2000 KENTUCKY REPORT TO CONGRESS ON WATER QUALITY

KENTUCKY NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DIVISION OF WATER
November 2000

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2000 Kentucky Report to Congress on Water Quality

Kentucky Department for Environmental Protection
Kentucky Division of Water
Water Quality Branch
Frankfort, Kentucky

This report has been approved for release:

_____
Jack A. Wilson, Director
Kentucky Division of Water

_____
Date

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This report includes the first year of an inter-agency watershed monitoring effort with the support of state, federal, and local agencies. There are many people and organizations to thank for helping to bring about this effort and for supporting the intensive watershed monitoring. In particular, we wish to thank the Kentucky Department of Fish and Wildlife Resources and their district fisheries personnel for their substantial contribution. Lee Colten, the Kentucky Division of Water's Watershed Coordinator, has worked diligently to promote the watershed effort. The U.S. Forest Service, Kentucky State Nature Preserves Commission, and the Louisville District of the U.S. Army Corps of Engineers contributed to both the planning and carrying out of the monitoring. The Kentucky Division of Environmental Services conducted the analyses of all surface water quality samples submitted by the Division of Water. Staff in the London and Hazard offices of the Field Operations Branch were responsible for the collection of many of the surface water samples. The Lexington Fayette Urban County Government and Kentucky American Water Company provided data on waters in the greater Lexington area. Jeff Ray collected biological data from several streams for his master's thesis from Eastern Kentucky University. The Nonpoint Source Program of the Kentucky Division of Water funded biological work by Eastern Kentucky University in the Eagle Creek watershed. Personnel from the Natural Resources Conservation Service, U.S. Fish and Wildlife Service (Cookeville, TN office), Kentucky Geological Survey, Kentucky Division of Conservation, Kentucky Division of Pesticides, Kentucky Division of Forestry, Kentucky Water Resources Research Institute, and the U.S. Geological Survey were involved in important planning stages. The USEPA National Health and Environmental Effects Research Laboratory in Corvallis, Oregon provided the random survey sampling design. Last, but certainly not least, I want to thank all the staff of the Water Quality and Groundwater branches of the Kentucky Division of Water, including secretaries Dru Ellen Hawkins and Mariam Wiley, for their work in making the watershed monitoring process a success. A special thanks to Tracy Burgess for preparing the ground water section and to Scott Hankla of my staff for his diligence and initiative in data management and geographical referencing.

Tom C. Van Arsdall
Kentucky 305(b) Coordinator
November 2000

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INTRODUCTION

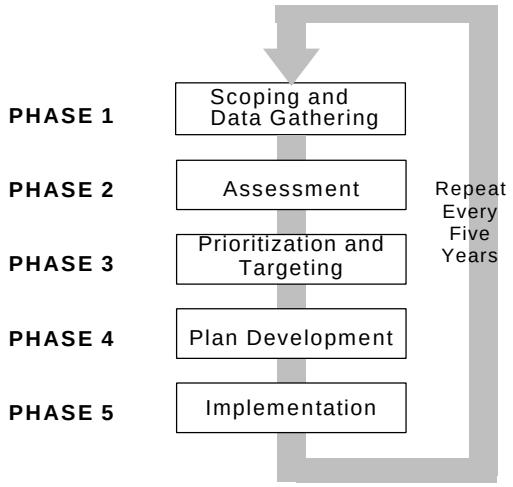
This report was prepared by the Kentucky Division of Water (DOW) following submittal of electronic data to the U.S. Environmental Protection Agency (EPA) in March 2000 to fulfill requirements of Section 305(b) of the Federal Water Pollution Control (or Clean Water) Act of 1972 (P.L. 92-500), as subsequently amended. Section 305(b) of the Act requires states to assess and report current water quality conditions to EPA every two years. This report presents an assessment of water quality conditions in the Kentucky River basin for the period October 1997 to December 1999. Other than the main stem of the Ohio River, only assessments of waters in the Kentucky River basin are presented. This is because the DOW initiated a five-year rotating watershed approach in 1997, and the Kentucky River basin was the first watershed management unit to be monitored and for which results are available for this report (see discussion below). Subsequent 305(b) reports will contain assessments of two watershed management units. Information contained in the Background and Atlas sections of the 1996 305(b) report has not changed and can be accessed in that report. Previous assessments of waters not within the Kentucky River watershed management unit can be found in the 1998 305(b) report (Kentucky Division of Water, 1998). Under the rotating watershed approach, waters in all areas of the state will have updated assessments by April 2004.

The Ohio River Valley Water Sanitation Commission (ORSANCO) regularly collects and analyzes data on the main stem of the Ohio River. These assessments are summarized by ORSANCO (2000).

WATERSHED MANAGEMENT FRAMEWORK

In order to better characterize the water of the state and better coordinate resources toward addressing problems, Kentucky has adopted a Watershed Management Framework. The purpose of this management framework is to use programs, people, information, and funds as efficiently as possible to protect, maintain, and restore water and land resources. This approach provides a framework, in time and place, within which participating individuals and institutions can link and support one another's efforts in watershed management.

According to the adopted Framework, the state is divided into five basin management units (see Schedule below) for the purposes of focusing management activities spatially. Activities within each unit will follow a five-year schedule, staggered by one year, so that efforts can be better focused temporally within a basin. Phases in the cycle include collecting information about water resources in the basin, identifying priority watersheds, listing the watersheds in the basin in order of priority and deciding which problems can be solved with existing funds, determining how best to solve the problems in the watershed, developing an action plan, and carrying out the strategies in the plan. Public participation is also encouraged throughout the process, allowing citizens and organizations to stay informed and have an active role in management of the resource.



Each basin will be phased into the Watershed Framework schedule as listed below:

- July 1997 – Kentucky River Basin
- July 1998 – Salt and Licking River Basins
- July 1999 – Cumberland, Tennessee, and Mississippi River Basins
- July 2000 – Green and Tradewater River Basins
- July 2001 – Big Sandy, Little Sandy, and Tygarts River Basins

Benefits of this approach include:

- Better coordination of resource management activities around common basin management units and schedules
- Better use of limited dollars for implementation activities
- Better information about water resources without higher monitoring costs
- More data as monitoring efforts are coordinated – a four-fold increase in assessment data is expected
- Better data as agencies standardize methods and procedures
- Greater opportunities for citizen involvement

SURFACE WATER

Data Collection

The water quality assessments of river, streams, and reservoirs in the Kentucky River basin are based on the support of designated uses in waters depicted on U.S. Geological Survey (USGS) 1:100,000 scale topographic maps. According to EPA's National Hydrologic Dataset (NHD), these maps contain 8,466 stream miles in the Kentucky River basin, of which 5,357 miles (63.3%) were assessed for this report by a combination of targeted and random survey results. The 664 miles of the Ohio River bordering Kentucky were assessed by the Ohio River Valley Water Sanitation Commission (ORSANCO, 2000).

Ambient Monitoring Network

Water Quality. The statewide ambient water quality monitoring network was increased from 44 to 71 fixed stations at the time monitoring under the watershed approach was initiated in May 1998. Ambient stations are located in the downstream and mid-unit reaches of USGS 8-digit (cataloging) hydrologic units, upstream of major reservoirs, and in the downstream reaches of major tributaries. The Kentucky River basin contains 16 of these fixed stations (Figure 1; Table 1). The ambient stations of a particular watershed management unit are sampled monthly during the year the unit is in the monitoring phase of the watershed cycle. During the other four years of the watershed cycle, sampling frequency is reduced to bimonthly to allow some monitoring and laboratory resources to be devoted to the rotating watershed water quality network described below. The purpose

Figure 1. Kentucky River Basin Monitoring Sites

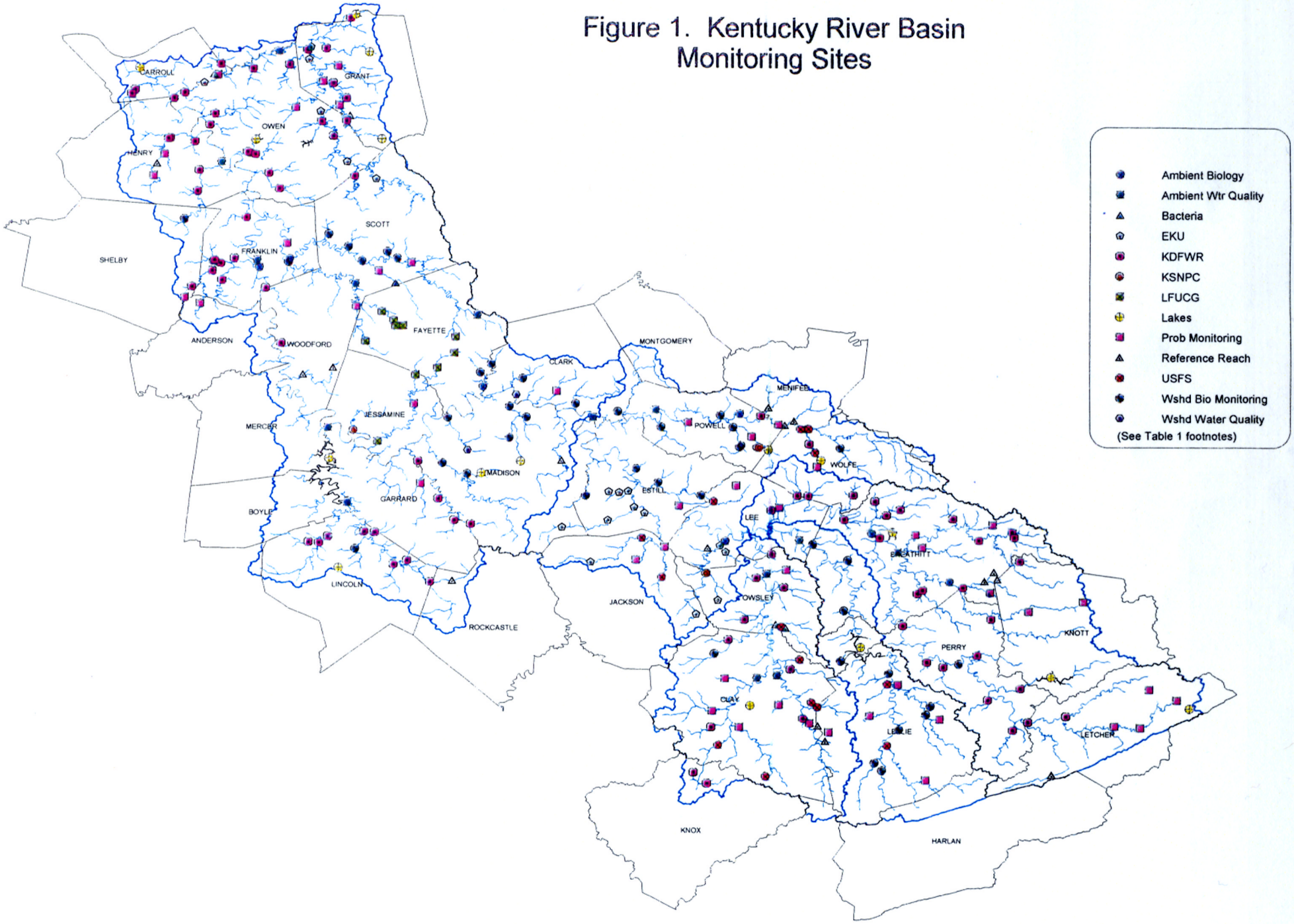


Table 1. Kentucky River Basin Monitoring Sites

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Arnolds Cr	3.5	Grant	WBM	KDFWR
Avon Fk	3.9	Fayette	WBM	DOW
Balls Fk	9.3	Knott	PROB	DOW
Bantas Fk	0.5	Henry	WBM	KDFWR
Back Cr	1.9	Garrard	PROB	DOW
Baughman Fk	0.9	Fayette	WBM	DOW
Beech Fk	2.4	Leslie	WBM	DOW
Benson Cr	2.8	Franklin	WBM	KDFWR
	6.3	Franklin	WBM	KDFWR
	8.7	Franklin	WBM	KDFWR
	21.6	Anderson	PROB	DOW
Big Caney Cr	0.9	Breathitt	WBM	KDFWR
	3.8	Breathitt	PROB	DOW
Big Cr	2.2	Clay, Perry	WBM	USFS
Big Dan Cr	0.1	Clay	-[c]	USFS
Big Double Cr	0.5	Clay	-[c]	KDFWR
Big Sinking Cr	8.2	Estill	-[c]	USFS
Big Twin Cr	2.2	Owen	WBM	KDFWR
Big Willard Cr	0.5	Perry	WBM	KDFWR
Bolen Br	1.0	Knott	PROB	DOW
Boone Cr	3.3	Fayette	BMP	DOW
	12.6	Fayette	WBM	DOW,LFUCG
Boone Fk	2.9	Breathitt	WBM	KDFWR
Brush Cr	4.0	Grant	WBM	KDFWR
Buck Cr	1.0	Estill	PROB	DOW
	1.9	Owsley, Estill	WBM	KDFWR
Buck Run	0.7	Owen	WBM	KDFWR
Buckhorn Cr	0.3	Breathitt	WBM	KDFWR
Buffalo Cr	0.5	Owsley	WWQ	DOW
	0.8	Owsley	RR	DOW
Bull Cr	0.6	Leslie	WBM	USFS
Bull Cr	1.8	Knott	WBM	KDFWR
Bullock Pen Cr	1.3	Boone, Grant	WBM	KDFWR
Bullskin Cr	3.5	Clay	WBM	KDFWR
Cane Cr	2.4	Powell	WBM,WWQ	DOW
Cane Cr	0.5	Breathitt	WBM	KDFWR
Cane Run	3.0	Scott	PROB	DOW
	5.8	Scott	WBM	LFUCG
	9.5	Fayette	IS	DOW
	14.3	Fayette	WBM	LFUCG
	15.0	Fayette	IS	DOW
Carr Fk	5.3	Perry	WBM	KDFWR
Cavanaugh Cr	0.5	Jackson	WBM	EKU
	0.7	Jackson	WBM	DOW
	3.7	Jackson	WBM	EKU
	6.5	Jackson	PROB	DOW
Cedar Cr	0.4	Lincoln	WBM	KDFWR
Cedar Cr	6.2	Owen	WBM	KDFWR
Cedar Run	2.8	Franklin	DMR	DOW
Chimney Top Cr	0.4	Wolfe	-[c]	KDFWR
Clarks Cr	0.9	Grant	PROB	DOW
Clarks Cr	4.5	Grant	WBM	EKU

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Clarks Run	3.0	Boyle	WET	DOW
	6.4	Boyle	WET	DOW
	10.5	Boyle	WET	DOW
Claylick Cr	0.5	Owen	IS	DOW
Clear Cr	4.1	Woodford	RR	DOW
Clemons Fk	0.5	Breathitt	RR	DOW
	3.0	Breathitt	RR	DOW
Coles Fk	0.6	Breathitt	RR	DOW
Collins Fk	4.9	Clay	WBM	USFS
Cope Fk	0.2	Breathitt	WBM	KDFWR
Copper Cr	0.1	Rockcastle	WBM	KDFWR
	2.3	Rockcastle	WBM	KDFWR
	4.4	Rockcastle	RR	DOW
Cow Cr	1.8	Estill	WBM	DOW
Cow Cr	1.4	Owsley	WBM	KDFWR
Crooked Cr	1.9	Estill	WBM	EKU
	4.7	Estill	WBM	EKU
Cutshin Cr	1.3	Leslie	PROB	DOW
	8.1	Leslie	WBM	DOW
	12.4	Leslie	WBM	DOW
Dix R	34.7	Garrard, Boyle	BMP,PRI	DOW
	75.8	Rockcastle	WBM	KDFWR
	77.9	Rockcastle	PROB	DOW
Dog Fk	0.5	Wolfe	-[c]	KDFWR
Drakes Cr	1.2	Lincoln	WBM	KDFWR
Drennon Cr	4.7	Henry	WBM	KDFWR
	7.2	Henry	WWQ	DOW
	10.5	Henry	RR	DOW
	14.0	Henry	PROB	DOW
Drowning Cr	8.5	Madison	WBM	DOW
Dry Run	1.2	Scott	WBM	DOW
Duck Fk	0.2	Lee	WBM	KSNPC
	1.2	Lee	WBM	EKU
Eagle Cr	0.4	Carroll, Owen	WBM	KDFWR
	7.0	Owen, Gallatin	WBM	EKU
	9.5	Eagle	PROB	DOW
	20.8	Owen	PRI,BMP	DOW
	27.8	Grant	WBM	KDFWR
	30.8	Grant	WBM	EKU
	47.6	Grant	PROB	DOW
	53.5	Owen, Grant	WBM	EKU
	70.4	Owen, Grant	WBM	EKU
	79.8	Owen, Scott	WBM	EKU
E Fk Indian Cr	1.0	Menifee	RR,WBM	DOW,KDFWR
E Fk Mill Cr	0.1	Carroll, Henry	WBM	KDFWR
E Fk Otter Cr	1.2	Madison	WBM	DOW
E Hickman Cr	8.9	Fayette	WBM	LFUCG
	13.0	Fayette	WBM	LFUCG
	13.5	Fayette	WBM	LFUCG
	13.5	Fayette	WBM	LFUCG
Elisha Cr	1.0	Leslie	RR	DOW

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Elk Cr	0.7	Owen	WBM	KDFWR
Elkhorn Cr	3.5	Franklin	BMP	DOW
	11.3	Franklin	PRI	DOW
	11.9	Franklin	PROB	DOW
Emily Run	0.1	Henry	WBM	KDFWR
Five Mile Cr	0.5	Henry	RR, PROB	DOW
Flat Cr	5.8	Franklin	WBM	KDFWR
Four Mile Cr	5.6	Clark	PROB	DOW
Freeman Fk	1.0	Breathitt	WBM	DOW
Frozen Cr	6.9	Breathitt	WBM	KDFWR
Gilberts Big Cr	2.4	Leslie	PROB	DOW
Gladie Cr	0.1	Menifee	WBM	USFS
	0.5	Menifee	RR, WWQ	DOW
Glenns Cr	0.5	Franklin	WBM	KDFWR
Goose Cr	0.8	Shelby	WBM	KDFWR
	3.5	Shelby	PROB	DOW
Goose Cr	3.4	Clay	PRI	DOW
	4.4	Clay	BMP	DOW
	25.9	Clay	PROB	DOW
Grannys Br	1.2	Clay	-[c]	USFS
Grapevine Cr	0.7	Perry	WBM	KDFWR
Grassy Run	1.8	Grant	WBM	KDFWR
Greasy Cr	0.4	Leslie	WBM	USFS
	15.3	Leslie	PROB	DOW
Griers Cr	1.0	Woodford	WBM	KDFWR
Hammons Fk	1.4	Knox	WBM	KDFWR
Hanging Fk	4.2	Lincoln	WWQ	DOW
	14.8	Lincoln	WBM	KDFWR
	16.6	Lincoln	WBM	KDFWR
Hardwick Cr	1.2	Powell	WWQ,WBM	DOW
Harts Fk	2.6	Madison	DMR	DOW
Hawes Fk	0.2	Breathitt	WBM	KDFWR
Hays Fk	4.7	Madison	DMR	DOW
Hell Cr	2.0	Lee	WBM	KDFWR
Hell for Certain Cr	0.2	Leslie	WBM	DOW
	1.0	Leslie	WBM	USFS
Hickman Cr	19.5	Jessamine	PROB	LFUCG,DOW
Holly Cr	4.8	Wolfe	WBM	KDFWR
Horse Cr	3.4	Clay	WBM	KDFWR
Hays Fk	1.4	Estill	WBM	EKU
Hunting Cr	0.6	Breathitt	WBM	KDFWR
Indian Cr	0.6	Carroll	RR	DOW
Indian Cr	0.2	Powell	WBM	KDFWR,DOW
Jessamine Cr	0.4	Jessamine	WBM	KSNPC
Judy Cr	2.5	Powell	PROB	DOW
Keens Fk	0.3	Clay	-[c]	USFS
Kentucky R	30.5	Henry, Owen	PRI	DOW
	64.8	Franklin	PRI	DOW
	66.4	Franklin	PRI[c]	DOW
	118.8	Jessamine, Garrard	WWQ	DOW
	167.5	Fayette		KAWC

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Kentucky River	176.7	Madison, Clark	WWQ	DOW
	191.2	Estill, Madison	WWQ	DOW
	249.1	Lee	BMP	KAWC
Knoblick Cr	3.2	Lincoln	WBM	KDFWR
Lanes Run	0-0.5	Scott	DMR	DOW
Laurel Cr	4.0	Clay	PROB	DOW
Leatherwood Cr	3.2	Perry	WBM	DOW
Leatherwood Cr	0.9	Breathitt	WBM	KDFWR
Leatherwood Cr	3.2	Perry	WBM	DOW
LeComptes Run	1.3	Scott	WBM	DOW
Lee Br	1.0	Woodford	DMR	DOW
Left Fk Buffalo Cr	0.1	Owsley	WBM	USFS
Left Fk Island Cr	2.4	Owsley	WBM	KDFWR
Left Fk Millstone Cr	2.2	Letcher	PROB	DOW
Lick Cr	2.4	Carroll	WBM	KDFWR
Line Fk	0.1	Letcher	WBM	KDFWR
	16.0	Letcher	WWQ	DOW
	17.3	Letcher	RR	DOW
Little Goose Cr	2.5	Clay	PROB	DOW
Little Sexton Cr	0.2	Clay	WBM	KDFWR
Little Sinking Cr	2.0	Lee	PROB	DOW
Little Sturgeon Cr	0.1	Owsley	WBM	KSNPC
	2.7	Owsley	WBM	EKU
	5.6	Owsley	WBM	EKU
Logan Cr	0.9	Lincoln	WET[c]	DOW
	2.8	Lincoln	WET[c]	DOW
	3.2	Lincoln	WET[c]	DOW
Long Fk	3.2	Breathitt	PROB	DOW
Long Fk	1.6	Clay	PROB	DOW
Lost Cr	4.4	Breathitt	WBM	KDFWR
Lotts Cr	2.2	Perry	WBM	KDFWR
Lower Buffalo Cr	2.2	Owsley	WBM	KDFWR
Lower Devil Cr	1.5	Lee	WBM	KDFWR
Lower Hood Br	0.5	Powell	WBM	KSNPC
Lower Howard Cr	4.5	Clark	WBM	DOW
Lulbegrud Cr	2.8	Clark	WBM	DOW
Lytles Fk	3.1	Scott	WBM	KDFWR
Maces Cr	0.2	Perry	WBM	KDFWR
			WWQ	DOW
McConnell Run	3.0	Scott	WBM	DOW
Meadow Cr	3.2	Owsley	PROB	DOW
Middle Fk KY R	8.3	Lee	PRI	DOW
	66.9	Leslie	WWQ	DOW
	79.9	Leslie	WBM	DOW
	88.9	Leslie	WBM	DOW
Middle Fk Quicksand Cr	3.0	Knott	WBM	KDFWR
Middle Fk Red R	2.2	Powell	WBM	DOW
	5.5	Powell	PROB	DOW
			IS	DOW
Mill Cr	1.8	Owen	WBM	KDFWR
			WWQ	DOW

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Mill Cr	4.7	Carroll	WBM	KDFWR
Millers Cr	4.9	Estill	WWQ	DOW
	6.5	Estill	WBM	DOW
Moseby Br	1.0	Owen	WBM	KDFWR
Muddy Cr	13.4	Madison	RR,WWQ	DOW
	22.0	Madison	RR	DOW
Musselman Cr	2.6	Grant	RR	DOW
N Benson Cr	1.0	Franklin	WBM	KDFWR
N Elkhorn Cr	0.1	Franklin	BMP	DOW
	26.4	Scott	WBM	DOW
	28.1	Scott	WWQ	DOW
	40.5	Scott	WWQ	DOW
	41.8	Scott	PROB	DOW
	53.7	Fayette	BMP	DOW
	60.5	Fayette	WBM	LFUCG
	71.5	Fayette	WBM	LFUCG
	71.8	Fayette	WBM	LFUCG
	72.6	Fayette	WBM	LFUCG
N Fk Kentucky R	38.1	Breathitt	BMP	DOW
	45.9	Breathitt	PRI	DOW
	95.0	Perry	PROB	DOW
	144.0	Letcher	PROB	DOW
	150.1	Letcher	PROB	DOW
N Fk N Benson Cr	0.1	Franklin	WBM	KDFWR
N Severn Cr	0.1	Owen	WBM	KDFWR
Otter Cr	1.6	Madison	WBM	DOW
Paint Lick Cr	3.7	Garrard, Madison	WBM	KDFWR
	7.4	Garrard, Madison	WWQ	DOW
	15.8	Garrard, Madison	WBM	KDFWR
Polls Cr	1.2	Leslie	PROB	DOW
Potter Fk	0.5	Letcher	PROB	DOW
Puncheon Camp Cr	7.7	Breathitt	WBM	DOW
Quicksand Cr	5.3	Breathitt	PROB	DOW
	25.3	Breathitt	WBM	KDFWR
Red Bird R	5.3	Clay	PRI;BMP	DOW
	17.5	Clay	WBM	USFS
	20.0	Clay	PROB	DOW
Red Lick Cr	0.7	Estill	WBM	EKU
	4.8	Estill	WBM	EKU
	8.2	Estill	WBM	EKU
	14.0	Madison	BMP, WBM	EKU
Red R	21.6	Powell	PRI	DOW
	44.3	Powell	BMP, WBM	DOW,USFS
	51.7	Menifee, Powell	WBM	USFS
	52.8	Menifee, Powell	PROB	DOW
	57.7	Menifee, Wolfe	WBM	DOW,USFS
	59.4	Menifee, Wolfe	BMP	DOW,USFS
Richland Cr	0.1	Owen	WBM	KDFWR
R Fk Buffalo Cr	1.1	Owsley	RR	DOW
Rockbridge Cr	0.3	Wolfe	-[c]	USFS
Rockhouse Cr	0.6	Letcher	WWQ,WBM	DOW,KDFWR

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Rockhouse Cr	21.5	Letcher	DMR	DOW
Rockhouse Cr	4.3	Leslie	PROB	DOW
Sandlick Fk	0.1	Powell	WBM	DOW
Sawdridge Cr	0.6	Owen	WBM	KDFWR
Severn Cr	2.7;3.7	Owen	WBM	KDFWR
Sexton Cr	13.2	Clay	WBM	KDFWR
	13.6	Clay	PROB	DOW
Shallowford Cr	6.9	Madison	DMR	DOW
Silver Cr	5.6	Madison	BMP, PRI	DOW
	11.2	Madison	PROB	DOW
Sixmile Cr	3.5	Henry	WBM	KDFWR
	19.2	Shelby	PROB	DOW
S Benson Cr	5.2	Franklin	WBM	KDFWR
S Elkhorn Cr	0.7	Franklin	WBM	DOW
	24.2	Scott, Woodford	PRI	DOW
	35.1	Woodford	PROB	DOW
	44.7	Fayette	WBM	LFUCG
S Fk Kentucky R	11.5	Owsley	BMP	DOW
	12.1	Owsley	PRI	DOW
S Fk Quicksand Cr	2.9	Breathitt	PROB	DOW
S Fk Red R	0.1	Powell	WBM	DOW
	4.3	Powell	WBM	DOW
S Fk Station Camp Cr	5.3	Jackson	RR, WBM	DOW;USFS
	6.0	Jackson	WBM	EKU
	9.6	Jackson	WBM	EKU
	17.6	Jackson	WBM	EKU
	19.6	Jackson	WBM	EKU
Spring Fk	3.8	Breathitt	WBM	KDFWR
Station Camp Cr	3.3	Estill	WBM	EKU
	10.8	Estill	WBM	EKU
	14.5	Estill	WBM	EKU
	15.2	Estill	WBM	EKU
	16.8	Estill	WBM	EKU
	19.0	Estill	WBM	EKU
	19.3	Estill	RR	DOW
	20.1	Jackson	WWQ	DOW
	20.6	Jackson	WBM	EKU
	21.8	Jackson	PROB	DOW
Steammill Br	1.5	Grant	DMRs	DOW
Stevens Cr	0.2	Grant	PROB	DOW
	15.8	Owen	PROB	DOW
Stillwater Cr	2.4	Wolfe	WBM	DOW
Sturgeon Cr	0.7	Lee	WBM	EKU
	1.3	Lee	WWQ	DOW
	3.9	Lee	WBM	EKU
	4.0	Lee	RR	DOW
	5.9	Lee	WBM	EKU
	9.9	Lee	WBM	EKU
	12.4	Lee, Owsley	WBM	EKU
	13.8	Jackson	WBM	KSNPC
	21.3	Owsley	WBM	EKU
	27.2	Jackson	WBM	EKU

Table 1. (Continued)

Waterbody	Sample Milepoint	County	Program[a]	Agency[b]
Sturgeon Cr	32.1	Jackson	WBM	EKU
Sugar Cr	0.8	Leslie	RR	DOW
Sulphur Cr	0.8	Henry	WBM	KDFWR
Tate Cr	0.7	Madison	WBM	DOW
	8.2	Madison	WWQ	DOW
Ten Mile Cr	0.3	Grant	WBM	EKU
Three Forks Cr	3.0	Grant	WBM	KDFWR
Town Br	6.1	Fayette	WBM	LFUCG
	8.9	Fayette	WBM	LFUCG
	10.5	Fayette	WBM	LFUCG
Town Br	3.5	Henry	DMR	DOW
Troublesome Cr	7.2	Breathitt	PRI	DOW
	11.7	Perry	BMP	DOW
	24.8	Knott	WBM	KDFWR
	42.1	Knott	DMR	DOW
Two Mile Cr	1.3	Owen	WBM	KDFWR
Upper Devil Cr	0.6	Wolfe	WBM	KDFWR
Upper Hood Br	0.3	Powell	-[c]	KSNPC
Upper Howard Cr	1.4	Clark	WBM	DOW
Upper Twin Cr	0.2	Breathitt	WBM	DOW
UT Cane Run	0.4	Scott	IS	DOW
	1.3	Fayette	IS	DOW
UT Clear Cr	0.6	Woodford	RR	DOW
UT Dry Run	2.5	Scott	DMR	DOW
UT E Fk Clear Cr	3.8	Jessamine	DMR	DOW
UT Swift Camp Cr	0.3	Wolfe	PROB	DOW
Walker Cr	2.0	Lee	PROB	DOW
War Cr	0.8	Breathitt	WBM	KDFWR
War Fk	5.0	Jackson	WBM	EKU
	7.8	Jackson	WBM	USFS
	11.5	Jackson	WBM	EKU
W Fk Mill Cr	0.1	Carroll	WBM	KDFWR
	2.7	Madison	WBM	DOW
W Hickman Cr	2.5	Jessamine	WBM	LFUCG
	3.4	Jessamine	WBM	LFUCG
	3.6	Fayette	WBM	LFUCG
White Lick Cr	0.9	Garrard	WBM	KDFWR
White Oak Cr	1.6	Estill	WBM	KDFWR
Wolf Run	0.6	Fayette	WBM	LFUCG
	1.2	Fayette	WBM	LFUCG
Wolfpen Cr	0.2	Menifee	RR	DOW
Wooten Cr	1.8	Leslie	WBM	DOW

[a]WBM = watershed (rotating biological)
BMP = biological monitoring program (fixed sites)
DMR = discharge monitoring reports
IS = intensive survey
PRI = primary (fixed) water quality
PROB = probability (random survey)
RR = reference reach
WET = whole effluent toxicity instream monitoring site
WWQ = watershed (rotating) water quality

[b]KDFWR = Kentucky Department of Fish and Wildlife Resources
DOW = Kentucky Division of Water
EKU = Eastern Kentucky Unversity
KAWC = Kentucky American Company
KSNPC = Kentucky State Nature Preserves
LFUCG = Lexington Fayette County Urban County Government
USGS = U.S. Forest Service

[c]Data collected prior to the interagency watershed

of the ambient water quality sampling is to assess conditions and detect long-term trends on the larger streams and rivers of the state.

Sediment. Sediment quality is determined at the ambient stations during the year in which monitoring occurs in a watershed management unit (Figure 1; Table 1).

Biology. Of 16 ambient biology stations, 12 are in close proximity to ambient water quality stations (Figure 1; Table 1). However, four of the ambient water quality stations on the Kentucky River are not sampled biologically because of the lack of adequate biological indices for large rivers and the difficulty in obtaining representative samples from all river habitats. The ambient biology stations will be revisited every five years. In conjunction with water quality data, biological data from the ambient stations will provide long-term and trend information on many main stem streams and rivers.

Fish Tissue. Fish tissue samples were obtained from 16 ambient stations and 10 other locations in the Kentucky River basin that are routinely used as sources of fish for consumptive use (Figure 1; Table 1). Tissue was analyzed for metals, including mercury, PCBs, chlordane, pesticides and herbicides. Results were used to determine if there were potential problems with contaminants in fish tissue that required further sampling. If results were not elevated, no further fish tissue sampling was conducted. Six of the 26 stations were re-sampled in 1999. Results were similar to those from 1998.

Other Fixed-Station Monitoring. The Lexington-Fayette Urban County Government (LFUCG) maintains several water quality and biological monitoring stations in Fayette County. Data from 20 of these stations on nine streams were used for assessing aquatic life and recreational use support (Figure 1; Table 1).

Rotating Watershed Network

Water Quality. An interagency monitoring team established several objectives for the one-year water quality monitoring stations. (For a more detailed description of that process, see Kentucky Water Research Institute, 2000). The objectives were to: (1) obtain an overall representation of the quality of the basin's water resources; (2) determine water quality conditions associated with major land cover/land uses such as forest, urban, agriculture, and mining; (3) characterize the basin's least impacted waters; and (4) collect data for establishing total maximum daily loads (TMDLs) as required by Section 303(d) of the Clean Water Act.

All but a few of the water quality samples were collected by the DOW and analyzed by the Division of Environmental Services, the laboratory of the Kentucky Natural Resources and Environmental Protection Cabinet. Because of the relative lack of resources, the watershed water quality-monitoring network consisted of only 25 stations (Figure 1; Table 1). These usually were located at the downstream reaches of USGS 11-digit watersheds, and most were coupled with biological sampling and with USGS gaging stations. Monthly sampling, often complemented by rain event sampling, was conducted over the 12-month watershed-monitoring phase to characterize the watershed represented by the sample site. For example, metals but not pesticides were analyzed at stations in mining areas.

Biology. Unlike water quality monitoring, there was a relative abundance of resources available for biological monitoring. For targeted monitoring, these resources allowed sampling at 240 sites on 162 streams and rivers in 1998. Also, for the first time in Kentucky, a random survey approach was used to characterize wadeable streams.

Together, the targeted and random survey programs sampled 290 sites on 183 streams and rivers in the Kentucky River basin.

For the watershed biological monitoring network, most targeted stations were placed in the downstream reaches of fourth order (on 1:24,000 scale USGS topo maps) stream watersheds (Figure 1; Table 1). One reason for this choice was that the number of fourth order stream watersheds in the Kentucky River basin fairly closely matched the available monitoring resources. Another favorable attribute of fourth order stream watersheds is that they are more hydrologically accurate and uniform in size than 11-digit watersheds. Most of the fourth order streams were monitored for at least one component of the biological community (fish, macroinvertebrate, algae) and habitat. The DOW collected fish, macroinvertebrates, and algae at 38 stations. The Kentucky Department of Fish and Wildlife Resources (KDFWR) sampled fish at 87 stations (see KDFWR, 1999). The U.S. Forest Service and Kentucky State Nature Preserves Commission collected macroinvertebrate samples at 15 and five stations, respectively. In addition, 319 Nonpoint Source grant monies were used to contract Eastern Kentucky University to collect fish and macroinvertebrates from 40 sites in the Eagle Creek basin (see Blanton et. al, 2000). The Sturgeon Creek and Station Camp Creek basins were sampled by a graduate student for thesis work (Ray, 1999).

A random survey of wadeable (generally first to fourth order) streams also was conducted using locations selected by the EPA National Health and Environmental Effects Research Laboratory in Corvallis, Oregon. Network design and sampling procedures followed that developed for EPA's Environmental Monitoring and Assessment Program (EMAP). The sample population was 1:100,000 scale blue-line

stream reaches contained in EPA's Reach File 3. The purpose of this sampling network was to assess, with a known statistical error, warm water aquatic life use for a greater number of stream miles than can be obtained through a targeted station approach. This "probabilistic" network consisted of 50 stations throughout the Kentucky River basin (Figure 1; Table 1). Macroinvertebrates were collected once at these sites during the summer to early fall. As with all biological sampling, habitat also was characterized at each site. EPA provided sampling locations as latitude/longitude coordinates. According to EMAP protocols, sampling was conducted in a reach equal to 40 times the width of the stream channel around the coordinates. Sampling methods followed those of the DOW biological programs (1993). However, because available habitat was not necessarily similar to that sampled by usual sampling protocols that rely on sampling all habitat types (riffle, pool, run), best professional judgement was used to interpret results from sampling reaches dominated by pool habitat.

In 1991, the DOW began a program to gather data from the state's least impacted streams. Biologists first identify potential least impacted waters representative of geographic regions of the state known as ecoregions. Then, data on chemical water quality, sediment quality, fish tissue residue, habitat condition, and biotic conditions are collected to: (1) define the potential environmental quality for the streams of a particular ecoregion; and (2) allow other streams in the same ecoregion to be compared to the reference condition. Potential aquatic life use of other streams in the same ecoregion can also be determined. Data from the reference reach program will provide the basis for the development of narrative and numerical biocriteria for the various ecoregions of the Commonwealth. Fifty-five stream sites from seven proposed ecoregions were initially

sampled in the spring and fall of 1992-1993. Since that time, many more potential reference reach streams have been sampled. Some were adopted as reference reach streams; others were rejected because they did not possess adequate quality to represent a least impacted condition. There currently are 52 reference reach streams throughout the Commonwealth; 17 of these streams are in the Kentucky River basin (Table 1; Figure 1). The DOW recently was able to add three streams (Gladie Creek, East Fork Indian Creek, and Wolfpen Creek) in the Kentucky River basin because of the newly implemented watershed monitoring effort.

Other Data Sources

Discharge Monitoring Reports. Discharge monitoring report data, collected by Kentucky Pollutant Discharge Elimination System (KPDES) permit holders, were accessed through DOW's permit compliance system database. Depending on the relative sizes of the wastewater discharge and the receiving stream and the severity of the permit violations, it sometimes was possible to assess instream uses as threatened or impaired.

Effects of Effluent Toxicity. Several streams were sampled in 1995 to test the hypothesis that failure of point source discharges to meet whole effluent toxicity permit limits results in instream biological impacts. All three biological assemblages were sampled both up- and downstream of the point source discharges.

Lakes and Reservoirs

Reservoirs and lakes also are monitored on a rotating basin approach, but unlike stream monitoring, there was adequate coverage of these waters prior to the watershed

approach. However, all the state's significant publicly owned lakes now will be monitored in a five-year cycle, whereas previously the cycle was seven to eight years. In the Kentucky River basin, 17 lakes were monitored for trophic state and use support (Figure 1; Table 9). Designated uses in lakes consist of Warm Water Aquatic Habitat (WAH) (sometimes in conjunction with Cold Water Aquatic Habitat (CAH) in lakes with a two-story fishery) and Primary and Secondary Contact Recreation (PCR and SCR). Many of the lakes also have a Domestic Water Supply (DWS) use. Composite nutrient and chlorophyll *a* samples were collected from the photic zone, and dissolved oxygen, temperature, pH, and specific conductivity measurements were obtained from profiles of the water column in the deepest part of the lake.

Assessment Methodology

Overall use support was assessed by following EPA guidelines (USEPA, 1997) that define fully supporting as fully supporting all uses for which data were available. If a segment supported one use but did not support another, it is listed as not supporting. For instance, if a segment supported WAH but not PCR, it is listed as not supporting (or impaired). 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 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 surveys and were generally no more than five years old. In some instances where conditions were believed to have remained mostly unchanged, monitored data collected prior to 1995 were still considered valid, and waters described by these data were categorized as monitored. Also, for the first time, data from a random survey network were used. The 4,356 wadeable stream miles represented by this sampling, and the specific reaches assessed by each individual station, are considered monitored waters. There are few evaluated waters remaining in the assessment database. All efforts in the watershed initiative are to gather defensible, monitored data. However, there are and will continue to be some monitored data more than five years old, strong anecdotal information, and extrapolation of discharge data that will result in some evaluated assessments.

The total number of assessed stream miles was determined by adding the miles represented by the random survey and the miles assessed by the targeted monitoring in streams greater than fourth order which were not covered by the random survey approach. The miles assessed by targeted monitoring in wadeable (first to fourth order) streams were included in miles assessed by the random survey.

In waters with water quality and biological data, the biological data were generally the determinant factors for establishing WAH use. This was especially true when data for total recoverable copper, lead, or zinc criteria disagreed with biological data. 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 more toxic "dissolved" fraction.

Water Quality. Chemical data collected by the DOW and LFUCG were assessed according to EPA guidance. Water quality data were entered into EPA's national storage and retrieval (STORET) database and compared to criteria. The segment fully supported 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 1997 through September 1999. Partial support was indicated if any one criterion for these parameters was not met in 11-25 percent of the samples. A segment was not supporting if any one of these criteria was not met more than 25 percent of the time.

Data for mercury, cadmium, copper, lead, and zinc were analyzed for violations of acute criteria listed in state water quality standards regulations using three years of data (October 1996 to September 1999). The segment fully supported WAH 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 and federal 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 PCR (swimming) use. The use was fully supported if the fecal coliform bacteria criterion of 400 colonies per milliliter was not met in less than 20 percent of the samples, partially supported if the criterion was not met in 25 - 33 percent of the samples, and not supported if the criterion was not met in 33 percent or more of the samples. Streams with pH less

than 6.0 units in more than 10 percent of the samples were considered to not support swimming use.

Lakes. Trophic status was assessed in lakes 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 it also provides for a distinction between oligotrophic, mesotrophic, and eutrophic lakes. The growing season (April – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately. Use support in lakes was determined by criteria listed in Table 2.

Biology. Biological data were collected in 1998 from 290 sites on 184 streams (see previous Data Collection section). These data were supplemented by data previously collected in the basin. 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. As outlined in Table 3, the metric scores were used to determine biotic integrity and aquatic life use support for each stream reach monitored. Expectations for metric values are dependent on stream size, ecoregion, and habitat quality. Bioassessments integrate data from the biological community, habitat, physical environment, water quality, and professional judgment of aquatic biologists. Table 3 explains the methodology behind determining aquatic life use support from biological data.

Table 2. 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)
	Fish kills caused by poor water quality	Widespread excess macrophytie/macro-scopic algal growth	Chronic taste and order complaints caused by algae
	Severe hypolimnetic oxygen depletion	Chronic nuisance algal blooms	Chronic treatment problems caused by poor water quality
	Dissolved oxygen average less than 4 mg/l in the epilimnion		Exceeds drinking water MCL
Partially Supporting: (At least one of the following criteria)	Dissolved oxygen average less than 5 mg/l in the epilimnion	Localized or seasonally excessive macrophyte/macroscopic algal growth	Occasional taste and odor complaints caused by algae
	Severe hypolimnetic oxygen depletion	Occasional nuisance algal blooms	Occasional treatment problems caused by poor water quality
	Other specific cause (i.e. low pH)	High suspended sediment concentrations during the recreation season	
Fully Supporting:	None of the above	None of the above	None of the above

Table 3. 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

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 use gives a clearer picture of actual water quality conditions.

Fish tissue data for mercury and PCBs were compared to the FDA action limits of 1.0 and 2.0 ppm.

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 sub-population that potentially could be at a greater cancer risk (e.g. pregnant women, children). Restricted consumption is defined as limits on the number of meals consumed per unit of time for one or more fish species.
- Not supporting – "no consumption" fish advisory or ban in effect for general population or a sub-population that potentially could be at greater risk, for one or more fish species, or a commercial fishing ban in effect.

[**Note:** Since the period covered by this report, the Kentucky Department for Environmental Protection (DEP) changed to a risk-based approach to evaluate fish tissue data. In April 2000, the DEP, in conjunction with the Kentucky Department of Fish and Wildlife Resources and the Kentucky Department for Public Health, issued a limited statewide fish consumption advisory. The advisory recommends those women of childbearing age and children six years and younger should eat no more than one meal per week of larger, older freshwater fish.]

Drinking Water Use Support

Drinking water use was assessed in lakes by surveys of drinking water operators on taste and odor problems and any use of biocides. Chemical data generally were not available to assess drinking water use. Lexington, the only Class 1 city in the Kentucky River basin, was the only public water supply (PWS) to regularly monitor the raw water supply. No PWSs incurred violations resulting in a nonsupport of the public water supply use.

Use Support Summary

Streams and Rivers

A total of 5,357 miles were assessed by a combination of targeted and random survey monitoring. Because of overlap, targeted and random survey miles are not additive.

Aquatic life, swimming, and fish consumption uses were assessed by the targeted monitoring. Full support of overall uses was attained in 1,158 miles (64.7 percent), partial use impairment was found in 335 miles (18.7 percent), and uses were not supported in 298 miles (16.6 percent) in the Kentucky River basin (Table 4). Support of individual uses also is shown in Table 4. Table 5 shows the miles of targeted monitored and evaluated waters supporting, supporting but threatened, and impaired for one or more uses. Figures 2 and 3 depict use attainment in the basin. As found in previous years' monitoring results, the highest percentage of use impairment was found for the primary contact recreation use (48.1 percent partial and non-support).

Compared to the targeted monitoring, the random survey approach yielded a greater percentage of waters not fully supporting aquatic life use, probably because the random survey represents many small (first and second order) streams (Table 6). With a few exceptions, mostly in the reference reach network, the targeted monitoring assessed third and higher order streams.

It is interesting to see that there is a smaller than expected increase in the number of miles assessed for aquatic life use in the Kentucky River basin in the intensive watershed monitoring as compared to the previous statewide monitoring approach. This can be explained by the use of more evaluated information in previous reports. Mileages in the current report were calculated more conservatively, and the vast majority was assessed using monitored data.

Table 4. Use Support Summary, Rivers and Streams (from targeted monitoring)

Degree of Use Support	Miles Evaluated	Miles Monitored	Miles Total
Fully Supporting All Assessed Uses	21.90	1054.65	1076.55
Fully Supporting All Assessed Uses but Threatened for at Least One Use	6.50	75.00	81.50
Impaired for One or More Uses[a]	9.10	623.50	632.60
Total Assessed	37.50	1753.15	1790.65

[a] Partially or not supporting a use

Table 5. Individual Use Support Summary (from targeted monitoring)

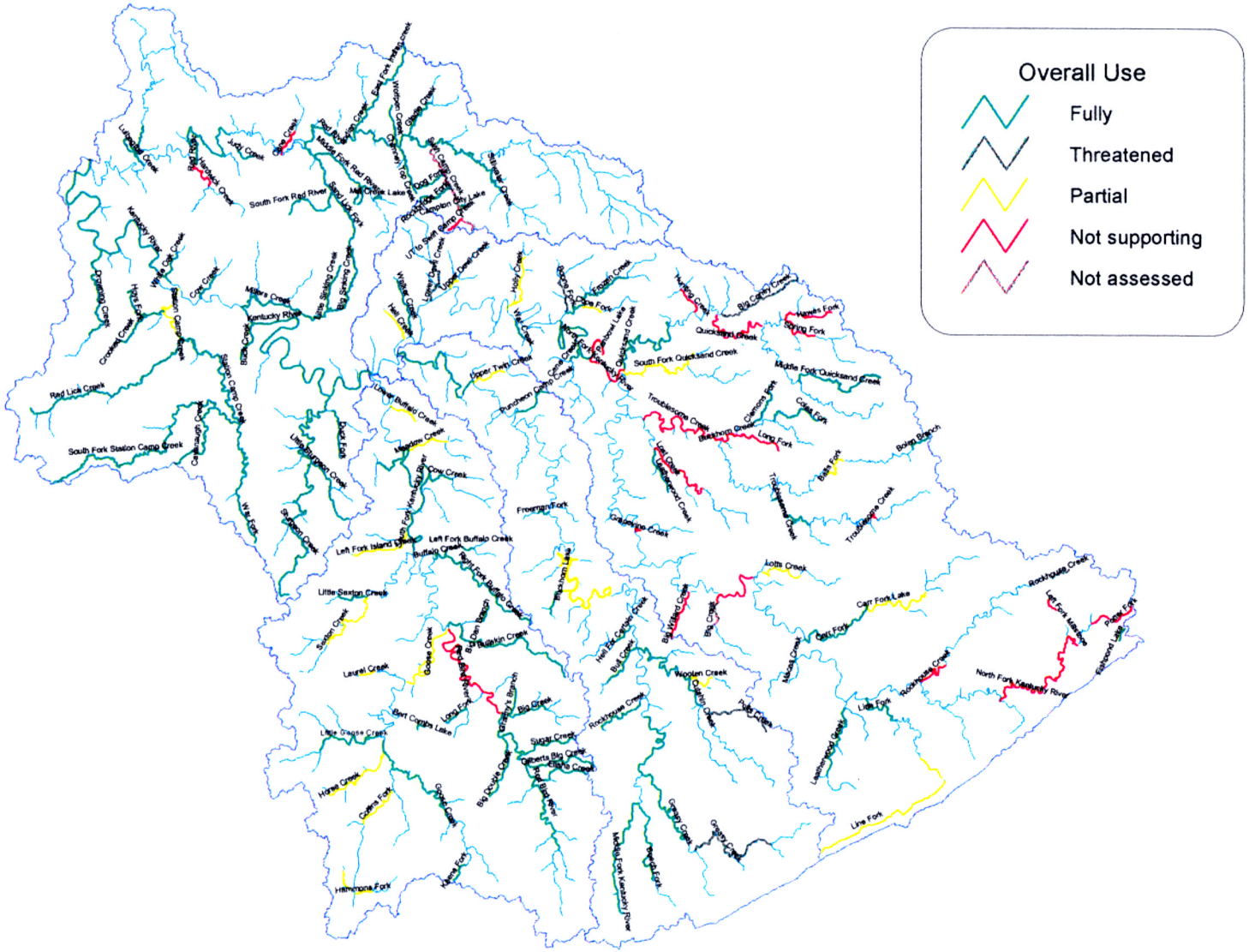
Use	Miles Assessed	Miles Fully Supporting	Miles Fully Supporting But Threatened	Miles Partially Supporting	Miles Not Supporting	Miles Not Attainable
Overall Use Support	1,790.65	1,076.55	81.50	335.00	297.60	0.00
Aquatic Life Support	1,784.65	1,320.35	81.50	283.10	99.70	0.00
Fish Consumption	464.90	464.90	0.00	0.00	0.00	0.00
Primary Contact (Recreation)	618.10	320.50	1.00	90.90	205.70	0.00
Drinking Water Supply	43.40	43.40	0.00	0.00	0.00	0.00

Table 6. A Comparison of Targeted and Random Survey Monitoring Results for Aquatic Life Use in the Kentucky River Basin

Aquatic Life Use Support	2000 Targeted Miles (percent)	2000 Random Miles (percent)	1998 Targeted Miles (percent)
Full Support	1402 (78.5)	2743 (63.0)	998 (67.5)
Partial Support	283 (15.9)	713 (16.4)	206 (13.9)
Non-Support	100 (5.6)	900 (20.7)	274 (18.5)
Total	1785 (100)	4356 (100)	1478 (100)

Figure 2. Lower Kentucky River Basin Use Support

Figure 3. Upper Kentucky River Basin Use Support



The major causes of waters not fully supporting uses were pathogens (swimming use) and siltation and habitat alterations (aquatic life use) (Table 7). The major sources were nonpoint such as agriculture, logging, and urban runoff (Table 8). Municipal point sources, resource extraction, straight pipes, and onsite waste systems (improperly operating or lack thereof) also accounted for a significant number of impaired waters.

In the Kentucky River basin, swimming use was fully supported in 52 percent (322 miles) of the 619 miles assessed for that use. A swimming advisory remained in effect in 86 miles of the upper reaches of the North Fork Kentucky River. There were no fish consumption advisories in the Kentucky River basin for the period covered by this report, so all miles (465) assessed for that use were determined to be fully supporting. However, a limited fish consumption advisory was issued in April 2000 for all waters of the state. The limited consumption advisory warns that women of child-bearing age and children less than six years old should not eat more than one fish meal a week.

Table 7. Summary of Causes Impairing Rivers and Streams

Cause/Stressor Category	Miles Impaired
Pathogens	275.60
Siltation	225.20
Other habitat alterations	135.10
Nutrients	88.70
Organic enrichment/Low dissolved oxygen	55.70
Flow alteration	49.40
Turbidity	42.10
Cause unknown	17.70
Salinity/TDS/Chlorides	11.00
pH	9.20
Exotic species	5.00
Noxious aquatic plants	4.90
Unionized ammonia	4.00
Algal growth/Chlorophyll a	2.70
Pesticides	2.30
Chlorine	2.00
Thermal modifications	1.00
Suspended solids	1.00

Table 8. Summary of Sources Impairing Rivers and Streams

Source Category	Miles Impacted
Agriculture	364.10
Grazing-related sources	225.10
Habitat modification (other than hydromodification)	152.20
Crop-related sources	118.80
Source unknown	112.70
Nonirrigated crop production	96.40
Removal of riparian vegetation	85.50
Urban runoff/Storm sewers	81.90
Bank or shoreline modification/destabilization	77.40
Silviculture	77.10
Municipal point sources	73.20
Pasture grazing - riparian and/or upland	72.00
Land disposal	66.70
Resource extraction	54.30
Harvesting, restoration, residue management	52.40
Onsite wastewater systems (septic tanks)	52.00
Surface mining	47.50
Inactive mining	45.60
Abandoned mining	43.10
Subsurface mining	42.10
Major municipal point source	26.90
Package plants (small flows)	24.00
Construction	21.40
Natural sources	19.60
Hydromodification	19.20
Highway/Road/Bridge runoff	12.80
Intensive animal feeding operations	12.20
Inappropriate waste disposal/Wildcat dumping	10.00
Erosion and sedimentation	9.60
Industrial point sources	8.00
Highway/Road/Bridge construction	7.70

Table 8. (Cont.)Summary of Sources Impairing Rivers and Streams

Source Category	Miles Impacted
Upstream impoundment	6.20
Channelization	6.00
Silvicultural point sources	3.50
Petroleum activities	3.50
Pasture grazing - upland	2.80
Dredging	2.80
Land development	2.20
Minor municipal point source	2.00
Highway maintenance and runoff	1.90
Collection system failure	1.90
Seepage disposal	1.50
Other urban runoff	1.00
Specialty crop production	0.80

ORSANCO assessed uses in the 664 miles of the Ohio River main stem that forms Kentucky's northern boundary. None of these miles fully supported uses. All of the miles partially supported the fish consumption use because of limited fish consumption advisories for PCBs and chlordane in fish tissue. The swimming use was not supported in 220 miles, mainly because of combined sewer overflows during and immediately following rainfall events in and downstream of urban areas.

Individual stream assessments and a map of the assessed uses in the Kentucky River basin can be found at DOW's website at: http://water.nr.state.ky.us/2000-305b.

Lakes

Tables 9 a, b, and c present use support and trophic state of lakes. Of the 17 reservoirs monitored in the Kentucky River basin, seven were eutrophic, five were mesotrophic, and five were oligotrophic. Nine lakes fully supported uses, six partially supported uses, and two did not support uses. The most common causes were nutrients (phosphorus, nitrogen, and carbon) that eventually result in depleting or lowering dissolved oxygen in the water column below criteria levels.

Table 9a. Kentucky River Basin Lakes - Full Support

Lake	Acres	County	Trophic State	Uses
Bert Combs	36	Clay	Oligotrophic	WAH,CAH,PCR, SCR, DWS
Boltz	92	Grant	Eutrophic	WAH,PCR,SCR
Bullock Pen	134	Grant	Eutrophic	WAH,PCR,SCR,DWS
Campton	26	Powell	Oligotrophic	WAH,PCR,SCR,DWS
Corinth	139	Grant	Mesotrophic	WAH,PCR,SCR
Fishpond	32	Letcher	Mesotrophic	WAH,PCR,SCR
Owsley Fork	151.6	Madison	Oligotrophic	WAH,PCR,SCR,DWS
Reba	78	Madison	Eutrophic	WAH,PCR,SCR
Mill Creek	41	Wolfe	Mesotrophic	WAH,CAH,PCR,SCR,DWS

Table 9b. Kentucky River Basin Lakes – Partial Support

Lake	Acres	County	Trophic State	Cause of Aquatic Life Use Impairment	Source of Impairment
Buckhorn	1,230	Perry	Oligotrophic	Siltation, Low DO, nutrients	Municipal point source, Agriculture, Natural sources, Resource extraction
Carr Fork	710	Knott	Mesotrophic	Siltation, Low DO, nutrients	Resource extraction, Source unknown
Elmer Davis	149	Owen	Eutrophic	Nutrients, Low DO	Agriculture
General Butler	26	Carroll	Eutrophic	Nutrients, Low DO	Internal nutrient recycling
Stanford City	43	Lincoln	Oligotrophic	Nutrients	Source unknown
Wilgreen	139	Madison	Eutrophic	Nutrients	Land disposal, Onsite wastewater systems (septic tanks)

Table 9c. Kentucky River Basin Lakes – Non-Support

Lake	Acres	County	Trophic State	Cause of Aquatic Life Use Impairment	Source of Impairment
Herrington	2,940	Mercer/ Garrard	Eutrophic	Nutrients, Low DO	Municipal point sources, Internal nutrient recycling, Land disposal, Agriculture
Pan Bowl	98	Breathitt	Mesotrophic	Nutrients, Low DO	Land disposal, Internal nutrient recycling

Ground Water

Introduction

Kentucky's ground water is an important source of drinking water for thousands of Kentuckians. It also provides water for industrial processes and irrigation and is a significant source for stream flow. An estimated 1.28 million Kentuckians are served by 299 groundwater-supported public water systems. Ninety percent of rural Kentuckians who are not connected to public water systems rely on ground water for their drinking water and everyday use. Protection of this resource is crucial to Kentucky's economy, public health, and the environment.

Availability and Use

Potable ground water is found throughout Kentucky, although available resources vary considerably according to regional and local geology. Kentucky's groundwater resources exist in three general aquifer types:

Alluvial and Continental Deposits. These are located in the Ohio and Mississippi River valleys and in the Jackson Purchase, characterized by sand, gravel, and loess deposits.

- Support household, industrial, and agricultural uses.
- Support large public water supply use.

Karst. Approximately half of Kentucky, mainly in the Inner Bluegrass and Pennyroyal regions areas are characterized by sinkholes, sinking streams, caves and springs.

- Generally provides sufficient water for public and domestic use.
- Contains many limited length, shallow, and conduit-flow systems.

- Locally supports agriculture and industry uses.
- Supply amounts vary widely.

Fractured Bedrock. Eastern and Western coalfields - Wells are bored into fractured sedimentary rock, predominantly sandstone, and shale.

- Generally provides sufficient water for domestic use and local agricultural and small public water supply use.

In 1997, 60 percent of public water systems in Kentucky depended on ground water as a source, withdrawing more than 60 million gallons per day. The largest public water systems withdraw ground water from the sand and gravel deposits along the Ohio and Mississippi rivers and in the Jackson Purchase. Public systems in eastern Kentucky are supplied by water wells and underground mine works, and a number of systems in the Pennyroyal and Bluegrass utilize natural springs.

Households that depend on private water wells for their drinking water are most numerous in eastern Kentucky and in the Jackson Purchase; these two regions account for more than 65 percent of all new wells constructed in the state.

Contamination Issues

Groundwater quality in Kentucky is generally good. Water quality trends can be related to groundwater sensitivity and well construction. Impacts on groundwater quality from human activities occur predominantly in the most sensitive (karst) areas and result primarily from agricultural activities (Table 10 and Table 11).

Table 10. Major Sources of Groundwater Contamination

Contamination Source	Ten Highest Priority Sources (?)	Factors Considered in Selecting a Contaminant Source	Contaminants
Agricultural activities			
Agriculture chemical facilities			
Animal feedlots	?	VII	J-K
Drainage wells			
Fertilizer applications	?	VII	E (J-L)
Irrigation practices			
Pesticides applications	?	VII	A, B
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)			
Storage and treatment activities			
Land application			
Material stockpiles			
Storage tanks (above ground)			
Storage tanks (underground)	?	VII	C, D, H
Surface impoundment	?	VII	C, D, H
Waste piles			
Waste tailings			
Disposal activities			
Deep injection wells			
Landfills	?	VII	A-D, H, (J-L)
Septic systems	?	VII	E, J, K, L
Shallow injection wells			
Other			
Hazardous waste generators			
Hazardous waste sites			
Industrial facilities			
Material transfer operations			
Mining and mine drainage	?	VII	C, G, H
Pipelines and sewer lines			
Salt storage and road salting			
Salt water intrusion			
Spills	?	VII	A-E, H-L
Transportation of materials			
Urban runoff	?	VII	A-D, G, H
Small-scale manufacturing and repair shops			

Factors

I- Human health and/or environmental risk (toxicity)
II- Size of the population at risk
III- Location of the sources relative to drinking water sources
IV- Number and size of contaminant sources
V- Hydrogeologic sensitivity
VI- State findings, other findings, best professional judgement

Contaminants

A- Inorganic pesticides
B- Organic pesticides
C- Halogenated compounds
D- Petroleum compounds
E- Nitrate
F- Fluoride
G- Salinity / Brine
H- Metals
I- Radionuclides
J- Bacteria
K- Protozoa
L- Viruses
M- Other (see narrative)

All contaminants were chosen based on best professional judgement that takes into consideration all factors.

Table 11. Groundwater Contamination Summary

Source Type[a]	Sites	Sites with Confirmed Releases	Sites with Groundwater Contamination	Contaminants[b]	Information Source
NPL	19	19	19	PCBs, SVOCs, VOCs, Metals, Inorganics, Pesticides, and Radionuclides	Division of Waste Management (DWM) Superfund Branch State Superfund Section
State Sites CERCLIS	1,800	1,160	97		
Non-UST Petroleum	950	865	36	Petroleum	
UST	6,647	4,181	774	BTEX, PAH, Lead	DWM - UST Branch
RCRA	RCRA-D = 24	24	24	Organics	DWM – Solid Waste Branch
Corrective Action	RCRA-C = 63	39	39	Cyanide, PCBs, VOCs, ABNs, PAHs, Metals, and Radionuclides	DWM – Hazardous Waste Branch
DOD/DOE	6	6	6		
UIC	Class I = 1 Class II = 3,897 Class V = 467	N/A	N/A	Varied	U.S. EPA Region IV Ground Water & UIC Section

[a]**NPL** - **N**ational **P**riority **L**ist
State Sites - Includes approximately 600 sites from CERCLIS that EPA has investigated. Approximately 500 sites have been closed by EPA and referred to Kentucky's State Superfund Program
CERCLIS - **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **I**nformation **S**ystem
UST - **U**nderground **S**torage **T**ank
RCRA - **R**esource **C**onservation and **R**ecovery **A**ct
RCRA – D (Solid Waste); **RCRA – C** (Hazardous Waste)
DOD - **D**epartment **O**f **D**efense
DOE - **D**epartment **O**f **E**nergy
UIC - **U**nderground **I**njection **C**ontrol
Class I Wells: Hazardous or non-hazardous wastes injected in geologic formations capable of containing fluids.
Class II Wells: Waste fluids associated with production of oil and natural gas
Class III Wells: Non-hazardous waste injected in or above underground sources of drinking water
[b]**PCB** - Polychlorinated Biphenyl
SVOC - Semi Volatile Organic Compound
VOC - Volatile Organic Compound
BTEX - Benzene, Toluene, Ethylene, and Xylene
PAH - Poly Aromatic Hydrocarbons
ABN - Acid Base Neutral

Pesticides are a concern, especially in karst regions, which are the only areas of the state where pesticides are routinely detected in groundwater samples (Table 12). For example, atrazine has been detected in 31 percent of groundwater samples, and 1.4 percent of samples exceeded the drinking water standard for atrazine. In contrast, atrazine has been detected in only 2.8 percent of well samples, and none of those detections have exceeded the drinking water standard.

Nitrate occurrence in ground water is more widespread. The median value for nitrate in wells and springs is well below the maximum contaminant level (MCL) for nitrate in drinking water. The highest nitrate levels in Kentucky wells are associated with shallow, hand-dug wells; the lowest nitrate levels occur in deeper, drilled wells. Nitrate and bacterial contamination of wells is associated locally with ineffective onsite sewage disposal. Nitrate and bacterial, including coliform and slime, contamination is also related to improper well construction (e.g., poorly cased wells and hand-dug wells) and inadequate well maintenance.

Wells in the eastern and western coalfields and in other parts of the state locally contain high iron, manganese, and sulfur levels. Groundwater users commonly experience strong sulfur smells in their water, iron staining of appliances and laundry, and bacterial growth in the well. The occurrence of iron, manganese, and sulfur in wells is associated with bacteria and is complicated by poor well construction and improper well maintenance.

Local contamination from sites such as landfills, underground storage tanks, Superfund and hazardous waste sites remains a concern in Kentucky as well as in other states. However, no widespread impact or negative regional trends on water quality

Table 12. Groundwater Monitoring Data

			Sites				Analyses					
Monitoring Data Type	Number of Wells and Springs Used in the Assessment	Parameter Group	Non Detect	< ½ MCL	> 1/2 MCL	> MCL	Detect	Non Detect	Number of Analyses	ND < 1/2 MCL	> 1/2 MCL	> MCL
Ambient Monitoring Network	141	VOC										
		SOC										
		NO3	15	97	25	4						
	43	MTBE	43				0	73	73	0	0	0
Untreated Water Wells and Springs	4,763	NO3		3,896	668	199	199	NR	7,093	6,125	749	219
	2,630	Fluoride		2,524	90	16	16	NR	4,848	4,701	123	24
	211	MTBE					19	360	379			
Treated Water Quality Data PWS Wells and Spring	204	VOC					197	22,856	23,053	185		12
	162	SOC					55	10,532	10,585	46		9
	181	IOC					529	2,891	3,420	506		23
	281	NO3					928	0	928	780	131	17

ND = non-detect
MCL = Maximum contaminant level

resulting from waste sites have occurred in Kentucky. Disruption of groundwater use because of a contaminated release or waste facility has occurred locally, but has been uncommon.

Kentucky's ground water is an important resource for private and public drinking water, irrigation, and other agricultural and industrial uses. Ground water in Kentucky is widely available and of generally good quality. The protection of this resource is crucial to Kentucky's economy, public health, and the environment.

Ambient Groundwater Monitoring Network

Since 1995, the Kentucky Division of Water has sampled ground water at approximately 170 sites. These sites were sampled for the state's ambient groundwater-monitoring program. Monitoring sites include public and private water supplies, unregulated public access springs (i.e., "roadside springs"), and unused springs. Approximately 70 sites are sampled from one to six times per year, depending on the type of aquifer. Water quality parameters include nutrients, major inorganic ions (e.g., carbonate, sulfate, iron and manganese, chloride, sodium, calcium, and magnesium), metals, and pesticides. In addition, each year the Division of Water conducts quarterly sampling at 30 additional sites on a watershed basis, as part of an ongoing watershed initiative/319-NPS cooperative effort.

Wellhead Protection Program

State groundwater protection programs are summarized in Table 13. Kentucky's Wellhead Protection Program requires public water systems that rely on ground water to develop a wellhead protection (WHP) plan for their source water. A WHP plan is

designed to identify the recharge area of the well(s) or spring(s), identify the potential contaminant sources in the recharge area, and implement groundwater protection strategies for these areas. Wellhead protection is an integral part of Kentucky's Source Water Assessment Program (SWAP). Kentucky has been a national leader on source water protection; it was the first state in the nation to have its SWAP approved by the U.S. Environmental Protection Agency. All groundwater-dependent public water systems will have completed their wellhead protection plans by May 2003.

Groundwater Protection Plan Program

Kentucky's Groundwater Protection Plan (GPP) regulation requires entities conducting activities that have the potential to pollute groundwater to develop and implement groundwater protection plans. The GPP includes pollution prevention activities such as preventive maintenance, best management practices, spill response plans, accurate record keeping, and personnel training. Regular inspections ensure that the protective practices are in place and functioning properly. Kentucky also has an Agricultural Water Quality Program that requires all agricultural, logging, and timber operations to develop and implement best management practices in accordance with Kentucky's Agriculture Water Quality Plan to prevent pollution of the waters of the Commonwealth.

Table 13. Summary of State Groundwater Protection Programs[a,b]

Programs or Activities	Implementation Status	Responsible State Agency
Active SARA Title III Program	Continuing efforts	Department for Environmental Protection Commissioner's Office
Ambient Groundwater Monitoring System	**Continuing efforts**	**Division of Water**
Aquifer vulnerability assessment	N/A	N/A
Aquifer mapping	Continuing efforts	Kentucky Geological Survey
Aquifer characterization	Continuing efforts	Kentucky Geological Survey
Comprehensive Data Management System	Established	Division of Water
EPA-endorsed Core Comprehensive State Groundwater Protection Program (CSGWPP)	N/A	N/A
Groundwater discharge permits	Continuing efforts	Division of Water
Groundwater best management practices	Established	Division of Conservation
Groundwater legislation	Implemented	Division of Water
Groundwater classification	N/A	N/A
Groundwater Protection Program	**Established**	**Division of Water**
Groundwater quality standards	N/A	N/A
Groundwater sensitivity mapping	Complete	Division of Water
Interagency coordination for groundwater protection initiatives	Established	Interagency Technical Advisory Committee
Non-point source controls	Established	Division of Water
Pesticides State Management Plans	Established	Division of Pesticides
Pollution Prevention Program	Implementing	Division of Water
Resource Conservation and Recovery Act (RCRA) Primacy	Continuing efforts	Division of Waste Management
Source Water Assessment Program	Continuing efforts	Division of Water
State Superfund	Established	Division of Waste Management
State RCRA program incorporating more stringent requirements than RCRA primacy	N/A	N/A
State septic system regulations	Established	Cabinet of Health Services
Underground storage tank installation requirements	Established	Division of Waste Management
Underground Storage Tank Redemption Fund	Established	PSTEAF
Underground Storage Tank Permit Program	Continuing efforts	Division of Waste Management
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)	**Established**	**Division of Water**
Well installation regulations	Continuing efforts	Division of Water

[a]Shaded programs are N/A (Not Applicable) at this time

[b]Bold-faced programs are elaborated on the following pages

[c]PSTEAF – Petroleum Storage Tank Environmental Assurance Fund

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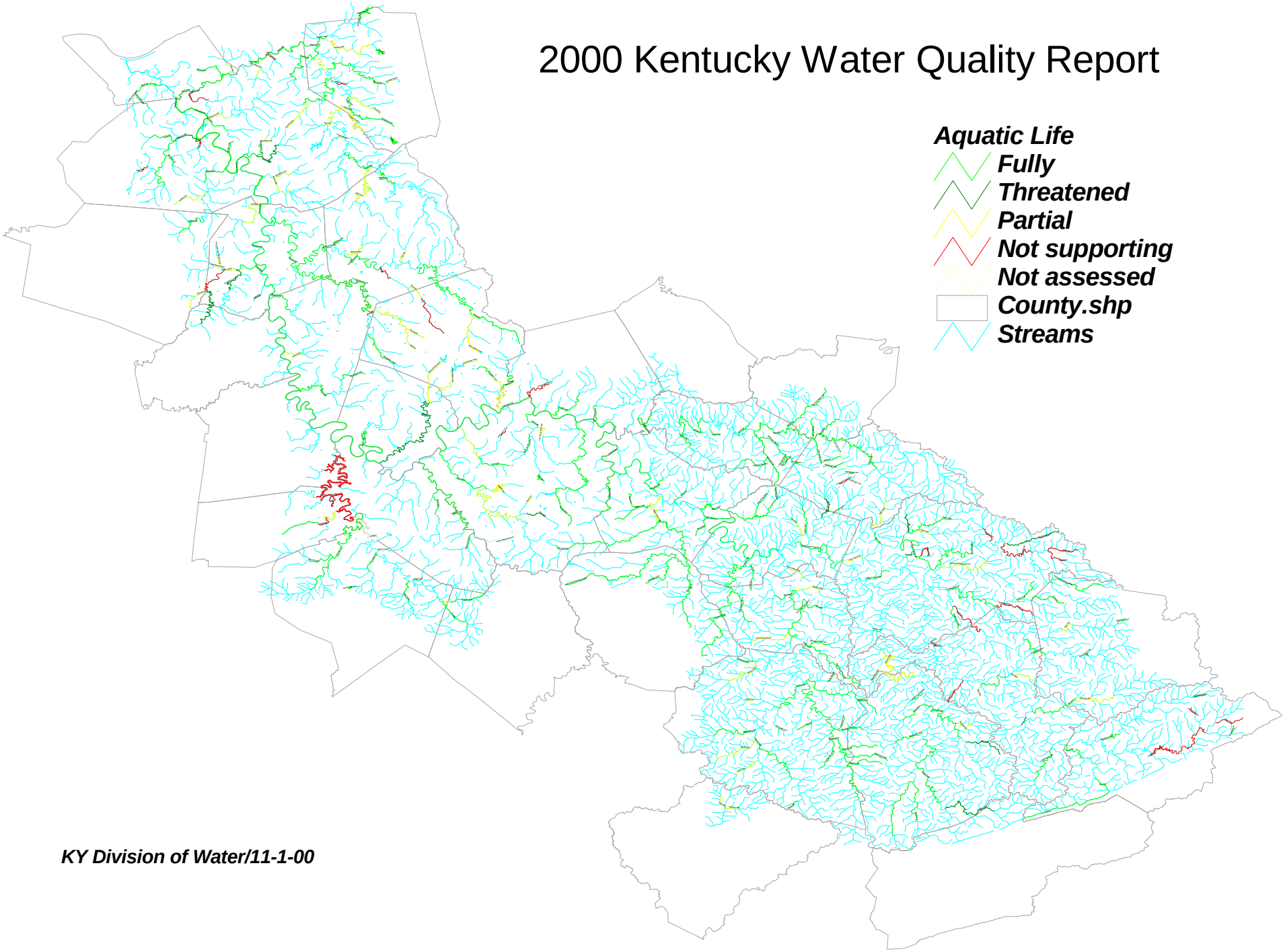

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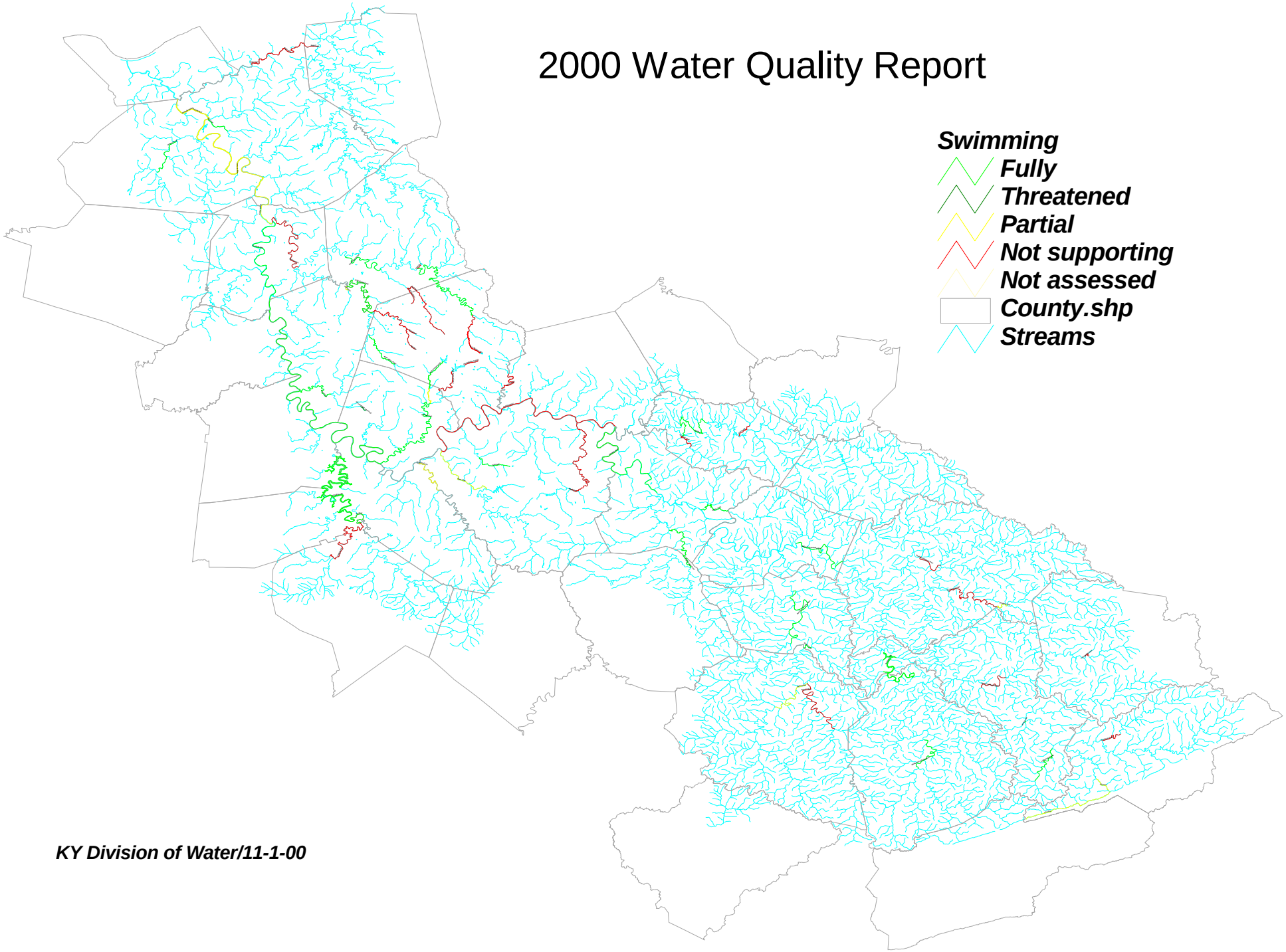

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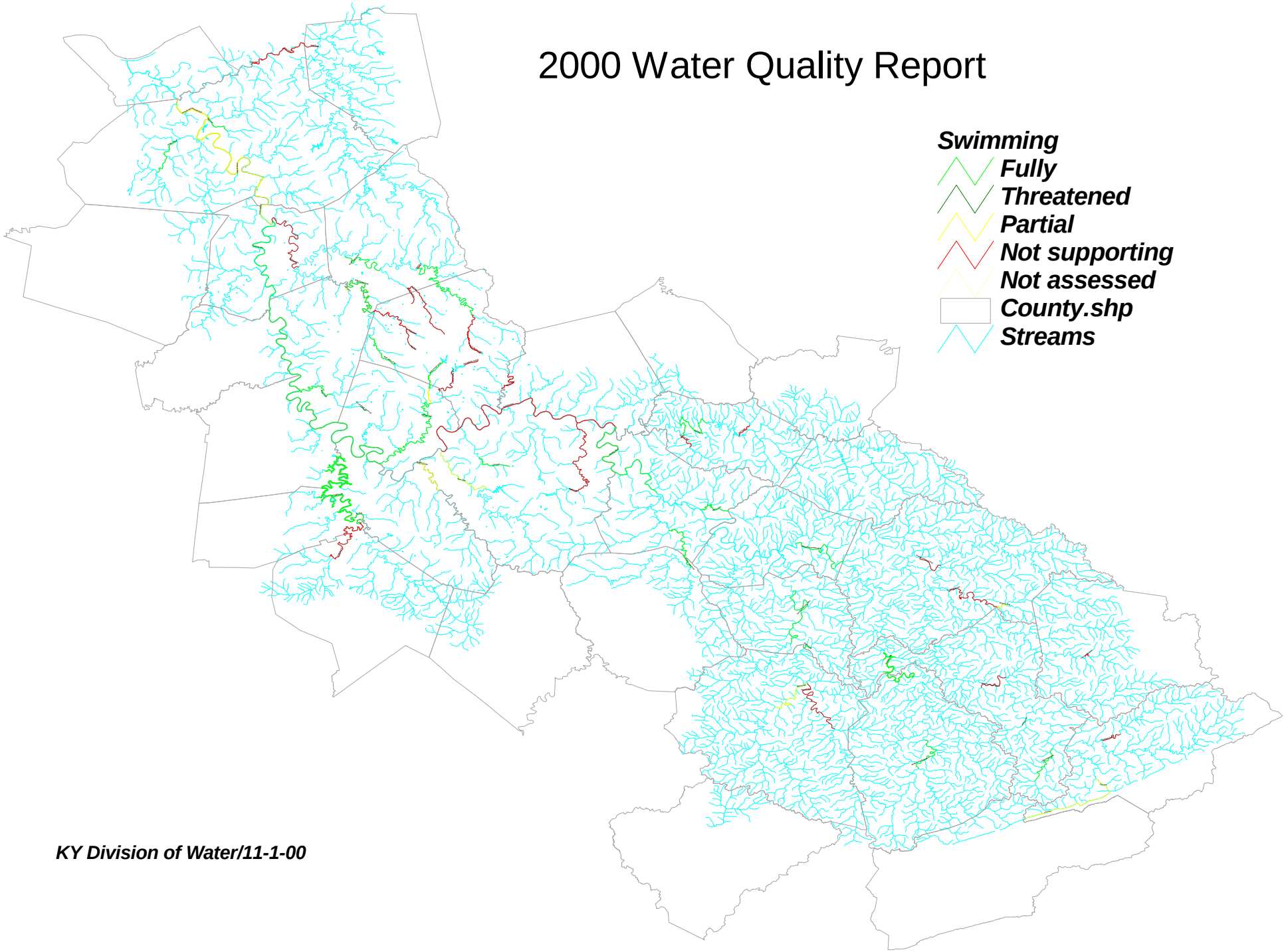

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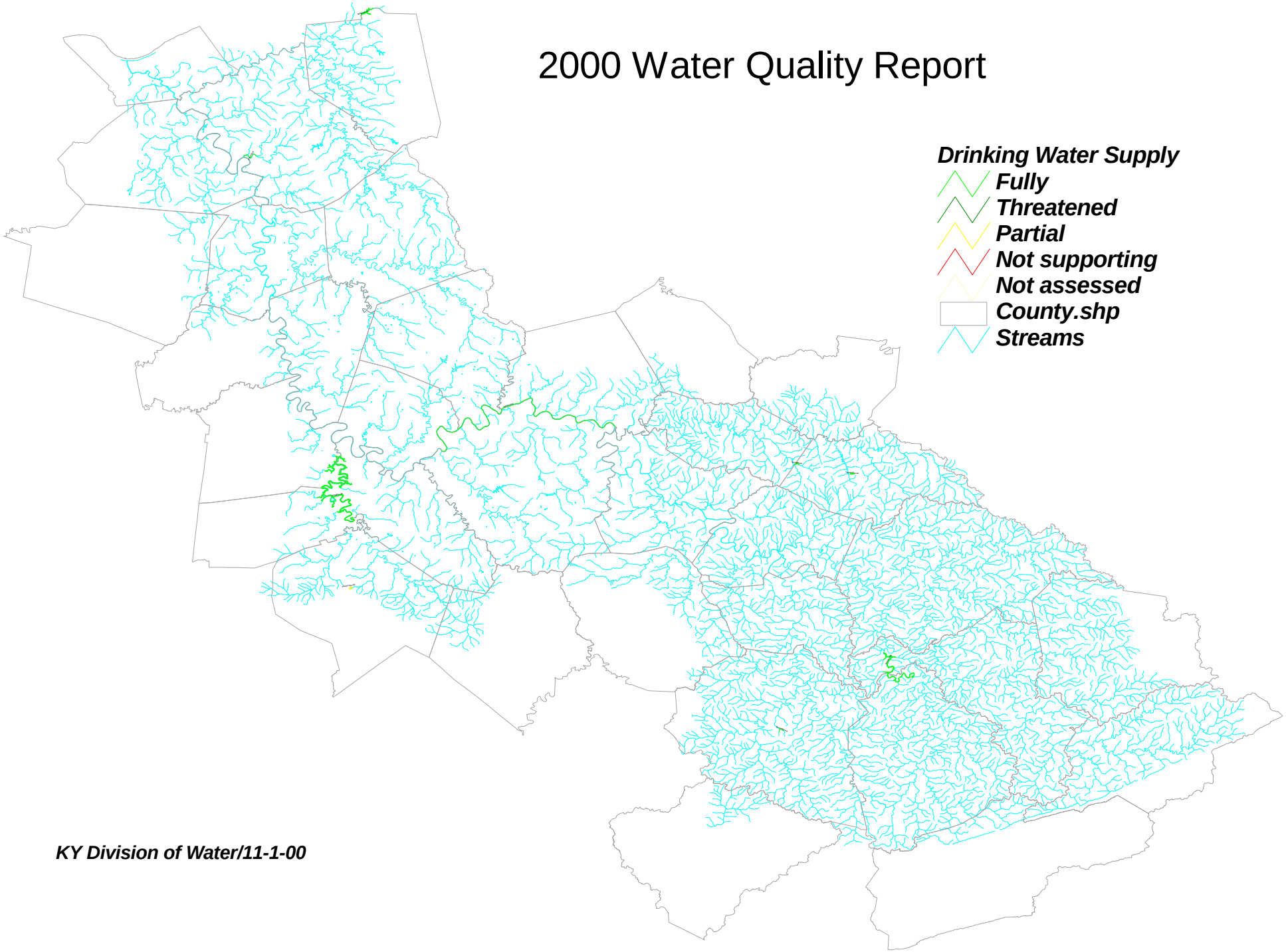

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