interested parties and to help set agency pollution control directions and priorities.

Thirteen major river basins lie within Kentucky. These major basins are further divided by the U.S. Geological Survey (USGS) into 42 smaller basins called cataloging units. The major river basins (from east to west) are the Big Sandy, Little Sandy, Tygarts, Licking, Kentucky, Upper Cumberland, Salt, Green, Tradewater, Lower Cumberland, Tennessee, and Mississippi. The Ohio River minor tributaries were also assessed by the DOW. The Ohio River Valley Water Sanitation Commission (ORSANCO) provided an assessment summary of the Ohio River mainstem. Water quality assessment information on waterbodies is stored in a computer software package called the Waterbody System (WBS). The software was developed by Research Triangle Park under guidance of EPA and several states. Kentucky was one of the states involved in the testing and development of the WBS software.

The assessment of lake conditions is based on data collected by the DOW in 1994 and 1995 through a lake assessment project funded partially under the federal Clean Lakes Program and from other current monitoring data. The 120 lakes that were assessed have a total area of 218,362 acres and make up more than 90 percent of the publicly owned lake acreage in the state. This includes the Kentucky portions of Barkley, Kentucky, and Dale Hollow lakes, which are border lakes with Tennessee. An EPA estimate made in 1993 of the number of lakes in the state is based on lakes shown on the 1:100,000 scale base map and separates lakes into two groups by size. According to those estimates, Kentucky has 2,721 lakes. Of the total, 1,768 are less than 10 acres and 953 are 10 acres or greater in size.

The DOW, in collaboration with the Kentucky Department of Fish and Wildlife Resources (KDFWR), contracted with the U.S. Fish and Wildlife Service to map wetlands in the Commonwealth. According to these estimates, Kentucky has a total of 836,871 acres of wetlands of all types, including those classified as deep water. Palustrine wetlands comprise the majority (441,480) of wetland acreage.

Kentucky's population at the time of the 1990 census was 3,685,296. The state has an approximate area of 40,598 square miles. It is estimated that there are approximately 89,431 miles of streams within the borders of Kentucky. That figure was determined from the Kentucky Natural Resources Information System, which has a computerized geographic database. All of the blue-line streams on the 7.5 minute (1:24,000) USGS topographic maps were digitized to produce the figure. Main channel and tributary river miles in reservoirs are included. EPA estimates from their Reach File 3 that there are 49,105 miles of streams in the state shown on USGS 1:100,000 scale maps. Of these stream miles, 18,745 are in Kentucky's assessment base, and 9,219 were assessed for this report. Kentucky has 855 miles of border rivers. The northern boundary of Kentucky is formed by the low water mark of the northern shore of the Ohio River, and extends 664 miles along the river from Catlettsburg, Kentucky in the east to the Ohio's confluence with the Mississippi River near Wickliffe in the west. The southern boundary is formed by an extension of the Virginia-North Carolina 1780 Walker Line that extends due west to the Tennessee River. Following the acquisition of the Jackson Purchase in 1818, the 36°30' parallel was accepted as the southern boundary from the Tennessee River to the Mississippi River.

Kentucky's eastern boundary begins at the confluence of the Big Sandy River with the Ohio River at Catlettsburg and follows the main stem of the Big Sandy and Tug Fork southeasterly to Pine Mountain, for a combined length of 121 miles, then follows the ridge of the Pine and Cumberland mountains southwest to the Tennessee line. The western boundary follows the middle of the Mississippi River for a length of 71 miles and includes several of the islands in the Mississippi channel. A listing of the above information is provided in Table I.

The climate of Kentucky is classified as continental temperate humid. Summers are warm and humid with an average temperature of 76°F, while winters are moderately cold with an average temperature of 34°F. Annual precipitation averages about 45 inches, but varies between 40 to 50 inches across the state. Maximum precipitation occurs during winter and spring and minimum precipitation occurs in late summer and fall.

Summary of Classified Uses

Kentucky lists waterbodies according to specific uses in its water quality standards regulations. These uses are Warmwater Aquatic Habitat, Coldwater Aquatic Habitat, Domestic Water Supply, Primary Contact Recreation, Secondary Contact Waters and Outstanding Resource Waters (ORW). Those waters not specifically listed are classified

Table I. Atlas

State population (1990 census)	3,685,296
State surface area (square miles)	40,598
Number of major river basins	13
Total number of river miles[a]	89,431
Number of river miles in EPA Reach File 3[b]	49,105
Number of miles in assessment base	18,745
Number of miles assessed	9,219
Number of river border miles (subset)	855
Number of lakes/reservoirs	2,721
Number of lakes 10 acres or greater in size	953
Total acres of lakes/reservoirs	Unknown
Number of publicly owned lakes/reservoirs assessed	120
Lake acres assessed	218,362
Wetland acres	836,871
Total palustrine wetland acres	441,480

[a] from 1:24,000 scale USGS maps; includes reservoir main channel and tributary channel miles
[b] from 1:100,000 scale USGS maps

(by default) for use as Warmwater Aquatic Habitat, Primary and Secondary Contact Recreation, and Domestic Water Supply. The Domestic Water Supply use is applicable at points of public and semipublic water supply withdrawals. In addition, high quality waters and Outstanding National Resource Waters (ONRW) were established for antidegradation purposes in the most recent triennial review of water quality standards Recreation, and Outstanding Resource regulations. While not designated uses, High Quality status affords 45 waters additional protection, and ONRW status prohibits any degradation from occurring in three rivers. The DOW adds waterbodies to the regulation list as an ongoing process in its revision of water quality standards. Intensive survey data and data from other studies, when applicable, are used to determine appropriate uses. Currently, 4,256 stream miles are listed as warmwater aquatic habitat, 410 miles as coldwater aquatic habitat, 732 miles as ORW, 30 miles as ONRW, and 5,081 miles as primary and secondary contact recreation. Also, underground river systems within Mammoth Cave National Park have ONRW status, and underground river systems adjacent to the park are classified as ORWs. By default, more than 84,000 miles are classified for the uses of Warmwater Aquatic Habitat, Primary and Secondary Contact Recreation, and Domestic Water Supply (if applicable). There are approximately 100 domestic water supply intakes in streams and another 80 intakes in 54 lakes. Twenty-nine lakes have been classified for specific uses in the water quality standards regulations.

CHAPTER 1

WATER QUALITY ASSESSMENT OF RIVERS AND STREAMS

WATER QUALITY ASSESSMENT OF RIVERS AND STREAMS

Surface Water Monitoring Program

An effective water monitoring program is essential for making sound pollution control decisions and for tracking water quality improvements. Specifically, the Division of Water's (DOW) ambient monitoring program provides data to identify priority waterbodies upon which to concentrate agency activities, to revise state water quality standards, to aid in the development of wasteload allocations, and to determine water quality trends in Kentucky surface waters. As outlined in the Kentucky Ambient Surface Water Monitoring Strategy (DOW, 1986), the major objectives associated with the Ambient Monitoring Program are:

1. To operate a fixed-station monitoring network meeting chemical, physical, and biological data requirements of the state program and EPA's Basic Water Monitoring Program (BWMP).

2. To conduct intensive surveys on priority waterbodies in support of stream-use designations, wasteload allocation model calibration/ verification, and other agency needs.

3. To store data in EPA's STORET system, a computerized water quality data base.

4. To coordinate ambient monitoring activities with other agencies (EPA, Ohio River Valley Water Sanitation Commission, U.S. Geological Survey, U.S. Army Corps of Engineers, etc.).

The following sections discuss the various components of the monitoring program. For streams, this consists of fixed-station physicochemical and biological stream stations, reference reach sites, intensive surveys, citizens' water watch program, and volunteer stream sampling projects. The state's publicly owned lakes are monitored on a rotating basis (See Chapter 3).

Fixed-Station Ambient Monitoring Network

Physicochemical

The DOW's physicochemical monitoring network consisted of 44 stream stations located in all 13 major river basins (Table 1-1 and Figure 1-1). The Ohio River mainstem is assessed by ORSANCO, which has 11 stations on the 664 miles of the river bordering Kentucky. Samples were collected monthly at each station for the constituents listed in Table 1-2.

The DOW utilizes a single mid-channel grab sampling approach. Mid-channel grab samples have not been found to differ consistently from samples

Table 1-1. Fixed-Station Monitoring Network[a]

Map No.	Station Name	River Mile	Road Location	Biological Sampling Performed 1994-1995[b]
1	Tug Fork at Kermit	35.1	KY 40	-
2	Levisa Fork near Louisa	29.6	KY 644	-
3	Levisa Fork near Pikeville	114.6	KY 1426	-
4	Little Sandy River near Argillite	13.2	KY 1	X
5	Tygart's Creek near Load	28.1	KY 7	X
6	Kinniconick Creek near Tannery	10.4	KY 1149	X
7	Licking River at Claysville	78.2	US 62	-
8	N. Fork Licking River at Milford	6.9	KY 19	-
9	S. Fork Licking River at Morgan	11.7	KY 1054	-
10	Licking River at West Liberty	226.4	US 460	-
11	Little KY River near Bedford[e]	9.4	US 42	X
12	Kentucky River at Frankfort	66.4	St. Clair St. Bridge	X
13	Kentucky River at Camp Nelson	135.1	Old US 127	X
14	Eagle Creek at Glencoe	21.5	US 127	X
15	S. Elkhorn Creek near Midway	25.3	Moores Mill Rd. Bridge	X
16	Dix River near Danville	34.6	KY 52	X
17	Boone Creek at Hunt Club[e]	3.8	Grimes Mill Rd.	X
18	Red River at Clay City	21.6	KY 11/15	
18A	Red River at Sky Bridge	51.7	KY 715	X
19	Kentucky R. near Trapp	191.2	Red River Ferry Rd.	X
20	N. Fk Kentucky R. at Jackson	304.5[c]	Old KY 30	X
21	M. Fk Kentucky R. at Tallega	8.3	KY 708	X
22	S. Fk Kentucky R. at Booneville	12.1	KY 28	X
23	Salt River at Shepherdsville	22.9	KY 61	-
24	Salt River at Glensboro	82.5	KY 53	-
25	Rolling Fk near Lebanon Junction[d]	12.3	KY 434	-

Table 1-1. (Continued)

Map No.	Station Name	River Mile	Road Location	Biological Sampling Performed 1994-1995[b]
25A	Rolling Fk at New Haven[e]	38.8	US 31E	-
26	Beech Fork near Maud	48.1	KY 55	-
27	Pond Creek near Louisville	15.5	Manslick Rd. Bridge	-
28	Green River near Island	74.4	KY 85	X
29	Pond River near Sacramento	12.4	KY 85	X
30	Rough River near Dundee	62.5	Barrets Ford Bridge	X
31	Mud River near Gus	17.4	KY 949	X
32	Barren River at Bowling Green[d]	37.5	College St. Bridge	
32A	Barren River at L & D 1[e]	14.5	Greencastle Rd	X
33	Green River at Munfordville	225.9	US 31W	X
34	Nolin River at White Mills	80.9	White Mills Bridge	X
35	Bacon Creek near Priceville	7.2	C. Avery Rd. Bridge	X
36	Tradewater River near Sullivan[d]	15.1	US 60/641	-
36A	Tradewater River near Olney[e]	72.7	KY 1220	X
37	Little River near Cadiz	24.4	KY 272	-
38	Cumberland R. at Turkey Neck[d]	393.7	KY 214 Ferry	-
39	S. Fk. Cumberland R. At Blue Heron	44.7	Old Rail Bridge	-
40	Rock Creek near Bell Farm	17.1	White Oak Bridge	-
41	Little South Fk Cumberland R near Ritner Ford	5.4	Freedom Church	-
42	Rockcastle River at Billows	24.4	Old KY 80	-
43	Horse Lick Creek near Lamero	7.5	Daugherty Rd. Ford	-
44	Cumberland R. at Cumberland Falls	562.3	KY 90	-
45	Cumberland River at Pineville[d]	654.4	Pine St. Bridge	-
46	Martins Fk near Cumberland Gap National Park	27.4	Off Hwy 987	-
47	Clarks River at Almo	53.5	Almo-Shiloh Rd. Bridge	-
48	Mayfield Creek nr Magee Springs	10.8	KY 121	-
49	Bayou de Chien near Clinton	15.1	US 51	-

[a] Water quality samples collected monthly
[b] Stations not sampled in 1994-95 were sampled in 1992-93
[c] 49.7 miles upstream of confluence with S. Fk KY R.
[d] Water quality site only
[e] Biological site only

Figure 1-1

Fixed Station Monitoring Network

Stream Station Locations

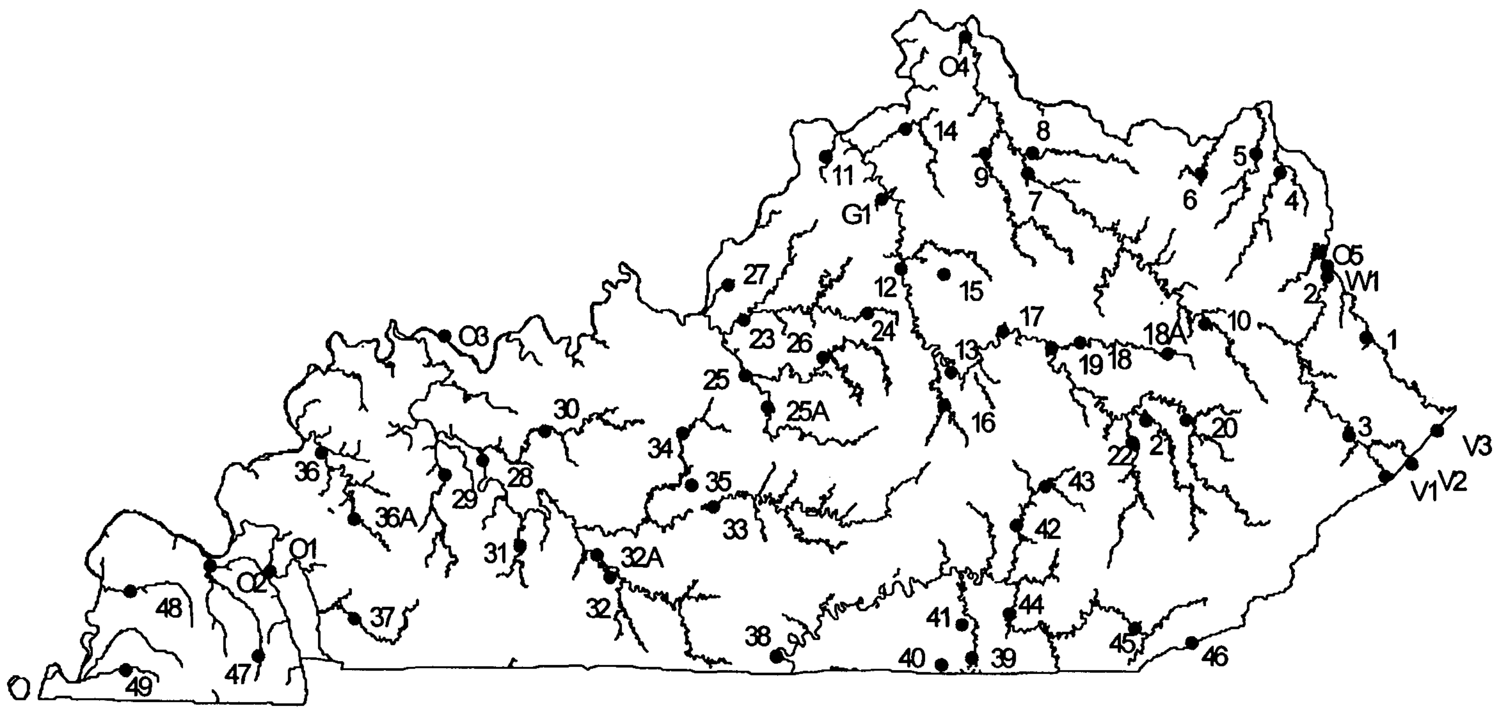


Table 1-2
Stream Fixed-Station Variable Coverage[a]

Field Data	Laboratory Data
Water temp, °C (00010)	Alkalinity, mg/l (00410)
Specific conductance, uS/cm @ 25° C (00094)	Chloride, mg/l (00940)
Dissolved oxygen, mg/l (00300)	Sulfate, dissolved mg/l (00946)
pH, S.U. (00400)	Suspended solids, mg/l (00530)
Turbidity, N.T.U. (82078)	Total organic carbon mg/l (00680)
Flow, cfs (00061)	
Minerals, Total	**Metals, Total Recoverable**
Calcium, mg/l (00916)	Aluminum, ug/l (01105)
Magnesium, mg/l (00927)	Arsenic, ug/l (01002)
Potassium, mg/l (00937)	Barium, ug/l (01007)
Sodium, mg/l (00929)	Cadmium, ug/l (01027)
Hardness, mg/l (00900)	Chromium, ug/l (01034)
	Copper, ug/l (01042)
Bacteria	Iron, ug/l (01045)
	Lead, ug/l (01051)
Fecal coliform, colonies per 100 ml (31616)	Manganese, ug/l (01055)
	Mercury, ug/l (071900)
Nutrients	Zinc, ug/l (01092)
Ammonia-nitrogen (00610)	
Nitrite & nitrate-nitrogen (00630)	
Total Kjeldahl nitrogen, mg/l (00625)	
Total phosphorus, mg/l (00665)	

[a] STORET codes are in parentheses

obtained by cross-sectionally integrated sampling. However, concentrations of suspended sediment and the total forms of some sediment-associated constituents, such as phosphorus, iron, and manganese, have been found to differ significantly, particularly under high-flow conditions. Field personnel follow guidelines in the Kentucky Standard Operating Procedure and Quality Assurance Manual for the Ambient Surface Water Monitoring Program. This manual was initially released in 1988 and has been reviewed and modified as necessary. Sampling is performed at 19 stations by the program coordinator in the central office and by regional office personnel at the other 25 stations. Field meter audits are performed semi-annually at the regional offices by the program coordinator. Data are edited for transcription errors before and after upload to STORET, EPA's national water quality data storage and retrieval system based in Research Triangle Park, North Carolina.

Excluding the mainstem of the Ohio River, water quality information generated by the fixed-station network was used to characterize 1,432 stream miles within the state. In addition to water quality information generated by its fixed-station network, the DOW used water quality data from a joint U.S. Geological Survey and Metropolitan Sewer District project at several sites in the Louisville metropolitan area and at ten sites throughout the state collected by the agencies indicated in Table 1-3.

The USGS discontinued water quality monitoring of the Kentucky River at the Lockport site in June 1995. However, the DOW began monitoring at this site in 1996.

Biological

Kentucky's biological monitoring program consists of a network of 49 stations located in 12 river basins (Table 1-1; Figure 1-1). The majority of the sites are at or near the physicochemical sampling sites. In 1993, the network was expanded to include stations on eight of the nine Kentucky Wild Rivers. Approximately one-fourth of the 49 sites are sampled each year, and sampling is done on a river basin approach. For instance, all stations in the Green River, Tygarts Creek, Little Sandy, and Tradewater river basins were sampled in 1994, and all stations in the Kentucky River basin were sampled in 1995. Data collected from these 25 stations were used to assess warmwater aquatic habitat (WAH) use support in 757.1 stream miles. The data were also used to determine potential sources of any use impairment, changes to existing water

Table 1-3. Water Quality Stations Maintained by Federal and Other State Agencies

	River Mile No.	Map
Ohio River Valley Water Sanitation Commission		
Cumberland River at Pinckneyville	16.0	O1
Tennessee R. at Paducah	5.0	O2
Green River near Sebree	41.3	O3
Licking River at Covington	4.5	O4
Big Sandy River near Louisa	20.5	O5
US Geological Survey		
Kentucky River at Lockport	31.0	G1
Virginia Dept of Environmental Quality		
Russell Fork near Elkhorn City	116.0	V1
Levisa Fork at state line	151.5	V2
Knox Creek at state line	7.6	V3
West Virginia Dept. of Natural Resources		
Tug Fork at Fort Gay, WV	0.1	W1

or habitat quality, background values against which future conditions can be compared, and problems with toxic and conventional pollutants, bacteriological contamination, and nuisance biological growth.

Algae. Algal samples were collected from each biological monitoring station using both artificial substrates (for biomass estimates) and natural substrates (for algal identification and community structure evaluation). The condition of the algal community was determined by a diatom bioassessment index (DBI), which includes the following metrics: total number of diatom species, diversity, pollution tolerance index, and relative abundance of sensitive species. Relative abundance of non-diatom algae and biomass (chlorophyll a and ash-free dry-weight) were used to arrive at the DBI.

Fish. Fish were collected for community structure evaluation at biological monitoring sites where sampling could be conducted. The condition of the fish community was determined by species richness, relative abundance, species composition, and the Index of Biotic Integrity (IBI). The IBI was used to assess biotic integrity directly by evaluation of 12 attributes, or metrics, of fish communities in streams. These community metrics include measurement of species richness and composition, trophic structure, and fish abundance and condition. The IBI was used to assign one of the following categories to a fish community: excellent, good, fair, poor, very poor, or no fish.

Macroinvertebrates. Macroinvertebrates are collected from both artificial substrates and all available natural habitats. A macroinvertebrate bioassessment index (MBI) is calculated from several other indices, including, at a minimum: 1) taxa richness, 2) total number of individuals, 3) Hilsenhoff Biotic Index, and 4) Percent Community Similarity Index. Additional metrics are used depending on factors such as ecoregion and type of impact.

Intensive Surveys

Kentucky uses intensive surveys to evaluate site-specific water quality problems. Information developed from intensive surveys is essential in providing information to:

- Document the attainment/ impairment of designated water uses.
- Verify and justify construction grants decisions.
- Address issues raised in petitions for water quality standards variances or use redesignations.
- Document water quality improvements and progress resulting from water pollution control efforts.
- Establish base-line biological data required for permit requirements and establishment of standards.

In 1994-1995, 17 intensive surveys were conducted on 106.1 miles of streams. The locations, purposes, and conclusions of these surveys are summarized in Table A1-2. Methods are similar to those described above in the fixed-station biological monitoring section. These assessments were pooled with other information to arrive at the final use-support decisions.

Reference Reach Program

The DOW began a program in 1991 to gather physical, chemical, and biological data from the state's least impacted streams. The program looks at candidate waters as representative of geographical regions of the state known as ecoregions. This program defines the physical, chemical, and biological potentials for the streams of a particular ecoregion and allows a comparison with other streams in the same ecoregion. It also helps determine the potential legitimate uses of other streams in the same region. The data from this program will provide the basis for the development of narrative and numerical biocriteria for the various ecoregions of the Commonwealth. Data on chemical water quality, sediment quality, fish tissue residue, habitat condition, and biotic conditions are collected.

Fifty-five stream sites from seven proposed ecoregions were initially sampled in the spring and fall of 1992-93 under the Reference Reach Program. For this reporting period, 11 new sites were also sampled, resulting in a total of 689 miles that have been assessed for WAH use since 1992. Forty of these sites have been placed into the Reference Reach Program (Table 1-4; Figure 1-2). Spring and fall collections will continue in order to increase the biological data base from undisturbed streams that can be used to compare with impacted streams. At the same time, program personnel will continue to develop and refine the necessary metrics used to evaluate the relationships between biotic communities and habitat conditions in streams across Kentucky.

Water Watch Volunteer Water Quality Monitoring Program

The DOW operates a volunteer services organization that conducts several key water quality improvement activities.

1. Water quality monitoring.

2. Shoreline cleanups and habitat improvement projects.

3. Community outreach and education projects.

4. Adult public participation and leadership training.

<u>Water Quality Monitoring</u>

The DOW has in place 270 water testing teams, each equipped with field kits that monitor dissolved oxygen, pH, temperature, nitrates, chlorides, and iron. Some teams have tests for detergents, phenols, or ortho-phosphate, depending on circumstances. These groups monitor local streams once each month and report their results to the DOW's Water Watch coordinator. Reports that indicate problem conditions can result in further

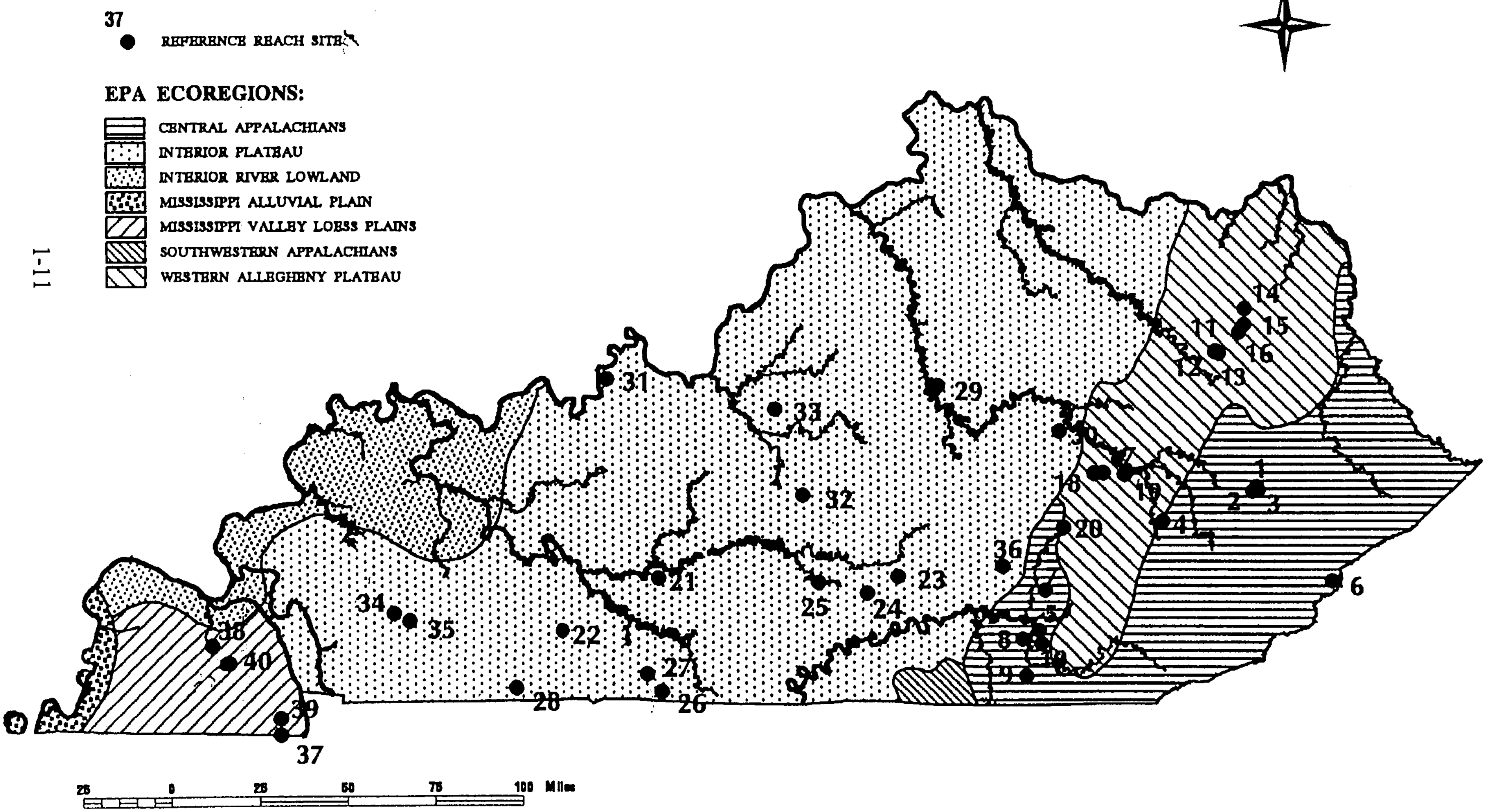
Table 1 - 4. REFERENCE REACH SITES				
Map No.	Station Name	River Mile	County	Road Location
CENTRAL APPALACHIAN ECOREGION				
Kentucky River Basin				
1	Clemons Fork	0.5	Breathitt	Robinson Forest Rd.
2	Clemons Fork	3.0	Breathitt	Robinson Forest Rd.
3	Coles Fork	0.6	Breathitt	Robinson Forest Rd.
4	Right Fork Buffalo Creek	1.1	Owsley	Off Whoopflarea Rd.
Upper Cumberland River Basin				
5	Bark Camp Creek	2.5	Whitley	USFS Rd. 193
6	Bad Branch	0.2	Letcher	KY 932 Bridge
7	Cane Creek	7.0	Laurel	Off Middle Fork Rd.
8	Eagle Creek	3.0	McCreary	KY 896 Bridge
9	Marsh Creek	12.6	McCreary	KY 478 Bridge
10	South Fork Dog Slaughter Cr.	3.6	Whitley	USFS Rd. 195
WESTERN ALLEGHENY ECOREGION				
Licking River Basin				
11	Bucket Branch	0.1	Morgan	Leisure-Paragon Rd. Br.
12	Devils Fork	0.2	Morgan	KY 711 Bridge
13	North Fork	13.0	Morgan	Off Leisure-Paragon Rd.
Little Sandy River Basin				
14	Arabs Fork	0.1	Elliott	KY 1620 Bridge
15	Big Caney Creek	7.9	Elliott	Off Binion Ford Rd.
16	Laurel Creek	7.6	Elliott	Carter School Rd. Br.
Kentucky River Basin				
17	Station Camp Creek	19.0	Estill	Off KY 1209
18	South Fork Station Camp Cr.	5.3	Jackson	KY 89 Bridge
19	Sturgeon Creek	4.0	Lee	Off Sturgeon Creek Rd.
Upper Cumberland River Basin				
20	Horse Lick Creek	1.9	Jackson	Horse Lick Creek Rd.

Table 1-4 (Continued)

INTERIOR PLATEAU ECOREGION				
Green River Basin				
21	Beaverdam Creek	7.6	Edmonson	KY 101-259 Bridge
22	Gasper River	32.4	Logan	Bucksville Rd. Bridge
23	Goose Creek	5.6	Casey	Off Brock Rd.
24	Russell Creek	60.5	Adair	KY 80 Bridge
25	Russell Creek	25.6	Adair	Off KY 768
26	Trammel Fork	18.5	Allen	Red Hill Rd. Bridge
27	Trammel Fork	26.6	Allen	Concord Church Rd. Br.
Lower Cumberland River Basin				
28	Whippoorwill Creek	4.3	Logan	KY 2395 Bridge
Kentucky River Basin				
29	Clear Creek	4.1	Woodford	Hifner Mill Rd. Bridge
30	Muddy Creek	13.4	Madison	KY 52 Bridge
Ohio River Basin				
31	Yellowbank Creek	4.4	Breckinridge	Cart-Manning Rd.
Salt River Basin				
32	Salt Lick Creek	5.3	Marion	Off Salt Lick Rd.
33	Wilson Creek	12.2	Bullitt	Mt. Carmel Church Rd.
Tradewater River Basin				
34	Sandlick Creek	6.7	Christian	Mt. Carmel-Camp Cr. Rd.
35	Upper Tradewater River	128.9	Christian	T. Sparkman Rd. Bridge
Upper Cumberland River Basin				
36	Buck Creek	28.9	Pulaski	Off Bud Rainey Rd.
MISSISSIPPI VALLEY LOESS PLAINS ECOREGION				
Tennessee River Basin				
37	Blood River	15.1	Calloway	Grubbs Lane Rd. Bridge
38	Panther Creek	1.2	Graves	KY 2580 Bridge
39	Panther Creek	1.0	Calloway	KY 280 Bridge
40	Soldiers Creek	2.6	Marshall	KY 58 Bridge

Figure 1-2

REFERENCE REACH SITES



investigation by the Field Operations Branch or Ecological Support Section. Reports are also provided to local Soil and Water Conservation Districts, planning authorities, and municipal wastewater treatment authorities.

The DOW has placed 160 biological monitoring teams that conduct simple rapid bioassessments based on the Isaak Walton League protocols. Reports are submitted to the DOW as above. The DOW also consults with local organizations conducting stream quality monitoring providing technical assistance on quality-assured monitoring with contracted laboratory services.

Shoreline Cleanups

The DOW offers technical assistance and organizational support for stream cleanups and restoration projects. Seventy-eight clean-up projects were supported by the DOW during the two-year period covered by this report. Volunteers are recruited to conduct refuse removal, tree planting, bank stabilization, and habitat improvement projects.

Community Education Projects

The DOW recruits, trains, and supplies volunteers who conduct local water quality community education campaigns. These include booths, displays, classroom presentations, and stream walks. The DOW holds at least six workshops each year providing background and orientation for the volunteer educators. The DOW supplies the volunteers with printed materials, audiovisual resources, display boards, use of the "Ollie Otter" clean water mascot, and field equipment to use in stream walks. An estimated 72,000 students and adults attended programs conducted by supported volunteer educators.

Leadership Training

The DOW sponsors training workshops for adult community group leadership on participation and involvement in community issues. This includes providing information on KPDES permitting, water quality standards review, policy development, and risk assessment. These workshops help establish a working relationship with environmental groups and neighborhood associations affected by agency permitting decisions.

Laboratory Support

The Division of Environmental Services was created in October 1982 to provide centralized laboratory services for environmental monitoring activities of the Department for Environmental Protection. Important programs requiring laboratory support include drinking water, ambient monitoring of lakes and streams, compliance monitoring of wastewater plants, ambient air monitoring, hazardous waste site investigations, and risk assessment activities. The division is organized according to functional areas in the laboratory and has an authorized staffing of 46 permanent employees. The laboratory is receiving approximately 5,000 samples annually from all programs within the department. These samples require more than 34,000 tests and result in more than 300,000 parametric results. The average time to complete testing is less than 30 days.

The Division of Environmental Services operates within the guidelines of the Department for Environmental Protection Quality Assurance Program Plan. This plan was initially established in 1983 and has been reviewed and approved by both the USEPA/Region IV Quality Assurance Officer and the Regional Administrator.

The laboratory has developed and implemented a Standard Operating Procedures Manual for daily operations, including analytical testing, chain-of-custody, data reporting, and quality assurance.

Laboratory chain-of-custody procedures are designed to ensure that custody of samples is maintained after delivery to the laboratory. Access to the laboratory is limited to authorized personnel and is controlled by a computerized security system. Visitors are required to register in and out of the laboratory and are accompanied by laboratory staff during their visit.

The Division of Environmental Services utilizes applicable, approved analytical methods and procedures as specified in the Federal Register for the following programs:

- Safe Drinking Water Act (40CFR Part 141)
- National Pollutant Discharge Elimination System (40 CFR Part 136)
- Resource Conservation and Recovery Act (40 CFR Part 261)
- Clean Air Act (40 CFR Part 53)
- Clean Water Act (40 CFR Part 35 subpart G (Appendix A), 40 CFR Part 136).

The Division has been certified since 1984 by the U.S. Environmental Protection Agency as the State Principal Laboratory for all reportable Safe Drinking Water Act measurements with the exception of radionuclides, dioxin, asbestos, and microbiological testing. Radionuclide testing is provided via contract with Teledyne Isotopes Midwest Laboratory in Northbrook, Illinois. Microbiological testing for the department is provided by certified commercial laboratories in the state. In addition, the Water Resources Laboratory at Morehead State University has been designated as the State Principal Laboratory for Microbiological Drinking Water analyses.

The Division of Environmental Services is committed to participating in several performance evaluation studies to better substantiate laboratory capability and data quality. At present these include:

- USEPA Water Pollution

Study - annually (plus follow-up study)
- USEPA Water Supply Study - annually (plus follow-up study)
- USEPA Air Pollution Studies for lead - semi-annually
- United States Geological Survey reference water samples - semi-annually
- Environmental Resource Associates - quarterly
- Resource Technology Corp. Laboratory Proficiency Testing Program - quarterly

Public Outreach

The Kentucky Legislature appropriated $100,000 in the 1994-96 biennium for matching grants to 20 local governments to "promote community and local government partnerships in restoring, maintaining, and enhancing local and regional river resources and their accompanying watershed, stream and riparian areas." Known as the Community Rivers and Streams Grants, this program is administered by the Department of Local Government with technical support provided by the DOW.

Local watershed groups working for river resource protection are being established across Kentucky. These groups are concentrating on education, water quality monitoring, water quantity, and riparian habitat protection. Most of these watershed groups are members of the Kentucky Waterways Alliance, a state-wide coalition of local organizations and individual citizens who have come together to promote networking, project support, education, and advocacy. The DOW is providing ongoing support for these local efforts.

An international Sister Rivers project, designed to promote partnerships of community-based river groups from different countries, was created by the DOW in 1993. The project seeks to pair citizens from watersheds in Kentucky with citizens from similar watersheds in other countries. Participants share common problems, ideas, and solutions to water-related issues.

Assessment Methodology

Aquatic Life and Primary Contact Recreation Use Support

The water quality and biological data described in the preceding pages were used to determine stream use support status. The data were categorized as "monitored" or "evaluated." Monitored data were derived from site specific ambient surveys and were generally no more than five years old. In some instances where watershed conditions remained mostly unchanged, monitored data collected prior to 1991 were still considered valid, and streams described by those data were categorized as monitored. Evaluated data were from other sources such as questionnaires to regional field personnel or from ambient surveys that were conducted more than five years ago. The criteria for assessing these data to determine use support are explained below.

In areas where both chemical and biological data were available, the biological data were generally the determinant factor for establishing WAH use support status. This was especially true when copper, lead, or zinc criteria were contradicted by biological criteria. The DOW made this decision in recognition of the natural ability of surface waters to sequester metals, rendering them less available to aquatic life by reducing the toxic "dissolved" fraction.

Water Quality Data

Chemical data collected by the DOW, ORSANCO, and the USGS at fixed stations were evaluated according to EPA guidelines for the preparation of this report. Water quality data were entered into EPA's national storage and retrieval (STORET) database and compared to criteria as noted in Table 1-5. All of the criteria in the table, except fecal coliform, were used to assess Warmwater Aquatic Habitat (WAH) use support. The segment fully supported the WAH use when criteria for dissolved oxygen, un-ionized ammonia, temperature, and pH were not met in 10 percent or less of the samples collected from October 1993 through September 1995. Partial support was indicated if any one criterion for these parameters was not met 11-25 percent of the time. The segment was not supporting if any one of these criteria was not met more than 25 percent of the time.

Table 1-5. Physical and Chemical Parameters and Criteria Used to Determine Use Support Status at Fixed Stations

Parameter	Criterion[a]
Dissolved oxygen	4.0 mg/l
Temperature	30°C
pH	6 to 9 units
Un-ionized ammonia-N	0.05 mg/l
Mercury	2.4 ug/l
Cadmium	$e^{(1.128 \ln x - 3.828)b}$
Copper	$e^{(.9422 \ln x - 1.464)b}$
Lead	$e^{(1.273 \ln x - 1.460)b}$
Zinc	$e^{(.8473 \ln x + .8604)b}$
Fecal coliform bacteria	400 colonies/100 ml (May 1 thru Oct. 31)

[a]from KY Water Quality Standards
[b]x = hardness in mg/l as $CACO_3$

Data for mercury, cadmium, copper, lead, and zinc were analyzed for violations of acute criteria listed in state water quality standards using three years of data (from October 1992 through September 1995). The segment fully supported its use if all criteria were met at stations with quarterly or less frequent sampling or if only one violation occurred at stations with monthly sampling. Partial support was indicated if any one criterion was not met more than once but in less than 10 percent of the samples. The segment was not supporting if criteria were exceeded in greater than 10 percent of the samples. The assessment criteria are closely linked to the way state water quality criteria were developed. Aquatic life are considered to be protected if, on the average, the acute criteria are not exceeded more than once every three years. Fecal coliform and pH data were used to indicate the degree of support for Primary Contact Recreation (swimming) use. The swimming use was fully supported if the criterion was not met in 10 percent or less of the measurements, partially supported if the criterion was not met in 11-25 percent of the measurements, and not supported if the criterion was not met more than 25 percent of the time. Streams with pH below 6.0 units were judged to not support swimming use.

Biological Data

Biological data for 1994-1995 were collected from 25 fixed monitoring network stations in six river basins, 51 reference reach sites, and 17 intensive surveys. Algae, macroinvertebrates, and fish were collected, and several community structure function metrics were analyzed for each group of organisms as described earlier in this chapter. These metrics were used to determine biotic integrity, water quality, and designated use support for each stream segment monitored (Table 1-6). Expectations for metric values are dependent upon stream size, ecoregion, and habitat quality and were applied accordingly. Bioassessments integrated data from each group of organisms, habitat data, selected physical and chemical parameters, and professional judgement of aquatic biologists.

The diatom bioassessment index classifies algal communities as excellent or good (supporting), fair (partially supporting), or poor (not supporting). For the macroinvertebrate evaluations, stream reaches were considered to fully support the WAH use if information reflected no alterations in community structure or functional compositions for the available habitats and if habitat conditions were relatively undisturbed. A reach was considered partially supporting uses when information revealed that community structure was slightly altered, that functional feeding components were noticeably influenced, or if available habitats reflected some alterations and/or reductions. Reaches were considered not supporting uses if information reflected sustained alterations or deletions in community structure, taxa richness and functional feeding types, or if available habitats were severely reduced or eliminated. For fish, reaches with an IBI of excellent or good were considered to fully support uses. Reaches were assessed as partially supporting uses if they had an IBI of fair, while reaches were considered not supporting uses when the IBI category was poor, very poor, or no fish.

Intensive Survey Data

Seventeen intensive surveys to determine use support were conducted in the 1994-1995 biennium. Data also were used from surveys conducted between 1986 and 1993. The streams were assessed by evaluating principally the biological communities (refer to Table 1-6), and secondarily physicochemical, toxicity, and habitat data, watershed activities, direct observation, and professional judgement. To analyze biological data, the DOW uses a multi-component approach involving algae, macroinvertebrate, and fish communities. At least two of the three components were used to assess water quality. Each component was analyzed using a variety of metrics that have proven sensitive to a wide variety of impacts. Stream mileages were grouped as supporting, supporting but threatened, partially supporting, or nonsupporting designated uses. Streams were considered to support designated uses if no or minor impacts to the biotic integrity, physical habitat, and water quality were observed. Supporting but threatened waters were those in which human activities occurring in the upstream drainage were extensive enough to degrade water quality if pollution abatement measures were not taken. Streams were determined to be partially supporting when the data indicated either stressed biotic communities, minor violations of water quality criteria, or some physical impairment to aquatic habitats. Nonsupporting streams were those showing severe stress, such as sustained species deletions, trophic imbalances in the biotic communities, chronic violations of water quality criteria, and severely impaired aquatic habitats.

Table 1-6
Biological Criteria for Assessment of
Warmwater Aquatic Habitat (WAH) Use Support

	Fully Supporting	Partially Supporting	Not Supporting
Algae	Diatom Bioassessment Index (DBI) classification of excellent or good, biomass similar to reference/control or STORET mean.	DBI classification of fair, increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor, biomass very low (toxicity), or high (organic enrichment).
Macroinvertebrate	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high EPT, sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in RA of sensitive taxa. Some alterations of functional groups evident.	MBI classification of poor, EPT low, TNI of tolerant taxa very high. Most functional groups missing from community.
Fish	Index of Biotic Integrity (IBI) excellent or good, presence of rare, endangered or species of special concern.	IBI fair	IBI poor, very poor, or no fish.

EPT = Ephemeroptera, Plecoptera, Trichoptera, RA = Relative Abundance, TNI = Total Number of Individuals

Regional Office Visits

Visits were made to the ten DOW regional offices to discuss water quality issues with field inspectors. Often, problems that were not identified by other means became evident by these discussions. Also, potential causes and sources of the problems were often known by the inspectors, who spend much of their time in the field.

Discharge Monitoring Data

Discharge monitoring report (DMR) data, collected by KPDES permit holders, were accessed through DOWs permit compliance system (PCS) database. Depending on the relative sizes of the wastewater discharge and the receiving stream and the severity of permit violations, it was often possible to assess instream uses as threatened or impaired.

Kentucky Department of Fish and Wildlife Resources Data

Fisheries investigation reports prepared by the Kentucky Department of Fish and Wildlife Resources (KDFWR) were used to assess WAH use for several streams. The DOW also sent questionnaires to District Fisheries Biologists of the KDFWR. The responses consisted of both monitored and evaluated assessments. The biologists were requested to rate the waterbody fishery either good or poor. If poor, the biologist was asked to state the reason(s).

In this assessment of use support, only those questionnaire responses indicating definite support or nonsupport were used. A waterbody was considered to fully support WAH use if:

(1) the waterbody supported a good fishery based on presence of both young-of-year and adult sport fishes or served as a nursery for a larger waterbody and

(2) water quality was judged good, with no repeated history of fish kills.

A waterbody did not support the WAH use if:

(1) the waterbody fishery was poor, and

(2) water quality was judged poor, with a history of recurrent fish kills.

Miles assessed by the district biologists' questionnaires are significantly fewer than were miles in the previous 305(b) report because of different methods of grouping streams into waterbodies. In the 1994 report, a waterbody consisted of several streams in a small watershed, and results were extrapolated from the primary stream in the waterbody to smaller streams in the waterbody. In the 1996 report, each stream is a distinct waterbody, and assessments were made on only those streams on which specific information was obtained.

The KDFWR conducts field surveys that identify streams capable of supporting a sustainable year-round trout fishery. These data allow the DOW to classify streams as Coldwater Aquatic Habitat (CAH). Streams classified as CAH were considered to fully support the CAH use and were considered as monitored waters in the assessment.

Another source of data for the evaluated category was a list of streams recommended by the KDFWR as candidates for Outstanding Resource Waters. They were recommended because of their outstanding value as sport fishing streams. These streams were assessed as fully supporting warmwater aquatic habitat use if there were no data which conflicted with the assessment.

Other Data Sources

The Louisville and Jefferson County Metropolitan Sewer District, in cooperation with the USGS, has a monitoring program for streams in Jefferson County. Twenty-six stations are monitored for a variety of parameters including fecal coliform bacteria. Macroinvertebrate and fish collections are also made. The chemical and bacteriological data from 1989 to 1991 were used for this report, and they were considered to be monitored data in the assessments.

Field work conducted for the U.S. Fish and Wildlife Service, and verified by the Kentucky State Nature Preserves Commission (KSNPC) and KDFWR, identified streams in Kentucky that harbored the blackside dace, a federally threatened species of fish. This work was considered as monitored data. These streams are automatically classified as Outstanding Resource Waters and were judged to fully support the WAH use.

Data from streams surveyed by the KSNPC for a special project to obtain background aquatic biota and water quality data in the oil shale region of the state was published in a 1984 report entitled Aquatic Biota and Water Quality and Quantity Survey of the Kentucky Oil Shale Region. Although more than ten years old, these data are still considered valid and were used in this report.

The Blaine Creek watershed has been monitored by the COE - Huntington District for several years in conjunction with the Yatesville Lake project. The COE macroinvertebrate and chemical data were utilized for this report.

U.S. Forest Service data were used for several streams in the Daniel Boone National Forest.

Fish Consumption Use Support

Fish consumption is a category that, in conjunction with aquatic life use, assesses attainment of the fishable goal of the Clean Water Act. Assessment of the fishable goal was separated into these two categories in 1992 because a fish consumption advisory does not preclude attainment of the aquatic life use and vice versa. Separating fish consumption and aquatic life uses gives a clearer picture of actual water quality conditions.

The following criteria were used to assess support for the fish consumption use:

- Fully Supporting: No fish advisories or bans in effect.

- Partially Supporting: "Restricted consumption" fish advisory or ban in effect for general population or a subpopulation that could be at potentially greater risk (e.g., pregnant women, children). Restricted consumption is defined as limits on the number of meals consumed per unit time for one or more fish species.

- Not Supporting: "No consumption" fish advisory or ban in effect for general population, or a subpopulation that could be at potentially greater risk, for one or more fish species; commercial fishing ban in effect.

Drinking Water Use Support

In 1986, amendments to the Safe Drinking Water Act (SDWA) required the U.S. Environmental Protection Agency (EPA) to set drinking water standards for 83 contaminants listed in the Act and an additional 25 contaminants every three years thereafter. EPA established a phased approach for introducing standards and requirements for testing for the first group of 83 contaminants.

Phase I - established maximum contaminant levels (MCLs) for a group of 8 volatile organic compounds.

Phase II - established MCLs for 17 pesticides, 8 inorganics, 10 volatile organics, a new MCL for PCBs (polychlorinated biphenyls), and deleted the MCL for silver.

Phase III - set criteria for radionuclides.

Phase IV - set criteria for disinfection by-products and for disinfection for groundwater.

Phase V - set drinking water standards for 5 inorganics, 3 volatile organics, 9 pesticides, and 6 other organic contaminants.

Other rules: public notification, total coliform, surface water treatment, lead and copper.

Criteria were set for other contaminants, such as bacteria and secondary contaminants, in other rules outside this phased approach.

Phase II of EPA's schedule required monitoring and reporting for a large number of contaminants to be completed by 1995. Phase V established maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) for a number of the Phase II contaminants. (MCLs are enforceable standards considered feasible and safe. MCLGs are nonenforceable health goals that water systems should try to achieve.) Phase V also took advantage of the monitoring information provided through Phase II. These two phases required testing for the largest number of contaminants of the five phases.

Original cost estimates for each

water system to do Phase II/Phase V analyses ranged from $10,000 to $12,000 a year. Because of costs and the small number of laboratories certified to do the required tests (in 1993, there were no labs fully certified for these tests in Kentucky), the Department for Environmental Protection committed its analytical laboratory, the Division of Environmental Services, and the Division of Water (DOW) to carry out testing for systems that served 10,000 or fewer customers. Larger public and industrial/commercial systems were responsible for their own sampling and analysis.

The department conducted sample analyses and provided sampling containers, preservatives, supplies, and transportation costs involved in getting the samples to the lab. During 1993, DOW personnel spent 3,844 hours in various aspects of the sampling program. The project consumed almost all of the laboratory's capacity for analyzing organics. Organic analysis of other samples collected by the department were contracted to commercial laboratories.

Sampling for each system was done on a quarterly basis, and results from four consecutive quarters were used to determine compliance.

Sampling for the first of the small systems was accomplished in 1993. The department completed the testing for 168 systems that year without missing a quarter.

No sampling was done by the department in 1994 because the laboratory moved its facilities to the new state central laboratory. Any interruption in the quarterly testing would have nullified results, and testing would have had to be repeated. However, approximately 70 facilities collected samples that were analyzed by recently certified commercial laboratories. Samples were collected at another 160 systems and analyzed by DES in 1995. The remaining 50 to 60 water systems, most very small, will be sampled in 1996.

Following the initial four quarters of sampling, a three-year monitoring period will be established. Waivers may be granted for individual systems for various contaminants based upon initial sampling results and vulnerability of the system to those contaminants.

Sampling and analysis of the state's smaller public drinking water systems has been a large, complex undertaking. However, the state will have a solid database for basing decisions about future monitoring to ensure the safety of drinking water for Kentuckians.

For purposes of assessing drinking water use, the Phase II/Phase V finished water results were compared to MCLs. Although not a quantitative measurement of ambient water quality, it highlights waters in which certain pollutants are high enough to exceed drinking water criteria even after conventional treatment by the drinking water plant. Lacking instream data, which historically has been scarce in Kentucky for drinking water constituents, EPA's 1996 305(b) report guidance recommends using the finished water data for assessing drinking water use.

Use Support Summary

Overall use support was assessed by following EPA guidelines that define fully supporting as fully supporting of all uses for which data are available. If a segment supported one use, but did not support another, it was listed as not supporting. For instance, if a segment supported a WAH use but not a primary contact recreation use, it was listed as not supporting. A segment is listed as partially supporting if any assessed use fell into that category even if another use was fully supported. Many waterbodies were assessed for only one use because data were not available to assess other uses.

Table 1-7 shows that of the 9,219 miles assessed, 65 percent fully supported uses and 35 percent were impaired (partial or non-support) for one or more uses. This summary does not include ORSANCO's assessment of the mainstem of the Ohio River. ORSANCO reports that none of the 664 miles of the Ohio River bordering Kentucky fully supported swimming, fish consumption, or public water supply uses. For aquatic life use, 110 miles fully supported and 80 miles were not assessed. The Mississippi River, which forms 71 miles of Kentucky's western border, is assessed by Missouri.

Table 1-8 shows the summary results of individual use assessments. The use most impaired was swimming, with only 18 percent of waters assessed supporting that use. In contrast, aquatic life use was fully supported in more than 75 percent, partially supported in 10 percent, and not supported in 14 percent of the assessed waters.

When individual use support is broken down by major river basin, it can be seen that some river basins had much higher percentages of uses being supported (Table 1-9). For example, aquatic life use was met in greater than 65 percent of the stream miles assessed in all river basins except the Big Sandy and the Tradewater. Ten river basins had 16 percent or less of their assessed stream miles supporting swimming use.

Causes of Use Nonsupport

Table 1-10 indicates the relative causes of use nonsupport. Stream segment lengths that either did not support or partially supported uses were combined to indicate the miles that were affected. Fecal coliform bacteria (pathogen indicators) were the greatest cause of use impairment and affected swimming use in 1,479 miles of streams and rivers. Siltation was the second greatest cause of use impairment, affecting aquatic life use in 897 miles of streams and rivers. Siltation affects the use by covering available habitat and reducing habitat for aquatic organisms. Other leading causes of use impairment were nutrients (549 miles), pH (511 miles, usually from acid mine drainage), and organic enrichment (431 miles). It should be noted that mileages of causes are not additive because more than one cause can affect the same reach of stream.

Table 1-7. Summary of Assessed[a] Use Support (miles)			
	Assessment Basis		
Degree of Use Support	Evaluated	Monitored	Total
Fully Supporting	1765.5	4041.4	5806.9
Fully Supporting but Threatened	116.7	58.8	175.5
Partially Supporting	511.6	668.8	1180.4
Miles Not Supporting	859.6	1196.5	2056.1
TOTAL	3253.4	5965.5	9218.9

[a]Excludes mainstems of Ohio and Mississippi rivers; refer to ORSANCO and Missouri 305(b) reports for assessments.

Table 1-8. Summary of Individual Use Support for Rivers and Streams

Use	Supporting	Supporting but Threatened	Partially Supporting	Not Supporting	Total
Aquatic Life	6171 (72.8%)	208 (2.4%)	878 (10.4%)	1221 (14.4%)	8478
Fish Consumption	1579 (91.7)	7 (0.4%)	14 (0.8%)	123 (7.1)	1723
Swimming	323 (13.8%)	95 (4.1%)	891 (38.0%)	1033 (44.1%)	2342
Drinking Water Supply	1651 (100%)	0	0	0	1651

Sources of Use Nonsupport

Sources of use nonsupport were assessed under point and nonpoint categories and are listed in Table 1-11. Nonpoint sources as a whole affected nearly three times as many miles of streams as point sources. In some cases, both nonpoint and point sources contribute to use nonsupport in a particular surface water.

Resource extraction (1,185 miles), agricultural nonpoint sources (1,126 miles), and municipal and package plant sanitary wastewater point sources (777 miles) were the leading sources of use nonsupport. About 500 miles of the resource extraction source category are attributed to acid mine drainage from abandoned mine lands that pre-date the Surface Mining Control and Reclamation Act of 1977.

Another way to analyze the data would be to say that of the 9,219 total miles assessed, resource extraction and agriculture impacted 13 and 12 percent, respectively.

Again, the source mileages are not additive because more than one source can affect the same reach of stream.

Rivers and Streams Not Supporting Uses

Appendix A1-3 lists specific stream segments that did not fully support designated uses. Stream segments affected, type of assessment data (monitored or evaluated), and causes and sources of impairment are also listed. Stream use support is shown graphically on the maps in the back cover.

Changes in Use Support: 1994 to 1996

Several waterbodies showed an improvement or a decline in water quality and a change in use support status since the 1994 report (Table 1-12). Many of the changes were in the swimming use category. The changes in swimming use support are probably most related to differing rainfall patterns between the years as fecal coliform contamination has been positively linked to rain events.

Trends in Water Quality

An assessment of water quality trends was performed at 31 ambient monitoring stations for the 1994 report and will be performed for the next 305(b) report when more than two years of additional data are available. The previous analysis showed decreasing trends for most of the 12 variables tested, including chloride and nutrients (nitrogen and phosphorus compounds). Iron exhibited an increasing trend at the majority of stations.

Public Health/Aquatic Life Impacts

Toxics

Although the biological monitoring program focuses on the protection of aquatic life from toxics and conventional pollutants, an underlying theme of aquatic life protection is subsequent public health protection. The DOW has played an increasing role in public health protection through assessing the need for fish consumption advisories based on

Table 1-9. Individual Use Support by Major River Basin (Miles)				
Basin	**Supporting**	**Threatened**	**Partially Supporting**	**Not Supporting**
Big Sandy				
Aquatic Life	344.5	22.1	206.7	111.6
Fish Consumption	107.6	7.0	0.0	0.0
Swimming	10.7	94.3	95.1	119.5
Drinking Water	128.5	0.0	0.0	0.0
Green River				
Aquatic Life	1185.9	5.9	98.6	248.3
Fish Consumption	387.9	0.0	0.0	116.2
Swimming	71.3	0.0	181.7	213.0
Drinking Water	418.5	0.0	0.0	0.0
Kentucky River				
Aquatic Life	970.9	19.7	242.6	267.9
Fish Consumption	456.1	0.0	0.0	0.0
Swimming	68.3	1.0	288.5	143.4
Drinking Water	413.2	0.0	0.0	0.0
Licking River				
Aquatic Life	646.0	8.8	42.8	96.5
Fish Consumption	75.4	0.0	0.0	0.0
Swimming	0.0	0.0	82.7	109.8
Drinking Water	337.0	0.0	0.0	0.0
Little Sandy				
Aquatic Life	213.6	0.0	0.0	11.9
Fish Consumption	43.7	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	26.0
Drinking Water	22.2	0.0	0.0	0.0
Lower Cumberland				
Aquatic Life	543.8	65.1	79.7	0.0
Fish Consumption	134.9	0.0	0.0	0.0
Swimming	101.7	0.0	0.0	27.2
Drinking Water	209.1	0.0	0.0	0.0

Table 1-9 (CONT.)				
Basin	**Supporting**	**Threatened**	**Partially Supporting**	**Not Supporting**
Mississippi River				
Aquatic Life	218.4	1.7	11.9	7.0
Fish Consumption	5.3	0.0	0.0	0.0
Swimming	35.4	0.0	11.9	0.0
Drinking Water	0.0	0.0	0.0	0.0
Ohio River (minor tribs)				
Aquatic Life	538.3	13.9	22.0	113.0
Fish Consumption	0.0	0.0	0.0	6.5
Swimming	0.0	0.0	48.5	29.8
Drinking Water	16.1	0.0	0.0	0.0
Salt River				
Aquatic Life	484.3	23.4	60.0	114.6
Fish Consumption	70.9	0.0	13.8	0.0
Swimming	10.2	0.0	50.1	55.5
Drinking Water	35.8	0.0	0.0	0.0
Tennessee River				
Aquatic Life	176.4	15.4	21.5	14.3
Fish Consumption	84.3	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	0.0
Drinking Water	0.0	0.0	0.0	0.0
Tradewater River				
Aquatic Life	68.3	0.0	26.3	92.9
Fish Consumption	0.0	0.0	0.0	0.0
Swimming	16.7	0.0	0.0	92.9
Drinking Water	5.1	0.0	0.0	0.0
Tygarts Creek				
Aquatic Life	88.9	0.0	0.0	2.1
Fish Consumption	89.1	0.0	0.0	0.0
Swimming	0.0	0.0	45.7	0.8
Drinking Water	11.3	0.0	0.0	0.0
Upper Cumberland				
Aquatic Life	691.8	31.6	66.2	140.6
Fish Consumption	123.5	0.0	0.0	0.0
Swimming	9.0	0.0	86.8	212.4
Drinking Water	54.1	0.0	0.0	0.0

Table 1-10
Causes of Use Nonsupport in Rivers and Streams

Cause Category	Miles Affected: Major Impact	Miles Affected: Moderate/ Minor Impact
Pathogen indicators	1300.5	178.8
Siltation	719.9	176.7
Organic enrichment/D.O.	281.4	149.9
Nutrients	237.7	311.5
pH	448.8	62.0
Metals	120.2	70.7
Salinity/TDS/ Chlorides	72.5	2.6
Priority organics	120.8	13.2
Unknown toxicity	30.0	3.6
Habitat alterations	71.0	159.4
Oil and grease	20.8	30.0
Suspended solids	25.0	197.9
Other	50.4	25.4

Table. 1-11
Sources of Use Nonsupport in Rivers and Streams

Source Category	Miles Affected: Major Impact	Miles Affected: Moderate/ Minor Impact
Point Sources		
Municipal/Package Plants	383.2	394.0
Industrial	130.9	73.9
Combined sewer overflows	67.4	58.3
TOTAL	581.5	526.2
Nonpoint Sources		
Resource extraction	1036.8	148.6
Agriculture	640.5	485.8
Land disposal/ septic tanks	389.0	373.7
Urban Runoff/ Storm sewers	218.7	180.8
Hydro/Habitat modification	93.2	76.6
Silviculture	29.8	72.8
Construction/ Development	26.4	51.9
Other	20.6	8.5
TOTAL	2455.5	1405.2
Unknown	82.1	10.9

the concentrations of contaminants in fish tissue samples.

Fish Consumption Advisories

Six individual fish consumption advisories are currently in effect in Kentucky (Table 1-13). The advisories are based on contaminant residues exceeding the U.S. Food and Drug Administration (FDA) action levels in edible portions (fillets). PCBs are the contaminant of concern in five of the six advisories. Chlordane is also of concern in the Ohio River advisory, and mercury is responsible for the sixth advisory. All advisories were jointly agreed upon and issued by the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC), the Kentucky Department of Fish and Wildlife Resources (KDFWR), and the Cabinet for Health Services (formerly Human Resources). Operational protocols established in 1990 outline the roles of each agency

Table 1-12
Changes in Use Support at Ambient Monitoring Stations
1994 to 1996

	Non-or Partial Support to Full Support	**Full Support to Non - or Partial Support**
Waterbody		
Levisa Fork near Louisa	X	
Tygarts Creek near Load		X
Kinniconick Creek		X
Middle Fork Kentucky River at Tallega		X
South Fork Kentucky River at Booneville		X
North Fork Kentucky River at Jackson		X
Red River at Clay City		X
Eagle Creek		X
North Fork Licking River at Lewisburg		X
Rockcastle River		X
Beech Fork near Maud	X	
Horse Lick Creek		X
Green River near Munfordville		X
Green River near Island		X
Barren River at Bowling Green		X
Little River	X	
Bacon Creek		X
Tradewater River near Sullivan	X	
Clarks River near Almo	X	
Mayfield Creek		X
Bayou de Chien		X

Table 1-13
Fish Consumption Advisory Summary

Stream	Pollutants	Source	Miles Covered	Date Established	Comments
Town Branch/Mud River (Logan, Butler, and Muhlenburg Counties)	PCBs	Dye-casting plant	71.5	October 1985	Cleanup in progress; monitoring continues. All species covered.
West Fork Drakes Creek (Simpson and Warren Counties)	PCBs	Adhesive plant	46.9	April 1985	Monitoring continues; levels in fish appear to be declining. All species covered.
Little Bayou Creek (McCracken County)	PCBs	Gaseous diffusion plant	6.5	April 1985	On-site clean-up in progress; monitoring continues; contamination appears limited to Little Bayou Creek. All species covered.
Ohio River (entire length of Kentucky border)	PCBs Chlordane	Urban runoff; no known point source discharge	663.9	June 1989	Channel catfish, carp, white bass,paddlefish, (and eggs) Monitoring continues.
West Kentucky Wildlife Management Area(McCracken Co)	Mercury	Unknown	5 Ponds	Nov. 1993	Largemouth bass
Green River Lake (Taylor and Adair counties)	PCBs	Gas pipeline compres-sor station	Entire Lake	Feb. 1994	Carp and channel catfish

in issuing fish consumption advisories. Additionally, ORSANCO and the states bordering the Ohio River coordinate the Ohio River advisory. In addition to the six advisories discussed above, Missouri has maintained an advisory on the 71 miles of the Mississippi River bordering Kentucky because of chlordane in fish tissue.

Conventional Pollutants

Chlorine, un-ionized ammonia, oxygen demanding substances, and pathogenic organisms such as bacteria and viruses are classed as conventional pollutants. These pollutants are a cause of concern because they are often responsible for fish kills or, like bacteria and viruses, can pose a threat to human health. Reports on fish kills, bacteriological evaluations of water quality, and beach closures are discussed below.

Fish Kill Incidents

Thirty-two fish- kill reports were received by KDFWR between January 1, 1994 and December 31, 1995. These kills involved 50 miles of streams. Oil and chemical spills were the most commonly identified causes of fish kills, but the causes of 21 fish-kill incidents were unknown. Table 1-14 summarizes the severity, causes, and locations of fish kills during the reporting period. A synopsis of fish-kill records from 1980-1993 is shown in Table 1-15.

Bacteriological Evaluations of Swimming Use

Fecal coliform bacteria are measured in water samples as indicators of the potential presence of other disease-causing bacteria. The most common illnesses experienced from swimming in waters contaminated by fecal coliform bacteria are gastroenteritis, ear infections, and skin infections (swimmers itch).

Several swimming advisories are in effect throughout Kentucky. These involve segments of several streams in the upper Cumberland River basin, 86 miles of the upper North Fork Kentucky River, and the lower Licking River and two tributary streams (see Appendix A1-4.). Also, the DOW and local governments have recommended that persons refrain from swimming in streams in and downstream of urban areas, especially after significant rainfall.

Bacteriological surveys were conducted during the 1994-1995 recreation seasons in the areas listed below:

- North Fork Kentucky River
- Upper Cumberland River Basin
- Three-mile Creek/Lower Licking River/Banklick Creek
- Fleming Creek
- Laurel River Lake
- Taylorsville Lake

Table 1-14
Fish Kill Summary

		1994	1995	Total
Severity:	Light(<100)	0	2	2
	Moderate (100-1,000)	4	5	9
	Major (>1,000)	4	7	11
	Unknown	3	7	10
	Total	11	21	32
Cause:	Sewage (WWTP)	1	3	4
	Agricultural operation	1	1	2
	Mining or oil operation	0	1	1
	Oil or chemical spill	2	5	7
	Natural (low D.O., etc.)	2	1	3
	Herbicides	0	0	0
	Unknown	5	10	15
	Total	11	21	32
River Basin:	Big Sandy	0	0	0
	Licking	2	3	5
	Kentucky	2	10	12
	Salt	3	2	5
	Green	2	2	4
	Upper Cumberland	0	2	2
	Lower Cumberland	0	0	0
	Tennessee	1	1	2
	Ohio tributaries	1	0	1
	Total	11	21	32
Approximate number of stream miles		13.82	36.14	49.96
Estimated number of fish killed		56,859	115,557	172,306

Table 1-15
Fish Kill Synopsis, 1980-1995

Year	Number of Incidents	Number of Waterbodies	Stream Miles Affected	Surface Acres Affected	Number Fish Killed	Number Major Fish Kills*	Known Causes
1980	24	25	53.2	-	22,413	10	10
1981	26	30	74.3	-	81,266	7	10
1982	26	28	52.0	72.0	98,436	5	12
1983	36	41	51.3	7.0	76,187	8	19
1984	33	35	67.3	47.5	106,514	7	18
1985	29	27	86.9	4.5	59,499	5	9
1986	23	20	23.3	47.0	129,583	10	9
1987	30	32	58.3	200.0	229,583	10	14
1988	19	16	105.6	-	319,212	10	10
1989	23	23	47.8	9.0	222,330	9	11
1990	16	17	19.4	1.10	74,170	5	5
1991	17	18	36.9	25.0	60,038	7	7
1992	16	18	34.45	-	100,859	6	13
1993	5	5	4.31	-	60	0	5
1994	11	10	13.82	68	56,749	4	8
1995	21	20	36.14		115,557	7	14

* > 1000 fish killed

o Herrington Lake

A swimming advisory was issued in July 1990 for the entire length (162.6 miles) of the North Fork Kentucky River. Ten mainstem monitoring stations were used to monitor fecal coliform levels. As a result of compliance sampling inspections, fines totaling $31,000 were issued to all permitted dischargers in the drainage that failed to meet KPDES permit limits for fecal coliform levels in their effluents. An improvement in water quality was found in May, 1993, and the swimming advisory was removed from approximately 76 miles in the lower portion of the drainage. However, numerous straight pipes (more than 1,200 in one county), which discharge untreated waste, were found in the upper portion of the drainage and are preventing the North Fork Kentucky River from attaining the primary contact recreational use.

Nonpoint source (Section 319) funds have been secured under the federal fiscal year 1994 grant to help implement a single on-site wastewater project for several homes at locations to be determined in the North Fork Kentucky River basin. These funds will also be used for education, enforcement, monitoring, and best management practices implementation.

An intensive survey was conducted in July and August 1993 in the upper Cumberland River basin. Water and wastewater samples for fecal coliform analysis were collected on two occasions at 21 mainstem stations and 43 tributary stations, as well as from the effluents of nine municipal wastewater treatment plant facilities (Williamsburg, Barbourville, Pineville, Loyall, Harlan, Cumberland, Benham, Lynch, and Evarts). Instream stations included five water plant intake locations (Williamsburg, East Knox, Harlan, Cumberland, and Cawood), four USGS gaging stations, and one drain pipe.

Four of nine municipal facilities tested did not meet KPDES permit limits for fecal coliform bacteria (Williamsburg, Pineville, Loyall, and Evarts). The effluents of Williamsburg, Pineville, and Evarts were indicative of raw sewage with little or no disinfection. Straight pipes, which discharge raw sewage, were also observed during the survey.

Fecal coliform data were collected again in 1994 and 1995 in the upper Cumberland basin. Sampling was performed at municipal wastewater treatment plants, package plants, and instream sites. This sampling resulted in the issuance of 25 Notices of Violation and 15 package plants referred to enforcement. Several municipalities, including Pineville, Harlan, and Benham, have either planned, begun, or brought on line new treatment facilities.

As a result of this intensive work in the Upper Cumberland River basin, swimming advisories were issued in 1994 and re-issued in 1995 for portions of the Cumberland River, Martins Fork, Poor Fork, and Looney Creek and for the entire reaches of Catrons Creek, Clover Fork, and Straight Creek. (See Appendix A1-4).

The DOW sampled Three-Mile Creek, Banklick Creek, and the lower Licking River in Campbell and Kenton counties in 1991 and found they were polluted by fecal coliform bacteria. Advisories were sent to residents, creeks were posted, and notices were published in local newspapers about the risk of swimming in these waters. The DOW and the University of Kentucky, the latter with Clean Water Act Section 104(b) funds awarded to the DOW, continued to monitor these areas for CSO impacts. The data indicated the problems were persisting, and advisories have been re-issued in each subsequent year.

Herrington, Taylorsville, and Laurel River lakes were monitored for the presence of fecal coliform bacteria during the 1994 recreation season (May thru October) and found to fully support swimming and other recreational uses. With support from a Section 314 grant obtained by the Water Quality Branch from EPA, three sites were sampled at both Herrington and Taylorsville lakes: in the headwaters, at midlake, and near the dam. Laurel River Lake was sampled at ten sites on a monthly basis during the recreational season by personnel from the DOW's London Regional Office.

The results of sampling indicated that all three lakes support both primary (i.e. swimming) and secondary (i.e. boating) contact recreational uses. With the exception of May 10 at Van Buren, all 26 samples collected from Taylorsville Lake were below the upper fecal coliform limit considered safe for swimming (400 fecal coliform colonies per 100 ml). The fecal coliform level at Van Buren on that day was most likely due to a period of wet weather that caused agricultural runoff from nonpoint sources in the headwater tributaries. A water sample collected on June 7 at Settlers Trace Marina was the only other sample above the geometric mean fecal coliform standard for primary contact recreational uses (200 colonies per 100 ml). Most of the remaining samples from Taylorsville Lake contained fecal coliform bacteria at very low levels. With the exception of a water sample collected at Sim's Midlake Boat Dock on July 12, all 26 water samples from Herrington Lake had fecal coliform levels less than 100 colonies per 100 ml. All monthly samples from Laurel River Lake were less than 400 colonies per 100 ml, usually much less.

Beach Closures

No state park beaches were closed during the 1994 or 1995 recreational seasons because of fecal coliform bacteria contamination. The Department of Parks built a swimming pool at Fort Boonesboro State Park that replaced the beach as a swimming area. The Department of Parks monitored the following state park beaches:

- Barren River Lake
- Buckhorn Lake
- General Butler
- Grayson Lake
- Green River Lake
- Greenbo Lake
- J.J. Audubon
- Kentucky Dam Village
- Lake Barkley
- Lake Cumberland
- Lake Malone
- Pennyrile Forest
- Rough River Dam

Public Health: Drinking Water

Of the more than 200 public water supply systems on surface waters sampled in the Phase II/Phase V program in 1993-95, only 20 had MCL violations as a result of contaminants present in the source water. Some systems had more than one MCL violation. The majority of violations were for thallium (8) and antimony (7). There were also three violations of the MCL for ethylene dibromide, two for arsenic, and one each for nickel, barium, and selenium. Stream segments with MCL violations were initially assessed as partially supporting drinking water use, which resulted in 217 impaired stream miles. However, follow-up sampling at the surface water supplies indicated no further MCL violations, and 1,651 miles of surface waters were assessed as supporting the drinking water use.

CHAPTER 1 APPENDICES

A1-1	Biological Monitoring Stations and Warmwater Aquatic Habitat Use Assessment
A1-2	Intensive Surveys Conducted During FFY 1994-1995
A1-3	Impaired Streams
A1-4	Swimming Advisory Notice

TABLE (A1 - 1) BIOLOGICAL MONITORING STATIONS AND WARMWATER AQUATIC HABITAT (WAH) USE ASSESSMENT (1994-1995)		
STATION	**MILES ASSESSED**	**WAH USE SUPPORT**
Green River Basin	**278.7**	
Green River - Munfordville	66.7	Full Support
Green River - Island	25.0	Full Support
Bacon Creek	31.2	Full Support
Barren River	21.0	Full Support
Mud River	21.5	Partial Support
Nolin River	49.2	Full Support
Pond River	30.1	Partial Support
Rough River	34.0	Full Support
Kentucky River Basin	**328.8**	
Kentucky River-Frankfort	53.7	Full Support
Kentucky River - Camp Nelson	39.9	Full Support
Kentucky River - Lock 11	35.4	Full Support
Kentucky River - Lock 14	29.0	Full Support
North Fk Kentucky River	9.2	Partial Support
Middle Fk Kentucky River	43.2	Full Support
South Fk Kentucky River	33.5	Full Support
Boone Creek	7.4	Full Support
Dix River	3.0	Full Support
Eagle Creek	38.8	Partial Support
Red River	18.1	Full Support
South Elkhorn Creek	17.6	Partial Support
Little Sandy River Basin	**39.3**	
Little Sandy River	39.3	Full Support
Ohio River Minor Basins	**38.3**	
Kinniconick Creek	24.5	Full Support
Little Kentucky River	13.8	Full Support
Tradewater River Basin	**26.3**	
Tradewater River	26.3	Partial Support
Tygarts Creek Basin	**45.7**	
Tygarts Creek	45.7	Full Support

Table A1-2. Intensive Surveys Conducted During FFY 1994 - 1995

Waterbody Name	Survey Purpose	Year Surveyed	Total Miles Assessed	Miles Supporting Uses	Miles Supporting Uses but Threatened	Miles Partially Supporting Uses	Miles Not Supporting Uses	Conclusions
Ohio River Basin								
Hite Creek	To determine the impact of municipal WWTP effluent on instream biological communities	Fall 1995	5.5				5.5	The first 1.9 miles are impacted by effluent from a municipal WWTP and the remaining 3.6 miles are degraded by nonpoint source pollution.
Big Bone Creek	To determine baseline water quality.	Spring 1995	2.1		2.1			Nonpoint source pollution from upstream agricultural operations is increasing siltation.
Gunpowder Creek	To determine the impact of ethylene glycol on instream biological communities	Spring 1995	5.0			2.7	2.3	Ethylene glycol from airplane deicing operations has degraded 2.3 miles of stream while 2.7 miles are impacted by unknown sources.
Pond Creek and UT Pond Creek	To determine the impact of a privately owned waste treatment plant (WWTP) on the instream biological communities.	Spring 1994	2.4 0.9		0.9	1.5 0.4	 0.5	A privately owned WWTP has impacted the lower 0.5 mi. of UT-Pond Creek and the lower 1.5 miles of Pond Creek. The upper 0.5 mi of Pond Creek above the UT are affected by nonpoint souce agricultural activities.

Table A1-2. Intensive Surveys Conducted During FFY 1994 - 1995

Waterbody Name	Survey Purpose	Year Surveyed	Total Miles Assessed	Miles Supporting Uses	Miles Supporting Uses but Threatened	Miles Partially Supporting Uses	Miles Not Supporting Uses	Conclusions
Kentucky River Basin								
Kentucky River Drainage Clarks Run	To determine the impact from municipal WWTP effluent on instream biological communities.	Fall 1995	13.9		7.3	4.3	2.3	A municipal WWTP is degrading 6.6 miles of stream below the discharge. 7.3 miles above the WWTP are supporting water quality criteria but are threatened by nonpoint source urban runoff and agricultural activities.
Logan Creek	To determine the impact from municipal WWTP effluent on instream biological communities.	Fall 1995	3.5		3.5			The lower 3.5 miles of Logan Creek are supporting warmwater aquatic life criteria but are threatened by municipal WWTP effluent and nonpoint source agricultural pollution.
Cumberland River Basin								
Pitman Creeek	To determine the impact from municipal WWTP effluent on instream biological communities	Fall 1995	5.4		3.7	1.7		A municipal WWTP is degrading 1.7 miles of stream below the effluent discharge. 3.7 miles above the WWTP are supporting warmwater aquatic life criteria but are threatened by nonpoint source agricultural pollution.
Sinking Creek	To determine baseline water quality	Fall 1995	1.8		1.8			The lower 1.8 miles are supporting warmwater aquatic life criteria but are threatened by urban runoff.

Table A1-2. Intensive Surveys Conducted During FFY 1994 - 1995

Waterbody Name	Survey Purpose	Year Surveyed	Total Miles Assessed	Miles Supporting Uses	Miles Supporting Uses but Threatened	Miles Partially Supporting Uses	Miles Not Supporting Uses	Conclusions
Green River Basin								
Little Pitman Creek	To determine the impact from municipal WWTP effluent on instream biological communities.	Fall 1995	5.3		1.1	4.2		At least 4.2 miles below a municipal WWTP have been impacted by effluent. The 1.1 miles above the WWTP were supporting warmwater aquatic life criteria but are threatened by unknown sources.
South Fork Russell Creek and UT #1 UT #2	To determine the impact of oil well brine discharges on instream biological communities.	Winter 1995	6.4 0.6 0.5	1.6 0.5	4.8		 0.6	A total of 6.4 miles of South Fork Russell Creek supports warmwater aquatic life criteria. 4.8 miles below UT #1 are threatended by brine discharges occurring in UT #1. UT#1 does not support warmwater aquatic life criteria.
Green River	To determine baseline water quality.	Summer 1994	12.0		12.0			Twelve miles of the Green River within the Mammoth Cave National Park are supporting warmwater aquatic life criteria but are threatened by an upstream municipal WWTP and nonpoint source agriculture activities.

Table A1-2. Intensive Surveys Conducted During FFY 1994 - 1995

Waterbody Name	Survey Purpose	Year Surveyed	Total Miles Assessed	Miles Supporting Uses	Miles Supporting Uses but Threatened	Miles Partially Supporting Uses	Miles Not Supporting Uses	Conclusions
Salt River Basin								
Salt River	To determine the impact from municipal WWTP effluent on instream biological communities.	Fall 1995	9.9		7.1	2.8		In Harrodsburg area, 2.8 miles of river have been impacted by municipal WWTP effluent. The remaining 7.1 miles support warmwater aquatic life criteria but are threatened by nonpoint source agriculture pollution.
Town Creek	To determine baseline water quality	Fall 1995	4.0		4.0			All 4.0 miles are supporting warmwater aquatic life criteria but are threatened by urban runoff.
Mill Creek	To determine the impact of a privately owned WWTP effluent on instream biological communities.	Fall 1993	7.0	2.8	4.2			All 7.0 miles are supporting warmwater aquatic life criterior, but 4.2 miles are threatened by effluent from a privately owned WWTP.
Mill Creek Branch and UT	To determine the impact of a privately owned WWTP effluent on instream biological communities.	Fall 1993	0.7 0.4			0.7	 0.4	Both Mill Creek Branch and the UT both have been impacted by effluent from a privately owned WWTP.

Table A1 - 2. Intensive Surveys Conducted During FFY 1994 - 1995

Waterbody Name	Survey Purpose	Year Surveyed	Total Miles Assessed	Miles Supporting Uses	Miles Supporting Uses but Threatened	Miles Partially Supporting Uses	Miles Not Supporting Uses	Conclusions
Licking River Basin								
Hinkston Creek	To determine the impact of municipal WWTP effluent on instream biological communities.	Fall 1995	7.8		4.9	2.9		Hinkston Creek above the WWTP (4.9 miles) supports warmwater aquatic life criteria but is threatened by agricultural nonpoint source pollution. A stream reach of 2.9 miles below the WWTP is degraded by the municipal WWTP effluent.
Somerset Creek	To determine baseline water quality	Fall 1995	3.9		3.9			All 3.9 miles support warmwater aquatic life criteria but are threatened by agricultural nonpoint source pollution.
	Totals		106.1	4.9	68.4	21.2	11.6	

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
BIG SANDY RIVER BASIN				
Beaver Creek (Floyd Co.)	AL-NS	0.0-7.0	Siltation	Resource Extraction
Big Sandy River (Lawrence Co.)	AL-PS AL-PS AL-PS AL-PS AL-PS	9.3-10.3 12.4-13.4 14.4-15.4 18.0-19.0 23.8-25.8	Other habitat alterations	Hydromodification
Buck Branch (Floyd Co.)	AL-NS SW-NS	0.0-0.7 0.0-0.7	pH	Resource Extraction
Bull Creek (Floyd Co.)	AL-PS	0.0-7.2	Pathogens Siltation	On-site Wastewater Systems (Septic Tanks) Resource Extraction
Horse Creek (Boyd Co.)	AL-NS SW-NS	0.0-1.0 0.0-1.0	Pathogens Organic enrichment/ low DO Nutrients	Sanitary Sewer Overflow
Hurricane Creek (Pike Co.)	AL-NS SW-NS	0.5-2.9 0.5-2.9	pH	Resource Extraction
Jennys Creek (Johnson Co.)	AL-NS	0.0-18.8	Siltation	Construction
Johns Creek (Floyd Co.)	AL-PS	19.5-107.2	Siltation	Resource Extraction
Knox Creek (Pike Co.)	AL-PS	0.0-7.6	Siltation	Resource Extraction
Left Fork Beaver Creek (Knott Co.)	AL-NS	0.0-28.0	Siltation	Resource Extraction
Left Fork Blaine Creek (Lawrence Co.)	AL-PS	0.0-7.3	Salinity/TDS/Chlorides	Petroleum Activities
Left Fork Middle Creek (Floyd Co.)	AL-NS SW-NS	4.2-9.5 4.2-9.5	pH	Acid Mine Drainage
Levisa Fork (Lawrence Co.)	AL-PS SW-NS SW-PS	116.2-124.1 57.6-124.1 1.0-38.9	Pathogens	On-site Wastewater Systems (Septic Tanks) Sanitary Sewer Overflow Municipal Point Source

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Lick Fork (Floyd Co.)	AL-NS SW-NS	0.0-2.0 0.0-2.0	pH	Resource Extraction
Long Fork (Pike Co.)	AL-NS SW-NS	0.0-5.1 0.0-5.1	pH	Resource Extraction
Middle Creek (Floyd Co.)	AL-PS	0.0-18.0	Siltation	Resource Extraction
Mud Creek (Floyd Co)	SW-PS	0.0-17.0	Pathogens	On-site Wastewater Systems (Septic Tanks)
Mudlick Creek (Floyd Co)	AL-PS	0.0-11.0	Siltation	Resource Extraction
Right Fk Beaver Creek (Knott Co)	AL-NS	0.0-39.0	Siltation	Resource Extraction
Right Fk Blaine Creek (Lawrence Co)	AL-PS	0.0-6.2	Salinity/TDS/Chlorides	Petroleum Activities
Russell Fork (Pike Co)	SW-PS	0.0-12.9	Pathogens	Sanitary Sewer Overflow
Shelby Creek (Pike Co)	AL-PS SW-PS	0.0-27.3 0.0-27.3	Pathogens Siltation	On-site Wastewater Systems (Septic Tanks) Resource Extraction
Stinking Branch (Pike Co)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Acid Mine Drainage
Tug Fork (Lawrence Co)	SW-NS	0.0-36.2	Pathogens	On-site Wastewater Systems (Septic Tanks)
Wolf Creek (Martin Co.)	AL-PS	0.0-20.5	Siltation	Resource Extraction
LITTLE SANDY RIVER BASIN				
Little Sandy River (Greenup Co.)	SW-NS	11.7-37.7	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture
Newcombe Co. (Elliott Co.)	AL-NS	0.0-11.9	Salinity/TDS/Chlorides	Petroleum Activities

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
TYGARTS CREEK BASIN				
Hood Creek (Boyd Co.)	AL-NS SW-NS	0.0-0.8 0.0-0.8	Pathogens Organic Enrichment/low DO Nutrients	Sanitary Sewer Overflow
Tygarts Creek (Greenup Co.)	AL-NS SW-PS	77.5-77.7 0.0-45.7	Pathogens Organic Enrichment/low DO	Agriculture Municipal Point Sources
White Oak Creek (Greenup Co.)	AL-NS	0.0-1.1	Other Habitat alterations	Habitat Modification
UPPER CUMBERLAND BASIN				
Bacon Creek (Whitley Co.)	AL-NS	0.0-4.0	Suspended Solids Other habitat alterations	Hydromodification
Barren Fork (McCreary Co.)	AL-NS SW-NS	0.0-5.3 0.0-5.3	pH	Acid Mine Drainage
Bear Creek (McCreary Co.)	AL-NS SW-NS	0.0-3.2 0.0-3.2	pH	Subsurface Mining Surface Mining
Bennets Fork (Bell Co.)	AL-PS	0.0-6.3	Other habitat alterations Siltations	Resource Extraction
Big Lily Creek (Russell Co.)	AL-NS	4.4-7.0	Salinity/TDS/Chlorides Organic Enrichment/low DO	Urban Runoff/Storm Sewers Municipal Point Sources
Brush Creek (Rockcastle Co.)	SW-NS	1.1-7.5	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture
Buck Creek (Whitley Co.)	AL-NS	1.4-2.8	Turbidity Other habitat alterations Siltation	Resource Extraction
Bucks Branch (Whitley Co.)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Acid Mine Drainage
Cane Branch (McCreary Co.)	AL-NS SW-NS	0.0-2.0 0.0-2.0	PH	Acid Mine Drainage

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Catron Creek (Harlan Co.)	SW-NS	0.0-8.5	Pathogens	On-site Wastewater Systems (Septic Tanks) Package Plants Municipal Point Sources
Clear Creek (Bell Co.)	SW-NS	2.5-3.7	Pathogens	Package Plants
Clear Fork Branch (Clinton Co.)	AL-PS SW-PS	2.6-3.6 2.6-3.6	Pathogens Organic Enriched/Low DO Nutrients	Municipal Point Sources
Clover Fork (Harlan Co.)	SW-NS	0.0-34.5	Pathogens	On-site Wastewater Systems (Septic Tanks) Package Plants Municipal Point Sources
Cloverlick Creek (Harlan Co.)	AL-NS	0.0-5.0	Suspended Solids Other habitat alterations	Resource Extraction
Copperas Creek (McCreary Co.)	AL-NS SW-NS	0.0-3.8 0.0-3.8	pH	Acid Mine Drainage
Crooked Creek (Rockcastle Co.)	SW-PS	1.0-6.4	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture
Crummies Creek (Harlan Co.)	AL-NS SW-NS	0.0-6.4 0.0-6.4	Suspended Solids pH Metals	Resource Extraction
Cumberland River (Upper Section) (Monroe Co.)	SW-NS SW-NS	650.6-654.4 684.9-694.2	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture Sanitary Sewer Overflow Municipal Point Sources
Devils Creek (McCreary Co.)	AL-NS SW-NS	0.0-2.4 0.0-2.4	pH	Acid Mine Drainage
East Ridge Branch (Knox Co.)	AL-NS	0.0-1.5	Other habitat alterations	Silviculture
Fugitt Creek (Harlan Co.)	AL-NS	0.0-4.5	Suspended Solids Other habitat alterations	Resource Extraction

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Gillis Branch (Laurel Co.)	AL-PS	1.7-3.2	Oil and Grease Siltation	Spills Construction
Greasy Creek (Bell Co.)	SW-PS	0.0-11.4	Pathogens	Source Unknown
Horse Creek (Laurel Co.)	AL-PS	0.0-1.0	Oil and Grease	Land Disposal
Horse Lick Creek (Rockcastle Co.)	SW-PS	0.0-21.2	Pathogens	On-Site Wastewater Systems (Septic Tanks)
Indian Creek (Jackson Co.)	AL-PS SW-PS	3.3-7.3 3.3-7.3	Suspended Solids Pathogens pH Nutrients	Resource Extraction Silviculture
Jennys Branch (McCreary Co.)	AL-NS	0.0-5.5	Suspended Solids	Construction
Lacy Fork (Pulaski Co.)	AL-PS SW-PS	0.0-1.0 0.0-1.0	pH	Resource Extraction
Left Fork Straight Creek (Bell Co.)	AL-NS SW-NS	0.0-13.0 0.0-13.0	Suspended Solids Pathogens pH	On-site Wastewater Systems Resource Extraction Package Plants
Lick Creek (McCreary Co.)	AL-NS SW-NS	0.0-5.7 0.0-5.7	Suspended Solids Other habitat alterations pH Metals	Resource Extraction
Little Clear Creek (Bell Co.)	AL-PS	0.0-16.4	Suspended Solids Other habitat alterations	Resource Extraction Silviculture
Little Laurel River (Laurel Co.)	SW-NS AL-NS	12.4-14.6 12.4-14.6	Pathogens Organic Enrichment/low DO Nutrients	Municipal Point Sources
Little Racoon Creek (Laurel Co.)	AL-NS SW-NS	0.0-7.7 0.0-7.7	Salinity/TDS/Chlorides pH Metals	Resource Extraction
Looney Creek (Harlan Co.)	SW-NS	0.0-5.5	Pathogens	Package Plants Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Lynn Camp Creek (Whitley Co.)	AL-PS	0.0-8.5	Oil and Grease Metals	Spills Urban Runoff/Storm Sewers Sanitary Sewer Overflow Water Treatment Plants Municipal Point Sources
Marsh Creek (McCreary Co.)	AL-NS	18.7-24.0	Other habitat alterations Siltation	Resource Extraction Agriculture
Martins Fork (Harlan Co.)	AL-NS SW-NS SW-NS	18.0-31.3 0.0-10.1 18.0-31.3	Pathogens pH	Resource Extraction Municipal Point Sources
Middle Fork Stinking Creek (Knox Co.)	AL-NS	0.0-1.5	Suspended Solids Other habitat alterations	Silviculture Agriculture
Pitman Creek (Pulaski Co.)	AL-PS	4.0-5.7	Nutrients Unknown Toxicity	Agriculture Municipal Point Sources
Pleasant Run (Whitley Co.)	AL-NS	2.0-2.7	Suspended Solids Other habitat alterations	Hydromodification Agriculture
Pond Creek (Jackson Co.)	AL-NS SW-NS	5.0-7.7 5.0-7.7	Suspended Solids Pathogens Organic Enrichment/low DO Unionized Ammonia	Package Plants Municipal Point Sources
Poor Fork (Harlan Co.)	SW-NS	0.0-25.1	Pathogens	On-site Wasterwater Systems (Septic Tanks) Package Plants Municipal Point Sources
Puckett Creek (Bell Co.)	SW-PS	0.0-10.0	Pathogens	Source Unknown
Robinson Creek (Laurel Co.)	AL-NS	0.0-13.1	Salinity/TDS/Chlorides Siltation	Resource Extraction
Rock Creek (McCreary Co.)	AL-NS SW-NS	0.0-4.1 0.0-4.1	Suspended Solids Other habitat alterations pH Metals	Resource Extraction

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Rockcastle River (Pulaski Co.)	SW-PS	8.5 -41.3	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture Municipal Point Sources
Ryans Creek (McCreary Co.)	AL-NS SW-NS	0.0-5.3 0.0-5.3	Suspended Solids pH	Acid Mine Drainage
Sinking Creek (Pulaski Co.)	AL-PS SW-NS	1.8-4.5 0.0-2.5	Oil and Grease Pathogens Cause Unknown	Source Unknown Resource Extraction Municipal Point Sources
Spring Creek (Clinton Co.)	AL-PS	3.7-7.3	Oil and Grease	Resource Extraction
Stinking Creek (Knox Co.)	AL-NS	9.5-12.6	Suspended Solids Other habitat alterations	Silviculture Agriculture
Straight Creek (Bell Co.)	SW-NS	0.0-23.5	Pathogens	On-Site Wastewater Systems (Septic Tanks)
Turkey Creek (Bell Co.)	AL-NS SW-NS	0.0-2.7 0.0-2.7	Suspended Solids Other habitat alterations pH	Resource Extraction
White Oak Creek (McCreary Co.)	AL-NS SW-NS	0.0-4.2 0.0-4.2	Suspended Solids Other habitat alterations pH Metals	Resource Extraction
White Oak Creek (Rockcastle Co.)	AL-NS	0.0-4.0	Suspended Solids Other habitat alterations	Silviculture
Whitley Branch (Laurel Co.)	SW-NS	0.0-2.5	Pathogens	Off-farm Animal Holding/Management Area Sanitary Sewer Overflow
Wildcat Branch (Pulaski Co.)	AL-NS SW-NS	0.0-2.1 0.0-2.1	pH	Acid Mine Drainage
Yellow Creek (Bell Co.)	AL-PS	0.0-18.5	Siltation Nutrients	Municipal Point Sources
Yocum Creek (Harlan Co.)	SW-NS	0.0-6.5	Pathogens	On-site Wastewater Systems (Septic Tanks)

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
LICKING RIVER BASIN				
Allison Creek (Fleming Co.)	AL-NS SW-NS	0.0-4.7 0.0-4.7	Noxious Aquatic Plants Pathogens Organic Enrichment/low DO Nutrients	Animal Operations Pasture Land Agriculture
Banklick Creek (Kenton Co.)	AL-NS SW-NS	0.0-19.0 0.0-19.0	Pathogens Other habitat alterations Organic Enrichment/low DO Nutrients	Hydromodification Urban Runoff / Storm Sewers Combined Sewer Overflow Municipal Point Sources
Beaver Creek (Menifee Co.)	AL-NS	13.5-14.5	Suspended Solids	Municipal Point Sources
Bullock Pen (Kenton Co.)	SW-PS	2.0-5.3	Pathogens	Sanitary Sewer Overflow
Craintown Branch (Fleming Co.)	AL-PS SW-PS	0.0-3.5 0.0-3.5	Noxious Aquatic Plants Pathogens Nutrients	Animal Operations Pasture Land Agriculture
Doty Creek (Fleming Co.)	AL-NS SW-NS	0.0-4.0 0.0-4.0	Pathogens Organic Enrichment/low DO	Animal Operations Pasture Land
Fleming Creek (Nicholas Co.)	AL-NS SW-NS	22.7-39.2 22.7-39.2	Pathogens Nutrients Organic Enrichment/low DO	Agriculture
Fowlers Creek (Kenton Co.)	AL-PS	0.0-6.9	Organic Enrichment/low DO Siltation Nutrients	Construction Package Plants Municipal Point Sources
Hinkston Creek (Bourbon Co.)	AL-PS	63.0-65.9	Nutrients Unknown Toxicity	Agriculture Municipal Point Sources
Houston Creek (Bourbon Co.)	SW-PS SW-PS	3.7-4.7 7.1-8.1	Pathogens	Minor Municipal Point Source Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Licking River (Bracken Co.)	AL-NS SW-PS SW-NS AL-PS SW-NS	267.7-301.1 71.6-106.8 0.0-4.6 237.7-244.1 226.4-239.3	Pathogens Salinity/TDS/Chlorides Organic Enrichment/low DO Siltation	Resource Extraction Agriculture Combined Sewer Overflow Municipal Point Sources
Logan Run (Fleming Co.)	AL-NS	0.0-2.3	Nutrients	Agriculture
Mill Creek (Mason Co.)	AL-PS SW-PS	0.0-11.0 0.0-11.0	Pathogens Nutrients	Animal Operations
North Fork Licking River (Bracken Co.)	SW-NS	0.0-31.8	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture
Shannon Creek (Mason Co.)	AL-PS SW-PS	0.0-11.2 0.0-11.2	Pathogens	Animal Operations
South Fork Licking River (Pendleton Co.)	SW-PS	11.5-27.1	Pathogens	On-site Wastewater Systems (Septic Tanks) Agriculture Municipal Point Sources
Stoner Creek (Bourbon Co.)	SW-NS	14.0-15.0	Pathogens	Municipal Point Sources
Strodes Creek (Bourbon Co.)	AL-NS SW-NS	20.5-22.0 20.5-22.0	Pathogens Organic Enrichment/low DO	Municipal Point Sources
Sycamore Creek (Montgomery Co.)	AL-PS SW-PS	0.0-0.9 0.0-0.9	Suspended Solids Pathogens Nutrients	Municipal Point Sources
Three Mile Creek (Campbell Co.)	AL-NS SW-NS	0.0-4.7 0.0-4.7	Pathogens Organic Enrichment/low DO Nutrients	Sanitary Sewer Overflow
Town Branch (Fleming Co.)	SW-NS	0.0-4.0	Pathogens	Animal Operations Pasture Land Agriculture
Trace Fork (Magoffin Co.)	AL-NS	0.0-8.4	Siltation	Resource Extraction

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
UT of Hinkston Creek at MP 51.0 (Bath Co.)	AL-NS	2.0-3.0	Organic Enrichment/low DO Nutrients	Municipal Point Sources
Wilson Run (Fleming Co.)	SW-NS	0.0-5.1	Pathogens	Animal Operations Pasture Land
KENTUCKY RIVER BASIN				
Baughman Fork (Fayette Co.)	AL-NS	0.0-1.1	Organic Enrichment/low DO Nutrients	Municipal Point Sources
Beech Fork (Leslie Co.)	AL-PS	0.0-6.0	Suspended Solids Other Habitat Alterations	Resource Extraction
Boone Fork (Letcher Co.)	AL-NS	0.0-3.3	Siltation	Resource Extraction
Bull Creek (Perry Co.)	AL-NS	0.0-5.3	Siltation	Resource Extraction
Cane Creek (Breathitt Co.)	SW-NS	0.0-9.5	Pathogens	Agriculture On-site Wastewater Systems (Septic Tanks)
Cane Run (Scott Co.)	AL-PS	0.0-17.4	Unknown Toxicity	Domestic Wastewater Lagoon
Carr Fork (Perry Co.)	AL-PS SW-NS	15.8-26.4 0.2-8.9	Siltation Pathogens	Resource Extraction On-site Wastewater Systems (Septic Systems)
Clarks Run (Boyle Co.)	AL-PS AL-NS	0.0-4.3 4.3-6.6	Organic Enrichment/low DO Nutrients Chlorine	Urban Runoff/Storm Sewers Agriculture Municipal Point Sources
Clear Creek (Knott Co.)	AL-NS SW-NS	0.0-5.5 0.0-5.5	pH	Resource Extraction
Copper Creek (Lincoln Co.)	AL-PS	0.0-11.8	Siltation Nutrients	Agriculture
Crawfish Branch (Clay Co.)	SW-NS	0.0-0.2	Pathogens	Land Disposal

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Cutshin Creek (Lesile Co.)	AL-PS	0.0-28.8	Suspended Solids Oil and Grease	Petroleum Activities Silviculture
Dix River (Jessamine Co.)	SW-PS	33.0-36.0	Pathogens	Agriculture Municipal Point Sources
Drowning Creek (Estill Co.)	AL-PS	0.0-3.1	Siltation	Agriculture
Dry Run (Scott Co.)	AL-PS	0.0-7.5	Nutrients	Industrial Point Sources
Eagle Creek (Carroll Co.)	AL-PS SW-PS	0.0-38.8 0.0-38.8	Pathogens	Agriculture
Four Mile Creek (Clark Co.)	AL-PS	1.3-3.0	Other habitat alterations	Hydromodification
Greasy Creek of Middle Fk Kentucky (Leslie Co.)	AL-PS AL-PS	8.4-20.5 25.5-26.5	Suspended Solids Other habitat alterations	Resource Extraction
Hickman Creek (Jessamine Co.)	AL-NS	0.0-25.0	Other habitat alterations Organic Enrichment/low DO Siltation Nutrients	Hydromodification Urban Runoff/Storm Sewers Construction Municipal Point Sources Industrial Point Sources
Jerushia Branch (Owsley Co.)	AL-PS	0.0-1.5	Suspended Solids Other habitat alterations	Silviculture
Kentucky River (Carroll Co.)	SW-PS SW-PS	64.5-158.1 190.8-226.2	Pathogens	Agriculture Combined Sewer Overflow
Kings Creek (Letcher Co.)	AL-NS	0.0-6.5	Siltation	Resource Extraction
Lanes Run (Scott Co.)	AL-PS	0.0-6.5	Nutrients	Industrial Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Laurel Creek (Clay Co.)	AL-NS SW-NS	2.5-5.4 2.5-5.4	Suspended Solids Pathogens Organic Enrichment/low DO Nutrients Unionized Ammonia	Municipal Point Sources Package Plants
Leatherwood Creek (Perry Co.)	AL-PS SW-PS	0.0-20.5 0.0-20.5	Siltation pH	Resource Extraction
Lee Branch (Woodford Co.)	AL-NS	0.0-1.0	Organic Enrichment/low DO	Municipal Point Sources
Little Eagle Creek (Scott Co.)	SW-NS	10.0-11.0	Pathogens	Package Plants Municipal Point Sources
Little Goose Creek (Clay Co.)	AL-NS SW-NS	3.7-4.7 3.7-4.7	Nutrients Pathogens	Package Plants
Lost Creek (Perry Co.)	AL-NS	0.0-18.5	Siltation	Resource Extraction
Maces Creek (Perry Co.)	AL-NS	0.0-6.8	Siltation	Resource Extraction
Middle Fork Kentucky River (Lee Co.)	AL-PS AL-NS SW-PS SW-PS	71.9-74.8 75.6-102.7 0.0-43.2 71.9-74.8	Suspended Solids Pathogens Organic Enrichment/low DO	On-site Wastewater Systems (Septic Tanks) Resource Extraction Package Plants Municipal Point Sources
Neals Creek (Lincoln Co.)	AL-NS	4.4-5.4	Suspended Solids	Water Treatment Plants Municipal Point Sources
North Fork Kentucky River (Lee Co.)	AL-PS AL-NS SW-NS	49.4-58.6 79.7-167.1 49.4-58.6	Metals Pathogens Organic Enrichment/low DO Siltation	Source Unknown Resource Extraction Package Plants Municipal Point Sources
Red Bird River (Clay Co.)	AL-PS	81.7-82.3	Suspended Solids Other habitat alterations	Silviculture

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Red River (Powell Co.)	AL-PS SW-NS	59.9-94.2 9.5-41.1	Pathogens Siltation Nutrients Unionized Ammonia	Source Unknown Streambank Modification/ Destabilization Removal of Riparian Vegetation Habitat Modification On-site Wastewater Systems (Septic Tanks) Urban Runoff/Storm Sewers Silviculture Agriculture Municipal Point Sources
Rockhouse Creek (Letcher Co.)	AL-NS SW-NS	0.0-24.3 0.0-24.3	pH Siltation	Resource Extraction
Sand Lick Fork (Powell Co.)	AL-NS	0.0-5.0	Salinity/TDS/Chlorides	Petroleum Activities
Smoot Creek (Letcher Co.)	AL-NS	0.0-7.4	Siltation	Resource Extraction
South Elkhorn Creek (Franklin Co.)	AL-PS SW-PS	16.4-34.0 16.4-34.0	Organic Enrichment/low DO Pesticides Pathogens	Urban Runoff/Storm Sewers Animal Operations
South Fork Kentucky River (Lee Co.)	SW-PS	11.5-45.0	Pathogens	Source Unknown Package Plants Municipal Point Sources
South Fork Red River (Powell Co.)	AL-NS	0.0-10.1	Salinity/TDS/Chlorides	Petroleum Activities
Stratton Fork (Perry Co.)	AL-NS	0.0-7.0	Siltation	Resource Extraction
Town Branch (Fayette Co.)	AL-NS	0.0-11.3	Nutrients Organic Enrichment/low DO	Urban Runoff / Storm Sewers

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Troublesome Creek (Breathitt Co.)	SW-NS	0.0-49.5	Pathogens	On-site Wastewater Systems (Septic Tanks) Urban Runoff/Storm Sewers Municipal Point Sources Package Plants
Turkey Creek (Letcher Co.)	AL-PS	0.0-6.4	Siltation	Resource Extraction
Wright Fork (Letcher Co.)	AL-NS	0.0-4.7	Siltation	Resource Extraction
Yonts Fork (Letcher Co.)	AL-NS	0.0-3.4	Siltation	Resource Extraction
SALT RIVER BASIN				
Brooks Run (Bullitt Co.)	AL-NS SW-NS	0.0-6.0 0.0-6.0	Organic Enrichment Pathogens	Package Plants Urban Runoff/ Storm Sewers
Buckhorn Creek (Marion Co.)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Hydromodification
Chenoweth Run (Jefferson Co.)	AL-PS SW-NS	0.0-5.2 0.0-9.0	Noxious Aquatic Plants Nutrients Pathogens	Municipal Point Sources
Cox Creek (Bullit Co.)	AL-NS	0.0-23.5	Siltation Nutrients	Agriculture
Fern Creek Northern Ditch (Jefferson Co.)	AL-NS SW-NS	0.0-10.1 0.0-10.1	Metals Organic Enrichment/low DO Pathogens	Municipal Point Sources Urban Runoff Storm Sewers On-site Wastewater Systems (Septic Tanks)
Fishpool Creek (Jefferson Co.)	AL-NS SW-NS	0.0-5.4 0.0-5.4	Metals Organic Enrichment/low DO Pathogens	Municipal Point Sources Urban Runoff/Storm Sewers On-site Wastewater Systems (Septic Tanks)

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Floyds Fork (Bullit Co.)	AL-PS AL-NS SW-NS	0.0-7.4 7.4-61.6 0.0-13.8	Organic Enrichment/low DO Nutrients Pathogens	Urban Runoff/Storm Sewers Agriculture Package Plants Municipal Point Sources
Mill Creek (Hardin Co.)	AL-NS	6.0-7.0	Organic Enrichment/low DO Chlorine Metals	Package Plants Municipal Point Sources Industrial Point Sources
Mill Creek Branch (Hardin Co.)	AL-PS	0.0-0.7	Organic Enrichment/low DO	Package Plants Municipal Point Sources
Mussin Branch (Marion Co.)	AL-NS SW-NS	0.0-0.5 0.0-0.5	pH	Hydromodification
Pond Creek (Bullitt Co.)	AL-NS SW-PS	0.0-17.0 0.0-17.0	Organic Enrichment/low DO Metals Pathogens	Combined Sewer Overflow Package Plants On-site Wasterwater Systems (Septic Tanks) Municipal Point Sources
Rolling Fork (Bullit Co.)	SW-PS	0.0-20.1	Pathogens	Agriculture
Salt River (Jefferson Co.)	AL-PS SW-PS SW-NS FC-PS AL-PS	125.9-128.7 78.0-88.5 11.4-25.2 11.4-25.2 25.2-59.0	Pathogens Organic Enrichment/low DO Siltation Nutrients Pesticides	Dam Construction On-site Wastewater Systems (Septic Tanks) Off-farm Animal Holding/Management Area Animal Operations Pasture Land Irrigated Crop Production Nonirrigated Crop Production Package Plants Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Town Creek (Mercer Co.)	SW-PS AL-PS	0.0-2.5 0.0-2.5	Pathogens Organic Enrichment/low DO Nutrients	Sanitary Sewer Overflow Urban Runoff
UT of Rolling Fork at MP 94.6 (Marion Co.)	AL-NS SW-NS	0.0-0.6 0.0-0.6	pH	Highway Construction
GREEN RIVER BASIN				
Bacon Creek (Hart Co.)	SW-PS	0.0-31.2	Pathogens	Agriculture
Barren River (Warren Co.)	SW-NS	29.4-43.6	Pathogens	Urban Runoff/Storm Sewers Agriculture
Bat East Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-7.3 0.0-7.3	pH Metals	Acid Mine Drainage
Beech Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-3.4 0.0-3.4	pH	Acid Mine Drainage
Boyds Creek (Barren Co.)	AL-NS	0.0-1.7	Oil and Grease	Natural Sources
Brier Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-4.7 0.0-4.7	pH	Acid Mine Drainage
Caney Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-7.1 0.0-7.1	pH Metals	Acid Mine Drainage
Caney Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-7.0 0.0-7.0	pH	Acid Mine Drainage
Cash Creek (Henderson Co.)	AL-NS	5.1-8.7	Siltation	Channelization Hydromodification
Craborchard Creek (Hopkins Co.)	AL-NS SW-NS	0.0-7.6 0.0-7.6	pH	Acid Mine Drainage
Cypress Creek (McLean Co.)	AL-PS AL-NS SW-PS SW-NS	22.9-25.0 25.0-33.3 22.9-25.0 25.0-33.0	pH	Acid Mine Drainage

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Dismal Creek (Edmonson Co.)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Acid Mine Drainage
Drakes Creek (Hopkins Co.)	AL-NS FC-NS SW-NS	0.0-8.5 0.0-21.3 0.0-8.5	Priority Organics pH	Industrial Point Sources Acid Mine Drainage
Duncan Creek (Logan Co.)	AL-PS SW-PS	0.0-2.4 0.0-2.4	Pathogens Organic Enrichment/low DO Nutrients	Agriculture
Flat Creek (Hopkins Co.)	AL-NS SW-NS	0.0-10.6 0.0-10.6	pH	Acid Mine Drainage
Grays Branch (Hopkins Co.)	AL-NS SW-NS	0.0-4.3 0.0-4.3	pH	Acid Mine Drainage
Green River (Henderson Co.)	AL-PS SW-PS	71.3-108.6 183.5-250.2	Pathogens Nutrients	On-site Wastewater Systems (Septic Tank) Nonirrigated Crop Production Land Disposal Agriculture Municipal Point Source
Harris Branch (Muhlenberg Co.)	AL-NS SW-NS	0.0-2.6 0.0-2.6	pH	Acid Mine Drainage
Issacs Creek (Hopkins Co.)	AL-NS SW-NS	0.0-5.8 0.0-5.8	pH	Acid Mine Drainage
Joes Run (Daviess Co.)	AL-NS SW-NS	0.0-4.3 0.0-4.3	pH	Acid Mine Drainage
Lewis Creek (Ohio Co.)	AL-NS SW-NS	0.0-11.8 0.0-11.8	Siltation pH	Acid Mine Drainage Agriculture
Lick Creek (Henderson Co.)	AL-NS	4.9-13.7	Siltation	Channelization Hydromodification
Little Cypress Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-10.4 0.0-10.4	pH	Acid Mine Drainage
Little Hazel Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-3.9 0.0-3.9	pH	Acid Mine Drainage

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Little Pitman Creek (Taylor Co.)	AL-PS	5.9-10.1	Metals Pesticides Unknown Toxicity	Source Unknown Municipal Point Sources
Little Reedy Creek (Butler Co.)	AL-NS SW-NS	0.0-12.0 0.0-12.0	pH	Acid Mine Drainage
Mud River (Ohio Co.)	AL-PS FC-NS	9.0-30.5 0.0-64.8	Priority Organics	Industrial Point Sources
Nelson Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-4.3 0.0-4.3	pH	Acid Mine Drainage
Nolin River (Edmonson Co.)	SW-PS	44.0-93.2	Pathogens	Agriculture
North Fork Panther Creek (Daviess Co.)	AL-NS	0.0-12.7	Other habitat alterations Flow Alterations	Channelization Hydromodification
Pleasant Run (Hopkins Co.)	AL-NS SW-NS	0.0-7.9 0.0-7.9	pH	Acid Mine Drainage
Pond Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-23.8 0.0-23.8	Metals pH	Acid Mine Drainage
Pond River (Hopkins Co.)	AL-PS SW-PS	1.0-31.1 1.0-31.1	pH	Resource Extraction
Render Creek (Ohio Co.)	AL-NS SW-NS	0.0-3.3 0.0-3.3	pH	Acid Mine Drainage
Rhodes Creek (Daviess Co.)	AL-NS	1.2-7.3	Other habitat alterations Siltation	Channelization Hydromodification Agriculture
Richland Slough (Henderson Co.)	AL-NS	0.0-6.2	Siltation	Channelization Hydromodification Agriculture
Sandlick Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-4.0 0.0-4.0	pH Metals	Acid Mine Drainage
South Fork Panther Creek (Daviess Co.)	AL-NS	22.6-32.5	Other Habitat Alterations Flow Alteration	Channelization Hydromodification
South Fork Russell Creek (Green Co.)	AL-NS	0.0-0.6	Salinity/TDS/Chlorides	Petroleum Activities

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Southards Creek (Ohio Co.)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Acid Mine Drainage
Thompson Creek (Muhlenberg Co.)	AL-NS SW-NS	0.0-6.0 0.0-6.0	pH	Acid Mine Drainage
Town Branch (Logan Co.)	AL-PS FC-NS	3.0-4.0 0.0-6.7	Organic Enrichment/low DO Metals Priority Organics	Municipal Point Sources Industrial Point Sources
West Fork Drakes Creek (Warren Co.)	FC-NS FC-NS	0.0-8.3 17.1-32.8	Priority Organics	Industrial Point Sources
Williams Creek (Ohio Co.)	AL-NS SW-NS	0.0-5.3 0.0-5.3	pH	Acid Mine Drainage
TRADEWATER RIVER BASIN				
Brooks Creek (Hopkins Co.)	AL-NS SW-NS	0.0-4.3 0.0-4.3	pH	Acid Mine Drainage
Buffalo Creek (Hopkins Co.)	AL-NS SW-NS	0.0-8.6 0.0-8.6	pH	Acid Mine Drainage
Cane Run (Hopkins Co.)	AL-NS SW-NS	0.0-3.4 0.0-3.4	pH	Acid Mine Drainage
Caney Creek (Hopkins Co.)	AL-NS SW-NS	0.0-11.3 0.0-11.3	pH	Acid Mine Drainage
Clear Creek (Hopkins Co.)	AL-NS SW-NS	0.0-25.8 0.0-25.8	pH	Acid Mine Drainage
Fox Run (Hopkins Co.)	AL-NS SW-NS	0.0-2.1 0.0-2.1	pH	Acid Mine Drainage
Lambs Creek (Hopkins Co.)	AL-NS AL-NS SW-NS SW-NS	2.5-3.7 4.1-7.8 2.5-3.7 4.1-7.8	pH	Acid Mine Drainage
Lick Creek (Hopkins Co.)	AL-NS SW-NS	0.0-18.1 0.0-18.1	pH	Acid Mine Drainage
Pogue Creek (Hopkins Co.)	AL-NS SW-NS	0.0-4.6 0.0-4.6	pH	Acid Mine Drainage
Pond Creek (Hopkins Co.)	AL-NS SW-NS	0.0-4.6 0.0-4.6	pH	Acid Mine Drainage

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Sugar Creek (Hopkins Co.)	AL-NS SW-NS	0.0-5.3 0.0-5.3	pH	Acid Mine Drainage
Tradewater River (Union Co.)	AL-PS	63.0-92.2	Siltation	Resource Extraction
LOWER CUMBERLAND BASIN				
Elk Fork (Todd Co.)	AL-PS	27.6-28.6	Suspended Solids Nutrients	Municipal Point Sources
Little River (Trigg Co.)	AL-PS	23.6-61.0	Nutrients Siltation	Nonirrigated Crop Production Pasture Land
North Fork Little River (Christian Co.)	AL-PS SW-NS	0.0-15.9 0.0-14.0	Pathogens Nutrients Siltation	Agriculture Urban Runoff/Storm Sewers Resource Extraction
South Fork Little River (Christian Co.)	AL-PS	0.0-25.4	Nutrients Siltation	Industrial Point Sources Agriculture
TENNESSEE RIVER BASIN				
Clarks River (McCracken Co.)	AL-PS AL-NS	37.7-59.2 31.1-36.0	Siltation Organic Enrichment/low DO Nutrients	Nonirrigated Crop Production Sanitary Sewer Overflow Municipal Point Sources
Island Creek (McCracken Co.)	AL-NS	0.0-10.3	Organic Enrichment/low DO Nutrients	Urban Runoff/Storm Sewers Agriculture Industrial Point Sources
MISSISSIPPI RIVER BASIN				
Anderson Creek (Graves Co.)	AL-NS	0.0-2.2	Suspended Solids	Resource Extraction
Bayou de Chien (Fulton Co.)	AL-PS SW-PS	14.0-25.9 14.0-25.9	Pathogens pH	Agriculture
Central Creek (Carlisle Co.)	AL-NS	0.0-0.4	Chlorine	Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Long Creek (Carlisle Co.)	AL-NS	0.0-0.8	Suspended Solids	Municipal Point Sources
Obion Creek (Graves Co.)	AL-NS	37.5-38.5	Siltation	Streambank Modification/Destabilization Hydromodification
Shawnee Creek (Ballard Co.)	AL-NS	7.9-8.9	Organic Enrichment/low DO Nutrients	Agriculture Municipal Point Sources
Truman Creek (Carlisle Co.)	AL-NS	2.5-3.1	Chlorine Organic Enrichment/low DO Suspended Solids	Municipal Point Sources
West Fork Mayfield Creek (Carlisle Co.)	AL-NS	17.2-18.2	Nutrients	Municipal Point Sources
OHIO RIVER BASIN (Minor Tribs)				
Allen Fork (Boone Co.)	AL-NS	2.0-4.6	Suspended Solids Other habitat alterations Nutrients	Hydromodification Urban Runoff/Storm Sewers Construction Municipal Point Sources
Bayou Creek (McCracken Co.)	AL-NS	0.0-11.3	Priority Organics	Land Disposal
Beargrass Creek (Jefferson Co.)	AL-NS	0.0-1.6	Metals Organic Enrichment/low DO	Urban Runoff/ Storm Sewers Combined Sewer Overflow Municipal Point Sources On-site Wastewater Systems
Brush Creek (Campbell Co.)	AL-NS	0.0-1.6	Organic Enrichment/low DO	Municipal Point Sources
Butchers Creek (Hancock Co.)	AL-NS SW-NS	0.0-2.3 0.0-2.3	pH	Acid Mine Drainage
Crooked Creek (Crittenden Co.)	SW-NS	22.3-23.3	Pathogens	Sanitary Sewer Overflow
Dry Creek (Gallatin Co.)	AL-NS	0.0-1.3	Suspended Solids Organic Enrichment/low DO	Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Elijahs Creek (Boone Co.)	AL-NS	0.0-5.2	Nonpriority Organics	Major Industrial Point Source Industrial Point Sources
Four Mile Creek (Campbell Co.)	AL-NS SW-NS	8.4-9.4 0.0-0.2	Pathogens Organic Enrichment/low DO Nutrients	Sanitary Sewer Overflow Package Plants Municipal Point Sources
Goose Creek (Jefferson Co.)	AL-PS AL-NS SW-PS SW-NS	4.5-11.7 0.0-4.5 0.0-4.5 4.5-11.7	Metals Organic Enrichment/low DO Pathogens	Municipal Point Sources Urban Runoff/Storm Sewers On-site Wastewater System (Septic Tanks)
Gunpowder Creek (Boone Co.)	AL-PS AL-NS	18.9-21.6 15.7-18.9	Nonpriority Organics Cause Unknown	Industrial Permitted Urban Runoff/Storm Sewers
Harrods Creek (Jefferson Co.)	AL-NS	0.0-4.0	Organic Enrichment/low DO Metals	On-site Wastewater Systems (Septic Tanks) Urban Runoff/Storm Sewers Package Plants Municipal Point Sources
Kinniconick Creek (Lewis Co.)	SW-PS	0.0-24.5	Pathogens	On-site Wastewater Systems (Septic Tanks)
Hite Creek (Jefferson Co.)	AL-NS	0.0-5.5	Unknown Toxicity	Municipal Point Sources
Lawrence Creek (Mason Co.)	SW-PS	6.0-7.0	Pathogens	Municipal Point Sources
Little Bayou Creek (McCracken Co.)	AL-NS FC-NS	0.0-6.5 0.0-6.5	Priority Organics	Hydromodification Industrial Point Sources
Little Goose Creek (Jefferson Co.)	AL-PS SW-NS	0.0-8.7 0.0-8.7	Metals Organic Enrichment/low DO Pathogens	Municipal Point Sources Urban Runoff/Storm Sewers On-site wastewater systems (Septic Tanks)
Massac Creek (McCracken Co.)	AL-NS	0.0-10.0	Organic Enrichment/low DO Nutrients	Package Plants Municipal Point Sources

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
Middle Fork Beargrass Creek (Jefferson Co.)	AL-NS	0.0-15.2	Organic Enrichment/low DO Metals	Urban Runoff/Storm Sewers Combined Sewer Overflow Package Plants Municipal Point Sources
Mill Creek (Jefferson Co.)	AL-NS SW-NS	0.0-4.4 0.0-4.4	Pathogens Siltation OrganicEnrichment/low DO Turbidity Other Habitat Alterations	Land Disposal Urban Runoff / Storm Sewers Hydromodification Construction
Muddy Fork (Jefferson Co.)	AL-NS SW-PS	0.0-6.9 0.0-6.9	Metals Organic Enrichment/low DO Pathogens Unknown Toxicity	Municipal Point Sources Urban Runoff/Storm Sewers On-site Wastewater Systems (Septic Tanks)
Notch Lick Creek (Carroll Co.)	AL-NS	0.0-2.0	Other habitat alterations	Hydromodification
Perkins Creek (McCracken Co.)	AL-NS SW-PS	0.0-3.0 0.0-3.0	Pathogens Organic Enrichment/low DO Nutrients	Sanitary Sewer Overflow
Pond Creek (Oldham Co.)	AL-PS	0.0-1.5	Nutrients Chlorine Cause Unknown	Municipal Point Sources Source Unknown Package Plants
South Fork Beargrass Creek (Jefferson Co.)	AL-NS SW-PS SW-NS	0.0-14.6 6.0-14.6 0.0-6.0	Pathogens Metals Organic Enrichment/low DO	Urban Runoff/Storm Sewers Combined Sewer Overflow
UT of Elijahs Creek (Boone Co.)	AL-PS	0.0-1.5	Nutrients	Logging Road Construction/Maintenance Silviculture

Table A1-3: Impaired Streams				
STREAM	**USE NOT SUPPORTED**	**SEGMENT MILEPOINTS**	**CAUSES OF IMPAIRMENT**	**SOURCES OF IMPAIRMENT**
UT of Pond Creek at MP1.5 (Oldham Co.)	AL-PS AL-NS	0.5-0.9 0.0-0.5	Organic Enrichment/low DO Siltation Nutrients Chlorine	Urban Runoff/Storm Sewers Land Development Package Plants Municipal Point Sources
West Fork Massac Creek (McCracken Co.)	AL-NS	0.0-3.7	Organic Enrichment/low DO Nutrients	Package Plants Municipal Point Sources
Woolper Creek (Boone Co.)	AL-NS	11.5-13.6	Suspended Solids Other habitat alterations Organic Enrichment/low DO Nutrients	Hydromodification Urban Runoff/Storm Sewers Construction Package Plants Municipal Point Sources

Abbreviations:

AL - Aquatic Life
FC - Fish Consumption
SW - Swimming
DW - Drinking Water
PS - Partial Support
NS - Nonsupport

News

from the Natural Resources and Environmental Protection Cabinet

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KENTUCKIANS ADVISED AGAINST SWIMMING IN SOME STREAMS IN THE STATE

FRANKFORT, KY (May 23, 1996) -- The Kentucky Division of Water, together with the Department for Health Services, advises Kentuckians to avoid swimming and other recreational contact with waters in three areas of the Commonwealth.

These advisories were issued in July 1994 and were re-issued in 1995 because of the presence of high levels of fecal coliform bacteria. The source of the fecal coliform bacteria, present in human and animal waste, includes sanitary (both municipal and package) wastewater treatment plant discharges, malfunctioning septic systems, and illegal straight-pipe discharges.

This type of bacteria indicates the presence of untreated or inadequately treated sewage and creates a potential for acquiring infectious disease, particularly diarrheal illnesses. Persons swimming or playing in the water in areas where swimming advisories are posted face the possibility of illness.

Sampling for 1996 has been completed for the North Fork of the Kentucky River and for the Upper Cumberland. High waters from recent heavy rains have delayed sampling of the Licking River this year, but the advisory there is considered still in effect until sampling is completed.

Swimming advisories are still in effect by the Division of Water and the Kentucky Department for Health Services for the following:

Upper Cumberland River

Results of recent sampling indicate the need to re-issue the advisory for the Upper Cumberland River for the following areas:

- The Cumberland River from Fourmile Bridge (HWY 2014) to Pineville at HWY 66 Bridge
- The Cumberland River from Wallins Creek Bridge (HWY 219) to Harlan

-more-

- Martins Fork from Harlan to Cawood Water Plant
- The entire stretch of Catrons Creek, the entire stretch of Clover Fork, and the entire stretch of Straight Creek
- Poor Fork from Harlan to Looney Creek
- Looney Creek from the mouth to Lynch Water Plant Bridge.

Problems in the area contributing to poor water quality include many bypasses from sewage collection systems as well as other noncompliance problems.

North Fork of the Kentucky River

A swimming advisory is being re-issued for the North Fork of the Kentucky River upstream of Chavies. Problems with municipal wastewater treatment plants as well as numerous illegal straight pipe discharges of sewage contribute to water quality problems in the area that remains posted.

Licking River

A swimming advisory is still in effect for the Licking River from Banklick Creek to the confluence with the Ohio River. The advisory includes the entire length of both Banklick Creek and Three Mile Creek. Problems in this area that contribute to high fecal coliform pollution include combined sewer overflows and sanitary sewer overflows.

Urban areas

The agencies also recommend that there be no swimming or other full-body contact with rivers in and directly below urban areas, particularly after a significant rainfall. This recommendation is for urban areas along waterways throughout Kentucky because of the increased potential for exposure to pollution from illegal straight pipe discharges, bypasses from sewage collection systems, and combined sewer overflows.

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NOTE TO EDITOR: Sampling data for the North Fork and for the Upper Cumberland are available from the Division of Water upon request.

CHAPTER 2

WETLANDS

WETLANDS

Jurisdictional Wetlands

Wetlands are included as surface waters of the Commonwealth in Kentucky water quality standards regulation 401 KAR 5:029. Wetlands are defined in that same regulation as land that has a predominance of hydric soils and that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions. All wetlands have three key attributes: (1) characteristic hydric soils that become flooded, saturated, or ponded long enough during the growing season to develop anaerobic conditions in the upper layers; (2) plants that tolerate and thrive in such conditions; and (3) a degree of flooding, saturation, or ponding during the growing season to sustain characteristic soils and vegetation. Jurisdictional wetlands are delineated by the U.S. Army Corps of Engineers (COE) in accordance with the COE Wetlands Delineation Manual (Technical Report Y-87-1, January 1987). Farmed wetlands, prior converted croplands, and other agricultural lands where the natural vegetation has been removed are delineated by the Soil Conservation Service (SCS) in accordance with the National Food Security Act Manual, Third Edition (NFSAM).

Wetland Functions

Wetlands perform many useful functions depending on the wetland type and position within the landscape. Landscape position affects both the opportunity to perform these functions and the wetland community that has developed through nutrient and water availability. The following functions are performed by wetlands:

1. Flood conveyance - Riverine wetlands and adjacent palustrine wetlands form natural floodways that convey flood waters from upstream to downstream points.

2. Flood storage - Wetlands act as natural reservoirs by storing water during floods and slowly releasing it to downstream areas, thereby lowering flood peaks.

3. Sediment and erosion control - Wetlands reduce velocity of flood water, which reduces erosion and sediment deposition.

4. Habitat for fish - Wetlands are important spawning areas and provide food sources for fish species.

5. Habitat for waterfowl and other wildlife - Wetlands provide essential breeding, nesting, feeding, and predator escape habitats for many forms of waterfowl, other birds, mammals, and reptiles.

6. Habitat for rare and endangered species - 55 percent of all rare and endangered species in Kentucky are either located in wetland areas or are dependent on them.

7. Recreation - Wetlands serve as recreation sites for fishing, hunting, and observing wildlife.

8. Water supply - With the growth of urban centers and dwindling ground and surface water supplies, wetlands are increasingly important as a source of ground and surface water.

9. Education and research - Inland wetlands provide educational opportunities for nature observation and scientific study.

10. Water Quality - Wetlands improve water quality by removing excess nutrients, sediments, and chemical contaminants.

Wetland Mitigation

Consistent with Section 401 and Kentucky water quality standards, wetland impacts should be avoided or minimized whenever possible. EPA has recommended in its guidance on administering the 401 Water Quality Certification program (discussed further in Chapter 4) that states use the COE regulations as outlined in the 404 (b) (1) guidelines (40 CFR Part 230) when determining whether to issue or deny 401 certifications. When unavoidable impacts occur as a result of the permitting process or as a result of an illegal fill subject to enforcement, mitigation is required to compensate for wetland acreage and functions lost.

Mitigation and monitoring plans are developed in accordance with interagency guidelines that have been prepared by DOW, Louisville COE, U.S. Fish and Wildlife Service, EPA, and Kentucky Department of Fish and Wildlife Resources. The "Wetland Compensatory Mitigation and Monitoring Plan Guidelines for Kentucky" are designed to assist applicants in preparing mitigation plans for agency review. The guidelines outline technical information that should be included to establish and monitor hydric soils, hydrophytic vegetation, and hydrology at the mitigation site. Mitigation usually includes restoration of wetland functions in prior converted cropland sites rather than enhancement or creation of wetlands. The "Guidelines" are currently under revision.

Attainment of functional equivalency should be the goal of all mitigation activities. The choice of restoration, creation, or enhancement mitigation for any project depends upon the site-specific characteristics of available locations. The choice should be based upon analysis of factors that limit the ecological functioning of the watershed, ecosystem, or region. Mitigation should be initiated either before or at the same time that the proposed project work is being undertaken. The mitigation plan must be made part of the project application. Where an activity does not result in a permanent loss, on-site restoration and compensatory mitigation should occur.

Wetland Classes and Extent

The majority of Kentucky's wetlands are classified as palustrine ecological systems as defined by the U.S. Fish and Wildlife Service's Cowardin classification system that was developed in 1979. Palustrine systems are freshwater wetlands in a concave or depressional landform relative to the surrounding landscape. They are dominated by hydrophytic trees, shrubs, and herbaceous plant species. They are often referred to as bottomland hardwood, floodplain, marsh, oxbow, scrub-shrub, swamp, and wet meadow. Hydrologically, palustrine systems in Kentucky are often linked to an adjacent riverine system; however, hydrologically isolated depressional systems that are maintained by precipitation also occur in the state. Flooding events in palustrine systems are extremely variable during the growing season, ranging from permanently flooded to temporarily flooded areas. Groundwater discharge plays an important role in maintaining surface water depths in many permanently flooded areas. However, even in temporarily flooded areas where surface water may be present for brief periods during the growing season, the water table lies below the soil surface and sustains hydrophytic vegetation and hydric soils.

Riverine systems include all wetlands and deepwater habitats contained within a channel that experience continuously or periodically moving water or connect two bodies of standing water. While wetlands of this type are not extensive in Kentucky, they sustain the surface hydrology for palustrine systems and convey flood waters. The riparian zone of riverine systems provides habitat for wildlife, depresses water temperature through shading, stabilizes stream banks, and reduces sedimentation to streams and wetlands.

Lacustrine systems include deep-water habitats in lakes and reservoirs that are situated in a topographic depression or dammed river channel. Vegetative cover is less than 30 percent, and total area usually exceeds 20 acres. These systems are usually limited in Kentucky to man-made lakes and their associated shorelines and spillways. The subsystems of lacustrine wetlands are described as limnetic (deepwater habitat) and littoral (shoreline habitat).

In 1985, the DOW provided funding to the Kentucky State Nature Preserves Commission to determine the status of Kentucky's wetlands. Recommendations for protection of remaining wetland areas were contained in the report <u>Wetland Protection Strategies for Kentucky</u> (KNPC, 1986). Among the Commission's findings was a rough estimate that, as of 1978, 637,000 acres remained of the original 1,566,000 acres of palustrine wetlands in Kentucky. Further, it was estimated that only 20 percent of Kentucky's wetland soils remained forested, which reflected a dramatic decline in bottomland hardwood wetlands. The Kentucky Department of Fish and Wildlife Resources estimated Kentucky's annual rate of wetland loss at 3,600 acres (KDFWR 1990). The Environmental Quality Commission (NREPC 1992) reported that only 360,000 acres of palustrine wetlands remained.

In 1988, the Kentucky Department of Fish and Wildlife Resources provided funding to the Natural Resources and Environmental Protection Cabinet (NREPC) to digitize all of the National Wetland Inventory (NWI) maps for Kentucky. The wetlands presented on these maps were identified through the use of stereoscopic analysis of high altitude aerial photography and reflect conditions observed during the period of March 1980 - April 1984. The maps were produced by the U.S. Fish and Wildlife Service's NWI office in St. Petersburg, Florida. The NREPC completed the digitization project in December, 1992.

Based upon the NWI digital information, 323,918 acres of palustrine vegetated wetland exist in the state (Table 2.1). Palustrine systems include forested, scrub-shrub, emergent, and aquatic bed vegetated wetlands. The 1994 305(b) report (Appendix C) provides a breakdown of the acreage of all wetland types as defined in the Cowardin Classification system for waterbodies in the state.

Wetlands as Outstanding Resource Waters

Wetlands classified as Outstanding Resource Waters (ORW) must meet the criteria as designated in 401 KAR 5:031(7). Currently, three of Kentucky's wetlands have been designated as ORWs: Metropolis Lake in McCracken County, Murphy's Pond in Hickman County, and Swan Lake in Ballard County. These ORWs have been designated for the uses of warmwater aquatic habitat and contact recreation. Other wetlands will continue to be evaluated for the ORW designation.

Water Quality Standards for Wetlands

Kentucky water quality standards include wetlands as waters of the state, but do not provide specific wetlands criteria. As waters of the state, wetlands are designated for the uses of warmwater aquatic habitat and contact recreation.

The DOW is working from a grant received in 1991 under Section 104(b)(3) of the Clean Water Act to address deficiencies in the water quality standards regarding wetlands protection. Under this grant, selected wetlands were added to the reference reach monitoring program. Representative wetlands were selected within physiographic regions for monitoring to characterize chemical water quality, sediment quality, fish tissue, habitat condition, and general biotic conditions. From this information, decisions were to be made regarding designation of appropriate use classifications, modifications to numerical chemical criteria, and development of narrative or numerical biocriteria.

However, staff limitations have reduced the current effort in this project, and wetland criteria development is being re-evaluated.

Table 2-1. Acreage of Palustrine Vegetated (PFO, PSS, PEM, PAB) Wetland Types in River Basins of Kentucky

River Basin	Acreage
Big Sandy	860.2
Little Sandy	2,186.2
Tygarts Creek	364.1
Licking	3,274.4
Kentucky	5,507.1
Cumberland	10,759.9
Salt	3,482.0
Green	87,584.0
Tradewater	29,578.4
Lower Cumberland	19,164.5
Tennessee	36,838.2
Mississippi	67,096.9
Ohio River Minor Tribs	40,057.9
Ohio River Mainstem	17,164.2
Total Palustrine Vegetated:	323,918.0

CHAPTER 3

WATER QUALITY ASSESSMENT OF LAKES

WATER QUALITY ASSESSMENT OF LAKES

Section 314 of the Clean Water Act of 1987 requires that states submit a lake water quality assessment as part of their biennial 305(b) report. Six areas to be included in the assessment are:

(1) An identification and classification according to eutrophic condition of all publicly owned lakes in a state.

(2) A general description of the state's procedures, processes, and methods (including land-use requirements) for controlling lake pollution.

(3) A general discussion of the state's plans to restore the quality of degraded lakes.

(4) Methods and procedures to mitigate the harmful effects of high acidity and remove or control toxics mobilized by high acidity.

(5) A list and description of publicly owned lakes for which uses are known to be impaired, including those lakes that do not meet water quality standards or that require implementation of control programs to maintain compliance with applicable standards, and those lakes in which water quality has deteriorated as a result of high acidity that may reasonably be attributed to acid deposition.

(6) An assessment of the status and trends of water quality in lakes including the nature and extent of pollution loading from point and nonpoint sources and the extent of impairment from these sources, particularly with regard to toxic pollution.

The U.S. Environmental Protection Agency (EPA) has developed a guidance document Guidelines for Preparation of the 1996 State Water Quality Assessments, which includes a section on lake assessment reports. Kentucky's report generally complies with the guidelines suggested by the EPA.

Lake Identification

Appendix A3-1 lists publicly owned lakes for which data were available to assess trophic status. Much of this information came from lake surveys conducted in 1989-1991 by the Division of Water (DOW) and Murray State University as part of a cooperative agreement funded under Section 314 of the Clean Water Act. The surveys were conducted on lakes that had originally been sampled by the DOW in 1981-1983 and on 11 lakes that had not previously been surveyed. More recent surveys on a few lakes, conducted by DOW, the U.S. Army Corps of Engineers (COE), Murray State University (Kentucky Lake), and Morehead State University, were also utilized. Not all of the significant publicly owned lakes in Kentucky are included in the table because of the lack of data. For purposes of this report, publicly owned lakes are those lakes that are owned or managed by a public entity such as a city, county, state, or federal agency where the public has free access for use. A nominal fee for boat launching charged by concessionaires may occur on some of these lakes. Lakes that are publicly owned, but have restricted public access because they are used solely as a source of domestic water supply, are not included. These lakes do not qualify for federal restoration funds under the Clean Lakes Program and were not monitored in the lake classification survey. EPA guidance suggests that all significant lakes be included in state surveys. The term "significant" is to be defined by the state so that all lakes that have substantial public interest and use are included. For this purpose, Kentucky considers all of the publicly owned lakes it has surveyed and listed in Appendix A3-1 and also those that have not yet been surveyed, but qualify as publicly owned lakes, as significant. All of these lakes have substantial local or regional public interest and use.

Trophic Status

Lake trophic state was assessed by using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy and also provides for a distinction (according to TSI value) between oligotrophic, mesotrophic, and eutrophic lakes. The growing season average TSI (chlorophyll *a*) value was used to rank each lake. Growing season was defined as the April through October period. A distinction was made for those lakes that exhibited trophic gradients. Areas of lakes that exhibited trophic gradients or embayment differences were often analyzed separately.

While there are several other methods of evaluating lake trophic state, the accuracy and precision of the chlorophyll *a* analytical procedure (determined from DOW quality control data) and proven ability of the chlorophyll *a* TSI to detect changes made it the index of choice for classifying lakes in Kentucky's program.

Chlorophyll *a* concentration data from the DOW ambient monitoring program and the most current chlorophyll *a* data collected during the spring through fall seasons (a minimum of three samples) by the COE on several reservoirs which they manage were used to update the trophic classifications for this report. Other data were obtained from a study of eastern Kentucky reservoirs by Dr. Brian Reeder of Morehead State University. Data averaged from water column depths of up to 20 feet or composite euphotic zone samples were used in calculating TSI values. Table 3-1 contains the trophic state rankings of lakes of 5,000 acres or more in size, and Table 3-2 lists and ranks the trophic state of lakes less than 5,000 acres in size. Lakes that have updated classifications are in bold face type. A "+" or "-" symbol is used to indicate a trend of increasing or decreasing trophy. Trends were defined as a change of 10 units from a previous TSI score. This represents a doubling or halving of Secchi disk depth and was chosen because it is an observable indication of change.

A summary of Tables 3-1 and 3-2 indicates that of the 104 classified lakes, 60 (57.7 percent) were eutrophic, 33 (31.7 percent) were mesotrophic, and 11 (10.6 percent) were oligotrophic. Three lakes in

Table 3-1
Trophic State Rankings for Lakes
5,000 Acres or Greater in Area
(by Carlson TSI (Chl α) Values)

Lake	TSI (Chl *a*)[a]	Acres
	Eutrophic	
Barkley	61	45,600
Kentucky	53	48,100
	Mesotrophic	
Barren River	50	7,205
Beaver Creek Arm	57 (Eutrophic)	1,565
Skaggs Creek Arm	50	1,230
Green River	48	8,210
Rough River	**46**	**5,100**
Cave Run	45	8,270
Nolin	**45**	**5,790**
	Oligotrophic	
Cumberland	**36**	**49,108**
Pitman Creek Embayment	**50 (Mesotrophic)**	**256**
Lily Creek Embayment	**50 (Mesotrophic)**	**144**
Beaver Creek Embayment	57 (Eutrophic)	742
Laurel River	38	4,990
Midlake-Laurel River Arm	43 (Mesotrophic)	754
Headwaters-Laurel River Arm	52 (Eutrophic)	316
Dale Hollow	33	4,300

[a]Scale: 0-40 Oligotrophic (nutrient poor, low algal biomass)
41-50 Mesotrophic (slightly nutrient rich, moderate amount of algal biomass)
51-69 Eutrophic (nutrient rich, high algal biomass)
70-100 Hyper eutrophic (very high nutrient concentrations and algal biomass)
Bold Type = Updated Classifications

Table 3-2
Trophic State Rankings for Lakes
Less Than 5,000 Acres in Area
(by Carlson TSI (Chl *a*) Values)

Lake	TSI (Chl *a*)[a]	Acres
	Hypereutrophic	
Beaver Dam	86	50
Mitchell	85	58
Happy Hollow	75	20
	Eutrophic	
Swan	69	193
Arrowhead	68	37
Fish	68	27
Spurlington	68	36
Campbellsville City	67	63
Marion County	67	21
Guist Creek	65	317
Wilgreen	65	169
Shelby (Shelby County)	64	17
Buck	64	19
Willisburg	64	126
Briggs	63	18
Kingfisher	63	30
Metropolis	63	36
Flat	62	38
Greenbriar[b]	62	66
McNeely	62	51
Taylorsville	62	3,050
Carpenter	61	64
Jericho	61	137
Sympson	61	184
Burnt Pond	60	10
Long Pond	60	56
Moffit	60	49

Table 3-2 (Continued)

Lake	TSI (Chl *a*)[a]	Acres
Shelby (Ballard County)	60	24
Turner	60	61
Carnico	59	114
Scenic	59	18
A.J. Jolly	58	204
Energy	58	370
Reformatory	**58**	**54**
Corinth	57	96
Freeman	57	160
Sand Lick	57	74
Beaver	56	158
Bullock Pen	56	134
Elmer Davis	56	149
Kincaid	56	183
Malone	56	826
Mauzy	56	84
Metcalfe County	**56**	**22**
Spa	56	240
Washburn	56	26
Boltz	55	92
General Butler	55	29
George	55	53
Fishpond	54	32
Salem	54	99
Shanty Hollow[b]	54	135
Pennyrile	53	47
Williamstown[b]	53	300
Caneyville	52	75
Doe Run	**52**	**51**
Herrington	**52**	**2,940**
Bert Combs	51	36
	<u>Mesotrophic</u>	
Chenoa	50	37
Corbin	50	139
Dewey	50	1,100
Liberty	50	79
Long Run	50	27

Table 3-2 (Continued)

Lake	TSI (Chl *a*)[a]	Acres
Morris	50	170
Beshear	49	760
Hematite	49	90
Honker	49	190
Laurel Creek	49	88
Linville	49	273
Pan Bowl	49	98
PeeWee	49	360
Reba	**49**	**78**
Grayson	48	1,512
Greenbo	48	181
Luzerne	48	55
Mill Creek (Monroe County)	48	109
Smokey Valley	47	36
Tyner	46	87
Wood Creek	46	672
Blythe	45	89
Campton	45	26
Mill Creek (Powell County)	43	41
Yatesville	**42**	**2,242**
Providence City	42	35
Fishtrap	42	1,143
Grapevine	41	50
	Oligotrophic	
Paintsville	**40**	**1,139**
Carr Fork	**39-**	**710**
Cranks Creek	**38**	**219**
Buckhorn	38	1,230
Loch Mary	38	135
Stanford	36	43
Cannon Creek[b]	33	243
Martins Fork	**29-**	**334**

[a]Scale: 0-40 Oligotrophic; 41-50 Mesotrophic; 51-69 Eutrophic; 70-100 Hypereutrophic
[b] = 2 samples only,
(+), (-) means upword (more eutrophic), or downword (less eutrophic) trend
Bold Type = Updated Classifications

eastern Kentucky changed trophic status. Paintsville and Martins Fork lakes changed from a mesotrophic to an oligotrophic state, and Carr Fork Lake changed from a eutrophic to an oligotrophic state. The trophic analysis is based on the status of the major areas of lakes and does not account for the trophic gradient that exists in some reservoirs nor the trophic status of the embayments of others. The dynamic nature of these reservoirs makes it more difficult to assign them a single trophic state because their water residence times, the nature of major inflows, and their morphology can result in different trophic states in separate areas. The tables indicate that trophic gradients exist in Barren River and Laurel River lakes and that certain embayments of Lake Cumberland are either mesotrophic or eutrophic, while the main lake area is oligotrophic.

The 104 assessed lakes have a total area of 217,328 acres. Only those portions of Barkley, Kentucky, and Dale Hollow lakes lying within Kentucky were included in the total. Tennessee reports on those portions within its borders. Of the total, 50 percent (108,151 acres) were eutrophic, 22 percent (46,726 acres) were mesotrophic and 29 percent (62,451 acres) were oligotrophic. The decrease in eutrophic acres from the 1994 305(b) report was because of the lowered trophic state of Lily Creek and Pitman Creek embayments of Lake Cumberland and the dramatic change of Carr Fork to an oligotrophic state. The change in the Lily Creek embayment is related to the decrease in nutrients that were supplied to this embayment by the discharge of the Jamestown sewage treatment plant to Lily Creek. Since the discharge is now to the main lake via a hypolimnetic diffuser, a reduction in trophic state was expected. The change at the Pitman Creek embayment is thought to be due to natural variation. The change at Carr Fork is thought to be related to unsuccessful fertilization of the lake, since its eutrophic status was maintained by fertilization carried out by the Kentucky Department of Fish and Wildlife Resources. The decrease in mesotrophic acreage was because of the changes to oligotrophic status at Paintsville and Martins Fork lakes. These changes are attributable to natural variation. The increase in oligotrophic acreage is because of their inclusion and the addition of Carr Fork.

Lake Pollution Control Activities

Kentucky utilizes several approaches to control pollution in its publicly owned lakes. The approach chosen is dependent upon the pollutant source and the characteristics of each lake. Point sources of potential pollution are more controllable than nonpoint sources. The following procedures are routinely used to control point sources of pollution.

Permitting Program

A lake discharge guidance procedure is applied to any new construction permit for a wastewater treatment facility that proposes to discharge into a lake, or for any application for a lake discharge permit under the Kentucky Pollutant Discharge Elimination System (KPDES). An applicant is required to evaluate all other feasible means of routing the discharge or to explore alternate treatment methods that would result in no discharge to a lake. If no reasonable alternatives are found, a lake discharge may be permitted. Permits for domestic wastes require secondary treatment and a discharge into the hypolimnion in the main body of the lake. More stringent treatment, including phosphorus removal, may be required depending upon lake characteristics. Surface discharges are not allowed. A permit may also be denied to a prospective discharger if the discharge point is within five miles of a domestic water supply intake.

Nonpoint Source Program

The NPS section of the DOW is engaged in numerous activities that protect Kentucky's lakes. These activities include demonstration projects, education, implementation of best management practices, and technical assistance.

Water Quality Standards Regulations

Kentucky has not adopted specific criteria to protect lake uses. Warmwater aquatic habitat, domestic water supply (if the lake is used for this purpose), and primary and secondary contact recreation criteria are generally applicable to lakes. In specific cases, a provision in the water quality standards regulation can be utilized to designate a waterbody as nutrient limited if eutrophication is a problem. Point source dischargers to the lake and its tributaries can then have nutrient limits included in their permits.

Lakes that support trout are further protected by another provision that requires dissolved oxygen in waters below the epilimnion to be kept consistent with natural water quality.

Kentucky is not planning to adopt statewide criteria specifically for lakes. A site-specific approach to lake pollution control is more realistic, feasible, and scientifically defensible.

Specific Lake Legislation and Local Initiatives

The Kentucky General Assembly passed specific legislation in 1984 to protect Taylorsville Lake. House Joint Resolution No.4 prohibits issuing any discharge permits that allow effluents to be directly discharged into the lake. It also prohibits issuing any permits that allow inadequately treated effluents to be discharged into contributing tributaries that drain the immediate watershed of the lake. In addition, wastewater permit applications in the basin above the lake must be evaluated to ensure that discharges will not adversely affect the lake or its uses. Other provisions provide for stringent on-site wastewater treatment requirements, promotion of nonpoint source controls, and proper management of sanitary landfills in the watershed.

Lake protection associations are not formally organized in Kentucky, although this is a mechanism that has proven to be successful in preventing lake pollution in other states. Local ordinances can be passed that restrict land-use activities and on-site treatment systems and lead to pollution abatement. Local grass roots opposition to activities that may degrade lakes can lead to state agency action. An example is the petition process in the state's surface mining regulations which can lead to lands being declared unsuitable for mining. Such a petition has been successfully made to protect the water quality of Cannon Creek Lake in Bell County. The lake is used as a water supply for the city of Pineville and is also used for fishing and recreation. A similar petition for Fern Lake, which is the water supply for Middlesboro, has been filed but is unresolved at this time.

In another case, the Lake Cumberland Trust, the Sierra Club, and Trout Unlimited opposed the change in the location of the discharge of the Russell County Regional Wastewater Treatment Plant from a tributary of Lake Cumberland to the main lake. A technical advisory committee consisting of representatives of the parties involved came to a resolution that allowed the discharge but also instituted pollution prevention initiatives by the major wastewater industrial contributor and an assessment of environmental effects. The main lake discharge became operational in April 1993. Two years of sampling have shown that the discharge plume from the diffuser is remaining well below the surface, is not having a harmful effect on the lake's aquatic life, and has not contaminated fish tissue used for human consumption.

Lake Monitoring

Monitoring water quality in lakes is a part of Kentucky's ambient monitoring program and is described in Chapter 1. The objectives of the monitoring program are flexible so that lakes can be monitored for several purposes, including:

- detection of trends in trophic state
- impacts of permit decisions
- ambient water quality characterization
- nonpoint source impacts
- long-term acid precipitation impacts
- pollution incidents such as fish kills and nuisance algal blooms
- new initiatives such as fish tissue analysis for toxics and fecal coliform surveys in swimming areas.

Lake Restoration Plan

Kentucky has not developed a formal state Clean Lakes Program. Several states have adopted programs modeled after the federal Clean Lakes Program and have had state funds appropriated to aid in lake restoration projects. The impetus for developing these programs has been the historical importance of lakes as recreational and aesthetic resources in these states. Pollution or the potential for pollution has prompted support for state development of these programs. Pollution of lakes in Kentucky has not reached a point at which there is a recognized need to develop a state program of this nature.

However, the DOW does participate in the federal Clean Lakes Program. The Natural Resources and Environmental Protection Cabinet is the state agency designated by the Governor to receive federal assistance under this program. Kentucky has received seven assistance awards. Two helped to fund projects that classified lakes in the state according to trophic state and assessed their need for restoration. One award helped to fund a

1993 study conducted by the Big Sandy Area Development District to determine fecal coliform levels in recreation areas of Dewey, Fishtrap, and Paintsville lakes. Another part of that award was used by DOW to start a fish tissue contamination survey of Kentucky lakes. Barkley Lake and Taylorsville Lake were the first two lakes surveyed. A similar project was funded in 1994. DOW surveyed Herrington Lake and Taylorsville Lake for fecal coliform levels to assess recreation impairment and collected fish tissue from McNeely, Guist Creek, Herrington, and Barren River lakes. The Kentucky Department of Fish and Wildlife Resources assisted in the field collections. The fish tissue results from 1993 and the fecal coliform results are reported elsewhere in this report. The fish tissue samples collected in 1994 were sent to a contract laboratory for analysis in March 1996. The results will be reported to the public in a press release. Two projects, through the assistance of state universities, studied the trophic state of selected reservoirs. The other award helped to fund a diagnostic/feasibility study of McNeely Lake in Jefferson County that was completed in 1982.

The DOW cooperated with local and federal agencies in all of these projects and prepared a grant for implementation of the restoration plan for McNeely Lake. The grant was not awarded because McNeely Lake was not technically eligible for assistance under federal guidelines. However, Jefferson County passed a bond issue to finance the implementation of the plan. It was completed in December 1988. The DOW monitored the lake as part of its ambient program and documented water quality improvements that showed the restoration was successful.

The DOW is ready to cooperate with local agencies and other interested groups to participate in the federal Clean Lakes Program. Funding is dependent upon federal appropriations. The preparation of the lake assessment chapter in the 305(b) report is a requirement for future participation in that program.

Toxic Substance Control/Acid Mitigation Activities

Kentucky does not have publicly owned lakes that have high acidity caused by acid precipitation; consequently, this requirement does not apply and will not be addressed.

Identification of Impaired and Threatened Lakes

Table 3-3 summarizes information on overall use support for Kentucky lakes. This information was gathered from published annual reports produced by the COE on reservoirs which they manage, from research reports by other investigators, and from DOW data bases. The total acres assessed equal the acres monitored. The analysis is based on chemical data relating to pH, manganese, and dissolved oxygen problems, biological data relating to algal biomass (blooms), taste and odor problems caused by algae, macrophyte infestations, fish kill reports, and finished drinking water data from public water systems (described in Chapter 1). Criteria were also developed based on other indicators of lake use support (see Table 3-4). A questionnaire was sent to

Table 3-3
Summary of Lake Use Support

Degree of Use Support	Acres Monitored[a]	Percent (by acres)
Acres Fully Supporting	101,939[b]	47
Acres Supporting But Threatened	97,779	45
Acres Partially Supporting	18,192	8
Acres Not Supporting	452	<1
Total Acres Assessed	218,362[b]	

[a]Total Kentucky Lake Acreage - 228,385
[b] Includes 16 additional (1,034 acres) lakes assessed by Phase II - Phase V drinking water program

operators of drinking water facilities that use lakes as raw water sources to assess use impairment. They responded to questions relating to taste and odor problems and the degree of treatment used to combat the problem. One of the criteria for support of aquatic life indicates that a use was partially supported if the average dissolved oxygen concentration within the epilimnion at any sampling event was between 4 and 5 mg/l and not supported if the dissolved oxygen was less than 4 mg/l.

The total lake surface area reported in Table 3-3 (228,385 acres) is based on the DOW's Dam Inventory Files and the acres inventoried in the lake classification program. The assessed acres represent more than 90 percent of the publicly owned lake acreage in the state. EPA published a draft document in October 1993 that updated a previous document titled Total State Waters: Estimating River Miles and Lake Acreages for the 1992 Water Quality Assessments (305(b) Reports). Total lake acreage reported for Kentucky was 225,097 acres. The acreages are derived from USGS 1:24,000 scale maps for lakes shown on the USGS 1:100,000 scale map series. The DOW derived its higher estimate of lake acreages from engineering drawings in its Dam Inventory Files, from reported acres (at certain elevations) in U.S. Army Corps of Engineers project reports of its major reservoirs in the state, and by planimetering USGS 1:24,000 scale maps for lakes with no reported acres. These are considered to be more accurate estimates than those reported by EPA. Total surface area of lakes in the state is unknown.

Many lakes have been classified by use in Kentucky and are listed in Kentucky's water quality standards. Waters not specifically listed by use in regulations are

Table 3-4
Criteria for Lake Use Support Classification

Category		Warmwater Aquatic Habitat		Secondary Contact Water Recreation	Domestic Water Supply
Not Supporting:		(At least two of the following criteria)		(At least one of the following criteria)	(At least one of the following criteria)
	1.	Fish kills caused by poor water quality	1.	Widespread excess macrophyte/macro-scopic algal growth	1. Chronic taste and order complaints caused by algae
	2.	Severe hypolimnetic oxygen depletion	2.	Chronic nuisance algal blooms	2. Chronic treatment problems caused by poor water quality
	3.	Dissolved oxygen average less than 4 mg/l in the epilimnion			3. Exceeds drinking water MCL
Partially Supporting:					
(At least one of the following criteria)	1.	Dissolved oxygen average less than 5 mg/l in the epilimnion	1.	Localized or seasonally excessive macrophyte/macro-scopic algal growth	1. Occasional taste and odor complaints caused by algae
	2.	Severe hypolimnetic oxygen depletion	2.	Occasional nuisance algal blooms	2. Occasional treatment problems caused by poor water quality
	3.	Other specific cause (i.e. low pH)	3.	High suspended sediment concentrations during the recreation season	
			4	Other specific cause (i.e. low pH)	
Fully Supporting:					
	1.	None of the above	1.	None of the above	1. None of the above

contact recreation (swimming), secondary contact recreation, fish consumption, and domestic water supply at points of domestic water supply intakes. Primary contact recreation was not assessed because routine sampling was not conducted for the primary indicator of use support (fecal coliform bacteria). The DOW has begun a program to monitor a few large lakes for fecal coliform bacteria in recreation areas in order to determine primary contact use support. This program was discussed earlier in this chapter.

Detailed information on previously assessed lakes can be found in the report on the lake classification program titled Trophic State and Restoration Assessments of Kentucky Lakes, published in 1984 by the DOW. Detailed information on newly assessed lakes has been included in a final report of the lake assessment project. DOW plans to reproduce the report for public distribution in the near future. Appendix A3-1 lists summary information on all of the lakes assessed.

Table 3-5 and Table 3-6 list lakes that did not support or partially supported their uses. The tables indicate the criteria from Table 3-4 that were used to determine nonsupport or partial support and the probable causes and sources for the support not being achieved. Table 3-7 lists those lakes that fully support their uses.

Table 3-8 summarizes individual use support information for lakes based on acres and number of lakes. More than 91 percent of the total acres assessed supported uses, and less than 9 percent did not fully support uses. Of the 120 lakes assessed, 86 (72 percent) fully supported their uses, 28 (23 percent) lakes partially supported uses, and 6 (5 percent) lakes did not support one or more uses. Of lakes more than 5,000 acres in size, only Green River Lake did not fully support uses. Herrington Lake was removed from the nonsupport list and placed in the supporting but threatened category because of improved water quality. Metcalfe County and Reformatory lakes were added to the nonsupport category because dissolved oxygen concentrations were below state standards. Laurel Creek, Liberty, and Morris lakes are being upgraded from the partial-support category to the full-support category. A study by DOW of suspended solids effects on recreation use in eastern Kentucky reservoirs resulted in the upgrade of Martins Fork and Fishtrap lakes from the partial-support category to the full-support category. A successful aeration and grass carp introduction by the Kentucky Department of Fish and Wildlife Resources removed aquatic weed and low dissolved oxygen problems at Carpenter Lake, thus moving it from partial-support to full support status. Fish consumption concerns arose in Green River Lake during this reporting period. Advisories are in effect against eating carp and channel catfish because of contamination from PCBs. Swimming in waters contaminated by bacteria was not considered to be a problem in any of the lakes. Also, there were no significant violations of drinking water maximum contaminant levels at any of the 57 water supply lakes where finished drinking water was sampled.

Table 3-5
Lakes Not Supporting Uses

Lake	Use Not Supported[a]	Criteria[b]	Cause	Source
Briggs	WAH	2,3	Nutrients	Lake fertilization
Corbin	DWS	1	Nutrients	Municipal point sources and agricultural nonpoint sources
Loch Mary	DWS	2	Metals (Mn) and other inorganics (noncarbonate hardness)	Surface mining (abandoned lands)
Mauzy	WAH	2,3	Nutrients	Lake fertilization
Metcalfe Co. nonpoint sources	WAH	2,3	Nutrients	Agriculture
Reformatory operations	WAH	2,3	Nutrients	Livestock

[a]WAH - Warmwater Aquatic Habitat, SCR - Secondary Contact Recreation, DWS - Domestic Water Supply
[b]Refer to Table 3-4

Table 3-6
Lakes Partially Supporting Uses

Lake	Use[a]	Criteria[b]	Cause	Source
Beshear	WAH	1	Nutrients	Natural
Buckhorn	SCR	3	Suspended solids	Surface mining
Campbellsville	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Caneyville	DWS	1	Nutrients	Natural
	SCR	1	Shallow Lake Basin	Natural
Carr Fork	SCR	3	Suspended solids	Surface mining
Cranks Creek	WAH	3	pH	Mining (abandoned lands)
	SCR	3	pH	Mining (abandoned lands)
	PCR	3	pH	Mining (abandoned lands)
Dewey	SCR	3	Suspended solids	Surface mining
George	WAH	1	Nutrients	Agricultural nonpoint sources
Grapevine	DWS	1	Nutrients	Unknown
Green River	FC	N/A	Priority organics (PCBs)	Industrial point source
Guist Creek	DWS	1	Nutrients, Metals (Mn)	Agricultural nonpoint sources, Natural
	WAH	1	Nutrients	Agricultural nonpoint sources
Honker	WAH	1	Nutrients	Natural
Jericho	WAH	2	Nutrients	Agricultural nonpoint sources
Kincaid	WAH	1	Nutrients	Unknown
Luzerne	DWS	2	Nutrients	Unknown
Marion County	SCR	2	Nutrients	Lake fertilization
McNeely	WAH	1,2	Nutrients	In-place contaminants (Sediments)

Table 3-6 (Continued)

Lake	Use[a]	Criteria[b]	Cause	Source
Pewee	DWS	1	Nutrients	Agricultural nonpoint sources
Salem	SCR	1	Shallow Lake Basin	Natural
Sand Lick Creek	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Scenic	WAH	1	Nutrients	In-place contaminants (sediments)
Shelby (Shelby Co.)	WAH	1	Nutrients	Agricultural nonpoint sources/In-place contaminants (sediments)
Spa	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Stanford	DWS	1	Nutrients	Natural
Taylorsville	WAH	2,3	Nutrients	Agricultural nonpoint sources
Wilgreen	WAH SCR	2 2	Nutrients Nutrients	Septic tanks Septic tanks
Washburn	WAH	2	Nutrients	Unknown
Wood Creek	DWS	1	Nutrients	Septic tanks

[a]WAH - Warmwater aquatic habitat, SCR - Secondary contact recreation,
DWS - Domestic water supply, FC - Fish consumption, N/A - not applicable
[b]Refer to Table 3-4

Table 3-7
Lakes Fully Supporting Uses

	Size	
5000 Acres or Larger	**Less than 5000 Acres**	
Barkley	A.J. Jolly	Linville
Barren	Arrowhead	Long Pond
Cave Run	Beaver	Long Run
Cumberland	Beaver Dam	Malone
Dale Hollow	Bert Combs	Martins Fork
Kentucky	Blythe	Metropolis
Laurel River	Boltz	Mill Creek (Monroe Co.)
Nolin	Buck	Mill Creek (Powell Co.)
Rough River	Bullock Pen	Mitchell
	Burnt Pond	Moffit
	Campton	Morris
	Cannon Creek	Paintsville
	Carnico	Pan Bowl
	Carpenter	Pennyrile
	Chenoa	Providence City
	Corinth	Reba
	Doe Run	Shanty Hollow
	Elmer Davis	Shelby (Ballard Co.)
	Energy	Smokey Valley
	Fish	Spurlington
	Fish Pond	Swan Pond
	Fishtrap	Sympson
	Flat	Turner
	Freeman	Tyner
	General Butler	Williamstown
	Grayson	Willisburg
	Greenbo	Yatesville
	Greenbriar	
	Happy Hollow	
	Hematite	
	Herrington	
	Kingfisher	
	Laurel Creek	
	Liberty	

Table 3-8
Use Support Summary for Lakes

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting
		(by Acres)		
Fish Consumption[a]	209,118	0	8,210	0
Aquatic Life[a]	159,404	52,179	5,567	178
Swimming[a]	217,109	0	219	0
Secondary Contact[a]	119,606	93,700	4,022	0
Drinking Water[b]	189,045	0	1,572	274
		(by Number)		
Fish Consumption[c]	103	0	1	0
Aquatic Life[c]	79	3	19	3
Swimming[c]	102	0	2	0
Secondary Contact[c]	90	2	12	0
Drinking Water[d]	48	0	7	2

[a]Total Assessed Acres = 217,328
[b]Total Assessed Acres for Domestic Water Supply = 190,891
[c]Total Assessed Lakes = 104
[d]Total Assessed for Domestic Water Supply = 57

Table 3-9
Threatened Lakes

Lake	Use Threatened[a]	Cause	Source
Kentucky	SCR	Macrophyte infestations	Natural or introduced exotic species
	WAH	Low dissolved oxygen	Unspecified nonpoint sources
Paintsville	WAH	Salinity/brine	Petroleum activities
Barkley	SCR	Suspended solids	Unspecified nonpoint sources
Herrington	WAH	Low dissolved oxygen	Unspecified nonpoint sources, municipal point sources, septic tanks

[a]SCR - Secondary Contact Recreation, WAH - Warmwater Aquatic Habitat

Table 3-10
Causes of Use Nonsupport[a] In Lakes

Major Impact[b]	Number of Lakes Affected	Acres	Percent Contribution (by Acres)
Nutrients	28	6,941	36
Priority organics (PCBs)	1	8,210	42
Suspended solids	3	3,040	16
Other (shallow lake basin)	5	498	3
pH	1	219	1
Metals (Mn)	2	452	2
Other inorganics (noncarbonate hardness)	1	135	<1

[a]Nonsupport is a collective term for lakes either not supporting or partially supporting uses
[b]No moderate or minor impacts were noted

EPA guidance asks for a list of threatened lakes. These are defined as lakes that fully support uses now, but may not in the future because of anticipated sources of or adverse trends in pollution. Table 3-3 indicates the total acres classified as threatened. Table 3-9 lists the lakes, uses threatened, and the causes and sources of the threats.

Table 3-10 indicates the causes responsible for nonsupport of uses in lakes. As noted in previous 305(b) reports, nutrients affected the largest number of lakes. Nutrients can stimulate growth of algae, which may cause taste and odor problems in lakes used for domestic water supplies. Dissolved oxygen can also be lowered by very productive algal populations that stimulate microbial respiration and may result in fish kills or a decrease in oxygen to levels that are not conducive to the support of healthy populations of fish. Priority pollutants (PCBs) affected only Green River Lake, but the entire lake (8,210 acres) was determined to not be meeting the fish consumption use. Suspended solids, the third largest contributor to nonsupport of uses, caused some reservoirs in eastern Kentucky to only partially support secondary contact recreational uses.

Table 3-11 indicates the sources responsible for nonsupport of lake uses. Industrial sources (40 percent), and nonpoint sources (41 percent) accounted for the highest percentage of lake acres with use nonsupport. More detailed studies in watersheds of the lakes in the agriculture category are necessary before contributing sources of nonpoint pollution can be distinguished. Surface coal mining and septic tanks are the other nonpoint source contributors to lake uses not being fully supported. Lake recreational uses are impaired because waters become turbid after receiving runoff laden with sediment from lands disturbed by surface mining activities. This turbidity reduces the incentive for secondary contact uses. Septic tank leachate contains nutrients that cause eutrophication and can impair aquatic life and domestic water supply uses. Natural causes and municipal point sources accounted for nine and less than one percent of use nonsupport, respectively.

Special Studies - Lake Cumberland

Sampling in Lake Cumberland was conducted in 1994 and 1995 to assess the effects of a discharge from the Russell County Regional Wastewater Treatment Plant (which includes a significant contribution from a Union Underwear facility) into the lake through a submerged multiport diffuser. Sampling of the thermally stratified lake by Jamestown and the DOW in late summer and early fall of both years indicated that pollutant concentrations were low and that the effluent remains well below the surface. These plume surveys detected increased conductivity and chloride in a thin (2-4 feet) layer at distances of almost 5,000 feet from the diffuser, but chloride concentrations were less than 15 mg/l. Near-field samples were taken for the first time in 1994 by divers from both the DOW and Jamestown. Samples were collected directly out of the pipe and at the edge of the zone of initial dilution (7 ft) to compare field results to earlier modeling predictions from which several permit limits were derived. Chloride concentrations in the 7-foot samples were highly variable, ranging from 6 to 180 mg/l, probably because of

Table 3-11
Sources of Use Nonsupport[a] in Lakes

Contributions Source	Major Impact (Acres)	Moderate/Minor Impact (Acres)	Percent (by Acres)
Point Sources			
Industrial	8,210		42
Municipal	139		<1
Nonpoint Sources			
Agriculture	4,526		23
Septic Tanks	841	317	6
Surface Mining	3,175		16
Other			
Natural	1,861		10
Lake fertilization	123		<1
In-place contaminants	86		<1
Unknown	314		2

[a]Nonsupport is a collective term for lakes either not supporting or partially supporting uses.

the turbulent nature of the plume at close proximity to the discharge ports. Kentucky's acute aquatic life criterion for chloride, applicable at the edge of the zone of initial dilution, is 1200 mg/l. Chloride samples taken from the edge of the mixing zone (70 ft) ranged from 9 to 34 mg/l. This compares to upstream control station concentrations of 1-4 mg/l and a chronic aquatic life water quality criterion applicable at the edge of the mixing zone of 600 mg/l. Total recoverable copper concentrations never exceeded 0.006 mg/l at any of the water quality monitoring sites outside the zone of initial dilution or 0.007 mg/l at the edge of the zone of initial dilution. These levels compare to background concentrations that were very low (0.001-0.003 mg/l) or undetectable, a chronic aquatic life criterion of about 0.008 to 0.010 mg/l, and an acute criterion of about 11-14 mg/l (copper criteria are dependent on water hardness).

Samples collected during unstratified conditions of February 1995 did not detect any increase in chlorides outside the mixing zone. Concentrations within the mixing zone were also much lower than during stratified conditions. These results were not unexpected because the lack of density differences in the receiving water allows more complete mixing of the effluent.

Studies by the DOW did not detect any appreciable differences in nutrient levels or phytoplankton biomass downstream of the diffuser compared to an upstream control station. Fish tissue and sediment samples did not indicate any significant differences between samples collected upstream and downstream of the diffuser. Zooplankton densities downstream of the diffuser did show significant reduction in the samples from the fall of 1994, but species richness was not affected. Further decreases of nutrients and biomass in the Lily Creek embayment, which previously received the effluent via Lily Creek, were also found.

CHAPTER 3 APPENDIX

A3 - 1: Lake Information and Explanatory Codes

Appendix A3-1
Lake Information and Explanatory Codes

COLUMN HEADER	DEFINITION
LAKE NAME	the name of the waterbody as shown on USGS topographic map
TOTAL ACREAGE	size of lake at summer pool or normal seasonal levels
USGS QUADRANGLE	quadrangle where the dam or waterbody is located
LATITUDE\LONGITUDE	location of the dam by degrees, minutes, and seconds
WATERBODY SYSTEM NUMBER	a stream identification number assigned by the Division of Water
COUNTY NAME	the name of the county where the dam or lake is located
RIVER BASIN	the name of the major river basin in which the waterbody is located
SUBBASIN	the name of the waterbody that receives the discharge from the lake or reservoir

LAKE NAME	TOTAL ACRES	USGS QUADRANGLE	LATI-TUDE	LONGI-TUDE	WATERBODY SYSTEM NUMBER	COUNTY NAME	RIVER BASIN	SUBBASIN
A.J.JOLLY LAKE	204	ALEXANDRIA	38-52-59	84-22-27	21000883	CAMPBELL	LICKING	PHILLIPS CREEK
ARROWHEAD LAKE	37	CAIRO,ILL-KY	37-01-50	89-07-20	21000661	BALLARD	MISSISSIPPI	CYPRESS SLOUGH
BARREN RIVER LAKE	10000	LUCAS	36-55-34	86-02-28	21001199	BARREN\ALLEN	GREEN	BARREN RIVER
BEAVER LAKE	158	ASHBROOK	37-57-45	85-01-20	21001280	ANDERSON	SALT	BEAVER CREEK
BEAVER DAM LAKE	50	OLMSTEAD ILL-KY	37-09-04	89-02-32	21001492	BALLARD	OHIO	HUMPHREY CREEK
BERT COMBS LAKE	36	BARCREEK	37-10-00	83-42-27	21031180	CLAY	KENTUCKY	BEECH CREEK
BOLTZ LAKE	92	WILLIAMSTOWN	38-42-12	84-36-45	21002985	GRANT	KENTUCKY	ARNOLDS CREEK
BRIGGS LAKE	18	HOMER	36-53-21	86-49-49	21003348	LOGAN	GREEN	MUD RIVER
BUCK LAKE	19	BARLOW,KY-ILL	37-02-26	89-05-22	21003796	BALLARD	MISSISSIPPI	SHAWNEE CREEK
BUCKHORN LAKE	1230	BUCKHORN	37-18-16	83-26-54	21003846	PERRY\LESLIE	KENTUCKY	MIDDLE FK.KENTUCKY RIV
BULLOCK PEN LAKE	134	VERONA	38-47-36	84-38-41	21003996	GRANT	KENTUCKY	BULLOCK PEN CREEK
BURNT POND	10	BARLOW,KY-ILL	37-02-40	89-07-02	21004124	BALLARD	MISSISSIPPI	DEEP SLOUGH
CAMPBELLSVILLE CITY RES.	63	CAMPBELLSVILLE	37-21-31	85-20-17		TAYLOR	GREEN	TRACE FK, L. PITMAN CK
CAMPTON LAKE	26	CAMPTON	37-44-42	83-32-37	21004520	WOLFE	KENTUCKY	HIRAM BR, SWIFT CAMP CK
CANEYVILLE CITY RESERVOIR	75	CANEYVILLE	37-26-34	86-27-42		GRAYSON	GREEN	NF CANEY CREEK
CANNON CREEK LAKE	243	MIDDLESBORO NORTH	36-40-51	83-42-08	21004694	BELL	UPPER CUMBERLAND	CANNON CREEK
CARPENTER LAKE	64	MACEO	37-50-51	86-58-51	21004751	DAVIESS	OHIO	UT TO PUP CREEK
CARR FORK LAKE	710	VICCO	37-14-04	83-00-03	21004822	KNOTT\PERRY	KENTUCKY	CARR FORK, KENTUCKY RIV
CAVE RUN LAKE	8270	SALT LICK	38-03-03	83-29-42	21005034	ROWAN\BATH	LICKING	N\A
CHENOA LAKE	37	KAYJAY	36-40-33	83-51-07	21005361	BELL	UPPER CUMBERLAND	CLEAR CREEK
CORBIN CITY RESERVOIR	139	CORBIN	36-59-23	87-07-07		LAUREL	UPPER CUMBERLAND	LAUREL RIVER
CORINTH LAKE	96	MASON	38-30-00	84-34-56	21006394	GRANT	KENTUCKY	THREE FORKS CREEK
CRANKS CREEK LAKE	219	HUBBARD SPRINGS,VA	36-44-23	83-13-12		HARLAN	UPPER CUMBERLAND	CRANKS CREEK
DALE HOLLOW LAKE	4300	DALE HOLLOW DAM,TN	36-36-31	85-19-29	21007039	CUMBERLAND\CLINTON	UPPER CUMBERLAND	OBEY RIVER
DEWEY LAKE	1100	DEWEY LAKE	37-41-39	82-42-22	21007522	FLOYD	BIG SANDY	LEVISA FORK
DOE RUN LAKE	51	INDEPENDENCE	38-59-19	84-33-07		KENTON	LICKING	BULLOCK PEN CREEK
ELMER DAVIS LAKE	149	GRATZ	38-29-51	84-52-40		OWEN	KENTUCKY	NORTH SEVERN CREEK
ENERGY LAKE	370	MONT	36-51-30	88-01-26	21008825	TRIGG	LOWER CUMBERLAND	CROOKED CREEK
FISH LAKE	27	BARLOW,KY-ILL	37-03-00	89-05-30	21009308	BALLARD	MISSISSIPPI	SHAWNEE CREEK
FISHPOND LAKE	32	JENKINS WEST	37-09-42	83-40-38	21031271	LETCHER	KENTUCKY	FISHPOND BRANCH
FISHTRAP LAKE	1143	MILLARD	37-25-39	82-22-12	21009357	PIKE	BIG SANDY	LEVISA FORK

LAKE NAME	TOTAL ACRES	USGS QUADRANGLE	LATI-TUDE	LONGI-TUDE	WATERBODY SYSTEM NUMBER	COUNTY NAME	RIVER BASIN	SUBBASIN
FLAT LAKE	38	BARLOW,KY-ILL	37-02-30	89-05-57	21009434	BALLARD	MISSISSIPPI	UT TO SHAWNEE CREEK
FREEMAN LAKE	160	ELIZABETHTOWN	37-43-15	85-52-17	21031223	HARDIN	GREEN	FREEMAN CREEK
GENERAL BUTLER ST.PK. LAKE	29	CARROLLTON	38-40-04	85-08-54		CARROLL	KENTUCKY	UT TO KENTUCKY RIVER
GRAPEVINE LAKE	50	MADISONVILLE EAST	37-18-16	87-28-40		HOPKINS	GREEN	UT TO FLAT CREEK
GRAYSON LAKE	1512	GRAYSON	38-11-48	83-02-36	21010844	CARTER\ELLIOTT	LITTLE SANDY	N\A
GREENBRIAR LAKE	66	PRESTON	38-01-11	83-51-34		MONTGOMERY	LICKING	GREENBRIAR CREEK
GREENBO LAKE	181	ARGILLITE	38-29-19	85-52-04	21010959	GREENUP	LITTLE SANDY	CLAYLICK CREEK
GREEN RIVER LAKE	8210	CANE VALLEY	37-14-59	85-20-02	21010945	ADAIR\TAYLOR	GREEN	N\A
GUIST CREEK LAKE	317	SHELBYVILLE	38-12-28	85-08-31	21011172	SHELBY	SALT	GUIST CREEK
HAPPY HOLLOW LAKE	20	OLMSTEAD ILL-KY	37-00-28	89-01-48		BALLARD	OHIO	HUMPHREY CREEK
HEMATITE LAKE	90	MONT	36-53-44	88-02-53	21011995	TRIGG	LOWER CUMBERLAND	LONG CREEK
HERRINGTON LAKE	2940	WILMORE	37-44-45	84-42-14	21012101	MERCER\GARRARD	KENTUCKY	DIX RIVER
HONKER LAKE	190	MONT	36-54-22	88-01-47	21012645	TRIGG	LOWER CUMBERLAND	LONG CREEK
KENTUCKY LAKE	48100	GRAND RIVERS	36-29-52	88-02-42	21014338\21014339	MARSHALL\LIVINGSTON	TENNESSEE	N\A
KINCAID LAKE	183	FALMOUTH	38-42-57	84-16-36		PENDLETON	LICKING	KINCAID CREEK
KINGFISHER LAKE	30	MACEO	37-50-42	86-58-35	21014459	DAVIESS	OHIO	PUP CREEK
LAKE BARKLEY	45600	GRAND RIVERS	36-44-12	87-57-58	21001106	LIVINGSTON\LYON	LOWER CUMBERLAND	N\A
LAKE BESHEAR	760	DAWSON SPRINGS	37-08-28	87-40-57	21001890	CALDWELL\CHRISTIAN	TRADEWATER	PINEY CREEK
LAKE BLYTHE	89	KELLY	36-55-32	87-30-00	21002850	CHRISTIAN	LOWER CUMBERLAND	WHITE CREEK
LAKE CARNICO	114	CARLISLE	38-20-48	84-02-30		NICHOLAS	LICKING	BRUSHY CREEK
LAKE CUMBERLAND	50250	WOLF CREEK DAM	36-54-47	84-58-43	21006949	RUSSELL\CLINTON	UPPER CUMBERLAND	N\A
LAKE GEORGE	53	MARION	37-17-49	88-05-25		CRITTENDEN	OHIO	UT TO CROOKED CREEK
LAKE JERICHO	137	SMITHFIELD	38-27-07	85-16-56	21023710	HENRY	LITTLE KENTUCKY	N\A
LAKE LINVILLE	273	WILDIE	37-23-20	84-20-40		ROCKCASTLE	UPPER CUMBERLAND	RENFRO CREEK
LAKE MALONE	826	ROSEWOOD	37-04-19	87-02-20	21017009	MUHLENBERG	GREEN	ROCKY CREEK
LAKE MORRIS	170	KELLY	36-55-44	87-27-18	21018602	CHRISTIAN	LOWER CUMBERLAND	UPPER BRANCH, LITTLE RIV
LAKE PEWEE	360	MADISONVILLE WEST	37-21-09	87-31-40	21020953	HOPKINS	TRADEWATER	GREASY CREEK
LAKE REBA		RICHMOND NORTH	37-44-28	84-15-07	21022751	MADISON	KENTUCKY	MUDDY CREEK
LAKE WASHBURN	26	DUNDEE	37-31-05	86-50-56		OHIO	GREEN	LICK BRANCH
LAUREL CREEK LAKE	88	WHITLEY CITY	36-41-18	84-26-35		MCCREARY	UPPER CUMBERLAND	LAUREL CREEK
LAUREL RIVER LAKE	6060	SAWYER	36-58-21	84-15-31	21014927	LAUREL\WHITLEY	UPPER CUMBERLAND	LAUREL RIVER

LAKE NAME	TOTAL ACRES	USGS QUADRANGLE	LATI-TUDE	LONGI-TUDE	WATERBODY SYSTEM NUMBER	COUNTY NAME	RIVER BASIN	SUBBASIN
LEWISBURG LAKE	51	LEWISBURG	36-58-14	86-55-36		LOGAN	GREEN	AUSTIN CREEK
LIBERTY LAKE	79	LIBERTY	37-19-03	84-54-26		CASEY	GREEN	HICKMAN CREEK
LOCH MARY	135	MADISONVILLE WEST	37-16-06	87-31-22	21016154	HOPKINS	TRADEWATER	UT TO CLEAR CREEK
LONG POND	56	CAIRO,ILL-KY	37-01-15	89-07-40	21016477	BALLARD	MISSISSIPPI	CYPRESS SLOUGH
LONG RUN PARK LAKE	27	CRESTWOOD	38-16-01	85-25-05		JEFFERSON	SALT	LONG RUN
LUZERNE LAKE	55	GREENVILLE	37-12-42	87-11-54	21026847	MUHLENBERG	GREEN	UT TO CANEY CREEK
MARION COUNTY LAKE	21	LEBANON EAST	37-30-54	85-14-45		MARION	SALT	UT TO ROLLING FORK
MARTIN'S FORK LAKE	334	ROSE HILL,VA-KY	36-44-36	83-15-58		HARLAN	UPPER CUMBERLAND	MARTINS FORK
MAUZY LAKE	84	BORDLEY	37-37-08	87-51-26		UNION	OHIO	CASEY CREEK
MCNEELY LAKE	51	BROOKS	38-06-09	85-38-07	21017423	JEFFERSON	SALT	PENNSYLVANIA RUN
METCALFE COUNTY LAKE	22	EAST FORK	37-02-30	85-36-32		METCALFE	GREEN	SULPHUR CREEK
METROPOLIS LAKE	36	JOPPA,ILL-KY	37-08-52	88-46-00	21017855	MCCRACKEN	OHIO	FLOOD PLAIN LAKE
MILL CREEK L. (MONROE CO)	109	TOMPKINSVILLE	36-40-44	85-41-45		MONROE	GREEN	MILL CREEK
MILL CREEK L. (POWELL CO)	41	SLADE	37-46-07	83-40-06		POWELL	KENTUCKY	MILL CREEK
MITCHELL LAKE	58	OLMSTEAD ILL-KY	37-06-24	89-02-43	21018370	BALLARD	OHIO	HUMPHREY CREEK
MOFFIT LAKE	49	BORDLEY	37-34-41	87-51-10	21018397	UNION	TRADEWATER	DYSON CREEK
NOLIN RIVER LAKE	5790	NOLIN LAKE	37-20-10	86-10-55	21019810	EDMONSON	GREEN	NOLIN RIVER
PAINTSVILLE LAKE	1139	OIL SPRINGS	37-50-28	82-52-38	21031555	JOHNSON	BIG SANDY	LEVISA FORK
PANBOWL LAKE	98	JACKSON,QUICKSAND	37-34-30	82-22-31	21020665	BREATHITT	KENTUCKY	NF KENTUCKY RIVER
PENNYRILE LAKE	47	DAWSON SPRINGS SW	37-04-06	87-39-50	21021010	HOPKINS	TRADEWATER	CLIFTY CREEK
PROVIDENCE CITY LAKE (NEW)	35	PROVIDENCE	37-22-30	87-47-49	21022390	WEBSTER	TRADEWATER	OWENS CREEK
REFORMATORY LAKE	54	LAGRANGE	38-23-52	85-26-16	21022864	OLDHAM	OHIO	CEDAR CREEK
ROUGH RIVER LAKE	5100	MCDANIELS	37-36-40	86-29-00	21023868	GRAYSON\BRCKINRDGE	GREEN	ROUGH RIVER
SALEM LAKE	99	HODGENVILLE	37-35-29	85-42-41		LARUE	GREEN	SALEM CREEK
SANDLICK CREEK LAKE	74	BURTONVILLE	38-23-23	83-36-41		FLEMING	LICKING	SAND LICK CREEK
SCENIC LAKE	18	EVANSVILLE S,ILL-KY	37-52-42	87-33-37		HENDERSON	OHIO	UT TO OHIO RIVER
SHANTY HOLLOW LAKE	135	REEDYVILLE	37-09-02	86-23-13	21025015	WARREN	GREEN	CLAY LICK CREEK
SHELBY LAKE (SHELBY CO)	17	SHELBYVILLE	38-13-59	85-13-02	21025101	SHELBY	SALT RIVER	CLEAR CREEK
SHELBY LAKE (BALLARD CO)	24	OLMSTEAD ILL-KY	37-11-01	89-01-52	21025100	BALLARD	OHIO	GAR CREEK
SMOKEY VALLEY LAKE	36	GRAHN	38-21-59	83-07-41	21025834	CARTER	TYGARTS CREEK	SMOKEY CREEK
SPA LAKE (MUD RIVER MPS 6A)	240	SHARON GROVE	36-56-04	87-01-25		LOGAN	GREEN	WOLF LICK CREEK

LAKE NAME	TOTAL ACRES	USGS QUADRANGLE	LATI-TUDE	LONGI-TUDE	WATERBODY SYSTEM NUMBER	COUNTY NAME	RIVER BASIN	SUBBASIN
SPURLINGTON LAKE	36	SPURLINGTON	37-23-18	83-15-12	21026202	TAYLOR	GREEN	BRUSHY FK, ROBINSON CK
STANFORD CITY RESERVOIR	43	HALLS GAP	37-29-12	84-40-48	21026443	LINCOLN	KENTUCKY	NEALS CREEK
SYMPSON LAKE	184	CRAVENS	37-48-27	85-30-17	21027336	NELSON	SALT	BUFFALO CREEK
SWAN POND	193	BARLOW,KY-ILL	37-15-50	89-07-05	21027258	BALLARD	MISSISSIPPI	MINOR SLOUGH
TAYLORSVILLE LAKE	3050	TAYLORSVILLE	38-00-05	85-13-12		SPENCER	SALT	N\A
TURNER LAKE	61	OLMSTEAD,ILL-KY	37-10-22	89-02-30	21028494	BALLARD	OHIO	HUMPHREY CREEK
TYNER LAKE	87	MCKEE	37-22-09	83-54-47		JACKSON	UPPER CUMBERLAND	FLAT LICK CREEK
WILGREEN LAKE	169	RICHMOND SOUTH	37-42-44	84-20-43		MADISON	KENTUCKY	TRACE FORK,SILVER CK
WILLIAMSTOWN LAKE	300	WILLIAMSTOWN	38-40-38	84-31-15	21030071	GRANT	LICKING	SF GRASSY CREEK
WILLISBURG LAKE	126	BRUSH GROVE	37-49-32	85-09-24	21030088	WASHINGTON	SALT	LICK CREEK
WOOD CREEK LAKE	672	BERNSTADT	37-11-24	84-10-48	21030426	LAUREL	UPPER CUMBERLAND	WOOD CREEK
YATESVILLE LAKE	2242	FALLSBURG, KY-WV	38-07-27	82-42-58		LAWRENCE	BIG SANDY	BLAINE CREEK

COLUMN HEADER	DEFINITION
ASSESSMENT:	
DATE	year of the most recent assessment
CAT	CATEGORY = the type of assessment made in determining the water quality condition of the waterbody M (monitored) assessments were based on current (< 10 yrs. old) site-specific data E (evaluated) assessments were based on information other than site specific criteria
TYPE	one digit code representing the type of water quality assessment made on the waterbody: 1 = assessment based on growing season sampling regime (three times per year) 2 = assessment based on data collected over time at fixed monitoring stations 3 = assessment based on Division of Water collections 4 = assessment based on U.S.Corps of Engineers collections 5 = assessment based on Tennessee Valley Authority collections
TROPHIC STATUS	the trophic state of the waterbody at the most recent assessment
TOX MON?	Toxics Monitoring? an indication of the existence of information (Y=yes;N=no) indicating the presence or absence of toxics in the waterbody
TOXIC CODES	the type of toxics monitoring information gathered at the waterbody 1 = Organics in the water column 2 = Organics in fish tissue 3 = Pesticides in water column 4 = Pesticides in fish tissue 5 = Metals in the water column 6 = Metals in the sediment 7 = Metals in fish tissue 8 = Toxics testing of discharge
FISH CONSUMPTION:	
SUPP	no fish/shellfish advisories or bans in effect
PART	a fish/shellfish advisory or ban in effect for "restricted consumption" which limits the number of meals or amount consumed per unit time
NOT	a fish/shellfish advisory or ban with a commercial fishing/shellfishing ban in effect for "no consumption" for one or more fish species

COLUMN HEADER	DEFINITION
SWIMMABLE:	
SUPP	the number of acres which support water-based recreational activities
PART	the number of acres which partially support water-based recreational activities
NOT	the number of acres which do not support water-based recreational activities
USE SUPPORT:	Use Support Status
FULL	all uses are supported(based on data)
PART	one or more uses are partially supported and the remaining uses are fully supported
NOT	one or more uses are not being supported 1) WAH = warmwater aquatic habitat 2) CAH = coldwater aquatic habitat 3) PCR = primary contact recreation 4) SCR = secondary contact recreation 5) DWS = domestic water supply
CAUSE\SOURCE:	a code which refers to the cause and source of the impact that caused the waterbody to either not or partially support the use

Cause	Source
1 = metals	A = natural
2 = nutrients	B = lake fertilization
3 = suspended solids	C = municipal (package treatment plants)
4 = shallow lake basin	D = septic tanks
5 = pH	E = unspecified nonpoint source
6 = other inorganics	F = surface mining/deep mining/abandoned lands
7 = priority organics	G = agricultural nonpoint source
8 = low dissolved oxygen/organic enrichment	H = animal holding and management areas
	I = in-place contaminants (sediments)
	J = industrial
	K = unknown

LAKE NAME	ASSESSMENT:			TROPHIC STATUS	TOX MON?	TOXIC CODES	FISH CONSUMPTION			SWIMMABLE:			USE FULLY SUPPORTED	USE PART SUPPORTED	USE NOT SUPPORTED	CAUSE/ SOURCE
	DATE	CAT	TYPE				S	PS	NS	S	PS	NS				
A.J.JOLLY LAKE	1989	M	1,3	EUTROPHIC	N		204			204			WAH,PCR,SCR,DWS			
ARROWHEAD LAKE	1989	M	1,3	EUTROPHIC	N		37			37			WAH,PCR,SCR			
BARREN RIVER LAKE	1987	M	2,4	MESOTROPHIC	N		10000			10000			WAH,PCR,SCR,DWS			
BEAVER CREEK ARM	1987	M	2,4	EUTROPHIC	N								WAH,PCR,SCR			
SKAGGS CREEK ARM	1987	M	2,4	MESOTROPHIC	N								WAH,PCR,SCR			
BEAVER LAKE	1989	M	1,3	EUTROPHIC	N		158			158			WAH,PCR,SCR			
BEAVER DAM LAKE	1991	M	1,3	HYPER-EUTROPHIC	N		50			50			WAH,PCR,SCR			
BERT COMBS LAKE	1990	M	1,3	EUTROPHIC	N		36			36			WAH,PCR,SCR,DWS			
BOLTZ LAKE	1989	M	1,3	EUTROPHIC	N		92			92			WAH,PCR,SCR			
BRIGGS LAKE	1990	M	1,3	EUTROPHIC	N		18			18			PCR,SCR		WAH	2,B
BUCK LAKE	1989	M	1,3	EUTROPHIC	N		19			19			WAH,PCR,SCR			
BUCKHORN LAKE	1989	M	2,4	OLIGOTROPHIC	Y	1,3,5,6	1230			1230			WAH,PCR,DWS	SCR		3,F
BULLOCK PEN LAKE	1989	M	1,3	EUTROPHIC	N		134			134			WAH,PCR,SCR,DWS			
BURNT POND	1989	M	1,3	EUTROPHIC	N		10			10			WAH,PCR,SCR			
CAMPBELLSVILLE CITY RES.	1989	M	1,3	EUTROPHIC	N		63			63			PCR,DWS	WAH,SCR		2,G/4,A
CAMPTON LAKE	1990	M	1,3	MESOTROPHIC	N		26			26			WAH,PCR,SCR,DWS			
CANEYVILLE CITY RESERVOIR	1990	M	1,3	EUTROPHIC	N		75			75			WAH,PCR	DWS,SCR		2,4,A
CANNON CREEK LAKE	1990	M	1,3	OLIGOTROPHIC	N		243			243			WAH,PCR,SCR,DWS			
CARPENTER LAKE	1990	M	1,3	EUTROPHIC	N		64			64			WAH,PCR,SCR			
CARR FORK LAKE	1994	M	2,4	OLIGOTROPHIC	Y	1,3,5,6	710			710			WAH,PCR	SCR		3,F
CAVE RUN LAKE	1989	M	2,4	MESOTROPHIC	Y	1,3,5,6	8270			8270			WAH,PCR SCR			
CHENOA LAKE	1990	M	1,3	MESOTROPHIC	N		37			37			WAH,PCR,SCR			
CORBIN CITY RESERVOIR	1990	M	1,3	MESOTROPHIC	N		139			139			WAH,PCR,SCR		DWS	2,C,G
CORINTH LAKE	1989	M	1,3	EUTROPHIC	N		96			96			WAH,PCR,SCR			
CRANKS CREEK LAKE	1994	M	1,3	OLIGOTROPHIC	N		219				219			WAH,PCR,SCR		5,F
DALE HOLLOW LAKE	1979	M	2,4	OLIGOTROPHIC	N		4300			4300			WAH,PCR,SCR			
DEWEY LAKE	1991	M	2,4	MESOTROPHIC	Y	1,3,5,6	1100			1100			WAH,PCR	SCR		3,F
DOE RUN LAKE	1995	M	1,3	EUTROPHIC	N		51			51			WAH,PCR,SCR			
ELMER DAVIS LAKE	1989	M	1,3	EUTROPHIC	N		149			149			WAH,PCR,SCR			
ENERGY LAKE	1989	M	1,3	EUTROPHIC	N		370			370			WAH,PCR,SCR			
FISH LAKE	1989	M	1,3	EUTROPHIC	N		27			227			WAH,PCR,SCR			

LAKE NAME	ASSESSMENT: DATE	CAT	TYPE	TROPHIC STATUS	TOX MON?	TOXIC CODES	FISH CONSUMPTION S	PS	NS	SWIMMABLE: S	PS	NS	USE FULLY SUPPORTED	USE PART SUPPORTED	USE NOT SUPPORTED	CAUSE/ SOURCE
FISHPOND LAKE	1990	M	1,3	EUTROPHIC	N		32			32			WAH,PCR,SCR			
FISHTRAP LAKE	1992	M	2,4	MESOTROPHIC	Y	1,3,5,6	1143			1143			WAH,PCR,SCR			
FLAT LAKE	1989	M	1,3	EUTROPHIC	N		38			38			WAH,PCR,SCR			
FREEMAN LAKE	1990	M	1,3	EUTROPHIC	N		160			160			WAH,PCR,SCR			
GENERAL BUTLER ST.PK. LAKE	1989	M	1,3	EUTROPHIC	N		29			29			WAH,PCR,SCR			
GRAPEVINE LAKE	1990	M	1,3	MESOTROPHIC	N		50			50			WAH,PCR,SCR	DWS		2,K
GRAYSON LAKE	1989	M	2,4	OLIGOTROPHIC	Y	1,3,5,6	1512			1512			WAH,PCR,SCR			
GREENBRIAR LAKE	1990	M	1,3	EUTROPHIC	N		66			66			WAH,PCR,SCR,DWS			
GREENBO LAKE	1989	M	1,3	MESOTROPHIC	N		181			181			WAH,PCR,SCR			
GREEN RIVER LAKE	1990	M	2,4	MESOTROPHIC	Y	1,2,3,5,6		8210		8210			WAH,PCR,SCR,DWS			7,J
GUIST CREEK LAKE	1989	M	1,3	EUTROPHIC	N		317			317			PCR,SCR	WAH,DWS		2,G/1,A
HAPPY HOLLOW LAKE	1991	M	1,3	HYPER-EUTROPHIC	N		20			20			WAH,PCR,SCR			
HEMATITE LAKE	1989	M	1,3	MESOTROPHIC	N		90			90			WAH,PCR,SCR			
HERRINGTON LAKE	1994	M	1,3	EUTROPHIC	N		2940			2940			WAH,PCR,SCR,DWS			
HONKER LAKE	1989	M	1,3	MESOTROPHIC	N		190			190			PCR,SCR	WAH		2,A
KENTUCKY LAKE	1993	M	2,4	EUTROPHIC	Y	1,2,3,4,5,6,7	8100			8100			WAH,PCR,SCR,DWS			
KINCAID LAKE	1990	M	1,3	EUTROPHIC	N		183			183			PCR,SCR	WAH		2,K
KINGFISHER LAKE	1990	M	1,3	EUTROPHIC	N		30			30			WAH,PCR,SCR			
LAKE BARKLEY	1984	M	5	EUTROPHIC	N		45600			45600			WAH,PCR,SCR,DWS			
LAKE BESHEAR	1990	M	1,3	MESOTROPHIC	N		760			760			PCR,SCR,DWS	WAH		2,A
LAKE BLYTHE	1990	M	1,3	MESOTROPHIC	N		89			89			WAH,PCR,SCR			
LAKE CARNICO	1990	M	1,3	EUTROPHIC	N		114			114			WAH,PCR,SCR			
LAKE CUMBERLAND	1995	M	2,4	OLIGOTROPHIC	N		49108			49108			WAH,PCR,SCR,DWS			
LILY CREEK ARM	1995	M	1,3	MESOTROPHIC	N		144			144			WAH,PCR,SCR			
BEAVER CREEK ARM	1990	M	1,3	EUTROPHIC	N		742			742			WAH,PCR,SCR			
PITMAN CREEK ARM	1994	M	1,3	MESOTROPHIC	N		256			256			WAH,PCR,SCR			
LAKE GEORGE	1990	M	1,3	EUTROPHIC	N		53			53			PCR,SCR,DWS	WAH		2,G
LAKE JERICHO	1992	M	1,3	EUTROPHIC	N		137			137			PCR,SCR	WAH		2,G
LAKE LINVILLE	1990	M	1,3	MESOTROPHIC	N		273			273			WAH,PCR,SCR,DWS			
LAKE MALONE	1990	M	1,3	EUTROPHIC	N		826			826			WAH,PCR,SCR			
LAKE MORRIS	1990	M	1,3	MESOTROPHIC	N		170			170			WAH,PCR,SCR,DWS			

LAKE NAME	ASSESSMENT:			TROPHIC STATUS	TOX MON?	TOXIC CODES	FISH CONSUMPTION			SWIMMABLE:			USE FULLY SUPPORTED	USE PART SUPPORTED	USE NOT SUPPORTED	CAUSE/ SOURCE
	DATE	CAT	TYPE				S	PS	NS	S	PS	NS				
LAKE PEWEE	1990	M	1,3	MESOTROPHIC	N		360			360			WAH,PCR,SCR	DWS		2,G
LAKE REBA	1995	M	1,3	MESOTROPHIC	N		78			78			WAH,PCR,SCR			
LAKE WASHBURN	1990	M	1,3	EUTROPHIC	N		26			26			PCR,SCR	WAH		2,K
LAUREL CREEK LAKE	1990	M	1,3	MESOTROPHIC	N		88			88			WAH,PCR,SCR,DWS			
LAUREL RIVER LAKE	1994	M	2,4	OLIGOTROPHIC	N		4990			4990			WAH,PCR SCR,DWS			
MIDLAKE-LAUREL R. ARM	1994	M	2,4	MESOTROPHIC	N		754			754			WAH,PCR,SCR,DWS			
HEADWTRS-LAUREL R. ARM	1994	M	2,4	EUTROPHIC	N		316			316			WAH,PCR,SCR			
LIBERTY LAKE	1989	M	1,3	MESOTROPHIC	N		79			79			WAH,PCR,SCR,DWS			
LOCH MARY	1990	M	1,3	OLIGOTROPHIC	N		135			135			WAH,PCR,SCR		DWS	1,6,F
LONG POND	1989	M	1,3	EUTROPHIC	N		56			56			WAH,PCR,SCR			
LONG RUN PARK LAKE	1989	M	1,3	MESOTROPHIC	N		27			27			WAH,PCR,SCR			
LUZERNE LAKE	1990	M	1,3	MESOTROPHIC	N		55			55			WAH,PCR,SCR	DWS		2,K
MARION COUNTY LAKE	1989	M	1,3	EUTROPHIC	N		21			21			WAH,PCR	SCR		2,B
MARTIN'S FORK LAKE	1994	M	2,4	OLIGOTROPHIC	N		334			334			WAH,PCR,SCR			
MAUZY LAKE	1990	M	1,3	EUTROPHIC	N		84			84			PCR,SCR		WAH	2,B
MCNEELY LAKE	1993	M	1,3	EUTROPHIC	N		51			51			PCR,SCR	WAH		2,I
METCALFE COUNTY LAKE	1995	M	1,3	EUTROPHIC	N		22			22			PCR,SCR		WAH	2,G
METROPOLIS LAKE	1989	M	1,3	EUTROPHIC	N		36			36			WAH,PCR,SCR			
MILL CREEK L. (MONROE CO.)	1990	M	1,3	MESOTROPHIC	N		109			109			WAH,PCR,SCR,DWS			
MILL CREEK L. (POWELL CO.)	1990	M	1,3	MESOTROPHIC	N		41			41			WAH,PCR,SCR,DWS			
MITCHELL LAKE	1991	M	1,3	HYPER-EUTROPHIC	N		58			58			WAH,PCR,SCR			
MOFFIT LAKE	1990	M	1,3	EUTROPHIC	N		49			49			WAH,PCR,SCR			
NOLIN RIVER LAKE	1995	M	2,4	OLIGOTROPHIC	Y	1,3,5,6	5790			5790			WAH,PCR,SCR			
PAINTSVILLE LAKE	1994	M	2,4	MESOTROPHIC	Y	1,3,5,6	1139			1139			WAH,PCR,SCR			
PANBOWL LAKE	1990	M	1,3	MESOTROPHIC	N		98			98			WAH,PCR,SCR			
PENNYRILE LAKE	1991	M	1,3	EUTROPHIC	N		47			47			WAH,PCR,SCR			
PROVIDENCE CITY LAKE (NEW)	1990	M	1,3	MESOTROPHIC	N		35			35			WAH,PCR,SCR,DWS			
REFORMATORY LAKE	1995	M	1,3	EUTROPHIC	N		54			54			PCR,SCR		WAH	2,I,H
ROUGH RIVER LAKE	1995	M	2,4	MESOTROPHIC	Y	1,3,5,6	5100			5100			WAH,PCR,SCR,DWS			
SALEM LAKE	1990	M	1,3	EUTROPHIC	N		99			99			WAH,PCR,DWS	SCR		4,A
SANDLICK CREEK LAKE	1989	M	1,3	EUTROPHIC	N		74			74			PCR	WAH,SCR		2,G/4,A

LAKE NAME	ASSESSMENT:			TROPHIC STATUS	TOX MON?	TOXIC CODES	FISH CONSUMPTION			SWIMMABLE:			USE FULLY SUPPORTED	USE PART SUPPORTED	USE NOT SUPPORTED	CAUSE/ SOURCE
	DATE	CAT	TYPE				S	PS	NS	S	PS	NS				
SCENIC LAKE	1990	M	1,3	EUTROPHIC	N		18			18			PCR,SCR	WAH		2,I
SHANTY HOLLOW LAKE	1991	M	1,3	EUTROPHIC	N		135			135			WAH,PCR,SCR			
SHELBY LAKE (SHELBY CO.)	1990	M	1,3	EUTROPHIC	N		17			17			PCR,SCR	WAH		2,G,I
SHELBY LAKE (BALLARD CO.)	1991	M	1,3	EUTROPHIC	N		24			24			WAH,PCR,SCR			
SMOKEY VALLEY LAKE	1989	M	1,3	MESOTROPHIC	N		36			36			WAH,PCR,SCR			
SPA LAKE (MUD RIV. MPS 6A)	1990	M	1,3	EUTROPHIC	N		240			240			PCR,DWS	WAH,SCR		2,G/4,A
SPURLINGTON LAKE	1989	M	1,3	EUTROPHIC	N		36			36			WAH,PCR,SCR			
STANFORD CITY RESERVOIR	1989	M	1,3	OLIGOTROPHIC	N		43			43			WAH,PCR,SCR	DWS		2,A
SYMPSON LAKE	1990	M	1,3	EUTROPHIC	N		184			184			WAH,PCR,SCR,DWS			
SWAN POND	1989	M	1,3	EUTROPHIC	N		193			193			WAH,PCR,SCR			
TAYLORSVILLE LAKE	1993	M	2,4	EUTROPHIC	Y	1,3,5,6	3050			3050			PCR,SCR	WAH		2,G
TURNER LAKE	1989	M	1,3	EUTROPHIC	N		61			61			WAH,PCR,SCR			
TYNER LAKE	1990	M	1,3	MESOTROPHIC	N		87			87			WAH,PCR,SCR,DWS			
WILGREEN LAKE	1990	M	1,3	EUTROPHIC	N		169			169			PCR	WAH,SCR		2,D
WILLIAMSTOWN LAKE	1990	M	1,3	EUTROPHIC	N		300			300			WAH,PCR,SCR,DWS			
WILLISBURG LAKE	1989	M	1,3	EUTROPHIC	N		126			126			WAH,PCR,SCR,DWS			
WOOD CREEK LAKE	1989	M	1,3	MESOTROPHIC	N		672			672			WAH,PCR,SCR	DWS		2,D
YATESVILLE LAKE	1994	M	2,4	MESOTROPHIC	Y	1,3,5,6	2,242			2,242			WAH,PCR,SCR			

* 936 Acres

CHAPTER 4

WATER QUALITY ASSESSMENT OF GROUNDWATER

WATER QUALITY ASSESSMENT OF GROUNDWATER

Introduction

Kentucky's groundwater program continues to make advances to update and strengthen existing groundwater protection strategies and groundwater remediation programs. A groundwater protection regulation is being implemented to protect the groundwater of the Commonwealth through pollution prevention planning.

Programs at various state agencies and universities continue to collect groundwater data that provide water quality information on a statewide and basin-specific basis. Figure 4-1 shows the locations of nonpoint source pollution studies conducted throughout Kentucky during the past two years. Current studies have increased sampling points to better represent the water quality of the entire state. These studies will acquire new data on ambient groundwater quality. Interpretation of new and existing data will enable agencies to determine which areas are sensitive to groundwater pollution and where pollution studies and pollution prevention funding and educational programs are needed to better protect this valuable resource in the future.

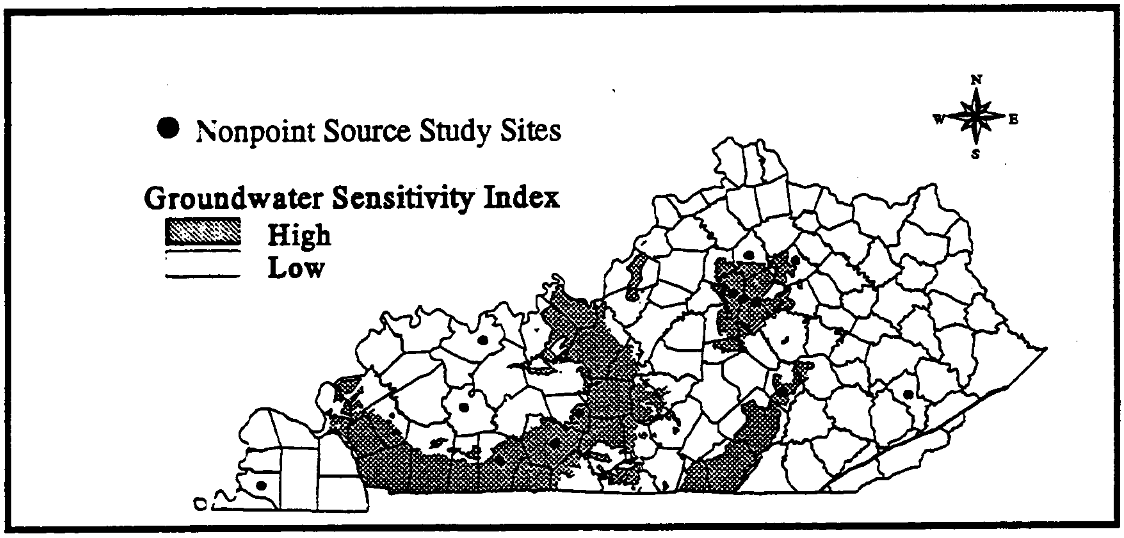


Figure 4-1. Nonpoint source groundwater quality study sites in Kentucky.

A new regulation for the protection of groundwater was promulgated by the Cabinet and approved by the Kentucky legislature. Effective August 24, 1994, 401 KAR 5:037 requires facilities whose activities have the potential to pollute groundwater to develop and implement groundwater protection plans no later than August 24, 1995. This regulation was designed to heighten people's awareness of their activities and how they can affect groundwater as well as to reduce groundwater contamination in Kentucky by requiring best management practices to be used where activities threaten groundwater resources.

Programs of the Division of Water, Groundwater Branch, such as the Drillers' Certification Program, have become fully established over the past few years. New programs, such as the Wellhead Protection Program, have been implemented and have begun to show beneficial results. Programs and regulations of agencies other than the Division of Water (*e.g.*, the State Superfund and Hazardous Waste programs) are also continuing their efforts to protect groundwater.

Groundwater quality monitoring efforts have included, in part, public water suppliers (PWSs) that use groundwater as a water source. Approximately 435,000 Kentuckians depend on these PWSs for their domestic water source. The quality of treated groundwater available through these PWSs has not changed substantially over the past two years. MCL violations at PWSs have averaged approximately five per year in the last three years. The population affected by MCL violations dropped sharply between 1992 and 1993 when a large PWS cleaned up an MCL exceedence. This number rose slightly in 1995 due to the consolidation of several PWSs over the last four years. Consequently, as more people depend on fewer water systems, each MCL violation affects a larger population.

The information reported by the Division of Waste Management, Solid Waste Branch, has remained unchanged at approximately 10-12 sites per year reported with contamination. Three sites have contamination that has moved off-site but does not impact any public water system.

The number of federal CERCLA sites in Kentucky with groundwater contamination has not changed since 1993, but three additional sites have reported off-site contamination since 1993. None of these CERCLA sites affect public water systems.

State superfund site data show 388 active sites and 423 site closures as of December 1995. No data were available on the number of sites with off-site contamination or whether any PWSs were affected. With over 1,000 state superfund sites identified, it is thought that the number of state superfund sites in Kentucky, given the current rate of attrition and discovery, will remain at this level over the next several years.

The U.S. EPA developed a guide for states to use to identify and report contaminants (and their sources) which pose the greatest threat to groundwater quality. Kentucky's groundwater contamination problems include nonpoint source pollutants such as pesticides and fertilizers. Bacterial and nutrient pollutants are also major concerns. However, even with the current influx of data, quantification of pollutants and identification of specific pollutant sources are challenges for the future.

Regulations and statutes, such as the Groundwater Protection Regulation, the Agriculture Water Quality Act, Wellhead

Protection Program, and Drillers Certification Program reduce pollution influx to groundwater systems. They reduce the pollution influx by requiring careful consideration of activities, the use of best management practices, public education, and specific activity standards.

Overview Of State Groundwater Protection Programs

The status of the groundwater protection programs in Kentucky is shown in Table 4-1. Specific groundwater quality standards were not adopted by Kentucky. Rather, the various agencies that have programs which regulate groundwater protection follow programmatic guidelines with regard to programmatic groundwater quality standards. For example, risk-based standards are followed by the Underground Storage Tank and State Superfund programs, while RCRA and CERCLA generally adhere to MCLs or method detection limits as clean-up standards.

The EPA-endorsed CSGWPP (Comprehensive State Groundwater Protection Program) is being evaluated for possible future implementation by the State. Basic differences exist between state projections and EPA's guidance on CSGWPP. A determination as to Kentucky's intent regarding submitting a core CSGWPP will be made in 1996.

Vulnerability assessment of groundwater for drinking water and wellhead protection programs is partly addressed in the Division of Water's Groundwater Sensitivity Map, which is slated for publication in 1996. This statewide map presents, on a generalized basis, groundwater's vulnerability to contamination from activities in particular areas.

A number of valuable studies related to groundwater issues are currently being performed in Kentucky. One of these studies is a DOW 319 program investigation designed to determine the water quality of a public water supply spring. Another representative study examines the effect of a program of Best Management Practices (BMP's) and public education to change attitudes about groundwater in a karst groundwater basin in the most productive agricultural region in Kentucky.

401 KAR 5:037 - A Significant New Development In Groundwater Protection

The Division of Water promulgated a new groundwater protection regulation that became effective in August 1994. This regulation, 401 KAR 5:037, Groundwater Protection Plans, is a pollution prevention regulation that requires persons engaging in activities with the potential to pollute groundwater to develop a groundwater protection plan (GPP) for those activities. GPP's must contain general facility information, identification of all activities which must be addressed, identification of all practices developed to prevent groundwater pollution, an implementation schedule, a description of employee training, an inspection schedule, and the incorporation of other programs where applicable. While plans can be either generic or site-

Programs or Activities	Check	Implementation Status	Responsible State Agency
Active SARA Title III Program	✓	Continuing efforts	Department for Environmental Protection Commissioner's Office
Ambient groundwater monitoring	✓	Continuing efforts	Division of Water
Aquifer vulnerability assessment	✓	Completed	Division of Water
Aquifer mapping	✓	Ongoing	KGS, USGS, DOW
Aquifer characterization	✓	Ongoing	KGS, USGS, DOW
Comprehensive data management system	✓	Fully established	Division of Water
EPA-endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)	✓	Evaluating	Division of Water
Groundwater discharge permits	✓	Continuing efforts	KPDES
Groundwater Best Management Practices	✓	Fully established	Div. of Conservation, DOW
Groundwater legislation	✓	Fully implemented	Division of Water
Groundwater classification			
Groundwater quality standards			
Interagency coordination for groundwater protection initiatives	✓	Fully established	Interagency Technical Advisory Committee
Nonpoint source controls	✓	Fully established	KPDES
Pesticide State Management Plan	✓	Fully established	Division of Pesticides
Pollution Prevention Program	✓	Beginning implementation	Division of Water
Resource Conservation and Recovery Act (RCRA) Primacy	✓	Continuing efforts	Division of Waste Management
State Superfund	✓	Fully established	Division of Waste Management
State RCRA Program incorporating more stringent requirements than RCRA Primacy			
State septic system regulations	✓	Fully established	Cabinet for Human Resources
Underground storage tank installation requirements	✓	Fully established	Division of Waste Management
Underground Storage Tank Remediation Fund	✓	Fully established	PSTEAF
Underground Storage Tank Permit Program	✓	Continuing efforts	Division of Waste Managements
Underground Injection Control Program		Fully established	EPA Region IV
Vulnerability assessment for drinking water/wellhead protection	✓	Completed	Division of Water
Well abandonment regulations	✓	Continuing efforts	Division of Water
Wellhead Protection Program (EPA-approved)	✓	Fully established	Division of Water
Well installation regulations	✓	Continuing efforts	Division of Water

Table 4-1. Summary of State groundwater protection programs.

specific, generic GPPs must be approved by the Division of Water prior to implementation.

Generic plans, developed by the Division of Water, Groundwater Branch, assist those least likely to have the resources to develop site-specific plans. Four generic groundwater protection plans are currently available from the Division of Water. Those generic plans now available to the public are for residential septic systems, domestic water well owners, water well drillers, and monitoring well owners. Copies of septic system and domestic water well generic plans are available through public libraries, health departments, Division regional field offices, and Agriculture Extension offices. All four generic plans are available from the Division's central office.

Site-specific GPPs do not have to be approved before being implemented. The Division of Water will prioritize the review of site-specific GPPs, beginning with facilities in approved Wellhead Protection Plan areas, requests from DOW Field Officers, and requests from third parties. This prioritization will coordinate with the DOW's watershed approach to environmental management.

As of January 31, 1996, the Division had distributed over 22,000 informational brochures concerning implementation of this regulation. In addition, 8 generic and 39 site-specific groundwater protection plans were submitted to the Division of Water. Forty-three plans had been reviewed and seven were approved without deficiencies.

Existing Groundwater Protection Programs

Wellhead Protection Program

The 1986 amendments to the Safe Drinking Water Act require states to adopt a Wellhead Protection Program (WHPP) to protect public water supply wells and springs from contamination. Wellhead protection prevents groundwater contamination by managing potential contaminant sources within a designated land area around a well or spring. The protected areas are called Wellhead Protection Areas (WHPAs). The U.S. Environmental Protection Agency (EPA) approved Kentucky's WHPP in September 1993.

Wellhead protection in Kentucky is implemented at the local level using a five-step program:

1. Form a community planning team;
2. Delineate WHPAs for public water supply wells and springs;
3. Inventory potential sources of contamination within the WHPA;
4. Develop management strategies to control potential contaminant sources;
5. Plan for the future.

Kentucky has 362 groundwater-dependent public water suppliers (PWSs). Of these, 273 are required by 401 KAR 4:220 to develop wellhead protection plans by July, 1998. Currently, 27 PWSs which serve 200,441 Kentuckians are in various stages of the WHP preparation process (Table 4-2). Many of these PWSs

	STEP					1996			
Area Development District	1	2	3	4	5	Population Affected	# of Systems in ADD	Total Population	% Population Affected
Barren River		1	2			68,984	4	69,564	99
Big Sandy		1				230	30	6,668	3
Bluegrass		1				17,074	9	21,167	81
Buffalo Trace		1				2,634	7	15,225	17
Cumberland Valley							43	12,114	0
Fivco		1			1	9,075	11	12,345	74
Gateway							6	1,014	0
Green River			1			57,056	5	72,132	79
Jackson Purchase		5	1			36,050	48	114,392	32
Kentucky River		3	3			276	54	17,409	2
KIPDA							5	37,596	0
Lake Cumberland							1	5,267	0
Lincoln Trail		3				631	19	125,805	1
Northern Kentucky							17	16,843	0
Pennyrile	1	2				8,431	14	23,162	36
TOTAL	1	18	7	0	1	200,441	273	550,703	36

Table 4-2. Public Water suppliers currently in WHP preparation process.

have been assisted in their work by the Kentucky Rural Water Association. In addition, a step-by-step guidance document to assist communities and PWSs prepare a Wellhead Protection plan has been drafted by Wellhead Protection Program staff and will be available in 1996.

In addition to reviewing Wellhead Protection Plans, Groundwater Branch staff are assisting some communities with aquifer tests to determine aquifer characteristics, which are needed for WHPA delineation calculations. In conjunction with these efforts, staff members have also assisted the U.S. EPA in UIC/UST inventories in four communities in the state.

The Wellhead Protection Program staff have sponsored community workshops to assist with Wellhead Protection Plan development, developed Phase-I and Phase-II WHP submittal forms to simplify the requirements for small communities and non-transient PWSs, and coordinated Retired Senior Volunteer Program efforts to assist communities in wellhead protection field work. In addition, Groundwater Branch staff have initiated dye tracing programs to delineate the karst basins for two public water supply springs.

The Wellhead Protection Program has obtained global positioning system (GPS) equipment, which will enable efficient potential contaminant source inventories and allow electronic transfer of data to the state geographic information system (GIS). These data will then be available for use by planners, disaster and emergency personnel, and environmental professionals.

Drillers' Certification Program

The Drillers' Certification Program requires all water well and monitoring well drillers to be certified by the Division of Water. This program establishes minimum well construction criteria to protect human health and groundwater from surface contaminants or potential contaminants in the subsurface, as well as requiring geologically and structurally sound wells be installed. Overall, the average number of certified drillers in Kentucky has remained at approximately

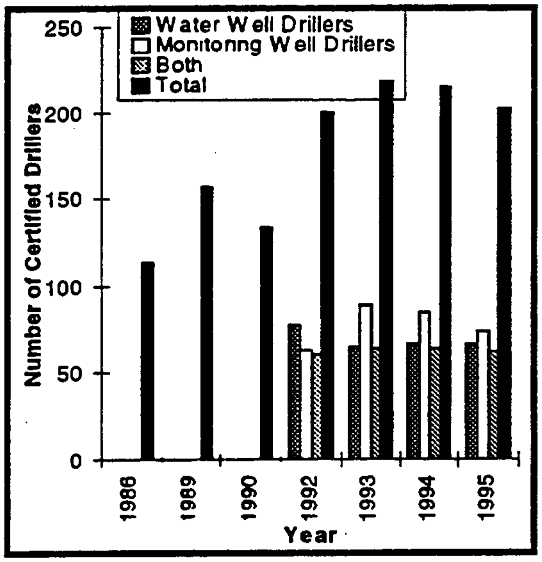


Figure 4-2. Number of drillers certified under Drillers' Certification Program.

200. Driller certifications include water well, monitoring well, and certification for both types of well drilling (Figure 4-2). The number of certified drillers is expected to remain at, or near present levels in the near future, and is only likely to change if the demand for various types of wells increases significantly for an extended period of time.

The Drillers' Certification Program provides valuable data for the Department of Environmental Protection Consolidated Groundwater Database, a database of wells and springs compiled for Kentucky. The number of water well

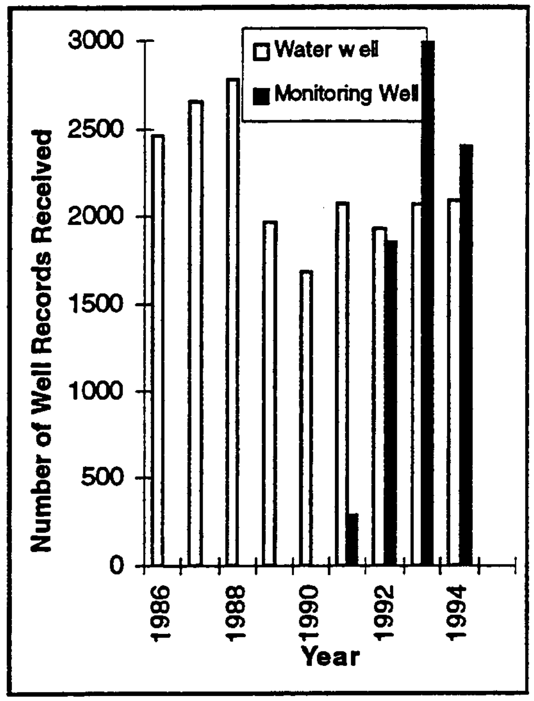


Figure 4-3. Number of well records received, 1986-1995.

records received by the program has averaged approximately 600 per quarter since the program's inception (Figure 4-3). Required submittal of monitoring well records became effective in 1991. The number of monitoring well records received since 1991, has also averaged approximately 600 per quarter.

Underground Storage Tank Program

The Underground Storage Tank Regulation Program has been in effect since 1984. As of December 31, 1995, a total of 41,795 underground storage tanks, located at approximately 14,000 facilities, have been registered with the Underground Storage Tank Branch of the Division of Waste Management. Approximately 400 of these registered sites have groundwater contamination above MCL levels for BTEX, PAHs, and/or Oil and Grease and lead. On average, about 20 new underground storage tank sites per year manifest groundwater contamination above allowable limits. The percentage of underground storage tank sites with groundwater contamination above allowable limits (approximately 15%) did not change over the last two years.

Federal regulations which were effective December 22, 1988 require compliance by all facilities by December 22, 1998. A marked increase in the number of sites undergoing closure and corrective action is expected in the next two years. However, the percentage of sites closing that end up in long-term groundwater remediation is expected to be smaller due to the risk-based cleanup standards of the new regulations.

RCRA Programs

RCRA-D (solid waste) sites are regulated by the Division of Waste Management, Solid Waste Branch. The number of sites with contamination are shown in Figure 4-4. There are 24 reported active sites with groundwater contamination in 1995, with three locations reporting off-site contamination.

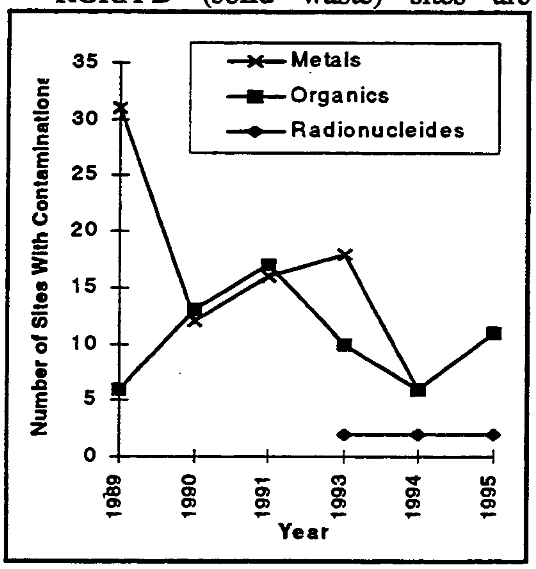


Figure 4-4. Number of RCRA-D sites with contamination 1994-1995 (incomplete).

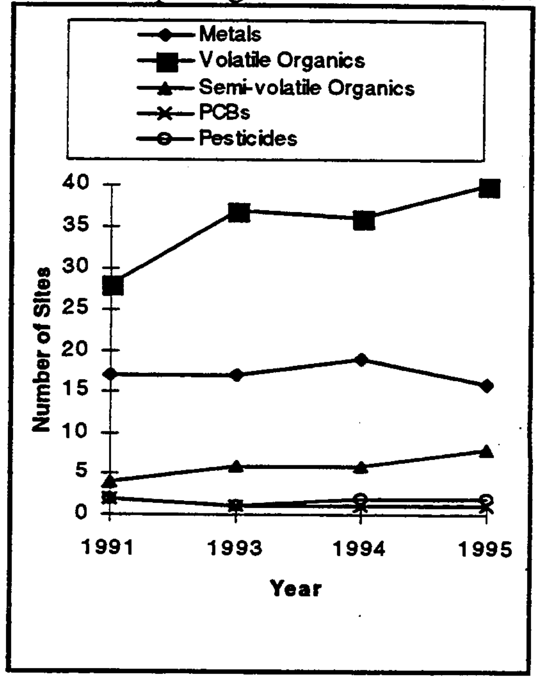


Figure 4-5. Number of RCRA-C sites with contamination 1994-1995.

RCRA-C (hazardous waste) sites in Kentucky are regulated by the Division of Waste Management, Hazardous Waste Branch. Approximately 54 sites in this program monitored groundwater during 1994-1995. Of these, 32 had confirmed groundwater contamination contained on site. Groundwater contamination extending off the property was confirmed at 11 sites.

Figure 4-5 illustrates the trends of site contamination over the last five years at RCRA-C facilities. There appears to be a general increase in the number of sites with contamination by organics, particularly volatile organics. Off-site conditions also reflect an increase in

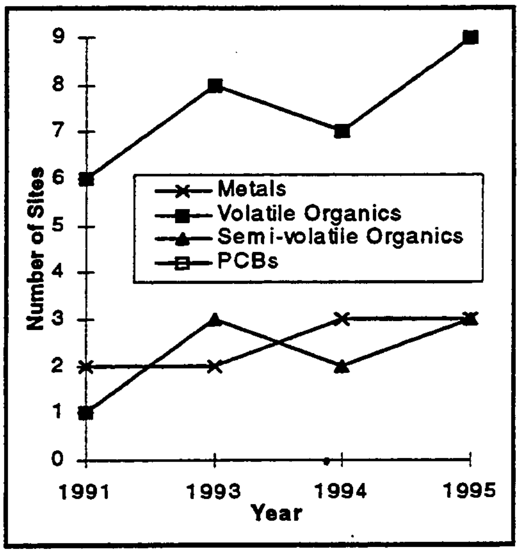


Figure 4-6. RCRA-C sites with off-site contaminations, 1991-1995.

organic contamination over the past five years (Figure 4-6). It is difficult to ascertain without further study whether this increase indicates higher off-site organic contamination or more accurate assessments.

Superfund Program

The Kentucky General Assembly passed House Bill 540 in the 1992 regular session to establish release reporting and cleanup requirements for the state. A computer-based tracking and inventory system was initiated in 1993 in compliance with HB 540. Subsequent data on all sites received has been entered into this system. A ranking and priority instrument was implemented in 1994, also to comply with HB 540. All sites evaluated, but rejected, by U.S. EPA for federal funding have been put through this state ranking instrument for funding prioritization.

The approximate number of sites reported to date is 1,957 (1,032 to EPA, 925 to Kentucky). Currently, there are 388 active sites, 423 sites closed as "in compliance," and 115 "non-incidentals" have been investigated. $3.2 million have been expended in remedial and emergency cleanups over the past 2 years.

For 1994/1995 combined, 6 of the top 12 priority sites were completed; 4 of the 12 are at remedy selection stage; and 2 are still under study. All $2.1 million remediation funds budgeted for FY 95 were allocated and/or expended.

The number of federal CERCLA sites with groundwater contamination has remained unchanged at 18 since 1993, when many CERCLA sites became State Superfund sites. However, the number of federal superfund sites with off-site contamination has risen by four to a total of 11 since 1993 (Figure 4-7).

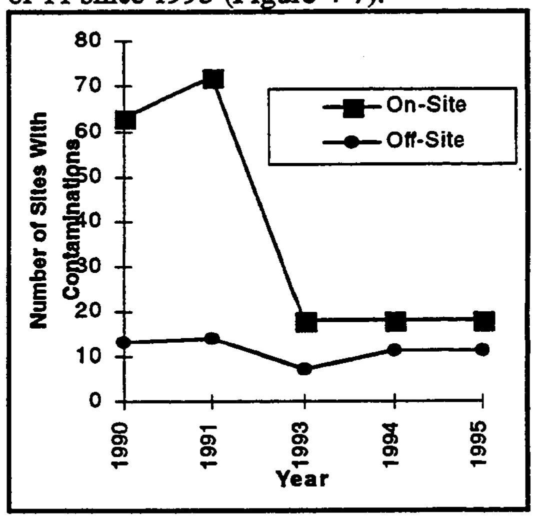


Figure 4-7. Federal CERCLA sites with groundwater contamination, 1990-1995.

The number of superfund sites in remediation (especially state superfund sites) is expected to increase slowly over the next five to ten years. Growth will be limited by the amount of funding received, as site clean-up is expensive.

Personnel limits will also be a factor. Currently the Superfund Branch has eight staff members to oversee 388 site investigations. While some sites are contracted to private firms, the Superfund Branch must still oversee their operation.

Groundwater Usage

Groundwater usage is difficult to determine in Kentucky because so many Kentuckians use well water without any gauge of how much water they use per day. For example, approximately 500,000 Kentuckians (14%) rely on private groundwater supplies. Calculating an average daily usage of 75 gallons per day per person supplied by private and semi-private well water yields an estimated 37.5 million gallons per day of groundwater utilized by this segment of the nonregulated users in the state.

In addition, unknown quantities of groundwater are withdrawn by many nonpermitted users. These nonpermitted users, who generally withdraw less than 10,000 gallons per day, include agricultural facilities, power plants, coal mines, public water suppliers and small industries. Also included as nonpermitted users are large agricultural operations and steam-generated power plants who withdraw over 10,000 gpd but are exempt by law from obtaining withdrawal permits.

Large groundwater withdrawers are monitored. Any withdrawals of more than 10,000 gallons per day require a permit from the Division of Water. Reporting the average daily and monthly volumes withdrawn is part of the requirement for the permit which allows the Kentucky Division of Water to determine groundwater usage per year. The total volume withdrawn by permitted "large" users has increased from approximately 37.8 million gallons per day in 1980 to 320 million gallons per day in 1995 (Figure 4-8). The total volume of groundwater withdrawn by these facilities rose from approximately 57 billion gallons

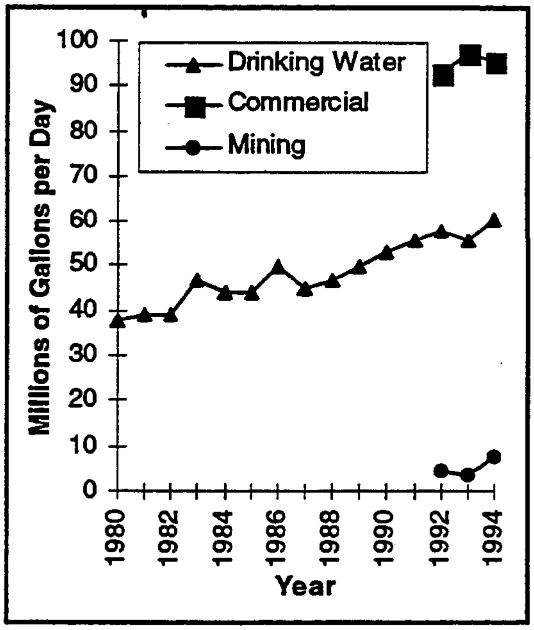


Figure 4-8. Volume of groundwater withdrawn, by category, since 1980.

per year for 1993 to approximately 59.7 billion gallons per year for 1994.

Summary Of Groundwater Quality

Public Water Supplies (PWS)

There were 362 public water suppliers using groundwater as principal, partial or supplemental supplies in 1994 and 1995. Eight (2%)

systems experienced finished water MCL violations in each of these years (Figure 4-9). The most common finished water violation in prior years has been excessive bacterial counts, with a peak of 33 reported in 1989. Four bacterial MCL violations occurred in 1994 and seven occurred in 1995.

Since 1991, nitrate and metal MCL violations have increased (Figure 4-9). In 1994, five nitrate MCL violations occurred and three developed in 1995. The number of metal MCL violations fluctuated, with five MCL violations in

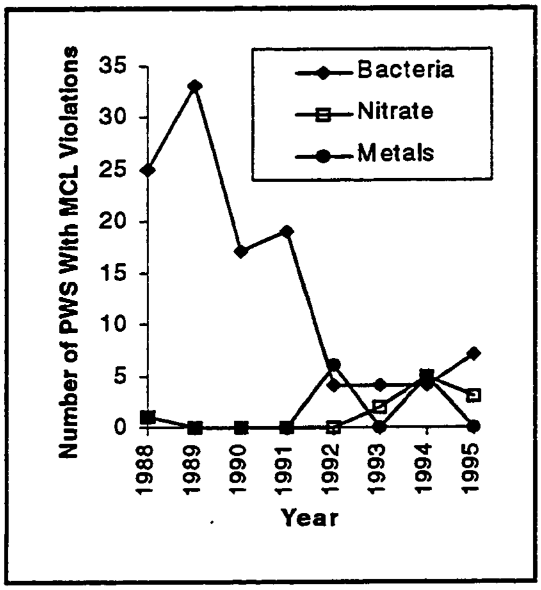


Figure 4-9. Community Public Water Suppliers with MCL violations.

1994 and two in 1995.

The population at risk from contamination by these MCL violations dropped from 32,410 in 1992 to 3,610 in 1993. This dramatic decrease in population affected occurred when one of the largest single public water suppliers cleaned up an MCL exceedence in 1992. The population affected by MCL violations for 1995 was 9,087, with the largest portion being affected by bacterial MCL violations.

Monitoring Groundwater Quality

Senate Bill 271, an act relating to agricultural chemical usage, brought together the University of Kentucky College of Agriculture, the Kentucky Geological Survey, and the Kentucky Water Resources Research Institute to jointly conduct a study of agricultural effects on groundwater. Eleven potential highly vulnerable sites were selected.

Seven of the eleven sites were selected for detailed study (Figure 4-10); four in karst-dominated carbonate terrains and three in areas of alluvial and continental deposits.

Land-use, geology, and topography were determined for each site, and groundwater samples were taken. In addition, soils were mapped and cropping practices were determined for each area. The result of this three-year study has been the compilation of a database of ambient groundwater quality in areas that are considered to be highly vulnerable to groundwater contamination. Using these results, groundwater basins may be targeted for further study or pollution prevention, such as 319 (nonpoint source) projects.

The Division of Water's Groundwater Branch began an ambient groundwater quality monitoring project in 1995. Approximately 70 water-well and spring sites are sampled and analyzed quarterly (Figure 4-11). Of these, 60 sites are dedicated sampling sites; ten sites are selected as variable sampling points. This is done to provide better statewide representation of Kentucky's diverse geologic and hydrogeologic framework.

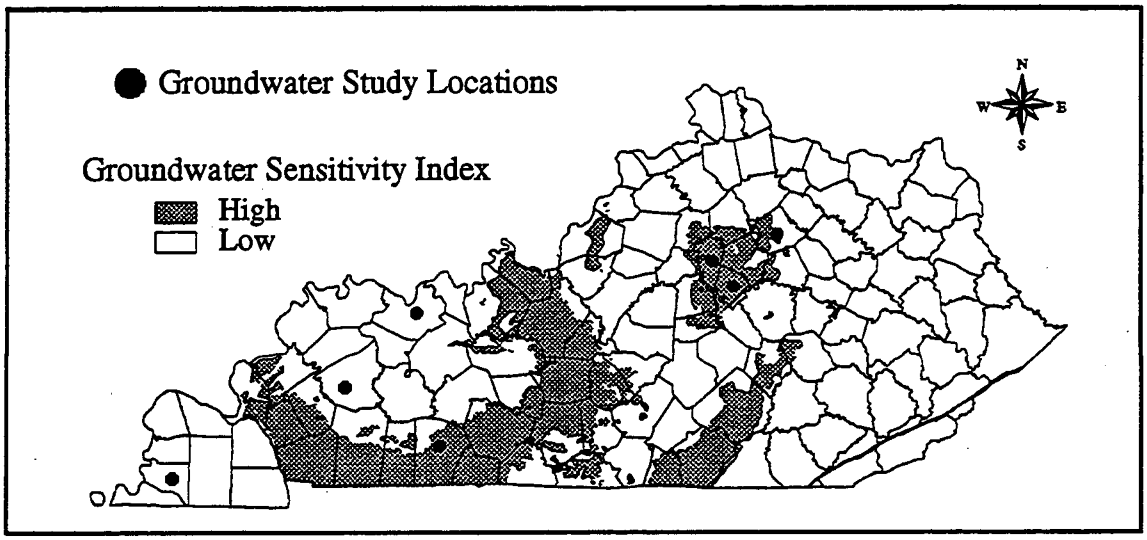


Figure 4-10. Kentucky Senate Bill 271 (1990) study sites selected for detailed studies.

Many of the wells and springs used in this monitoring network serve as public and private water supplies. These ambient monitoring sites are sampled for parameters which include nutrients, pesticides, herbicides, total dissolved solids, total suspended solids, biologic oxygen demand, pH, conductivity, and alkalinity. Due to holding time restrictions, bacterial analyses were not included in this sampling program.

Of the 69 raw groundwater analyses conducted to date, 23 had nitrate levels above 10 mg/l (the MCL for nitrate); 19 showed pesticide levels above the MCL for one or more pesticides, and 9 sites had exceeded MCL's for both pesticides and nitrates. The pesticides detected include metribuzin, metolachlor, malathion, diazinon, atrazine, and permethrin.

A breakdown of wells and springs with nitrate detections showed that 19% of the wells tested had nitrates in excess of 10 mg/l, while 39.5 percent of the springs had nitrate in excess of 10 mg/l. Pesticide levels above MCL's were detected in only 2 well analyses. However, 39.5 percent of the springs showed elevated levels of pesticides. Both nitrate and pesticide detections above MCLs occurred in 3% of wells tested. Elevated levels of both nitrate and pesticides were detected in 21% of the springs tested.

These statistics reflect data gathered over three quarters in 1995. It is especially noteworthy that one site exceeded the MCL for nitrate three times and 8 sites exceeded the MCL for nitrate twice. Metribuzin MCLs were also

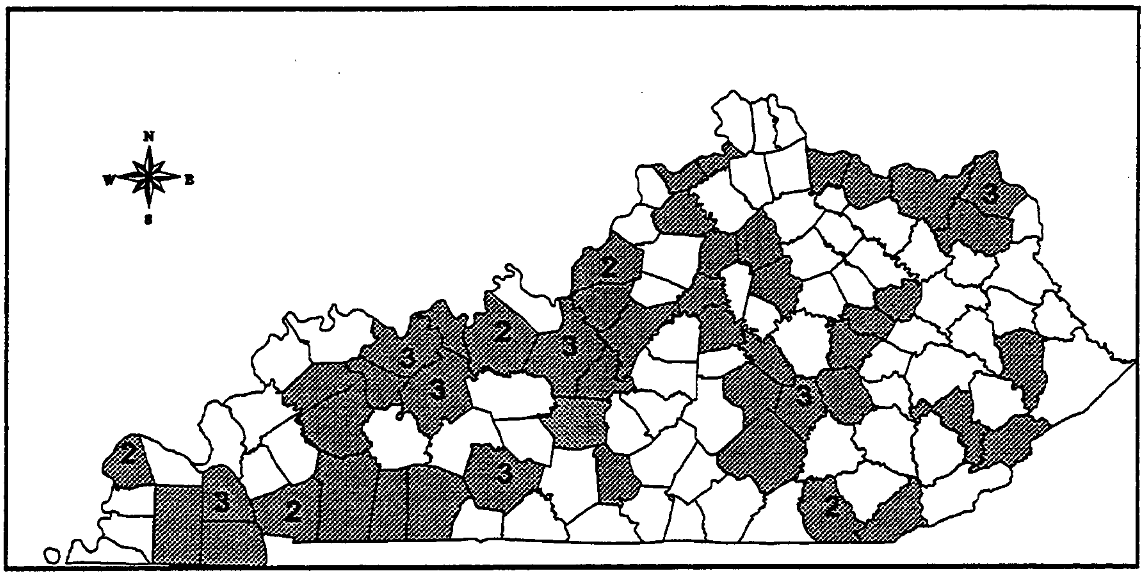


Figure 4-11. Distribution of groundwater monitoring sites in Kentucky. Numbers within shaded counties is the number of sites within that county. Numberless shaded counties have 1 site within the county.

exceeded twice at one site.

Data gathered from this study will enhance the knowledge of Kentucky's ambient groundwater quality. The results will be used to target those groundwater basins that may need further study and to focus future pollution prevention projects such as 319 BMP projects.

CHAPTER 5

WATER POLLUTION CONTROL PROGRAMS

WATER POLLUTION CONTROL PROGRAMS

Point Source Control Program

Wastewater Treatment Facility Permitting

Point source pollution refers to any discharge from municipal or industrial facilities that can be identified as emanating from a discrete source such as a conduit or ditch. Kentucky has more than 10,000 active individual or general permits covered by the Kentucky Pollutant Discharge Elimination System (KPDES) program. Of the 2,332 individual permits, 244 are municipal, 969 are industrial, and 1,119 are commercial or private. More than 4,800 coal mining-related discharges are covered under the KPDES Coal General Permit. Starting with the October 1992 EPA deadline for certain existing industrial stormwater sources, Kentucky has covered more than 2,600 facilities under eight general permits. EPA deadlines also required stormwater permit applications from two Kentucky metropolitan areas (Louisville and Lexington). The permits issued by the state for these areas mandate comprehensive pollution prevention planning programs augmented by system-wide stormwater monitoring.

The overflow from combined sanitary and stormwater sewers in excess of the interceptor sewer or regulatory capacity that is discharged into a receiving water without going to a publicly owned treatment works (POTW) is considered a combined sewer overflow (CSO). There are currently 354 CSO points statewide from 16 facilities. Most of these are located on the Ohio River and its immediate tributaries. The state began to include permit language addressing CSOs in the summer of 1991 as permits expired and were reissued. Currently, all of the facilities have permits reissued with CSO language included.

Section 104(b)(3) grants have been awarded to the Kentucky Division of Water (DOW) for CSO studies by the Metropolitan Sewer District in Louisville - Jefferson County and by the University of Kentucky's Water Resources Research Institute in the Northern Kentucky area. Water quality data specifically related to CSO events were being collected to determine the role of CSOs in water quality problems in the study area. Both grants have been completed and reports written. This information was used in developing a statewide database for tracking CSO trends and should facilitate future permitting and implementation strategies.

Wastewater permit limits in Kentucky have been water quality based since National Pollutant Discharge Elimination System (NPDES) program delegation on September 30, 1983. Generally, there are two approaches for establishing water quality-based limits for toxic pollutants: (1) chemical-specific limits, which are based on individual chemical criteria for all known toxic or suspected toxic pollutants in an effluent; and (2) whole effluent toxicity (WET) testing, which sets limits on an effluent's total toxicity as measured by acute or chronic bioassays on appropriate aquatic organisms. Both approaches have advantages and drawbacks, but when both are integrated into a toxics control strategy, they provide a flexible and effective control for the discharge of toxic pollutants.

Effluent Toxicity Testing

Toxicity data are available for only a limited number of compounds. Single parameter criteria often do not adequately protect aquatic life if the toxicity of the components in the effluent is unknown, there are synergistic (greater than predicted) or antagonistic (less than predicted) effects between toxic substances in complex effluents, or a complete chemical characterization of the effluent has not been carried out. Since it is not economically feasible to conduct exhaustive chemical analysis or determine the toxicity of each potentially toxic substance, the most direct and cost-effective approach to measuring the toxicity of complex effluents is to conduct whole effluent toxicity tests with aquatic organisms.

The DOW adopted an integrated strategy in 1988 to control toxic discharges into surface waters that included both chemical-specific limits and WET limits on certain KPDES permits. These limits were applied to most major and selected minor discharges with an approved pretreatment program. The WET limitations were developed for both acute and chronic levels based on a case-by-case evaluation of the discharge type and volume and the size of the receiving stream. WET is a useful complement to chemical-specific limits because it directly measures toxicity to aquatic organisms. It takes into account the aggregate toxicity in complex effluents and the chemical and physical interactions occurring in the effluent.

The DOW has implemented the WET limit into KPDES permits as a toxicity unit (TU). The TU allows acute and chronic toxicity to be reported numerically in the permit and on a discharge monitoring report (DMR) in order to determine compliance. Toxicity tests are conducted on a monthly basis for the first year of biomonitoring and quarterly in subsequent years. Test species are water fleas *(Ceriodaphnia dubia)* and fathead minnow *(Pimephales promelas)*. Acute tests are 48-hour static exposures. Chronic tests are the 7-day *P. promelas* growth test and the 7-day *C. dubia* reproduction test. Non-compliance with the acute toxicity limit is demonstrated if the LC50 (that concentration which causes 50 percent mortality in the test organisms) is less than the permit limit concentration. Non-compliance with the chronic limit is demonstrated if the IC25 (that concentration which causes a 25-percent reduction in growth or reproduction) is less than the permit concentration. Prior to 1993, compliance with a chronic limit had been based on a no-observable-effect level (NOEL).

During 1994 and 1995, toxicity

Table 5-1
Division of Water Effluent Toxicity Testing
1994-1995

FACILITY	TOXIC SITES	TOTAL SITES	PERCENT TOXIC
	1994		
MUNICIPAL:			
MAJOR[a]	1	2	50
MINOR WITH PRETREATMENT[b]	0	0	0
TOTAL	1	2	50
INDUSTRIAL	6	21	29
	1995		
MUNICIPAL:			
MAJOR	4	11	36
MINOR/PRETREATMENT	0	3	0
TOTAL	4	14	29
INDUSTRIAL	0	2	0

[a]At least one million gallons a day
[b]Less than one million gallons a day and with a pretreatment program

tests were performed by the DOW at 16 municipal and 23 industrial facilities. Results of these tests indicated acute toxicity at 6 locations (21 percent) and chronic toxicity at 5 (45 percent) (Table 5-1). These effluent tests indicated potential impacts to portions of receiving streams in six river basins.

The DOW has placed toxicity limits on 81 municipal and 43 industrial treatment facilities. Figure 5-1 and Table 5-2 show a breakdown of these 124 permits by facility type and toxicity limit.

During 1994 and 1995, a total of 2,073 tests were conducted by these facilities in accordance with KPDES biomonitoring permit requirements. The results showed 104 facilities (84 percent) met their toxicity limit (Table 5-2). Those not in compliance are conducting a toxicity reduction evaluation (TRE). The TRE is a step-wise process in which the operation of the facility is first evaluated and optimized. The effluent is then fractionated, if necessary, to

Table 5-2. Summary of Biomonitoring Permitted Facilities at the End of 1995

	FACILITIES	TREs	PERCENT COMPLIANCE
INDUSTRIAL			
ACUTE	35	5	85.7
CHRONIC	8	2	75.0
MUNICIPAL			
ACUTE	24	1	95.8
CHRONIC	57	12	78.9
TOTAL	124	20	83.9

determine what constituents are contributing to the toxicity, and efforts are made to eliminate these agents through source reduction or treatment optimization. Figure 5-2 shows the percentage of facilities in compliance since 1988. The percent compliance had remained relatively constant, ranging from 68 to 78 percent since the program started in 1988 until 1993. A steady increase in the percentage of facilities in compliance can be seen in this two-year reporting period. As the number of KPDES permits with biomonitoring has increased over the years, the number of resolved TREs had also increased up to 1993 (Figure 5-3). In the 1994-1995 reporting period, as fewer facilities entered into a TRE, the number of TREs being completed dropped.

Thirteen facilities had completed TREs by the end of 1994, and 12 were finished by the end of 1995. Twenty facilities (of a total of 124 with toxicity limits) are currently conducting TREs. The time needed to complete a TRE has ranged from eight months to four years and seven months. There are currently five facilities that have been in a TRE for more than five years. These facilities have not been able to determine a cause of their chronic toxicity.

Figure 5-3 shows the progression of successfully completed TREs since 1990. The reduction of toxic discharges is being achieved through new treatment plant construction, plant improvements, plant operational changes, identification of new treatment options, removal of toxic sources, and enforcement of pretreatment program requirements.

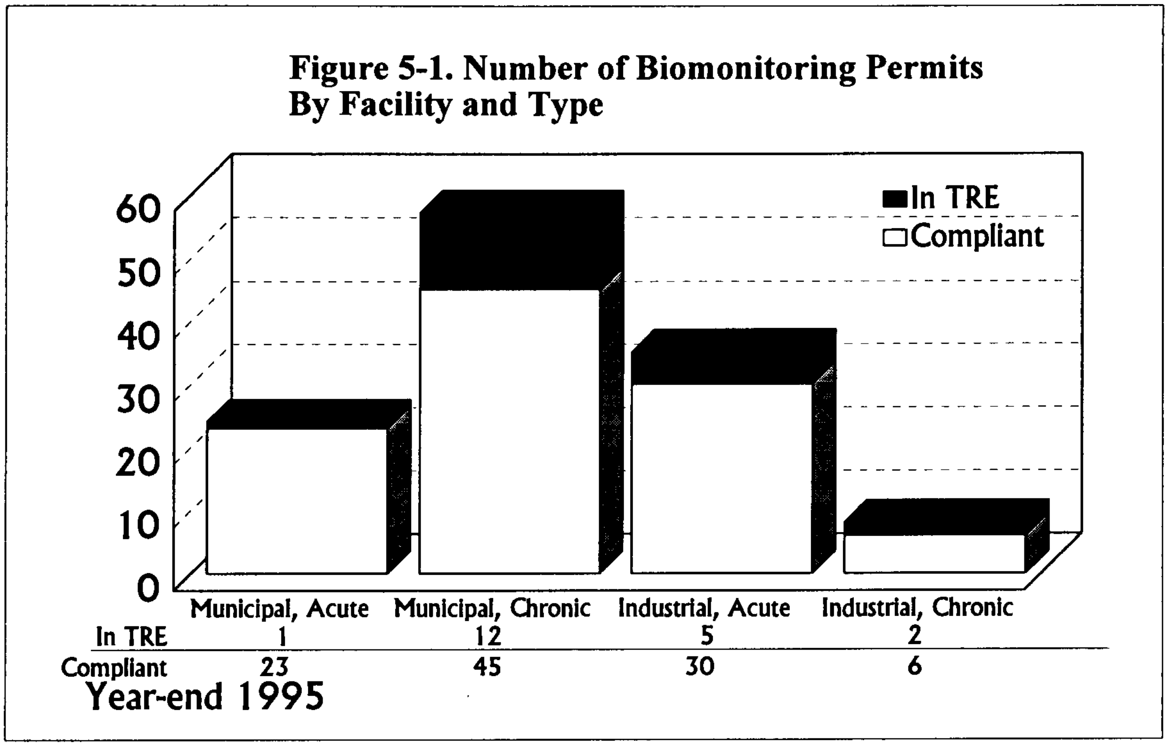


Figure 5-1. Number of Biomonitoring Permits
By Facility and Type
60
50
40
30
20
10
0
In TRE
Compliant
Municipal, Acute
Municipal, Chronic
Industrial, Acute
Industrial, Chronic
In TRE 1 12 5 2
Compliant 23 45 30 6
Year-end 1995

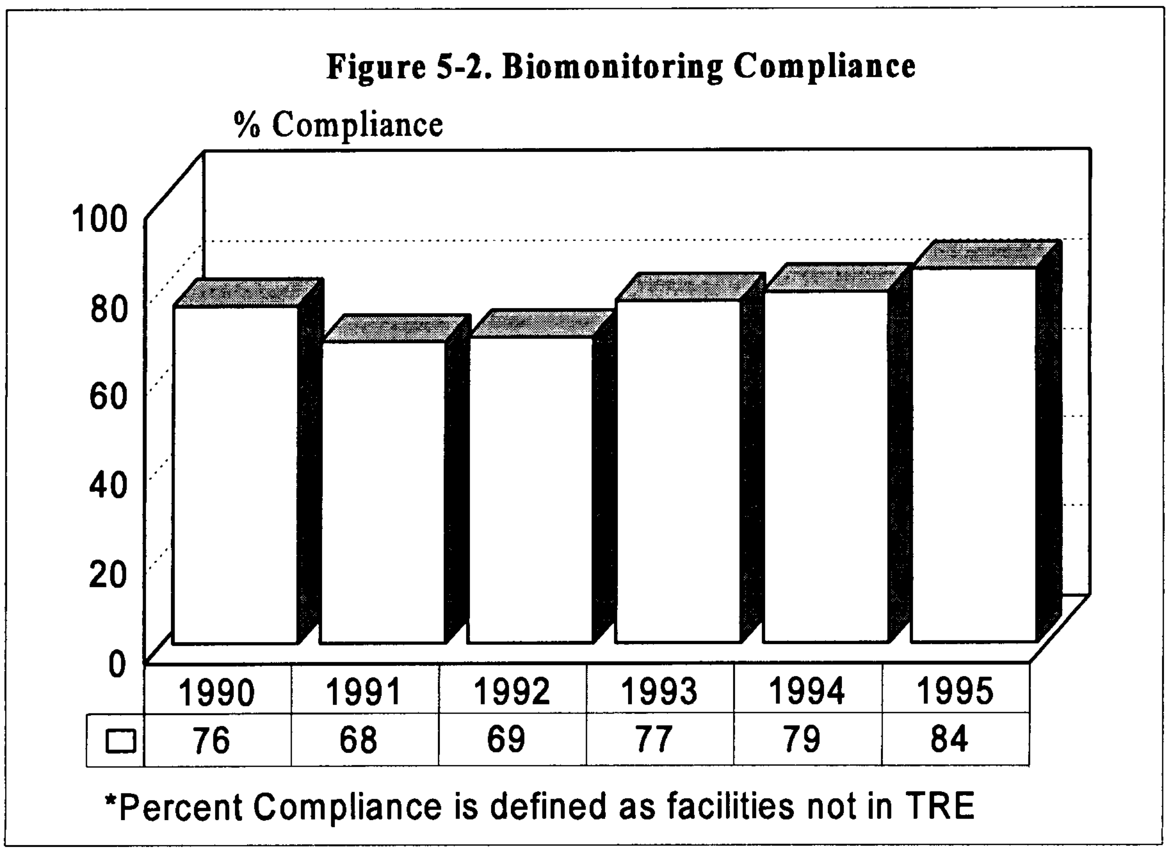


Figure 5-2. Biomonitoring Compliance
% Compliance
100
80
60
40
20
0
1990 1991 1992 1993 1994 1995
76 68 69 77 79 84
*Percent Compliance is defined as facilities not in TRE

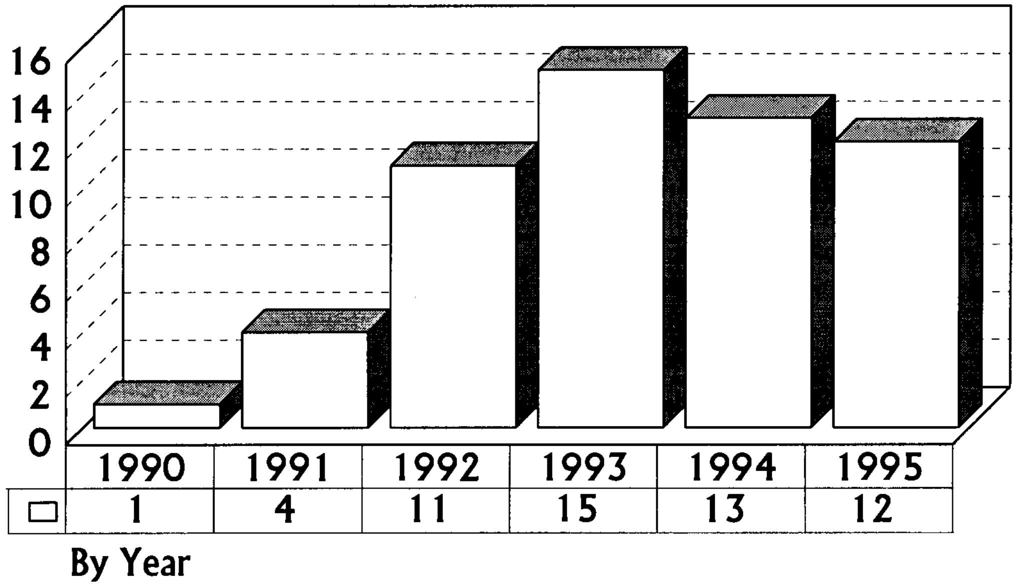


Figure 5-3. Number of TRE's Completed

Pretreatment Program

The quality of Kentucky's surface waters continues to face a threat from improperly treated industrial waste discharged into municipal sewage treatment systems. Such waste often contains pollutants that are either not removed by the municipal treatment process or, if removed, result in the generation of contaminated sludge. In an effort to control this problem, Kentucky has approved pretreatment programs in 71 cities (64 active, 7 inactive as of December 1995) and has screened several others to determine their need for a pretreatment program. New programs are being developed by Carrollton, Hickman, Irvine, and Morehead. Program submission and approval is expected in 1996. A list of communities with approved pretreatment programs and the estimated costs to administer the local program are presented in Table 5-3. The facilities that need programs are all on schedule for obtaining approval. Once approved, each program is inspected annually and must submit semi-annual status reports to the DOW for review. These reports are incorporated into a computer data base known as the Permit Compliance System (PCS) and Pretreatment Permits and Enforcement Tracking System (PPETS). Kentucky was recognized by U.S. EPA in 1991 and 1992 for achievements in its use of the PPETS program. Kentucky assesses pretreatment program effectiveness by reviewing wastewater sludge quality for five heavy metals: cadmium, copper, lead, nickel, and zinc. Sludge quality has shown continuous improvement in the 1994-95 period.

Table 5-3
Total Estimated Level of Annual Funding Required to Implement the POTW Pretreatment Program

No.	POTW	$/Year
1	Adairville	INACTIVE
2	Ashland	88,847
3	Auburn	15,000
4	Bardstown	25,000
5	Beaver Dam	2,000
6	Berea	7,000
7	Bowling Green	100,0000
8	Cadiz	INACTIVE
9	Calhoun	N/A
10	Calvert City	5,000
11	Campbellsville	79,550
12	Campbell/Kenton SD #1	125,000
13	Caveland Sanitation	2,000
14	Corbin	50,146
15	Cynthiana	25,000
16	Danville	25,000
17	Edmonton	INACTIVE
18	Elizabethtown	159,280
19	Elkton	10,000
20	Eminence	13,500
21	Flemingsburg	6,000
22	Frankfort	110,000
23	Franklin	25,000

Table 5-3 (Continued)

No.	POTW	$/Year
24	Fulton	N/A
25	Georgetown	12,000
26	Glasgow	N/A
27	Guthrie	8,000
28	Harrodsburg	12,500
29	Hartford	5,000
30	Henderson	37,500
31	Hopkinsville	24,358
32	Jamestown	11,500
33	Lancaster	INACTIVE
34	Lawrenceburg	13,450
35	Lebanon	12,000
36	Leitchfield	15,050
37	Lexington	148,000
38	Livermore	N/A
39	London	N/A
40	Louisville	1,761,400
41	Madisonville	25,000
42	Marion	INACTIVE
43	Mayfield	8,500
44	Maysville	14,000
45	Middlesboro	15,000
46	Monticello	10,000

Table 5-3 (Cont.)

No.	POTW	$/Year
47	Morganfield	N/A
48	Morgantown	30,000
49	Mt. Sterling	13,000
50	Murray	N/A
51	Nicholasville	10,000
52	Owensboro	75,000
53	Owingsville	N/A
54	Paducah	78,000
55	Paris	10,000
56	Princeton	20,000
57	Richmond	18,000
58	Russellville	14,900
59	Scottsville	INACTIVE
60	Shelbyville	19,500
61	Shepherdsville	N/A
62	Somerset	125,000
63	South Campbell County	-[a]
64	Springfield	11,000
65	Stanford	2,000
66	Tompkinsville	INACTIVE
67	Versailles	3,000
68	Williamsburg	15,000
69	Williamstown	3,760
70	Winchester	30,000
71	Wurtland	20,000
	TOTAL	$3,504,741

[a] Operated by and costs included with Campbell/Kenton SD #1

Table 5-4. Wastewater Treatment Facilities That Came on Line During Federal Fiscal Years 1994-1995 (October 1, 1993 - September 30, 1995)

Facility	Date on Line	Cost
Loan		
Brandenburg	10/01/93	1,802,290
Georgetown	10/28/93	6,119,705
Greenup	10/29/93	450,000
Williamsburg	11/15/93	1,042,411
Melbourne	12/10/93	773,156
Middlesboro	12/16/93	178,085
London	12/17/93	6,305,754
Hickman	01/07/94	1,779,494
Wheelwright	03/15/94	361,675
Providence	04/08/94	820,069
Murray	04/19/94	5,161,272
Olive Hill	05/25/94	2,467,915
Stanford	06/03/94	685,295
Franklin	06/29/94	497,979
Flemingsburg	11/21/94	1,142,183
Morehead	01/13/95	3,347,424
Corinth	02/24/95	200,766
Eminence	03/25/95	1,375,000
Martin	04/15/95	579,212
Pineville	05/11/95	2,314,150
Total		**37,403,835**
Grant		
Louisville MSD	09/26/94	10,256,677
Martin	04/15/95	868,840
Caveland Sanitation Authority	04/19/95	5,018,949
Total for EPA Funded Projects		**16,144,466**

During 1994, a cooperative arrangement was strengthened between the DOW and the state's Economic Development Cabinet to coordinate industrial recruiting and siting as affected by pretreatment considerations.

In the fall of 1995, DOW pretreatment staff, with the assistance of the programs in Louisville and Owensboro, conducted two pretreatment program implementation workshops for more than 180 municipal, industrial, and consultant personnel.

The National Pretreatment Excellence Awards recognize those publicly owned wastewater treatment plants that have developed and implemented effective and innovative pretreatment programs. EPA's award program was divided into four categories based on flow of the POTW: 0 to 2.0 MGD, 2.01 to 5.0 MGD, 5.01 to 20.0 MGD, and greater than 20 MGD. These categories have been changed to ones based on the number of significant industrial users (SIUs) served: 1-10, 11-20, 21-50, and greater than 50.

With the beginning of the awards program in 1989, Kentucky POTWs have fared well, with a total of five programs that have received the awards:

Year	POTW	Category
1989	Louisville MSD	(20 + MGD)
1990	Bardstown	(0 - 2.0 MGD)
	Richmond	(2.01 - 5.0 MGD)
1991	Leitchfield	(0 - 2.0 MGD)
	Corbin	(2.01 - 5.0 MGD)

Table 5-5
Investment Needs for Wastewater Treatment Facilities in KY 1994-2014
(In millions of January 1994 dollars)

Facility	Projected Needs 2014 Population
Secondary treatment	$566
Advanced secondary treatment	$102
Infiltration/Inflow	$124
Major rehabilitation of sewers	$149
New collector sewers	$618
New interceptor sewers	$532
Correction of combined sewer overflows	$1170
Total	$3,261

Municipal Facilities

Construction grants, state revolving loan fund monies, and other funding programs have provided more than $53 million for the construction of 23 wastewater projects that came on line during FFY 94-95 (Table 5-4). More than $850 million have been awarded since 1972; $281.5 million in the past ten years and $90.3 million in the last two years. The 1994 needs survey, conducted by the DOW as part of its facilities planning process, indicated that some municipal discharges continue to impair water quality and pose potential human health problems.

Table 5-6 NEEDS BY ADD	
ADD	**NEED**
Barren River	$66,462,877
Big Sandy	$131,088,000
Bluegrass	$311,299,000
Buffalo Trace	$19,317,000
Cumberland Valley	$139,202,766
FIVCO	$56,543,258
Gateway	$34,415,500
Green River	$179,723,500
Kentucky River	$61,523,950
KIPDA	$509,503,800
Lake Cumberland	$71,085,844
Lincoln Trail	$104,490,475
Northern Kentucky	$233,518,000
Pennyrile	$114,753,000
Purchase	$57,638,000
CSO Projection	$1,170,593,000
TOTAL	**$3,261,157,970**

State and federal minimum treatment requirements are not being met in some instances. The 1994 Needs Survey identified a capital investment need of $3.26 billion through the year 2014 to construct and rehabilitate wastewater treatment facilities and components for Kentucky, based on the 1990 population. A detailed breakdown of investment needs is presented in Table 5-5.

To determine the 1994 CSO needs, an inflation factor was derived from the engineering news record construction cost indices. The projected 1994 CSO needs are $1,170,593,000. Regional needs can be shown by area development district (ADD). The total needs for each ADD are listed in Table 5-6. Because of the lack of documentation in some areas, the reported CSO needs have been omitted from each ADD in Table 5-6 and included at the bottom of the list to give a more unbiased comparison.

Kentucky has operated the state revolving loan fund (SRF) for seven years. Seventy-six projects totaling $190.2 million have been funded by SRF money through September 1995. Project costs have averaged more than $2 million and have ranged from $83,000 to $15,553,000.

The SRF has proved to be a popular funding program for publicly owned wastewater treatment facilities. With interest rates ranging from 0.4 to 4.3 percent, the SRF is used for funding complete projects as well as to supplement grant-funded projects.

The funding formula for allocation of capitalization grants for SRF loans provides 1.2872 percent of the authorized amount for Kentucky. This figure falls short of Kentucky's fair share, whether compared on a needs or a population basis. A funding allotment percentage for Kentucky of approximately 1.55 percent would be more in line with needs and population figures. The estimated annual difference in available state revolving fund money would translate into two or three additional wastewater projects for Kentucky communities. A change in the allotment is being considered by Congress.

Wastewater Regionalization

The DOW has directed major efforts toward promoting wastewater regionalization with the goal of eliminating small "package" wastewater treatment plants. These plants, which compose a majority of the state's 1,580 non-municipal wastewater treatment facilities, tend not to be properly maintained and thus are less effective and less efficient than larger plants. Data compiled by the DOW on the performance of 757 private facilities and 58 small municipal plants in the 38 counties from April 1989 through March 1990 indicated that performance of these facilities was not good. Regional wastewater treatment facilities eliminate discharges from many of these existing small plants by diverting the flow to a larger facility or by combining two or more existing facilities into a new or selected regional treatment facility. Regional facilities also prevent new discharges by requiring connection to an existing facility or creating sanitation districts and regional wastewater authorities.

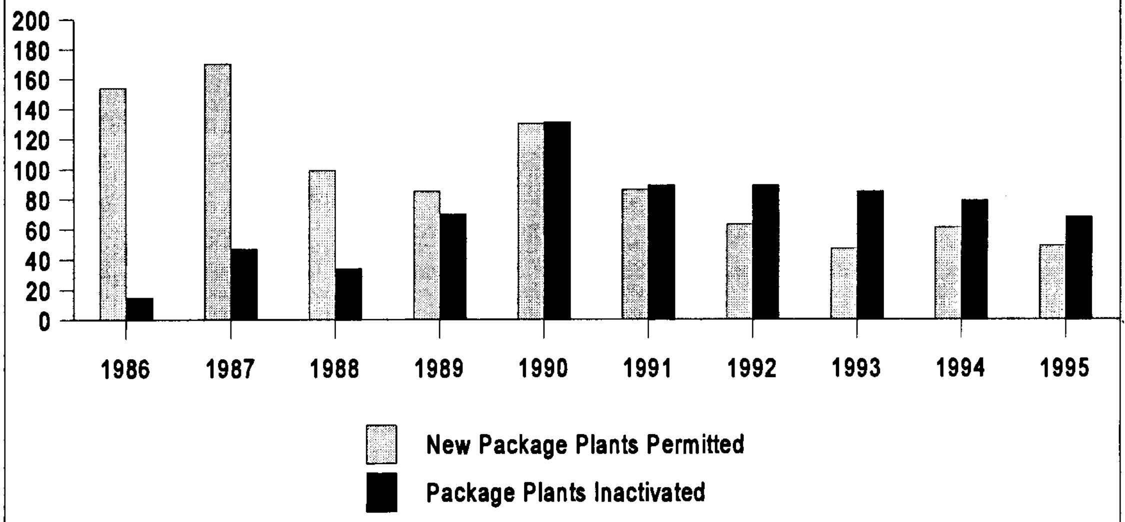
Progress in the regionalization effort is evident over the past several years. Beginning in 1990, more discharge permits have been inactivated than new ones added (Figure 5-4). Thirty-one package plants in the Northern Kentucky area (Boone, Campbell, and Kenton counties) and 40 package plants in the Louisville/Jefferson County area were eliminated in the two-year reporting period. Reductions in the number of package plants will continue to be realized because of projects in the planning or construction phase in several counties. Contracts with three area developments districts, one regional health organization, and the Council of State Governments have provided information for the development of regionalization strategies at the state and local level. These agencies have provided technical assistance to many plants to enhance water quality.

Kentucky's 15 area development districts (ADDs) are regional planning agencies empowered to engage in the work of program development through administrative, research, and planning efforts in their constituent counties in order to encourage the development of public and private property in the most appropriate relationships. Among their many duties, the ADDs may advise municipalities and special districts seeking technical and financial support for wastewater treatment projects (e.g., selecting engineering services, applying for federal grant/loan funding). Most ADDs also provide management assistance (e.g., budgeting, personnel policies) to wastewater utilities. Some ADDs provide wastewater facilities with assistance in day-to-day utility operation and maintenance. The DOW facilitates regional planning via the Section 604(b) water quality management planning program.

The **Gateway District Health Department (GDHD)** has contracted with the DOW for wastewater regionalization activities in eastern

Figure 5-4

New Package Plant Permits v. Inactivations 1986-1995



Kentucky since 1990. The GDHD promotes public awareness of wastewater treatment issues, trains package plant operators, and publicizes the regionalization concept. Most notably, the GDHD completed an innovative and successful water/wastewater education project for students at Ezel Elementary School in the fall of 1992. The GDHD is now bringing the Ezel program to other schools in the Gateway Region. GDHD has also conducted rural wastewater disposal system surveys in the Gateway counties in an effort to identify areas where small-scale methods of sewage disposal are not working, assisted land owners in taking appropriate corrective action, and assessed people's knowledge of wastewater systems in order to develop effective educational programs. Gateway officials have been instrumental in securing public support in several unsewered communities for sewer line extensions to regional facilities. Since entering the Section 205(j)/604(b) program, the GDHD's efforts have already eliminated three package plants, and another five will be eliminated upon completion of the current projects described above. Through the GDHD's work, first-time sewer service will have been extended to nearly five percent of the total households in the Gateway region by 1995.

The **Kentucky River Area Development District (KRADD)** in southeastern Kentucky entered the Section 205(j)/604(b) program in FFY 1993 to address sewage problems in the North Fork in the Kentucky River. The purpose of the project is to improve the water quality within the district, with emphasis on regionalization of wastewater treatment and use of nonpoint source pollution alternatives to ensure proper disposal of sewage. The DOW has issued a swimming advisory for all or part of the North Fork for the past four summers, citing excessive levels of fecal coliform bacteria, indicating a pervasive problem still exists. Due to this, KRADD continues to have the North Fork Task Force meet regularly to work with the KRADD project coordinator to develop and implement project activities. KRADD convenes the Regional Water Quality Committee, composed of local citizens and elected officials, to discuss the status of the task force's efforts and assist in planning and directing those efforts. KRADD also continues to work with the DOW, the Kentucky River District Health Department, local officials, and citizens to identify clusters of houses with straight pipe discharges of raw sewage and map the information using GIS technology. This was done on a watershed basis from February to May 1993. KRADD checks with all KPDES wastewater permittees to make sure of compliance, offer assistance to those who are still in compliance, and provides assistance to any proposed new systems. Finally, KRADD is assisting local health departments in the development and implementation of a program of public outreach and education to develop an awareness of wastewater treatment problems and nonpoint source pollution issues.

The **Purchase Area Development District (PADD)** in western Kentucky has participated in the Section 205(j)/604(b) program since FFY 1990. The PADD's not-for-profit Purchase Public Service Corporation (PPSC) provides technical assistance to several wastewater facilities in the ADD. The PPSC also contracts to provide routine operation and maintenance services and has even assumed ownership of plants. The PPSC performs necessary repairs or modifications to such forfeited systems and seeks to incorporate them into more comprehensive systems. For example, throughout 1995, PPSC addressed issues surrounding the Blandville West Estates wastewater facility. Technical assistance of the PPSC staff included forwarding a collection system evaluation to the DOW. Modifications included repairing and replacing manhole covers and installation of an aerobic digester at the facility that will increase plant efficiency and reduce sludge hauling costs. Finally, they concluded that due to the facility's proximity to Paducah's main and the McCracken County Sewer District No. 2 collection system, the most efficient alternative was to consolidate with one of those entities. The PPSC also dealt with the Holifield Heights Subdivision facility in 1995 and, after reviewing options, completed a protective structure for the Great Oaks Subdivision system blower/motor units, which should ensure proper long-term operation of the facility. Finally, financial records have been maintained for all systems owned by the PPSC. This information will permit rate increases to be filed in order to make each system self-sufficient.

Madison County entered into a Memorandum of Agreement (MOA) with the DOW in December 1994 to study the feasibility of a regionalized sanitary sewer district for a portion of northern Madison County. The Madison County Fiscal Court (MCFC) expects pressure for development in the northern portion of the county since this part of Interstate

75 is among that proposed for widening to six lanes. Local officials work to anticipate and plan for the impending growth and future economic viability of the area, while protecting its quality of life and natural resources. To plan for this growth and protect the health of the citizens of the county, the MCFC desires to develop a plan to provide sanitary sewer service to the described area that the city of Richmond cannot serve. The feasibility study will determine the economic and engineering feasibility of regionalized sanitary sewer service for the study area to eliminate the existing point source discharges to small streams and the potential degradation of ground water resources by subsurface disposal methods. This study is currently in process and should be finalized by the summer of 1996.

Section 104(b)(3) Water Quality Improvement Grants

The Kentucky DOW determined in its 1992 Section 305(b) report that because of water quality problems, Herrington Lake does not support its designated aquatic life use, and the 1992 Section 303(d) report identified the lake as a high priority water body requiring a Total Maximum Daily Load (TMDL) study. Due to these findings, a study to determine existing phosphorus loadings, to identify the principal sources of this investigate pollutant, and to estimate the reductions needed to lower the trophic status of the lake began in July 1994. The study is being funded under the FFY 1994 Clean Water Act Section 104(b) (3) Special Studies Program. The DOW contracted the data collection and analysis components of this project to qualified staff in the U.S. Geological Survey (USGS), and the data collection program is being conducted over a two-year time frame with 16 sampling dates each year. As the official grant recipient of this project, the DOW provides staff oversight and management assistance to the contractor to fulfill the obligations of the work plan. A final report, scheduled for September 1997, will describe the existing problems in Herrington Lake and provide a detailed analysis of the sources of these problems. The report will be used in making permit decisions for point source discharges and will serve as a reference for all agencies and citizen groups involved with reducing nonpoint sources of pollution.

Chenoweth Run, a tributary of Floyds Fork in Jefferson County, is an urban stream affected by both point source discharges and urban runoff from the most likely sources of the Jeffersontown Wastewater Treatment Plant and the Bluegrass Industrial Park. Two citizen groups repeatedly expressed concern over the poor water quality in the stream causing the DOW to begin a study in August 1994. The study, funded under the FFY 1994 TMDL mini-grant, is to determine the most significant source or sources of pollutants affecting Chenoweth Run and propose solutions. The DOW began by conducting quarterly meetings with other interested agencies and citizen groups to solicit comments and contracting with the U.S. Geological Survey to conduct the data collection program. The report generated from this study will serve as a reference for all agencies and citizen groups involved with this stream and will also be used by the DOW when making regulatory decisions regarding point and nonpoint source controls.

In the spring of 1991, the DOW began a detailed investigation into the wastewater treatment plant (WWTP) at Bardstown in Nelson County. This facility employs two large, deep surface-aerated lagoons at the head of the plant, where all raw sludge entering the system settles. Since the plant's existence, the lagoons have experienced no significant growth in sludge depth, and Bardstown has not had to dispose of any sludge. A DOW investigation completed in 1992 confirmed that the city was experiencing surprising results with its innovative treatment system. The DOW then proposed, with the use of Section 104(b)(3) funding, to further evaluate the Bardstown model and determine its applicability to other settings in Kentucky. Phase I of this project was the analysis of the Bardstown system. The DOW then contracted with the Water Resource Research Institute to analyze the results of the DOW investigation. A two-part report containing the Kentucky Sludge Survey and the pathogen reduction analysis was completed and delivered to the DOW and EPA. The WRRI is now beginning an investigation of groundwater quality in the areas surrounding the lagoons. This work should be completed by September 1997.

In 1991, the DOW received funding to conduct a water quality study of combined sewer overflows (CSO) in the northern Kentucky region. The original objective of this project was to develop a database framework for use in assessment and management of CSOs in Kentucky, with a secondary objective of an assessment of the impact of CSOs on the water quality of the northern Kentucky region. Both components of the study are being conducted through the Kentucky Water Resources Research Institute (WRRI) and funded through the 104(b)(3) grant program. It is expected that the results of the water quality assessment study will provide valuable information for use by the DOW in the preparation of CSO permits for the northern Kentucky region. The CSO assessment component began in February 1993 with extensive sampling conducted on Banklick Creek in Kenton County. The CSO database component of the project began in September 1993. During 1994, the CSO assessment was extended to the Licking River in order to augment the results of the Banklick study with some additional samples. Also, the CSO database study involved the assembly and construction of the proposed database framework. After consultation with the DOW, final adjustments are being made to the database. Final reports have been received for both the Banklick Creek and Licking River assessments.

Under the FFY 95 Section 104(b)(3) Water Quality Improvement program, $200,000 in federal funding was awarded to purchase a workstation for the construction and management of a project-specific geographic information system, test the watershed approach on an impaired river segment, and assess the needs of the agency's information systems required to implement the watershed approach. The DOW has purchased the necessary hardware and software to begin development of a geographic information system and has hired a consultant to serve in the DOW offices as a full-time GIS technician. Work is under way to construct the base map for the project area. Given the organizational development of the Kentucky River Authority, the DOW has elected to focus its FFY 95 funding on conducting a watershed study of the North Fork of the Kentucky River, with the Institute to conduct the study. The agency's data assessment is under way with a comprehensive work flow analysis planned for 1996 to determine the information system requirements for the DOW's transition to the watershed approach. For FFY 96, the DOW proposes to further develop the approach through the convening of an in-house task force to oversee framework development, stakeholder facilitation, and staff training. Global positioning systems (GPS) will be used to verify point source outfall locations within the study area. This information will be built into the project's GIS. Finally, the DOW will utilize FFY 96 funding to expand its environmental education efforts in areas within the Kentucky River basin.

Boat Sewage Disposal

Boats are not allowed to discharge sanitary wastewaters into most of Kentucky's lakes. Where such discharges are allowed, the potential exists for local water quality problems in areas of concentrated houseboat activity. The DOW, Division of Water Patrol, Department of Parks, and Department of Fish and Wildlife Resources entered into an MOU in 1993 to address the problem of boat sewage disposal. Funding was obtained through the Clean Vessel Act to provide public education and pumpout facilities at several marinas. The Department of Fish and Wildlife Resources has acted as the lead agency. The first four projects, at Jenny Wiley, Rough River, Buckhorn Lake, and Dale Hollow state parks, were directed at state-operated marinas. Total funding for these four projects was $85,500, with 75 percent as CVA money and 25 percent as state in-kind matching funds. The second round of CVA funding was obtained in 1995. Funds were directed at the following six marinas operated by private vendors:

- Moutardier Resort and Marina - Nolin Lake
- State Dock - Lake Cumberland Resort Park
- KY Dam Village State Resort Park Marina - Kentucky Lake
- Kuttawa Harbor Marina - Lake Barkley
- Limestone Bay Yacht Club - Ohio R. At Louisville
- Big Bear Resort - Kentucky Lake

Funds for these six projects totaled $109,815, again with a 75/25 percent federal/state split. All projects except at Kentucky Dam Village have been completed.

Section 401 Water Quality Certification

Statutory authority over water quality certification is contained in KRS

224.16-50. All existing uses of surface waters, including those of wetlands, are protected under Kentucky Water Quality Standards (401 KAR 5:026;029;030;031) even if the waters and their designated uses are not specifically listed in regulation. "Existing use" is defined as attainment of legitimate uses in or on a surface water of the Commonwealth on or after November 28, 1975 (401 KAR 5:029, Section (1)(p)). The state may issue, waive, or deny water quality certification for any federally permitted or licensed activity that may result in a discharge into one acre or more of wetlands or 200 linear feet of blue-line stream as designated on a U.S.G.S. 7.5 minute (1:24,000) topographic map. The state is to certify that the materials to be discharged into surface waters of the Commonwealth will comply with the applicable effluent limitations, water quality standards, and any other applicable conditions of state law. Discharges may include, but are not limited to, dredged spoil, solid waste, garbage, rock, and soil. The DOW (1993) also has issued guidelines to mitigate unavoidable impacts to streams.

The state certification process is typically triggered through an individual Section 404 permit application and the associated COE Public Notice. Water quality certifications are also required for COE nationwide permits as listed in Table 5-7. Nationwide permits include discharge activities that are substantially similar in nature and have been determined by the COE to cause minimal adverse impacts to waters of the U.S. Water quality certifications of nationwide permits protect water quality and aquatic life from a wide array of discharge activities within waters of the Commonwealth.

Table 5-8 summarizes 401 certification activities for this 305(b) reporting period. While the program has become increasingly effective in protecting waters of the Commonwealth from activities not typically regulated by point source programs, there is a lack of sufficient resources for compliance assurance and enforcement programs. The COE and DOW need to significantly increase surveillance and enforcement activities in order to ensure permitted and unpermitted activities are not degrading or eliminating stream and wetland resources.

Nonpoint Source Pollution Control Program

Nonpoint source pollution is generally agreed to be the largest contributor to water quality problems in the country and in Kentucky today. The Nonpoint Source Section of the DOW was established in 1988 to address these problems. Basically, the Kentucky Nonpoint Source Pollution Control Program consists of programs and projects to implement best management practices (BMPs).

The Kentucky Nonpoint Source Management Program was prepared by the DOW in accordance with the requirements of the Water Quality Act of 1987 and received approval from EPA in November 1989. It describes the control measures, including BMPs, that Kentucky will use to control pollution resulting from each NPS pollution category (agriculture, construction, etc.) identified in the Kentucky Nonpoint Source Assessment Report, the programs to achieve implementation of those BMPs, and a schedule for implementing those programs.

Because nonpoint source pollution arises from a wide spectrum of diffuse sources throughout the Commonwealth, there are a variety of programs in several agencies that address NPS pollution control. The DOW serves as the lead oversight agency for these programs. Agencies and institutions cooperating in the implementation of Kentucky's NPS Management Program include, but are not limited to, the Kentucky Division of Conservation (DOC), Division of Forestry, Division of Waste Management, Division of Pesticides, Department for Surface Mining Reclamation and Enforcement, Kentucky Conservation Districts, Kentucky Resource Conservation and Development Councils, Kentucky Geological Survey, U.S. National Park Service, U.S. Natural Resources Conservation Service (NRCS), U.S. Agriculture Stabilization and Farm Services Agency (FSA), U.S. Forest Service, U.S. Geological Survey, U.S. Army Corps of Engineers, Tennessee Valley Authority (TVA), University of Kentucky Water Resources Research Institute, University of Kentucky College of Agriculture, Western Kentucky University, The Nature Conservancy, the American Cave and Conservation Association, and the Kentucky Waterways Alliance.

From 1990 through 1995, a total of $7.4 million was received from EPA through Section 319(h) Nonpoint Source Implementation Grants. These projects have included education, technical assistance, watershed projects, demonstration projects, financial assistance, training, and/or enforcement.

Section 319(h) Nonpoint Source Implementation Grant Memoranda of Agreement executed or active during October 1993-October 1995 include:.

14- University of Kentucky
4- Division of Conservation
3-American Cave and Conservation Association
2 - Gateway District Health Department
2 - Kentucky State University
1 - Western Kentucky University
1 - The Nature Conservancy
1 - Kentucky Waterways Alliance
1 - Community Farm Alliance
1 - Kentucky River Area Development District
1 - Barren River Area Development District
1 - Jefferson County Conservation District
1 - Campbell County Conservation District
1 - US Geological Survey

The Kentucky Nonpoint Source Program strives to achieve a balanced approach with the nonpoint source pollution control projects funded under Section 319(h). Optimally, Section 319(h) funded projects should address nonpoint source pollution problems in all major river basins and physiographic regions.

TABLE 5-7. SECTION 404 NATIONWIDE PERMITS (NWP)

NWP Number	Status	WQC Purpose
1	A	Aids to navigation
2	A	Structures in artificial canals
3	A	Maintenance
4	A	Fish & wildlife harvesting, enhancement and attraction devices and activities
5	A	Scientific measurement devices
6	A	Survey activities
7	A	Outfall structures
8	A	Oil and gas structures
9	A	Structures in fleeting and anchorage
10	A	Mooring buoys
11	A	Temporary recreational structures
12	B	Utility line backfill and bedding
13	B	Bank stabilization
14	B	Minor road crossing
15	B	U.S. Coast Guard approved bridges
16	C	Return water from upland contained disposal areas
17	B	Hydropower projects
18	C	Minor discharges
19	A	25 cubic yard dredging
20	A	Oil spill cleanup
21	B	Surface coal mining activities
22	A	Removal of vessels
23	B	Approved categorical exclusions
24	A	State administered Section 404 program
25	A	Structural discharge
26	B	Headwaters and isolated waters
27	B	Wetland and riparian restoration and creation activities
28	A	Modifications of existing marinas
32	A	Completed enforcement actions
33	B	Temporary construction, access and dewatering
34	A	Cranberry production activities
35	A	Maintenance dredging of existing basins
36	A	Boat ramps (no discharge in wetlands)
37	B	Emergency watershed protection and rehabilitation
38	B	Cleanup of hazardous and toxic waste
40	A	Farm buildings

(A) 401 water quality certification not required

(B) 401 general certification denied for activities disturbing >200 linear ft. of stream and/or >1 acre of wetland; individual certification required

C) 401 general certification denied in total; individual certification required

Table 5-8. 401 Certification Activities		
	1994	1995
Section 404 activity	81	79
Nationwide activity	129	178
Certification issued	161	226
Certification waived	4	7
Certification denied	4	2
Certification exempt	41	22

Another type of balance striven for is programmatic balance. Projects that will provide the most effective solutions to local nonpoint source pollution problems are sought for funding. These include education, professional training, technical assistance, enforcement, and watershed demonstration projects.

In addition to geographic and programmatic balance, balance among nonpoint source categories such as agriculture, construction, and resource extraction is also a goal.

Funding priority is given to projects which address nonpoint source (NPS) problems in priority watersheds. Priority watersheds include groundwater, wetlands, rivers, streams, and lakes impacted by NPS pollution. Also, priority watersheds include high quality waters, which because of changing land uses, are threatened by NPS pollution. Priority watersheds impacted by nonpoint source pollution will be published in an updated Kentucky NPS Assessment Report, available from the DOW in early 1997. Based on available water quality monitoring data, the DOW has determined these watersheds to be the most severely impacted in the state. The Kentucky NPS Assessment Report will identify priority nonpoint source watersheds where Kentucky's fishable/swimmable water quality goals are not being met. With limited Section 319(h) Grant funds available for controlling NPS pollution in Kentucky, it is imperative that resources are targeted to priority watersheds, impacted or threatened.

In order to provide accountability for both the state and EPA, those projects selected for Section 319(h) funding must include measures of success. EPA has moved toward accepting a more flexible approach for determining project success. Monitoring of biological and physicochemical parameters in waters is no longer the only acceptable way to determine whether a project is successful.

The most appropriate choice for indicators of project success depends upon the type of project planned. For example, in the case of watershed projects, the end result should be the attainment of water quality standards. However, for projects dealing with the nonpoint source public awareness programs, measures of success may include surveys of the target audience. Examples of measures of success include:

- Photo or video documentation.

- Demonstrable improvement in relevant chemical, physical, or biological water quality parameters.

- Number of plans implemented for erosion and sediment control, storm water, nutrient management, pest management, etc.

- Number of best management practices (BMPs) implemented in watersheds of impaired or threatened waters.

- Percentage of needed BMPs implemented in watersheds of impaired or threatened waters.

- A statistically based survey of BMP implementation rates, based on periodic compliance surveys.

- A statistically based survey of public awareness, knowledge, and actions to measure changes in attitudes and behavior over time.

Monitoring

Nonpoint source pollution problems in the waters of the Commonwealth originate from land-based activities. The direct interrelationship between land activities and water quality necessitates that both land and the aquatic environments be monitored and evaluated. To this end, the NPS Pollution Control Program includes two aquatic biologists who are responsible for the collection, assessment, evaluation, and interpretation of water quality and corresponding land-based data.

Physical characteristics, water chemistry, aquatic biological community structure, and land-based activities are different aspects of the waterbody's ecosystem that may be monitored. A multifaceted approach is necessary for NPS monitoring because of the mobility of NPS pollutants, the varying degrees of pollutant toxicity, the close interrelationship of land-based activities and NPS pollution, and the spatial and temporal variabilities of ecosystems. Nonpoint source standard operating procedures provide instruction and guidance in, and ensure standardization of, study plan development, station location selection, and monitoring of water quality, land use, land treatment, and weather. The standard operating procedures manual for nonpoint source water quality monitoring projects is available from the NPS Pollution Control Program.

Water Quality monitoring is an important aspect of the NPS program, especially if monitored water Quality data are lacking, existing NPS pollution problems need to be quantified, or documentation is needed to show changes in water quality where alterations in land-use practices have occurred. Monitoring is an important component of NPS watershed pollution remediation demonstration projects.

Demonstration Projects

Mammoth Cave. Public awareness and concern over water quality problems affecting Mammoth Cave National Park resulted in the development of the Mammoth Cave Karst Area Water Quality Oversight Committee. Its purpose is to achieve coordination among citizens, land users, and government agencies in monitoring and improving water quality in this karst drainage area.

A multi-agency technical committee consisting of representatives from local and state NRCS offices, FSA, U.S. National Park Service, DOC, DOW, Kentucky Geological Survey, U.S. Geological Survey, TVA, University of Kentucky College of Agriculture, Western Kentucky University Department of Agriculture, and Western Kentucky University Center for Cave and Karst Studies was established to work with the Mammoth Cave Karst Area Water Quality Oversight Committee to develop a nonpoint source watershed pollution remediation project for the Mammoth Cave area. The DOW's role in the watershed project is focused on evaluating BMP effectiveness on select demonstration farms.

Local NRCS and FSA representatives prioritized farms in the Mammoth Cave project area as potential agricultural demonstration sites. Based on land resource needs, accessible water monitoring areas, and farmer cooperation, five farms were chosen as demonstration sites. The farms are being used to educate farmers in the project area about the use of BMPs for controlling nonpoint source pollution. BMPs have been implemented in a holistic systems approach at two farms, and animal waste treatment facilities are planned or have been installed at three other farms.

Multi-agency monitoring efforts are being used to document agricultural impacts on the quality of surface water, groundwater, and wetlands and to address cross-media interactions. The DOW has developed monitoring study plans for each of the demonstration farms, has coordinated monitoring activities with other involved agencies, is monitoring water quality, and will interpret and document changes in water quality that relate to BMP implementation.

Upper Salt River/Taylorsville Lake Watershed. Taylorsville Lake is highly eutrophic and has experienced problems with low dissolved oxygen concentrations, algal blooms, suppressed fish production, and occasional fish kills. The reason for these problems is the elevated nutrient levels in the streams feeding the reservoir. In an effort to alleviate these problems, the NRCS, Kentucky DOC, COE, and the DOW have undertaken studies and projects to determine the nutrient concentrations in the reservoir and streams feeding the reservoir, specific sources of these nutrients, the amount of nutrient reduction needed to improve reservoir water quality, and methods to achieve the needed reductions. The U.S. Geological

Survey is also assisting with high-flow water sample collection through a cooperative agreement with DOW.

Agricultural best management practice (BMP) cost-share funds have been made available to remediate nonpoint source pollution in the watershed as part of a U.S. Department of Agriculture (USDA) five-year Hydrologic Unit Area Water Quality (HUAWQ) project. The goal of the HUAWQ project is to abate or prevent water quality degradation in both surface and groundwater in the watershed. To achieve this goal, the identified sources of contamination are being addressed by the use of best management practices. For FFY91 through FFY93, the HUAWQ project received a total of approximately $850,000. In addition, $55,000 cost-share funds were awarded in FFY92 as part of a Water Quality Incentive Program for implementing non-construction, management-type BMPs.

One of the first nonpoint source monitoring initiatives in the watershed was an intensive bacteriological investigation. The bacteriological data were used to: (1) assess point source compliance, (2) determine support or nonsupport of primary contact recreation, and (3) target animal waste BMPs in the watershed. Another bacteriological investigation in 1994 determined that animal waste management practices have reduced bacterial contamination in the watershed.

High phosphorus concentrations in the Salt River found by the pre-BMP sampling were attributed primarily to nonpoint source runoff from the fertile soils of the Inner Bluegrass physiographic region. The U.S. Army Corps of Engineers (COE) is presently modeling the response of the water quality of Taylorsville Lake to various watershed management techniques by means of the CE-QUAL-W2 model and available water quality data. Modeling results will be used to identify BMPs in the watershed that will most effectively reduce nutrients from nonpoint sources. More than $1 million has already been spent to implement BMPs to treat wastewater from concentrated animal management areas on dairy farms. These BMPs have not only reduced known bacteria contamination problems, they also were a first step in reducing nutrient input to streams in the watershed. Post-BMP monitoring of streams in the watershed and in Taylorsville Lake will determine the effectiveness of the program.

Big South Fork/Bear Creek Interstate Watershed. The Big South Fork/Bear Creek demonstration project is located in an interstate watershed that lies in both Tennessee and Kentucky. Bear Creek flows north from Tennessee into Kentucky, where it joins with the Big South Fork of the Cumberland River. A large portion of the Big South Fork watershed is classified and operated as a National River and Recreation Area by the National Park Service. Nonpoint source pollution impacts to Bear Creek begin outside the Big South Fork National River and Recreation Area (BSFNRRA) in Tennessee. The lower portion of Bear Creek lies in Kentucky, mostly within the BSFNRRA.

The Bear Creek drainage is primarily affected by unreclaimed strip mines. The abandoned coal mine sites are characterized by heavily eroding spoil banks and acid mine drainage. Minimal reclamation efforts were implemented after mining, and consequently, severe water quality problems exist because of abandoned mine land runoff. The biological communities within Bear Creek are severely impacted by acid mine drainage, and the creek does not support the aquatic life use. Values for pH ranged from 4.3 to 8.2 SU, with an average value near 5.6 SU. These low pH values also affect contact recreational uses.

The goal of this project is to improve water quality by reducing acid mine runoff, improving stream and bank habitat, and improving citizen understanding of the project. To meet this goal, the Tennessee Nonpoint Source Program, in cooperation with the Tennessee Land Reclamation Program, developed a rehabilitation plan for the Bear Creek watershed that calls for the implementation of BMPs and water quality monitoring. The BMPs, including drainage control structures, subsurface limestone drains (anoxic alkaline trenches), aeration, and artificial wetlands, are expected to be installed by the end of 1997.

To document changes in water quality associated with BMP implementation, the Tennessee Nonpoint Source Monitoring Team is monitoring water quality in the Tennessee portion of Bear Creek before and after BMP implementation. The Kentucky Nonpoint Source Monitoring Team is supplementing Tennessee's activities by monitoring water quality at a station at the mouth of Bear Creek in Kentucky. To address possible temporal variability in water quality of Bear Creek, Rock Creek, a Kentucky Outstanding Resource Water, has been selected as an appropriate reference stream. An automatic water sampler was installed at the Bear Creek station to collect rain-event water samples for analysis. Quarterly biological monitoring is being conducted at both the impacted and reference stations in order to document recovery of the stream biota. To ensure that biological data from Tennessee and Kentucky are comparable, Tennessee Standard Operating Procedures are being used by Kentucky for this project.

Fleming Creek. Fleming Creek, a tributary of the Licking River, is 39 miles long and drains an area of 61,670 acres. The mainstem and tributaries are contained almost entirely within Fleming County in northeastern Kentucky. Fleming County ranks third statewide in number of dairy cattle. Eighty-five feedlot operations occur in this watershed. Moreover, an estimated 1.7 million cubic feet of animal waste is washed into local streams annually, resulting in water quality degradation.

A USDA BMP cost-share project for the Fleming Creek watershed was funded in 1992. The DOW and USDA are cooperating agencies in this project area. DOW has the responsibility of monitoring the effectiveness of the pollution remediation activities in the watershed.

The water quality monitoring for this project is being conducted in three distinct phases. The first phase consisted of a bacteria and nutrient survey throughout the watershed during both high- and low-flow conditions in the spring and summer of 1992. The main purpose of this phase was to examine the entire watershed with respect to point and nonpoint pollution sources to target those areas most affected by animal wastes. It is envisioned that this survey will be repeated once all BMPs are installed to determine if water quality improvements occurred as a result of BMP implementation.

The second phase consists of long-term monitoring at select stations to measure water quality changes in the watershed over time resulting from BMP installation. Nutrient water quality data are the focus of this monitoring phase. Based on phase one monitoring, five long-term water quality monitoring sites were selected. Although some data from low-flow conditions will be collected during this phase, most monitoring will be associated with storm events.

The third phase consists of biological and physicochemical data collection at two of the more impacted tributaries within the watershed as well as a station located on Fleming Creek downstream of all proposed BMPs. This phase will supplement phase two physicochemical data collection. Biological communities will be biometrically compared over time to evaluate and document changes in community structure that reflect improvements in water quality.

Pre-BMP water quality data indicate that Fleming Creek has been impacted from animal waste. The bacteriological survey indicates that the entire watershed is affected. Stations were established on Fleming Creek and at the mouth of every major tributary within the watershed. Fecal coliform levels ranged from 500 colonies per 100 ML to more than 15,000 colonies per 100 ML at the tributary stations for the high-flow event. Total phosphorus and nitrogen levels (TKN and NO_2 - NO_3) have been detected at elevated levels (1-3 mg/l), particularly at the tributary stations. Based upon algal data, eutrophic to hyper-eutrophic conditions occur at certain locations within the watershed. In addition, there is an unusually high number of tolerant macroinvertebrate species at Allison Creek station. However, a preliminary evaluation of biological communities in Fleming Creek does not indicate impairment.

319(h) Implementation Grant Projects

Horse Lick Creek. Horse Lick Creek lies within a 62-square mile watershed in Jackson and Rockcastle counties in the Upper Cumberland River Basin. It was designated as one of the "Last Great Places" by the Nature Conservancy in 1992. About 15,000 of the 40,000 acres are within the Daniel Boone National Forest, and the Nature Conservancy owns 1,700 acres. The creek is home to a unique aquatic community. Almost a quarter of Kentucky's mussel species and more than 30 species of fish are found there. Of the 72 mussel species that historically inhabited the upper Cumberland River basin in Kentucky, 36 are extinct, and 11 of the remaining species are rare at the state or federal level. Also, the watershed harbors a number of other endangered species, especially bats and cave invertebrates. These characteristics make Horse Lick Creek one the premier sites for the protection of biological diversity on the western slope of the Appalachians.

The Nature Conservancy has entered into MOUs with the U.S. Forest Service, the Kentucky Department of Fish and Wildlife Resources, and the Kentucky Nature Preserves Commission to protect and improve the Horse Lick Creek watershed.

The Kentucky Chapter of the Nature Conservancy is gathering physicochemical and biological data designed to target water quality problems within the Horse Lick Creek watershed. Monitoring commenced before and continues during and after the installation of BMPs in an effort to document water quality improvements. Water quality monitoring began in May 1994 and will continue for three years.

Triplett Creek. Triplett Creek in Rowan County is impacted by nonexistent and failing onsite (home) wastewater treatment systems, causing unacceptable levels of pathogens and nutrients. The purposes of this project are to:

1) establish baseline water quality in the watershed;
2) identify specific residential areas contributing sewage-related contaminants;
3) develop compliance options for failing or nonexistent onsite wastewater systems;
4) install preferred options, with cost-share support if necessary; and
5) document post-BMP water quality changes.

Nutrient and Pesticide from Turfgrass Management Areas. The primary purpose of this project is to evaluate the impact of several chemicals (nitrate, phosphate, 2,4-D, chlorpyrifos, diazine, chlorothalonil, and metalyaxyl) used in lawn care and golf course turfgrass management in areas of karst topography. These data will be used to produce a Turfgrass Industry BMP manual for Kentucky. The golf course provided daily chemical application data. Therefore, water samples were analyzed for pesticides in response to treatment on the golf course.

Lawn treatment companies were contacted and asked to cooperate by providing application schedules. Pesticides were analyzed in response to application.

Samples were collected every Monday between April 1 and November 30, 1994. If a significant precipitation event occurred, samples were collected every four hours to attempt to quantify the storm event impact on pollutant transport. Samples were collected from all three sites.

Elkhorn Creek. Portions of the Elkhorn Creek watershed are impaired due to sediment, nutrient, and pathogen loading from nonpoint and point sources.

Livestock production is important in the watershed and potentially contributes a large part of the nonpoint pollutant loading. The stream is a valuable recreational resource to the area and has provided an emergency source of drinking water during prolonged summer droughts. However, primary contact recreation and warmwater aquatic habitat uses are being adversely affected and, in much of the watershed, are not being supported. Direct access of livestock to streams within the watershed is contributing to degradation of the streams. This degradation affects water quality, wildlife habitat, and recreation activities. Moreover, riparian vegetation provides the major continuous wooded area and crucial wildlife habitat within the watershed.

Often, traditional methods of excluding livestock from streams and providing livestock water supply are not cost effective or practical. Fortunately, promising fencing systems and water supply alternatives are available. This project is demonstrating to farmers the following four alternatives:

1) ram pump
2) pasture pump
3) solar powered water pump
4) limited access watering points, using new fencing components (solid state automatic water-sensing electric fencing switches)

These systems have the potential to protect stream quality while providing a cleaner and safer water supply for livestock. To facilitate the acceptance of new BMPs, demonstration farms are needed. In addition, documentation of changes in water quality and habitat resulting from the use of BMPs is required.

The purpose of the monitoring is to document effectiveness of selected BMPs in reducing nonpoint source impacts on water quality and to document or demonstrate changes in water quality for the Elkhorn Creek basin.

Each of four nontraditional BMPs, which provide alternatives to unlimited stream watering and access by farm livestock, are being implemented on selected demonstration farm sites. Monitoring program elements include water chemistry, habitat, and biological. Monitoring is being conducted at each of the demonstration farm sites and includes upstream and downstream stations at each site. Two years of post-BMP water quality data will be collected. Habitat assessment will be conducted for four years in order to adequately document changes in habitat.

Pleasant Grove Spring Karst Basin. A three-phase effort is ongoing to test the effectiveness of a Best Management Plan (BMP) program to manage the impact of agricultural production on ground-water quality in a karst drainage basin. For this reason, a karst basin large enough to include a variety of agricultural practices was chosen, as opposed to an individual farm or field.

Pleasant Grove Spring drainage basin is a mature karst aquifer encompassing approximately 10,291 acres (16.1 square miles) which underlies an intensively farmed area in Logan County. A general land-use inventory showed that 92 percent of the watershed is in some type of agricultural production. Except for rural housing, no other activities which might result in ground-water contamination, such as industry or petroleum production, occur in the basin. No single BMP is expected to have a measurable improvement on ground-water quality at this scale. Rather, the impact of the program as a whole, including public education regarding ground-water contamination, will be monitored.

Phase I, initial reconnaissance and mapping, and Phase II, data collection for quantifying the contaminant load from the watershed under current land use and BMP conditions, have been completed.

Phase III is quantifying contaminant loads discharging from the spring during and after BMP installation to gage the effectiveness of the program. The annual flux of triazine, nitrate, and sediment will be calculated from sample concentrations and a continuous discharge hydrography for the spring. Four upstream sites monitored during Phase II are also being monitored in Phase III.

Funding has been obtained through the USDA Water Quality Incentive Program to aid farmers adopting farm management practices that protect ground water. Funds granted for this work total $251,000 over a three-year period. Most of the money will be used during the first year. The funding was sought by the Bowling Green office of the Natural Resources Conservation Service under a proposal titled "Pleasant Grove Spring, Water Quality Incentive Project (WQIP) Application." The plans that farmers will have available to them are listed in the proposal and include brush management, conservation cover, conservation cropping sequence, conservation tillage, contour farming, cover crops, critical area planting crop residue use, deferred grazing, filter strips, grasses and legumes in rotation, integrated crop management, livestock exclusion, mulching, pasture and hayland management, pasture and hayland planting, planned grazing system, record keeping waste management systems, waste utilization. More than 40 farms are at least partly within the watershed. It is not known at this time which BMP, or how many of each, will be applied to each farm. The budget in the WQIP Proposal details the relative emphasis each BMP will receive. However, the plans that focus on the prevention of sediment loss, reduction of runoff from crop fields, nutrient management, reductions in pesticide use, and animal waste management will be strongly encouraged by KGS. However, it should be noted that if the implementation of the BMPs fails to improve ground-water quality, then the need to restructure USDA protection programs will be strongly indicated.

Data Collection/Data Management

A necessary and important function of the nonpoint source program is the collection and management of NPS-related information. The cooperative, multi-agency nature of the program prescribes the reliance upon, and utilization of, existing data such as land-use classification statistics, baseline water quality values, and best management practice evaluations. To this end, an NPS document library has been developed. All NPS-related documents are catalogued, and pertinent data are entered on computer for future retrieval. In addition, a computer literature search service has been identified and utilized for accessing other scientific and technical information pertinent to the program. Several statewide databases have been identified and utilized, including county-specific fertilizer and pesticide databases.

Education

To a large extent, the implementation of BMPs to control NPS pollution relies upon voluntary adoption of BMPs by those who manage the use of Kentucky's land resources. Therefore, education plays a vital role in Kentucky's NPS Management Program. NPS education programs inform land users and other Kentucky citizens about the causes, consequences, and solutions (BMPs) for the various types and sources of NPS pollution.

The DOW nonpoint source program supports and coordinates with a wide spectrum of NPS education activities and programs conducted by a number of agencies and institutions. The DOW has provided program speakers for school classrooms, field days, environmental fairs, civic groups, trade organizations, and professional meetings. Additionally, exhibits and other educational materials have been provided for use in conferences, fairs, field days, and clean-up days.

Several NPS education projects supported by 319 funds have been or are currently being conducted under the oversight of the DOW NPS program:

- The slide/video program and accompanying brochure, "Every Time It Rains," a general introduction to NPS pollution problems in Kentucky targeted to the general public, was produced by the Center for Math, Science, and Environmental Education at Western Kentucky University (WKU).

- WKU has also produced a video program on abandoned minelands and water quality targeted to general audiences in Kentucky and Tennessee. It centers on the Bear Creek/Big South Fork demonstration project as an example of how these problems can be solved.

- The Kentucky Division of Forestry developed a forestry NPS video, slide/tape show, brochure, and best management practices manual to promote the use of forestry best management practices.

- The Gateway Region Environment-Education Network (GRE-EN), based in the Gateway District Health Department, conducted a multi-faceted education program in the five-county Gateway Region that targeted agriculture, septic systems, and illegal dumps.

- o The Warren County Conservation District has been conducting a number of educational activities that present NPS pollution problems and solutions arising from construction and urban runoff in karst regions, including contractor field days and the construction of a high-quality portable exhibit.

- o The American Cave Conservation Association (ACCA) built an exhibit in its American Museum of Caves and Karstlands, located in Horse Cave, which illustrates the many types of human activity that can pollute groundwater. ACCA is currently implementing a statewide karst education program that includes a school curriculum, a series of newspapers for classrooms, and teacher training workshops.

- o The Groundwater Education and Rural Well Water Testing Program conducted public educational meetings in most of Kentucky's 120 counties concerning groundwater quality. Private well water analysis and technical assistance to remedy problems revealed by the testing were made available to program participants.

- o The University of Kentucky Cooperative Extension Service has adapted the national Farmstead Assessment System (Farm*A*Syst) program to produce the Kentucky Assessment System (KY *A* Syst). The program includes sets of informational flyers and assessment worksheets. A pilot program is being conducted in several Kentucky counties. KY*A*Syst is a comprehensive farm site assessment that helps rural residents and farmers assess the impact of their farmstead structures, soil geology, and management practices on groundwater quality.

The Water Watch program (described in Chapter 1 of this report) has proven to be a particularly valuable channel for educating citizens about NPS water quality problems and solutions. The Water Watch and NPS program staff have further expanded Water Watch educational materials and programs to include more information on BMPs and NPS pollution control. Water Watch trains citizen volunteers to identify land-use activities that are contributing to NPS pollution of their adopted waterbody and collect data about water quality, aquatic life, and aquatic habitat conditions, including supplemental monitoring for NPS demonstration projects. Specifically, the Water Watch Nonpoint Source Local Education Initiative, funded under Section 319, conducted training workshops for selected Water Watch groups and produced accompanying sets of specific localized publications and slide/video programs. It also conducted a program for high school students to study the impact of spring rainstorms on stream water quality that utilizes immunoassay screening for pesticides.

Future Direction

The DOW is in the process of updating its program milestones and the original Kentucky Nonpoint Source

Management Program document. Nonpoint Source programs and issues that are being addressed in the update are based on input gathered during an interdisciplinary meeting held in March 1995 and formal public comment.

Also, in an effort to more effectively support state nonpoint source (NPS) programs, EPA is significantly restructuring its nonpoint source grant program and revising its process for evaluating state grant requests. EPA is recognizing that what is an effective nonpoint source program in one state may not be effective in another.

However, while Kentucky will have more flexibility in choosing the most effective nonpoint source programs for the Commonwealth, it will also be held more accountable for making progress in achieving and maintaining beneficial uses of water. To ensure that Kentucky is striving to achieve this vision, EPA has outlined the following eight key elements for evaluating nonpoint source management programs:

- Explicit short- and long-term goals for protecting surface water and groundwater.
- Emphasis on preventing degradation from both present sources and future activities.
- Identification of those waters significantly damaged by nonpoint source pollution.
- Flexible, targeted, and iterative approaches to maintaining water quality standards.
- Sound financial management.
- Strong partnerships with appropriate stakeholders.
- Identification of federal lands and management objectives that are not consistent with state program objectives.
- A self-evaluation procedure for states to assess and improve their programs.

Section 319(h) funded projects are noticeably absent in the far eastern and western portions of the state. In order to achieve better geographic balance, focused nonpoint source pollution control initiatives in these areas are needed. For better programmatic balance, more statewide initiatives that address nonpoint source pollution control through both education and professional training are needed. In addition to statewide programs, Kentucky needs specific watershed projects that address preventing nonpoint source pollution from both current and future sources.

CHAPTER 6

ECONOMIC BENEFITS

ECONOMIC BENEFITS

There is much anecdotal evidence that Kentucky has made progress in protecting its water resources. In recent 305(b) reports, approximately two-thirds of streams and rivers assessed have been seen to be are meeting standards designed to protect aquatic life, swimming, and public water supply. Of more than 100 public lakes monitored, approximately two-thirds fully support swimming, fishing, and drinking water uses. Such evidence is helpful in discerning program benefits broadly. However, to measure the benefits of water programs adequately, it is necessary to define a set of parameters and value changes in these parameters in a consistent and meaningful way.

In Appendix A of the 1994 Kentucky Report to Congress on Water Quality, the Trend Analysis and Data Summary Tables provide evidence of statistically significant improvements in water quality. The parameters chosen for the trend analysis were followed for several years in each of Kentucky's river basins. A parameter is considered to follow a trend toward improvement if a linear regression of the parameter on years is appropriately positive or negative. However, there has been no attempt to place value on these changes in such a way that their importance, both relative and absolute, can be ascertained.

In the following sections we will consider how best to measure the benefits of Kentucky's efforts in protecting stream, river and lake water quality, groundwater quality, and water quantity. First, one useful scheme for classifying water quality and quantity benefits is presented. Then, a list of benefit values gathered from studies deemed respectable by economists and public policy experts is provided.

A Classification of Water Quality Benefits

The benefits of water quality are many and varied. With some slight variation within the discipline, an approach to classifying benefits has been developed by economists. Table 1 provides one classification scheme for benefits.

First, benefits can be labeled as either Intrinsic or Use. Intrinsic Benefits include Option Value, the value of possible access to a resource in the future, and Existence Value, the knowledge that a resource exists. Use Benefits are categorized as Indirect or Direct. Indirect benefits are those which do not require actual contact with a resource. For example, the values of fishing equipment, lake-front property, and beautiful scenic views all involve the use of water, but only in an indirect way. Direct Benefits involve contact with the given resource. Direct Benefits can be examined more closely.

Direct Benefits may be classified by the consumption of the resource. Swimming and Boating are examples of Non-Consumptive Direct Use Benefits.

Consumptive Benefits are as varied as the quantity of municipal water supplies and the quality of recreational fishing. These Consumptive Benefits can be categorized by their ability to be valued in the market system. Some benefits, such as quality irrigation water for agriculture and the better catches for commercial fishermen, are easily expressed by the market. Such benefits are called Market Benefits. Other benefits, known as Non-Marketed Benefits, include such things as recreational fishing.

Table 6-1. Classification of Benefits

Use Benefits	Intrinsic Benefits
Direct	
Consumptive *Market*	**Option Value**
Consumptive *Nonmarket*	**Existence Value**
Non-Consumptive	
Indirect	

Representative Water Benefit Value Estimates from Respected Studies

Although there have been many applied studies evaluating the benefits of water, there are few studies specific to Kentucky. For example, there are more than 510,000 jobs associated with waterborne commerce in the Ohio Valley states along the Ohio River from the movement of commodities that have a 1980 dollar value of $43 billion (Palmer, 1985), but there are no estimates for the effects on Kentucky alone. However, there are some indicators of each of the various types of benefits of Kentucky's water resources.

Drinking water is one type of marketable consumptive direct-use benefit. Approximately 2.9 million people (81 percent of the Kentucky population) use public or semi-public water supplies, while 500,000 people (14 percent of the Kentucky population) use private wells for domestic water (Kentucky Outlook 2000, 1995). The daily water supplies for about 70 percent of Kentuckians come from surface-water sources, while about 25 percent come from ground-water sources.

A non-marketable consumptive direct use benefit of Kentucky's water is recreational fishing. The "National Survey of Fishing, Hunting, and Wildlife--Associated Recreation, Kentucky" (1991) reported that 647,000 Kentucky residents (36 percent of the Kentucky population), and 714,400 U.S. residents, fished in Kentucky streams during 1990-1991. The same report found that the in-state trip-related expenditures for fishing were $162.3 million (or $227 dollars per person). These expenses include some indirect use benefits such as food, lodging, transportation, license fees, and bait. The "1991 Kentucky Angler Survey," (1991) found that the average Kentucky angler fished 23.7 days in 1991. The anglers reported that they were fishing less than they had in the past, and fewer Kentucky residents under the age of 16 were purchasing licenses.

The use of Kentucky's lakes as camping sites is a type of non-consumptive direct-use benefit. William Hoyt (1989) was able to show that for each additional 100 acres of lake, there is an increase of 22 overnight camping stays, everything else held constant. However, Hoyt showed that lakes do substitute for one another. For every lake within 35 miles of any other one lake, 840 overnight stays are lost.

An example of the intrinsic value of Kentucky's water resources is the value people in the state place on the existence of a wetland. Whitehead and Blomquist (1990) showed that Kentucky citizens were willing and able to pay a one-time fee between $3 and $13 to keep the Clear Creek wetland in Kentucky from potential surface coal mining. These fees estimate existence value because only 16 percent of the surveyed sample had actually visited the wetland.

Many studies outside Kentucky have been conducted concerning water benefits. A collection of values intended for use as a reference point in the creation of realistic hypothetical models of watershed quality benefit valuation is presented in Appendix A6-1. Those studies which have followed state-of-the-art benefit measurement techniques have been used to provide at least one value for several benefit types. Some benefit categories include more than one value while other categories are excluded altogether due to a lack of quality studies in the area. These values have some usefulness in estimating the order of magnitude for various water quality benefits across different use categories.

WATER QUALITY BENEFIT VALUATION
APPENDIX A6-1

Outline of Value Types

I. Instreem Benefits

A. Hydropower

B. Recreation

C. Aquatic Habitat Preservation

D. Other Instream Benefits

1. Waste

2. Navigation

II. Withdrawal Benefits

A. Domestic

B. Commercial and Industrial

C. Irrigation

I.A. Hydropower

This table provides a list of Short-run marginal Values of Water for Hydroelectric Power Generation on four rivers. Power plants, with feet of head, and cumulative feet of head for each power plant along the rivers are given. Then the Cumulative kWh per acre-foot is given. Finally Cumulative Water Values in (1980) dollars per acre-foot is given. (Gibbons, 1987),

Plant	Feet of Head	Cumulative Feet of Head	Cumulative kWh	Cumulative water values
Columbia River				
Bonneville	59	59	51.33	0.87
The Dalles	83	142	123.54	2.10
John Day	105	247	214.89	3.65
McNary	74	321	279.27	4.75
Priest Rapids	77	398	346.26	5.89
Wanapum	78	476	414.12	7.04
Rock Island	38	514	447.18	7.60
Rocky Reach	87	601	522.87	8.89
Wells	67	668	581.16	9.88
Chief Joseph	167	835	726.45	12.35
Grande Coulee	343	1178	1024.86	17.42
Snake River				
Ice Harbor	98	419	364.53	6.20
Lower Monu.	100	519	451.53	7.68
Little Goose	98	617	536.79	9.13
Lower Granite	100	717	623.79	10.60
Hells Canyon	210	927	806.49	13.71
Oxbow	120	1047	910.89	15.49
Brownlee	277	1324	1151.88	19.58
Swan Falls	24	1348	1172.76	19.94
C.J. Strike	88	1436	1249.32	21.24
Bliss	70	1506	1310.22	22.27
Lower Salmon Falls	59	1565	1361.55	23.15
Upper Salmon Falls	80	1645	1431.15	24.33
Shoshone Falls	212	1857	1615.59	27.47
Twin Falls	147	2004	1743.48	29.64
Minidoka	48	2052	1785.24	30.35
American Falls	107	2159	1878.33	31.93
Tennessee River				
Kentucky	50	50	43.50	0.78
Pickwick Landing	46	96	83.52	1.49
Wilson	93	189	164.43	2.94
Wheeler	48	237	206.19	3.68
Guntersville	39	276	240.12	4.29
Nickajack	39	315	274.05	4.89
Chickamauga	45	360	313.20	5.59
Watts Bar	54	414	360.18	6.43
Fort Loudon	70	484	421.08	7.52
Colorado River				
Shoshone	170	170	147.90	2.51
Palisades	80	250	217.50	3.70
Glen Canyon	566	816	709.92	12.07
Parker	78	894	777.78	13.22
Davis	131	1025	891.75	15.16
Hoover	530	1555	1352.85	23.00

I.B. Recreation

This table provides estimates for various types of recreational uses of water. When known, the location of the study is given.

Benefit Type	Location	Value	Study
Boatable Water	National	$93 (1993) annual household value	Carson-Mitchell 1993
Kayaking	Colorado	$3.60 (1980) daily value per kayaker per acre foot of instream flow	Walsh et al. 1980
Rafting (White Water)	Colorado	$2.36 (1980) daily value per kayaker per acre foot of instream flow	Walsh et al. 1980
Swimmable Water	Boston	$46.10 (1981) per household per year	Gramlich,1977
	National	$78 (1993) annual household value	Carson-Mitchell 1993
From Boatable to Swimmable	Monongahela	$14.71 (1981) per household per season	Smith,Desvousges and McGivney 1983
Fishable	National	$70 (1993) annual household value	Carson-Mitchell 1993
From Boatable to Fishable	Monongahela	$7.01 (1981) per household per season	Smith,Desvousges and McGivney 1983
	Monongahela	$0.98-$2.03 (1982) per person per trip	Smith,Desvousges and McGivney 1983
	Cold Water Area	$1.00-$3.00 (1982) per person per day	Loomis-Sorg, 1982
		$4.00-$8.00 (1982) per person per day	Vaughan-Russell, 1982
Rough Fishing to Game Fishing (Catfish to Trout)		$5.76-$8.64 (1981) per person per day	Charbonneau-Hay 1978
		$4.55-$9.10 (1981) per person per day	Vaughan-Russel, 1982
Boating, Swimming, Fishing (Total)	National	$242 (1993) annual household vlaue	Carson-Mitchell 1993
10% Reduction in oil, color, and bacteria pollution	Boston	$1.34 (1981) per capita per year	Feenberg and Mills, 1980

I.C. Aquatic Habitat Preservation

Option, Existence, and Bequest values will indicate the value of preservation, and examples are provided in the first two tables that follow. WTP values for endangered species can also be found. A Whooping Crane Value is given in the third table as an example.

Table 1 (Greenley, Walsh, and Young):

Annual and Present Social Values (1980 dollars) from Water Quality Preservation in the South Platte River Basin, Colorado

Area Surveyed	Option value	Bequest value	Existence value	Recreation value	Recreation and Preservation value
Denver Metro.					
Annual Value	2,042,682- 6,161,700	2,366,693- 6,981,107	2,732,107- 11,060,147	5,330,492- 16,886,624	12,471,974- 41,089,578
Present Value	32,42,078-	37,124,596-	54,920,408-	83,615,571-	207,702,653-
	96,654,102	109,507,561	173,492,502	264,888,216	664,542,381
Fort Collins					
Annual Value	193,236- 548,307	94,651- 348,562	132,461- 419,523	417,390- 1,191,622	837,702- 2,508,014
Present Value	3,031,153- 8,600,896	1,484,157- 5,467,634	4,125,956- 6,580,752	6,547,290- 18,692,110	15,188,556 39,341,192
South PlatteRiver Basin					
Annual Value	3,581,687- 10,526,153	3,118,513- 9,782,102	3,792,942- 14,399,346	8,658,460- 26,399,220	19,151,602- 61,106,821
Present Value	56,183,321- 165,116,132	48,917,856- 153,444.736	59,497,134- 225,892,099	135,818,977- 414,105,414	300,417,288- 958,538.381

Table 2:

Preservation values per household

Study	Location	Total WTP	Recreation Use	Option	Existence	Bequest
Clonts-Malone 1988 (in 1987 dollars)	Alabama	57	8	9.50	22.50	17
Aiken, 1985 (in 1983 dollars)	Colorado	58	15	12	13	17

Table 3 (Bowker and Stoll, 1988):

WTP (1988 dollars) per individual for Whooping Crane Conservation: $21-$141.

I.D. Other Instream Benefits

Table 1. Waste

This table provides regional values (in 1980 dollars per acre-foot) of the water required for BOD Dilution. The first value is the marginal cost of moving from a 35% dillution level to a 70% municipal and a 50% industrial treatment level. The second value is for the least-cost combination of treatment and dilution. References: Gibbons (1986) and Gray and Young (1974).

Region	70/50 % Treatment	Least-cost combination
New England	1.25	1.25
Delaware and Hudson	2.41	4.83
Chesapeake	0.68	1.20
Ohio	3.41	3.52
Eastern Great Lakes	0.94	1.31
Western Great Lakes	0.37	1.68
Upper Mississippi	4.57	2.52
Lower Mississippi	2.98	2.15
Upper Missouri	1.16	4.03
Lower Missouri	6.81	5.82
Upper Arkansas-White-Red	1.47	6.98
Lower Arkansas-White-Red	1.99	1.99
Southeast	0.37	0.57
Cumberland	1.05	0.63
Tennessee	0.15	2.04
Western Gulf	0.68	1.36
Rio Grande and Pecos	0.79	3.63
Colorado	0.15	0.63
Great Basin	0.42	0.48
Southern Pacific	0.74	1.57
Central Pacific	0.48	1.31
Pacific Northwest	0.20	0.48

Table 2. Navigation

This table contains the short-run Average Values of Water for Navigation on Selected Waterways. First the Water Requirement is given (in thousands of acre-feet per year). Then Total Water Values in thousands of dollars is provided (determined by subtracting operation and maintenance costs of the waterways from the savings over railroad costs). Finally the Total Water Values are divided by the Water Requirement to get the Average Water Values in dollars per acre-foot. Source: Gibbons (1986).

Waterway	Water Requirement	Total Water Values	Average Water Values
Ohio River	604.80	166,067.06	275
Illinois Waterway	119.84	28,600.83	239
Tennessee River	412.16	21,374.00	52
Mississippi River	131,040.00	758,547.50	6
Columbia /Snave Rivers	7,168.00	19,013.92	3
Missouri River	23,968.00	3,229.65	<1

II.A. Domestic

This table provides the marginal values for Residential Water Demand in 1980 Dollars per hundred cubic feet.

Season	Location	Marginal Value ($/hundred cubic feet)	Study
Winter	Arizona	$0.72	Young, 1973
	North Carolina	1.27	Danielson, 1977
	Ontario	0.79	Grima, 1972
Summer	Arizona	$0.83	Young, 1973
	North Carolina	1.23	Danielson, 1977
	Ontario	0.79	Grima, 1972

II.B. Commercial and Industrial

This table shows the Impact of Water Pollution Control Requirements on Water Costs and Recycling Rates. Water is used in the production process and it is assumed a firm will operate on the cost minimization principal unless otherwise controlled. The "Best Available Treatment" here is based on 1975 data. The Total Costs are in 1980 dollars per acre foot of water used in the four different applications. Source: Gibbons, 1986.

Application	Total Cost-No Control	Total Cost-Best Available Treatment
Non-contact cooling water	21	33
Integrated cotton textile mill	162	465
Unbleached Kraft paper Mill	41	75
Basic oxygen steelmaking operations	56	192

II.C. Irrigation

This table provides the values of water used for irrigation of various crops. The values are in terms of 1980 Dollars per acre-foot. These are average values unless otherwise specified with an"M" for marginal.

Crop	Location	Value	Study
Alfalfa	Colorado	$25	Young, 1984
	Arizona	15	Willitt, et al., 1975
Apples	Washington	86	Washington State Univ., 1972
Barley	Arizona	5	Willitt, et al., 1975
Beans (Dry)	California	25-41	Shumway, 1973
Carrots	Arizona	313	Martin and Snyder1979
Corn	Washington	31	Washington State Univ., 1972
	Texas	67	Lacewell, et al., 1974
Cotton	Arizona	89-166	Kelso, et al., 1974
Cotton (Pima)	Arizona	51	Martin and Snyder, 1979
Cotton (Upland)	Arizona	55	Willitt, et al., 1975
Grain Sorgham	Arizona	23	Martin and Snyder, 1979
	Texas	113 (M)	Hoyt, 1982
Hops	Washington	10	Washington State Univ., 1972
Lettuce	Arizona	118	Martin and Snyder, 1979
Melons	California	21-40+	Shumway, 1973
Onions (dry)	Arizona	23	Martin and Snyder, 1979
Pears	Washington	78	Washington State Univ., 1972
Potatoes	Idaho	282-698 (M)	Ayer, et al., 1983
Safflower	California	15-28	Shumway, 1973
Soybeans	Texas	101	Lacewell et al., 1974
Sugar Beets	California	22	Shumway, 1973
	Washington	144 (M)	Ayer, 1983
Tomatoes	California	390 (M)	Kelley and Ayer, 1982
Wheat	Arizona	30-32	Kelso et al., 1974
	Texas	27	Lacewell et al., 1974

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CHAPTER 7

CONCERNS AND RECOMMENDATIONS

CONCERNS AND RECOMMENDATIONS

Concerns that are significant issues in Kentucky affecting its water quality programs:

- Making the transition to a watershed approach, including the cycling of permits without creating a backlog and monitoring and assessment that will properly focus limited resources.
- Erosion of program budget, resulting in loss of staff and other resources.
- Implementing new antidegradation regulations in a fair and consistent manner to further protect known and potential high quality waters.
- Providing policy makers, permit writers, and others with sound environmental data on which to base decisions.
- Resolving enforcement actions.
- Reducing time devoted to permit adjudications.
- Promoting public awareness of the division's successful programs and its role in improving the water environment.
- Comprehensively evaluating sanitary wastewater collection systems, including pump stations.
- Providing the technical and financial support to help municipalities maintain their wastewater treatment facilities and reduce wet weather flows from inadequate collection systems.
- Re-engineering the permitting and other water programs for greater effectiveness and efficiency
- Effectively implementing elements of the Agricultural Water Quality Plan

Recommendations to achieve further progress in meeting the goals and objectives of the Clean Water Act:

- Increase training to municipal and industrial wastewater treatment personnel on the implementation of pretreatment programs.
- Develop and implement practical alternatives for on-site waste disposal.
- Strengthen and update the requirements of the 201 planning process to promote wastewater regionalization.
- Re-establish Section 314 Clean Lakes funding for better assessing the condition of the state's lakes.
- Address problems in water distribution systems, which are not now effectively regulated.
- Initiate permitting system for drinking water plans.

- Institute performance bonds for package plants and oil and gas wells.

- Guidance is needed on stormwater and combined sewer overflow permitting in regard to: development of wet weather criteria, appropriate governing stream flows for water quality-based permits, the need to apply human health-based criteria for carcinogens, appropriate sampling techniques, and available and appropriate treatment procedures.

- Research at the federal level is needed to develop a logical progression of steps to identify and determine ways to eliminate chronically toxic components of effluents. National guidelines are needed to develop consistency in the implementation of whole effluent toxicity limits with the NPDES program.

- Greater financial support and simplified administration requirements should be provided to small communities (<3500 population), and possibly even individuals, for both water supply and sanitary sewer systems.