EXPANSION OF FECAL COLIFORM ASSESSMENTS IN THE LOWER CUMBERLAND/TENNESSEE/MISSISSIPPI RIVER WATERSHEDS

Final Project Report

For a Section 319(h)
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NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
KENTUCKY DIVISION OF WATER

from

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We would like to thank all of the many people who worked to produce this report:

- Gary Beck of Ecological Support Division at the Kentucky Division of Water worked with us at the beginning to determine the specific sampling locations.
- John Rundle was instrumental in collecting most of the bacterial samples
- Field and laboratory assistance: Kelly Bush, Mindy Wolfe, Lori Stonecipher, Scott Wright, Jeremy Rogers, Heather Richards, Suzanne Key, Ashley McKendree, Mike Clark, Christy Meredith, Jason Albritton, Carey Bush.
- Gerry Harris assisted with report preparation.
- Technical support provided by Jane Benson, Mike Busby, and Mark Drew at the Mid-America Remote Sensing Center.

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EXECUTIVE SUMMARY

Thirty-three stream and river sites in Western Kentucky were monitored for fecal coliforms from May through October 2000 to assess water quality conditions. All sites were selected by Kentucky Division of Water personnel and were located at bridges. Fecal coliform analyses followed Standard Methods, and monthly reports were provided to the Division of Water. Numbers of fecal coliform colonies generally decreased at all sites from May to October as stream flow decreased. For most of the 33 sites, fecal coliform levels appeared to be related to nonpoint surface runoff from rainfall events, particularly in May and September. In October, only 4 of 33 sites had fecal coliform colonies greater than 200. Several sites had low numbers of colonies in most months with single exceptions, e.g., West Fork of the Clarks River in June, Middle Fork Creek in September, Humphrey Creek in September, and Chestnut Creek in September. Two sites, Cooley Creek and Damon Creek, had consistently high colony counts throughout the sampling period. These sites appear to be heavily impacted by animal wastes, particularly Damon Creek, which warrants further investigation into the causes of fecal coliform contamination.

Data from this study are available from the Center for Reservoir Research (CRR) Database, and from the KDEP. CRR data are stored in dbaseIII+ and are available to researchers in most electronic formats or hardcopy.

INTRODUCTION AND BACKGROUND

The purpose of the study was to assess fecal coliform levels in selected western Kentucky streams in the lower Cumberland, Tennessee, and Mississippi River watersheds. The specific objectives were to 1) determine recreation use support in targeted NPS impacted sub-basins and compare fecal coliform (FC) levels with non-NPS impacted areas, 2) attempt to pinpoint sources of NPS impacts, and 3) aid in TMDL development. The goals were to determine water quality in the watersheds and indicate problem areas in recreational uses from point and non-point sources.

MATERIALS AND METHODS

Thirty-three stream sites were selected for monitoring (Table 1, Figure 1) by Center and Kentucky Division of Water personnel. Gary Beck (KDOW) participated in the first month's sampling. Collections were made monthly over a 3-day period (Table 2). All sites were located at bridges for ease of access. A global positioning system (Trimble model ProXR GPS) was used to record site coordinates (Table 1).

Table 1. Site locations for fecal coliform sampling during 2000.

Site	County	Latitude	Longitude
Angle Creek at Walter Harris Road	Marshall	37.0136	-88.4229
Bear Creek at Capp Springs Road	Marshall	36.8578	-88.2332
Bee Creek at North 4th Street Bridge	Calloway	36.6269	-88.3018
Blizzard Pond at 450 Bridge	McCracken	36.9676	-88.5448
Camp Creek at 450 Bridge	McCracken	36.9566	-88.5434
Central Creek at Railroad Street	Carlisle	36.8686	-89.0100
Chestnut Creek at Oak Valley Road	Marshall	36.9219	-88.3700
Clay Lick Creek at Seven Branch (Seven Ridge) Road	Livingston	37.2088	-88.2011
Clayton Creek at 121 Bridge	Calloway	36.5804	-88.2520
Cooley Creek at Hickory	Graves	36.8239	-88.6426
Damon Creek at 1836 Bridge	Calloway	36.7183	-88.4592
Dry Creek at 903 Bridge	Caldwell	37.0282	-87.9293
Duncan Creek at 1836 Bridge	Marshall	36.7579	-88.4490
East Fork Clarks River at Hwy 94 Bridge	Calloway	36.6126	-88.2884
Eddy Creek 1 at Eddy Creek Road Bridge	Lyon	37.0356	-87.9741

Eddy Creek 2 at 903 Bridge	Caldwell	37.0693	-87.9184
Fergusson Creek at Scotts Chapel Road	Livingston	37.1557	-88.3611
Hickory Creek at Vaughn Road	Livingston	37.1775	-88.2997
Humphrey Creek 1 at 1105 Bridge	Ballard	37.1166	-89.0451
Humphrey Creek 2 at Sally Crice Road Bridge	Ballard	37.1362	-89.0803
Island Creek at 60/62 Bridge	McCracken	37.0604	-88.5937
Kenady Creek at 276 Bridge	Trigg	36.9513	-87.7964
Little Cypress Creek at Little Cypress Road	Marshall	37.0173	-88.4424
Livingston Creek at 295 Bridge	Crittenden	37.1424	-88.1626
Middle Fork Clarks River at 641 Bridge	Calloway	36.5808	-88.3147
Middle Fork Creek at 348 Bridge	Marshall	36.8782	-88.4115
Richland Creek at Tiline (Vanhooser) Road	Livingston	37.1005	-88.2453
Sandy Creek at Vicksburg (Head) Road	Livingston	37.1988	-88.3039
Skinframe Creek at 1943 Bridge	Lyon	37.1466	-88.1143
Sugar Creek at Highway 70	Livingston	37.1631	-88.2692
West Fork Clarks River 3 at 348 Bridge	Graves	36.9330	-88.5444
West Fork Clarks River 7 at Tim Road Bridge	Graves	36.8378	-88.5273
West Fork Clarks River at 464 Bridge	Calloway	36.7055	-88.4613

Figure 1.

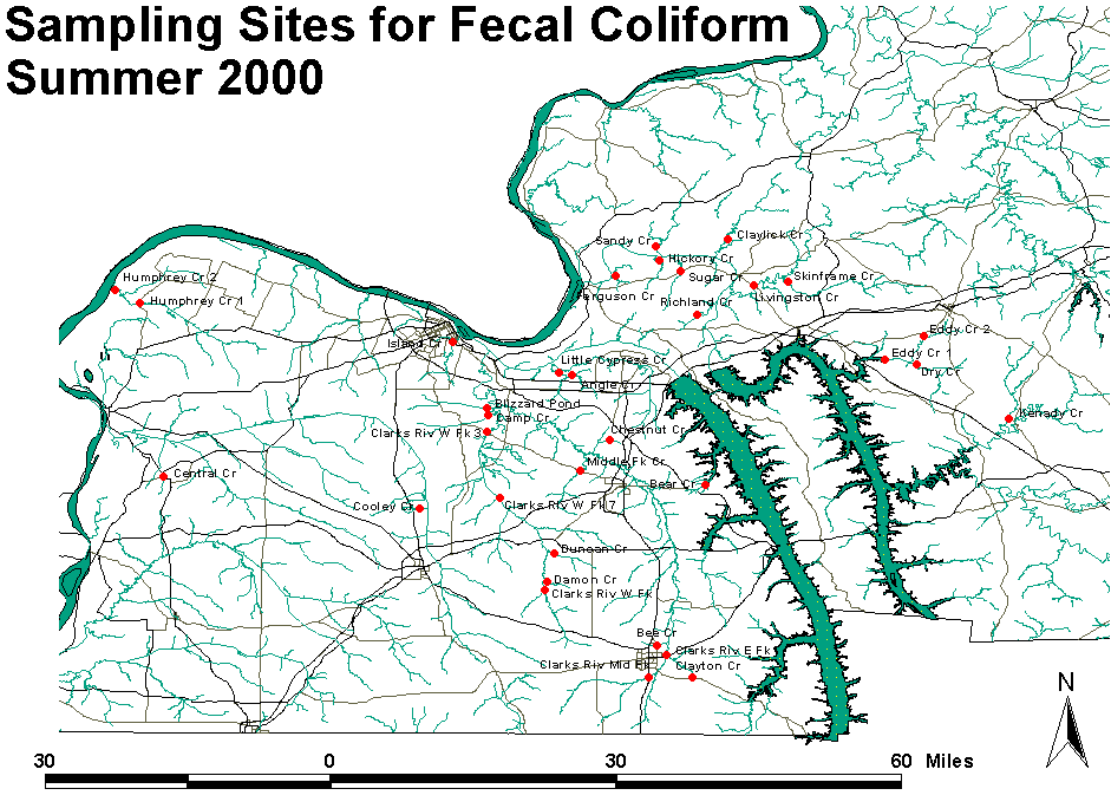


Table 2. Sampling dates for fecal coliform in 2000.

MONTH	DAYS
May	23, 24, 25
June	19, 20, 21
July	24, 25, 26
August	21, 22, 23
September	25, 26, 27
October	23, 24, 25

SAMPLING METHODS -- Water samples were collected from the bridges using a fishing pole and line onto which a 100-mL sterile coliform sampling container (Corning 1700-100) was attached. Bottles were lowered from the bridge into the water and filled, then reeled in and sealed. Samples were immediately placed into a cooler with ice for transportation to the laboratory. Duplicates were collected for 10% of the samples.

LABORATORY ANALYSIS -- Once at the laboratory, samples were stored at 4 °C until analyzed. All analyses were performed within 6 hours of sample collection. Samples were analyzed by the Fecal Coliform Membrane Filter Procedure (Section 9222 D, APHA, 1998). Dehydrated media (DIFCO) was used to ensure consistency. Blanks were run for each filtration apparatus at the beginning and end of each set of samples.

For most samples, aliquots of 0.5, 2.0 and 10.0 mL were plated. Fecal coliform density was computed from sample quantities that produced between 20 and 60 fecal coliform colonies when possible. When not possible, the dilution yielding the number closest to the ideal range was used to calculate density, and the datum was flagged in the report. Monthly reports were sent to Gary Beck, microbiologist, Kentucky Division of Water.

RESULTS AND DISCUSSION

Based on the criteria of fewer than 200 fecal coliform colonies per 100 mL for human contact, fewer than 1000 for fishing and boating, and fewer than 2000 for domestic water supply, most of the sites were within accepted public health levels except in May. There were, however, several sites and times where high fecal coliform levels occurred. The high-count occurrences appeared to be related to two factors: precipitation events and land use. Daily precipitation as recorded at the Hancock Biological on Kentucky Lake (approximately the center of the study area) was compared with fecal coliform colony counts (Figure 2).

May sampling occurred during a very rainy period, and most sites showed the effects of surface runoff into the streams, as only 14 of 33 sites had fewer than 2000 colonies per 100 mL. The Damon Creek site with a colony count of 170,000 was exceptionally high in fecal coliforms. Duncan Creek, Livingston Creek, and Sandy Creek also had high fecal coliform levels. Rainfall during the June sampling period was very spotty which was reflected in at least four high coliform colony counts: 230,000 at Damon Creek, 160,000 at Cooley Creek, 82,000 at the West Fork of the Clarks River (464 bridge), and 16,000 at Bear Creek. The July sampling period occurred several days after a light rainfall and should not have been greatly affected by surface runoff. Two sites, however did have fairly high fecal coliform colony counts: Cooley Creek at 15,000 and Damon Creek at 5,000. The August sampling period also occurred a few days after a rainfall event, and effects of runoff should have been minimal. Only Damon Creek (21,000) and Cooley Creek (1,600) had unusually high fecal coliform colony counts. For the September sampling dates, a heavy rainfall occurred early on the first day's sampling, and colony counts for that day showed the effects of surface runoff. High day two colony counts included Middle Fork Creek (460,000), Humphrey Creek 1(220,000), Chestnut Creek (93,000), Blizzard Pond

(48,000), Angle Creek (37,000), Central Creek (36,000), and Humphrey Creek 2 (34,000). Samples in October were collected after a long period of no rainfall and most sites had colony counts less than 100. The primary exception was Damon Creek; although 3 other sites had colony counts greater than 200.

CONCLUSIONS

Under base flow conditions of July through October, most of the streams sampled met either the human contact (<200 colonies per 100 mL) or fishing and boating (<1000 colonies per 100 mL) criteria. All of the streams examined are heavily influence by non-point surface runoff as seen in elevated colony counts following rain events. Even under base flow conditions, Damon Creek and Cooley Creek were consistently more contaminated. The highest level of contamination was in Damon Creek, which only on one occasion had fewer than 2000 colonies per 100 mL. This site appears to be severely affected by animal wastes through both surface runoff and direct input of fecal material. Elevated fecal coliform levels in Cooley Creek are harder to interpret although it appears that both surface runoff and direct input of fecal material may be occurring.

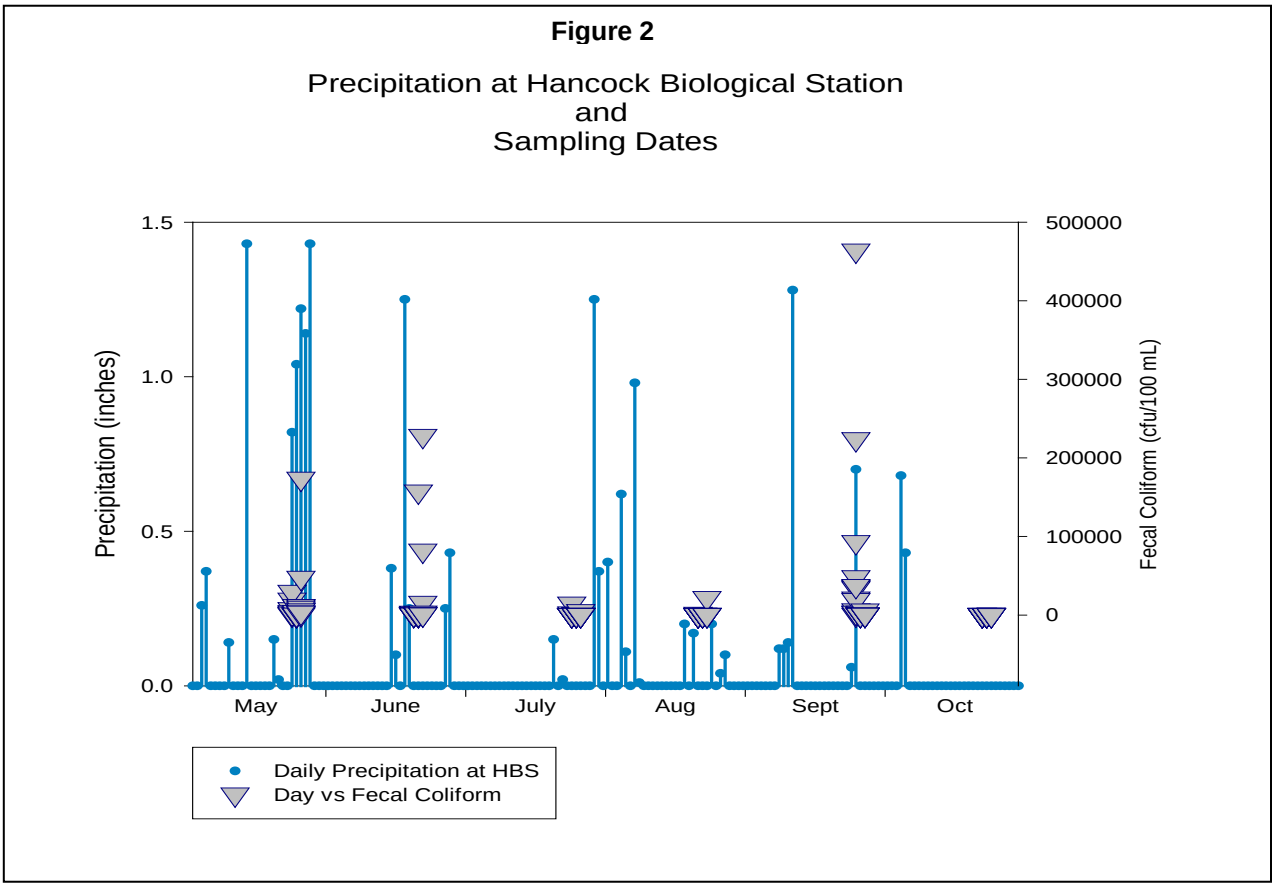
LITERATURE CITED

APHA. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed., American Public Health Association, Washington, DC.

Table 3. Fecal coliforms (colonies per 100 mL) for sites examined in 2000. Dry indicates no water in the stream at the time of sampling. Data are rounded to two significant numbers.

Site	May	June	July	Aug	Sept	Oct
Angle Creek at Walter Harris Road	530	900	50	90	37,000	160
Bear Creek at Capp Springs Road	11,000	16,000	dry	dry	dry	70
Bee Creek at North 4th Street Bridge	11,000	3,200	340	370	580	70
Blizzard Pond at 450 Bridge	700	410	350	160	48,000	30
Camp Creek at 450 Bridge	1,800	320	160	30	420	300
Central Creek at Railroad Street	2,000	2,800	500	dry	36,000	dry
Chestnut Creek at Oak Valley Road	1,400	300	10	210	93,000	10
Clay Lick Creek at Seven Branch (Seven Ridge) Rd	3,600	3,000	1,300	60	900	40
Clayton Creek at 121 Bridge	11,000	1,700	600	dry	740	dry
Cooley Creek at Hickory	<10	160,000	15,000	1,600	3,000	380
Damon Creek at 1836 Bridge	170,000	230,000	5,000	22,000	5,900	750
Dry Creek at 903 Bridge	2,600	530	80	30	130	<10
Duncan Creek at 1836 Bridge	47,000	1,500	190	100	400	70
East Fork Clarks River at Hwy 94 Bridge	9,400	800	10	30	400	10
Eddy Creek 1 at Eddy Creek Road Bridge	3,300	1,100	90	<10	1,200	10
Eddy Creek 2 at 903 Bridge	900	340	140	150	620	40
Fergusson Creek at Scotts Chapel Road	580	1,200	380	470	2,200	50
Hickory Creek at Vaughn Road	7,600	1,500	490	60	950	10
Humphrey Creek 1 at 1105 Bridge	140	950	90	100	220,000	60
Humphrey Creek 2 at Sally Crice Road Bridge	110	400	10	280	34,000	dry
Island Creek at 60/62 Bridge	1,800	2,700	260	210	21,000	40
Kenady Creek at 276 Bridge	3,200	660	250	110	250	30
Little Cypress Creek at Little Cypress Road	3,800	70	80	160	19,000	10
Livingston Creek at 295 Bridge	30,000	800	850	320	900	250
Middle Fork Clarks River at 641 Bridge	6,800	1,100	80	30	480	60
Middle Fork Creek at 348 Bridge	280	570	2,100	260	460,000	10
Richland Creek at Tiline (Vanhooser) Road	6,000	2,600	300	dry	850	<10
Sandy Creek at Vicksburg (Head) Road	20,000	1,500	430	60	190	30
Skinframe Creek at 1943 Bridge	1,900	610	640	270	390	90
Sugar Creek at Highway 70	1,600	290	20	30	3,200	10
West Fork Clarks River 3 at 348 Bridge	1,600	1,500	100	60	3,000	40
West Fork Clarks River 7 at Tim Road Bridge	1,100	2,100	150	20	6,000	40
West Fork Clarks River at 464 Bridge	7,000	82,000	150	290	200	90

Figure 2



Figures 3 – 8 on the next pages depict aerial coverage of the fecal coliform counts per month in the lower Cumberland, lower Tennessee, and Mississippi River watersheds of western Kentucky: green circles are less than

Figure 3

Fecal Coliform May 2000

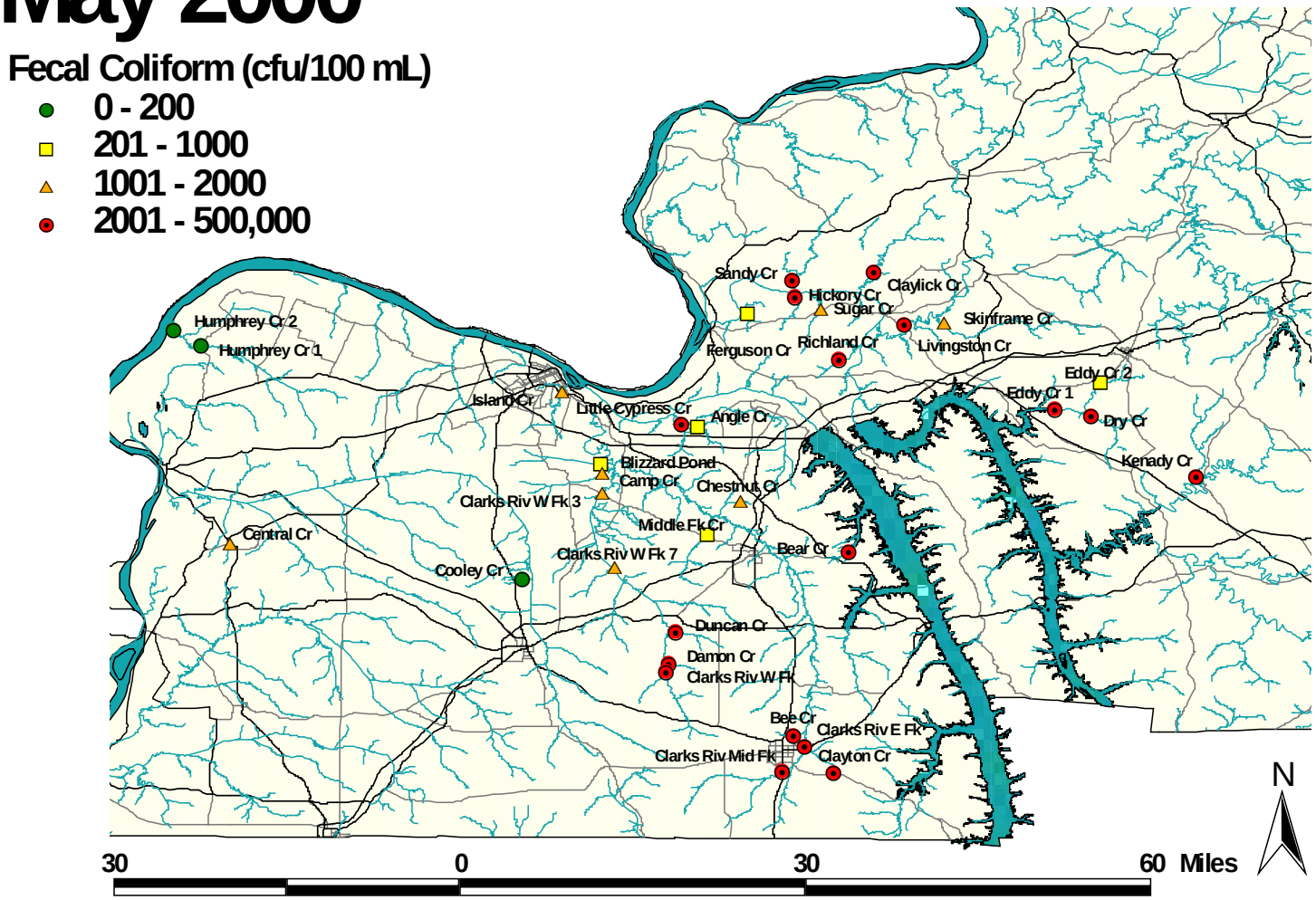


Figure 4

Fecal Coliform June 2000

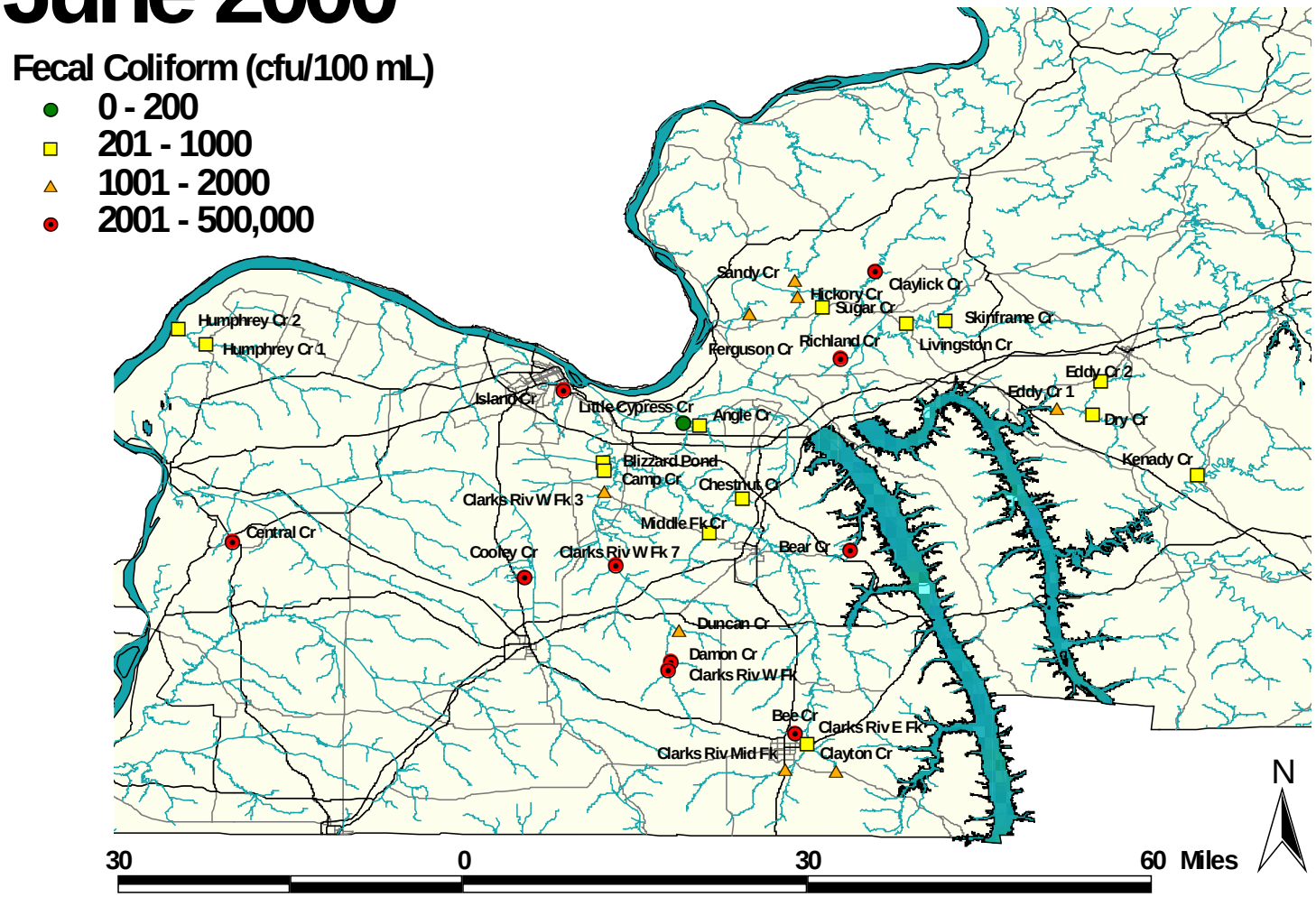


Figure 5

Fecal Coliform July 2000

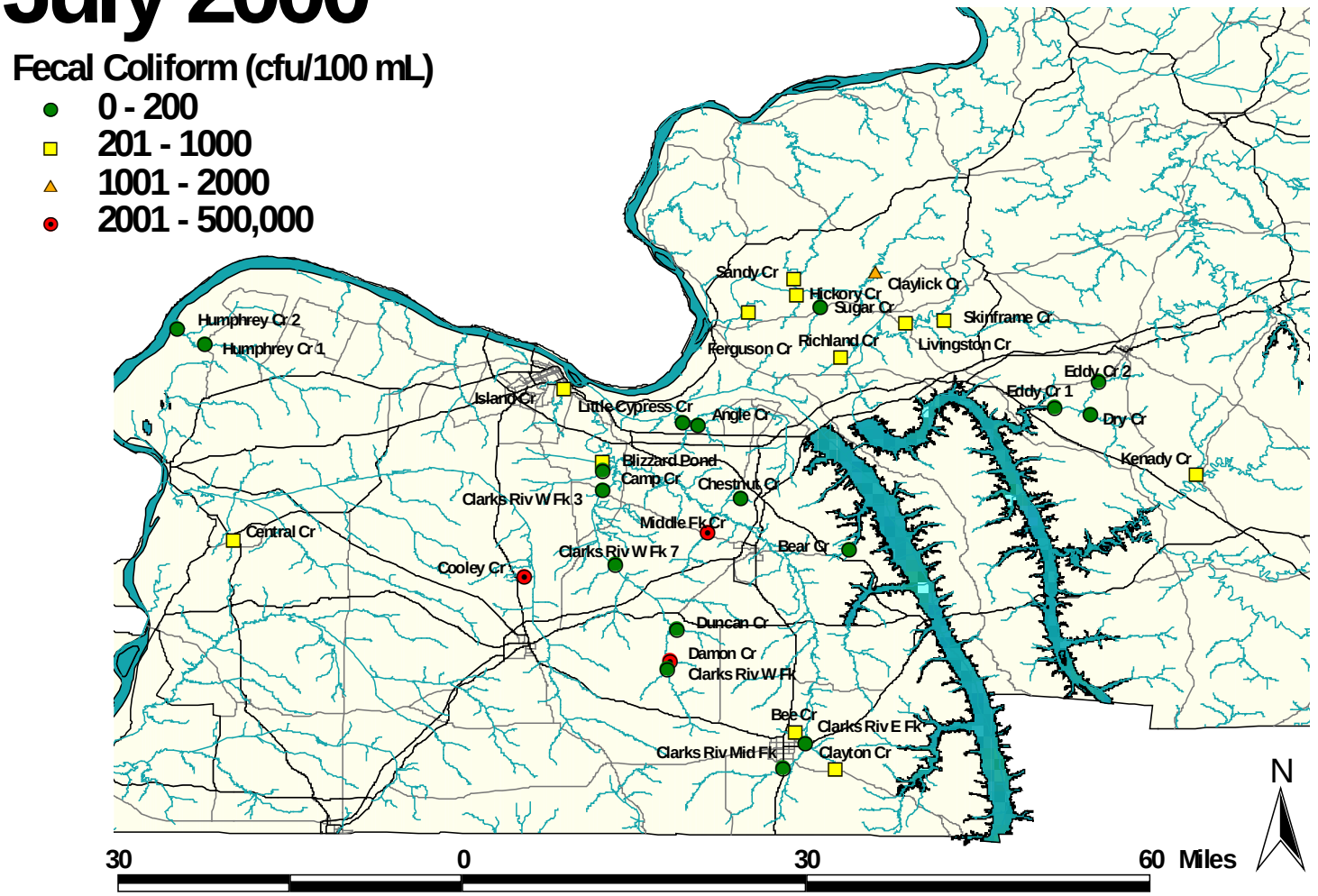


Figure 6

Fecal Coliform August 2000

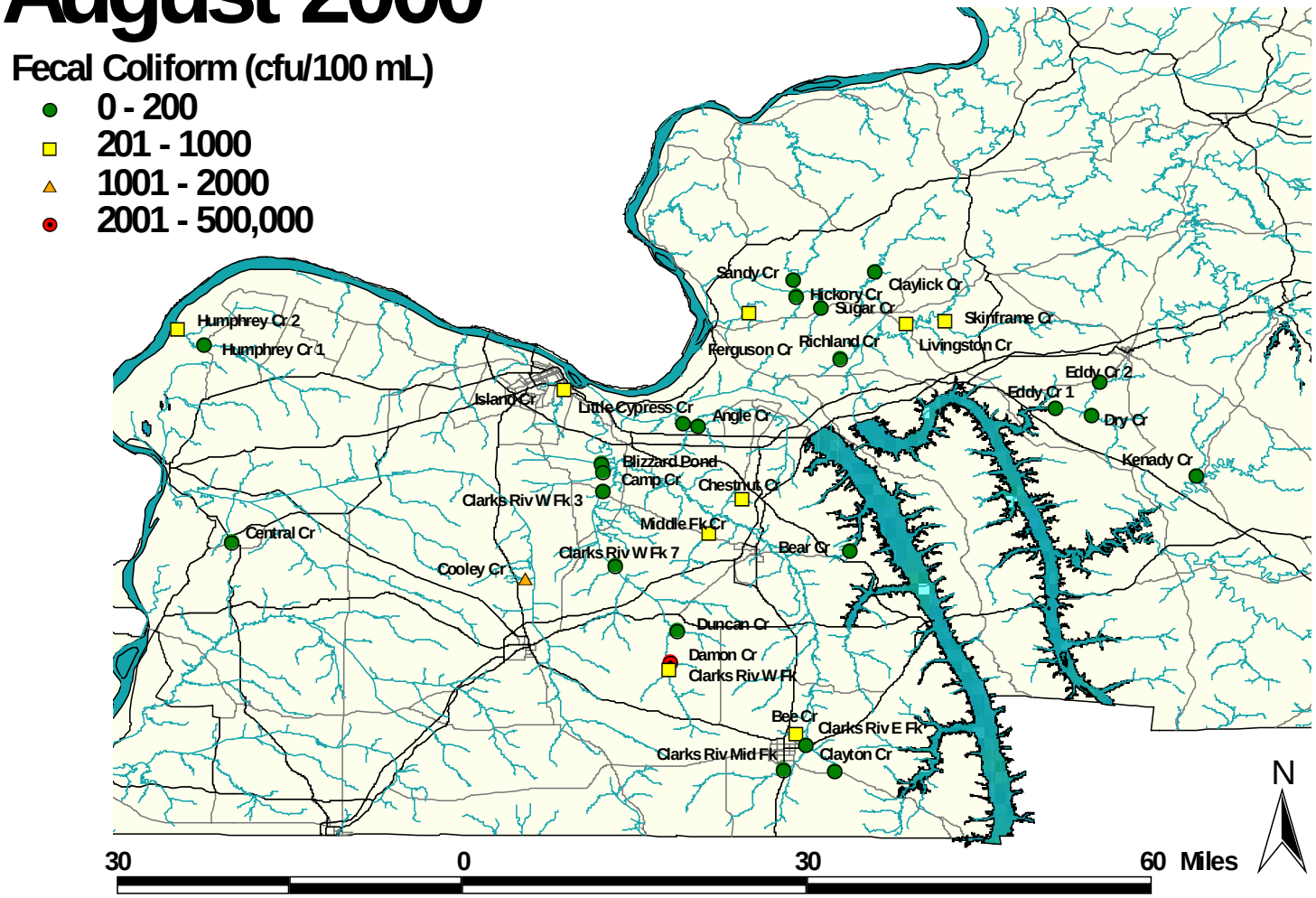


Figure 7

Fecal Coliform September 2000

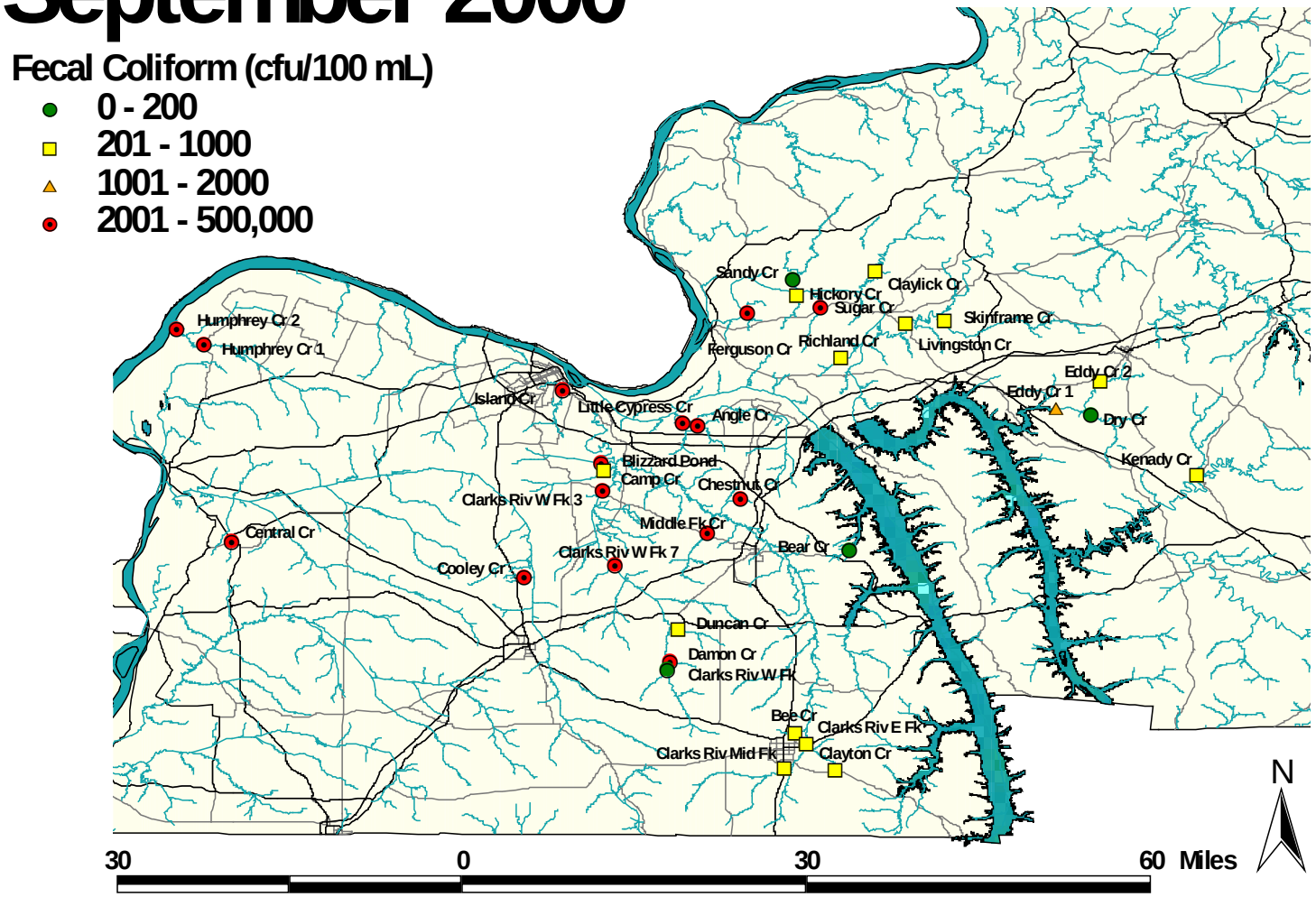
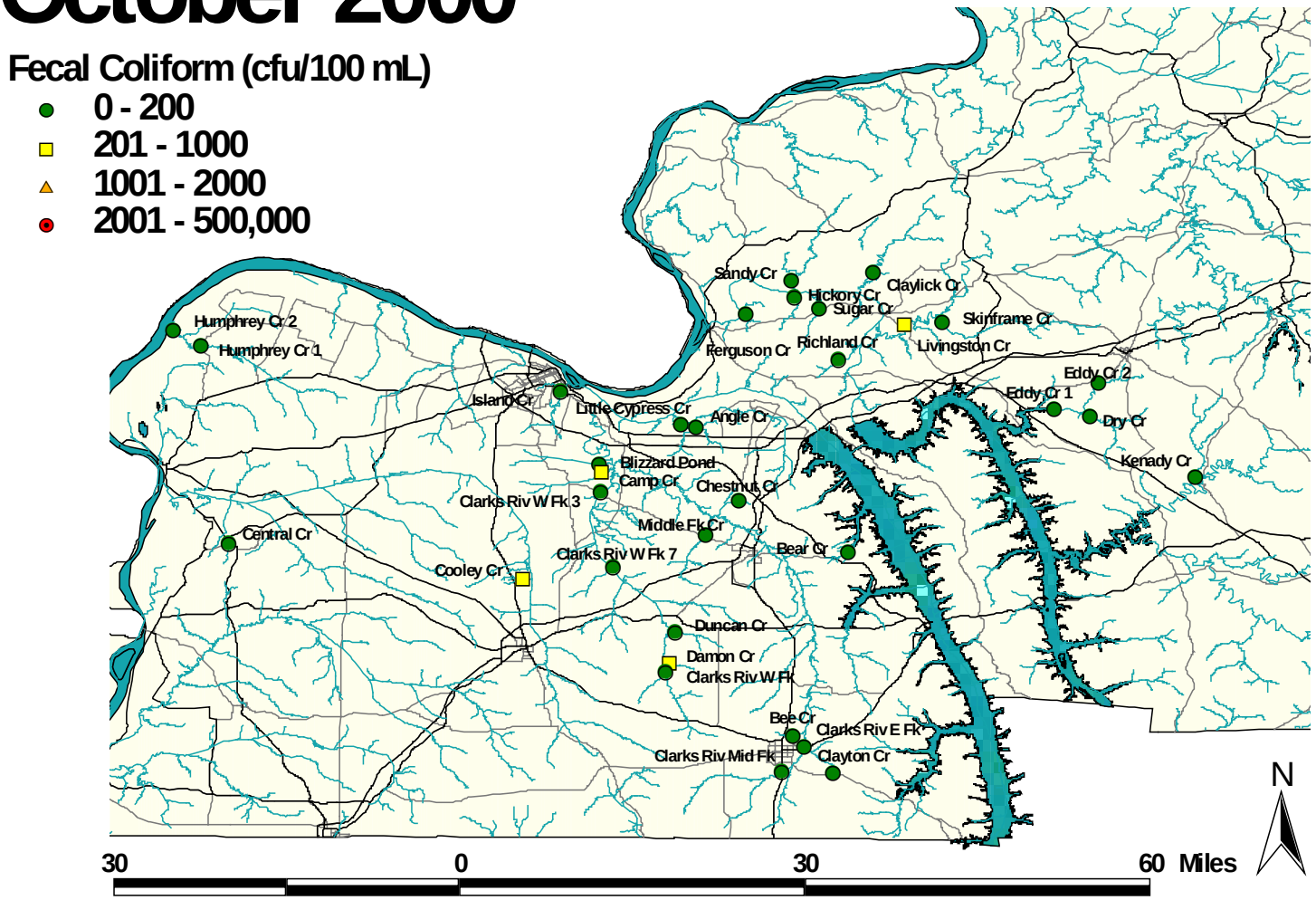


Figure 8

Fecal Coliform October 2000



2. Equipment NO EQUIPMENT WAS PURCHASED WITH PROJECT FUNDS AND THERE WAS NOT EQUIPMENT PURCHASED WITH A FAIR MARKET VALUE EXCEEDING $5,000.

APPENDIX B.

Quality Assurance Statement

Quality assurance follows the guidelines listed in EPA Requirements for Quality Assurance Project Plans, EPA AA/R-5, EPA/240/B-01/003, March 2001, Office of Environmental Information, Washington, DC. Specific guidelines are listed in Chapter 3 (QA Project Plan Elements. All components of the guidelines that apply to this project are listed below.

Sampling Process Design:

Types and numbers of samples required: one fecal coliform sample per stream site, per month during the sampling period.
Design of sampling network: Sampling design was pre-determined by KDOW based on need for information at specific sites.
Sampling locations and frequencies: Sites and frequencies are listed in Tables 1 and 2 of the final report.
Parameter of interest: Number of fecal coliform colony forming units per 100 mL.

Sampling Methods:

Water samples were collected from bridges using a fishing pole and line onto which a 100-mL sterile coliform sampling container (Corning 1700-100) was attached. Bottles were lowered from the bridge into the water and filled, then reeled in and sealed. Samples were immediately placed into a cooler with ice for transportation to the laboratory. Precautions were taken to avoid contamination of sampling containers. Duplicates were collected for 10% of the samples. Relative percent difference (RPD) was calculated and is available with the bench sheets.

Sample Handling and Custody:

Samples were stored at 4 °C until analyzed. All analyses were performed within 6 hours of sample collection. Field notes, including date and time of sample collection, sample matrix, container type, and sampler's name, were recorded on the KNREPC Chain of Custody Record form (DEP5005, Rev. 12/01/92). This form was also used to document chain of sample custody from the sampler to the laboratory technician. Chain of Custody forms are kept on file at the Hancock Biological Station.

Sample Analysis:

Samples were analyzed by the Fecal Coliform Membrane Filter Procedure (Section 9222 D, APHA, 1998). Dehydrated media (DIFCO) was used to ensure consistency. Blanks were run for each filtration apparatus at the beginning and end of each set of samples. For most samples, aliquots of 0.5, 2.0 and 10.0 mL were plated. Plates were incubated for 24 ± 2 hours in a circulating water bath at 44.5 ± 0.2 ° celcius. A NIST traceable coliform incubator thermometer was maintained to verify proper temperature.

Colonies were counted using a Ziess dissecting microscope at 15X with fiber optic lighting from above the plates. Fecal coliform density was computed from sample quantities that produced between 20 and 60 fecal coliform colonies when possible. When not possible, the dilution yielding the number closest to the ideal range was used to calculate density, and the datum was flagged in the report.

Training:

The laboratory manager who has a BA in microbiology trained all laboratory technicians. Gary Beck (Kentucky Division of Water microbiologist) inspected the laboratory and field methods prior to be beginning of the project.

Reporting:

Signed monthly reports were sent to Gary Beck, microbiologist, Kentucky Division of Water. A final report was submitted.