Final
Total Maximum Daily Load for *E. coli*
Eight Stream Segments within the Cypress Creek Watershed
Muhlenberg County, Kentucky

September, 2011

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Kentucky
UNBRIDLED SPIRIT

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Kentucky Department for Environmental Protection
Division of Water

This report is approved for release

Sandra L. Gruzesky, P.E., Director
Division of Water

9/26/11
Date

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Glossary of Acronyms

AFO	Animal Feeding Operation
AWQA	Agriculture Water Quality Act
BMP	Best Management Practices
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
cfs	Cubic feet per Second
CPP	Continuing Planning Process
f^3	Cubic Feet
HUC	Hydrologic Unit Code
KAR	Kentucky Administrative Regulations
KAWQA	Kentucky Agriculture Water Quality Authority
KDOW	Kentucky Division of Water
KISOP	Kentucky Inter-System Operational Permit
KRS	Kentucky Revised Statutes
KIA	Kentucky Infrastructure Authority
KNDOP	Kentucky No Discharge Operating Permit
KPDES	Kentucky Pollution Discharge Elimination System
KYTC	Kentucky Transportation Cabinet
L	Liter
LA	Load Allocations
MAF	Mean Annual Flow
ml	milliliter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agricultural Statistics Service
NHD	National Hydrography Dataset
NLCD	National Landcover Database
NS	Nonsupport
PCR	Primary Contact Recreation
QA/QC	Quality Assurance/Quality Control
RM	River Mile
SOP	Standard Operating Procedures
SWS	Sanitary Wastewater System
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WBID	Waterbody Identification Number
WLA	Waste Load Allocation
WQC	Water Quality Criteria
WQS	Water Quality Standard
WWTP	Wastewater Treatment Plant

Total Maximum Daily Load Synopsis

State: Kentucky
Major River Basin: Green River Basin
United States Gelogical Survey (USGS) HUC8 #: 05110006
County: Muhlenberg
Pollutant of Concern: *E. coli*

The Upper Cypress Creek watershed is located entirely in Muhlenberg County. The majority of the watershed is west of South Carrollton and Central City and north of Powderly. The Western Kentucky Parkway traverses the southern portion of the watershed while US 62 and 431 traverse the eastern portion. A map depicting the location of the Upper Cypress Creek watershed is shown in Figure S.1.

To facilitate TMDL development, KDOW staff intensively sampled the Upper Cypress Creek watershed during the 2009 Primay Contact Recreation (PCR) season (May–October) for *E. coli*. This monitoring resulted in eight PCR-impaired listings for *E. coli*. The *E. coli* impaired segments for which TMDLs are developed in this document are listed in Table S.1. The location of these impaired segments is shown on the map in Figure S.1.

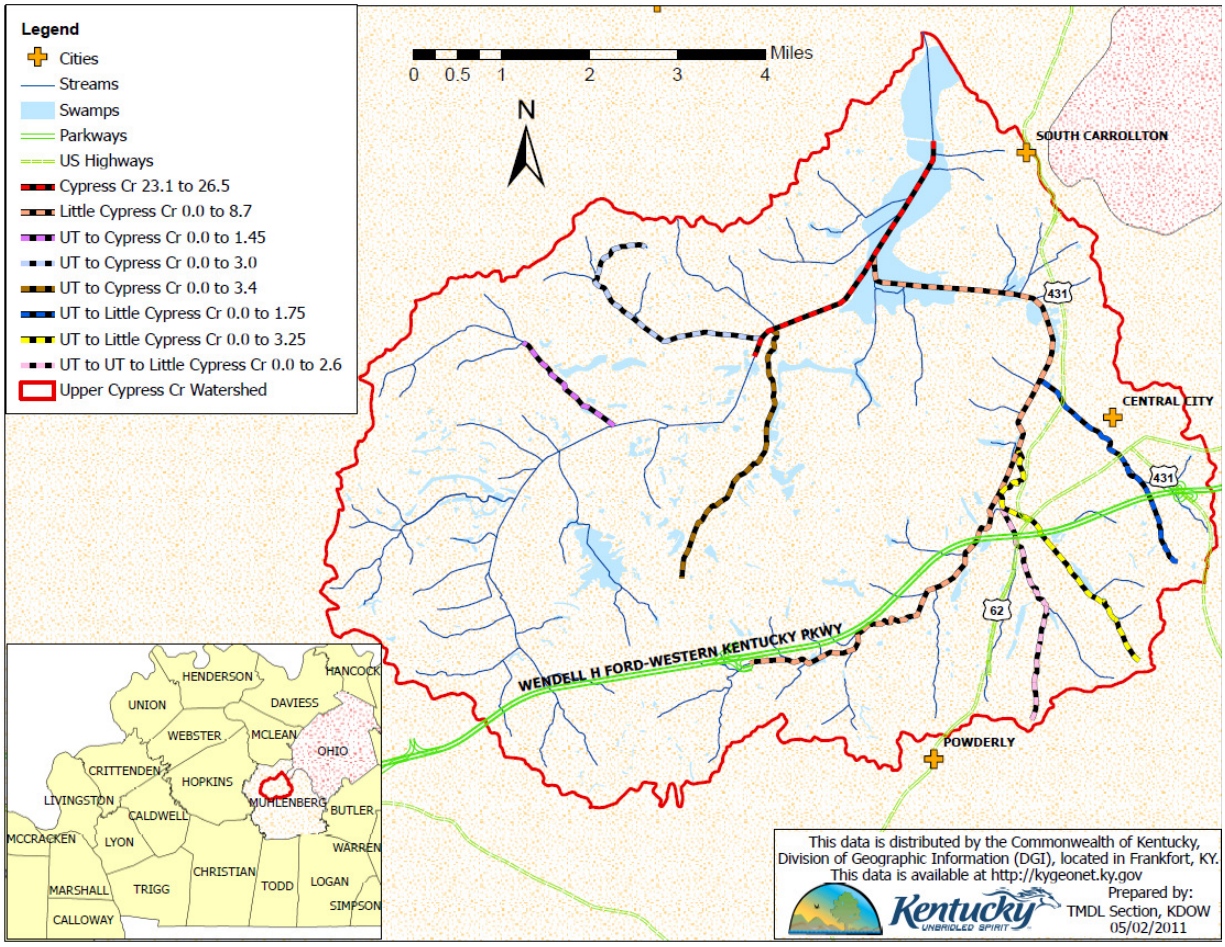

Figure S.1 Location of Upper Cypress Creek Watershed

Table S.1 *E. coli* Impaired Segments in Upper Cypress Creek River Watershed

Waterbody Name	Pollutant	County	Waterbody Identification Number	Suspected Sources	Impaired Use (Support Status)[1]
Cypress Creek 23.1 to 26.5	*E. coli*	Muhlenberg	KY490526_02	Source Unknown	PCR (NS)
Little Cypress Creek 0.0 to 8.7	*E. coli*	Muhlenberg	KY496701_01	Source Unknown	PCR (NS)
UT of Cypress Creek 0.0 to 3.4	*E. coli*	Muhlenberg	KY490526-26.1_01	Source Unknown	PCR (NS)
UT to Cypress Creek 0.0 to 1.45	*E. coli*	Muhlenberg	KY490526-28.6_01	Source Unknown	PCR (PS)
UT to Cypress Creek 0.0 to 3.0	*E. coli*	Muhlenberg	KY490526-26.3_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 1.75	*E. coli*	Muhlenberg	KY496701-3.1_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 3.25	*E. coli*	Muhlenberg	KY496701-4.0_01	Source Unknown	PCR (NS)
UT to UT to Little Cypress Creek 0.0 to 2.6	*E. coli*	Muhlenberg	KY496701-0.9-4.0_01	Source Unknown	PCR (NS)

Note: [1]NS indicates that the stream segment is nonsupport of the PCR use while PS indicates partial support.

Kentucky Water Quality Criteria (WQC) and the TMDL Endpoint (i.e. Water Quality Standard/ TMDL Target):

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR use are based on both fecal coliform and *E. coli*. Per 401 KAR 10:031:

"The following criteria shall apply to waters designated as primary contact recreation use during the primary contact recreation season of May 1 through October 31: Fecal coliform content or Escherichia coli content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for Escherichia coli."

There are insufficient *E. coli* measurements to calculate a 5-sample, 30-day geometric mean, so the instantaneous criterion of 240 colonies/100 ml was used to calculate allowable loadings to bring the watershed into compliance with the PCR designated use. An explicit Margin of Safety of 10% was applied to yield an in-stream target of 216 colonies/100 ml.

TMDL Equation and Calculations:

A TMDL calculation is performed as follows:

$$TMDL = WLA + LA + MOS$$
(Equation 1)

The WLA has three components:

$$WLA = SWS\text{-}WLA + MS4\text{-}WLA + Future\ Growth\text{-}WLA$$
(Equation 2)

Definitions:

TMDL: the WQC, expressed as a load. The WQC is defined as an instantaneous concentration of 240 colonies/100 ml for *E. coli*.
MOS: the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality.
TMDL Target: the TMDL minus the MOS.
WLA: the Wasteload Allocation, which is the allowable loading of pollutants into the stream from KPDES-permitted sources, such as SWSs and MS4s.
SWS-WLA: the WLA for KPDES-permitted sources, which have discharge limits for pathogen indicators (including wastewater treatment plants, package plants and home units). There are no pathogen-indicator KPDES-permitted outfalls in this watershed.
Future Growth-WLA: the allowable loading for future KPDES-permitted sources, including new SWSs, expansion of existing SWSs, new storm water sources, and growth of existing storm water sources (such as MS4s). Also includes the allocation for the KPDES-permitted sources that existed but were not known at the time the TMDL was written.
Remainder: the TMDL minus the MOS and minus the SWS-WLA (also equal to Future Growth-WLA plus the MS4-WLA and the LA).
MS4-WLA: the WLA for KPDES-permitted municipal separate storm water sewer systems (including cities, counties, roads and right-of-ways owned by the KYTC, universities and military bases). There are no MS4 permitted entities in this watershed.
LA: the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
Seasonality: yearly factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses.
Critical Condition: the time period when the pollutant conditions are expected to be at their worst.
MAF: the Mean Annual Flow as defined by USGS.
Adjusted MAF: the MAF plus SWS-WLA design flows.
Critical Flow: the flow used to calculate the TMDL as a load (is equivalent to the Adjusted MAF for MAF TMDLs)
Existing Conditions: the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment.

Percent Reduction: the reduction needed to bring the existing conditions in line with the TMDL Target.
Load: concentration * flow * conversion factor
Concentration: colonies per 100 milliliters (colonies/100ml)
Flow (i.e. stream discharge): cubic feet per second (cfs)
Conversion Factor: the value that converts the product of concentration and flow to load (in units of colonies per day); it is derived from the calculation of the following components: (28.31685 L/f^3 * 86400 seconds/day * 1000 ml/L)/(100ml) and is equal to 24,465,758.4.

Calculation Procedure:

1) The MOS, if an explicit value, is calculated and subtracted from the TMDL first, giving the TMDL Target;
2) Percent reductions are calculated to show the difference between Existing Conditions and the TMDL Target;
3) The SWS-WLA (if any) is calculated and subtracted from the TMDL Target, leaving the Remainder;
4) The Future Growth-WLA is calculated and subtracted from the Remainder;
5) If there is a MS4 present upstream of the impaired segment, the MS4-WLA is subtracted from the Remainder based on percent land use, leaving the LA.

A summary of TMDL allocations for the impaired segments is shown in Table S.3.

Table S.3 TMDL Summary Table

Stream Segment	Existing Load (*E. coli* colonies/ day)	**Total TMDL** (*E. coli* colonies/ day)	**MOS** (*E. coli* colonies/ day)	TMDL Target (*E. coli* colonies/ day)	% reduction	remainder (*E. coli* colonies/ day)	**Future Growth WLA**[(1)] (*E. coli* colonies/ day)	**LA** (*E. coli* colonies/ day)
Cypress Creek 23.1 to 26.5	1.70E+12	**3.89E+11**	**3.89E+10**	3.50E+11	79.3%	3.50E+11	**3.50E+09**	**3.47E+11**
Little Cypress Creek 0.0 to 8.7	1.76E+12	**1.74E+11**	**1.74E+10**	1.57E+11	91.1%	1.57E+11	**3.14E+09**	**1.54E+11**
UT to Cypress Creek 0.0 to 1.45	4.83E+10	**2.11E+10**	**2.11E+09**	1.90E+10	60.6%	1.90E+10	**9.51E+07**	**1.89E+10**
UT to Cypress Creek 0.0 to 3.0	1.89E+11	**1.88E+10**	**1.88E+09**	1.69E+10	91.1%	1.69E+10	**1.69E+08**	**1.67E+10**
UT to Cypress Creek 0.0 to 3.4	2.78E+11	**2.76E+10**	**2.76E+09**	2.48E+10	91.1%	2.48E+10	**2.48E+08**	**2.46E+10**
UT to Little Cypress Creek 0.0 to 1.75	2.07E+11	**2.06E+10**	**2.06E+09**	1.85E+10	91.1%	1.85E+10	**9.25E+08**	**1.76E+10**

Stream Segment	Existing Load (*E. coli* colonies/ day)	**Total TMDL** (*E. coli* colonies/ day)	**MOS** (*E. coli* colonies/ day)	TMDL Target (*E. coli* colonies/ day)	% reduction	remainder (*E. coli* colonies/ day)	**Future Growth WLA**[(1)] (*E. coli* colonies/ day)	**LA** (*E. coli* colonies/ day)
UT to Little Cypress Creek 0.0 to 3.25	1.94E+11	**3.29E+10**	**3.29E+09**	2.96E+10	84.7%	2.96E+10	**5.92E+08**	**2.90E+10**
UT to UT to Little Cypress Creek 0.0 to 2.6	7.67E+10	**1.64E+10**	**1.64E+09**	1.48E+10	80.7%	1.48E+10	**2.96E+08**	**1.45E+10**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

Translation of WLAs into Permit Limits

If any future SWS sources are approved in the watershed, their WLAs (from the Future Growth WLA) will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average.

1.0 Introduction

Section 303(d) of the Clean Water Act (33 U.S.C. § 1251, Section 303(d), 1972) requires states to identify waterbodies within their boundaries that have been assessed and are not currently meeting their designated uses (401 KAR 10:026 and 10:031) and that require the development of a Total Maximum Daily Load (TMDL). States must establish a priority ranking for such waters, taking into account their intended uses and the severity of the pollutant. Section 303(d) also requires that states provide a list of this information called the 303(d) list. This list is submitted to the United States Environmental Protection Agency (USEPA) during even-numbered years and each submittal replaces the previous list. The 2010-303(d) information for Kentucky can be found in the *2010 Integrated Report to Congress on the Condition of Water Resources in Kentucky Volume II. 303(d) List of Surface Waters* (Kentucky Division of Water [KDOW], 2010) and can be obtained at: http://water.ky.gov.

States are also required to develop TMDLs for the pollutants that cause each waterbody to fail to meet its designated uses. The TMDL process establishes the allowable amount (i.e. "load") of the pollutant the waterbody can naturally assimilate while continuing to meet the water quality criteria (WQC) for each designated use. The pollutant load must be established at a level necessary to implement the applicable WQC with seasonal variations and a Margin of Safety (MOS) that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. This load is then divided among different sources of the pollutant in a watershed. Information from the USEPA on TMDLs can be found at: http://www.epa.gov/owow/tmdl.

By providing bacteria allocations and reductions, this TMDL can provide an analytical foundation for identifying, planning, and implementing water quality-based controls to reduce bacteria pollution from identified sources. The ultimate goal is the restoration and maintenance of water quality in the waterbody so that designated uses are met.

2.0 Problem Definition

The Clean Water Act requires states to designate uses for surface waters within their jurisdiction. The designated uses assigned to waterbodies in Kentucky can be found in 401 KAR 10:026 and includes primary contact recreation (PCR). 401 KAR 10:001 defines PCR waters as those "waters suitable for full body contact recreation during the recreation season of May 1 through October 31." 401 KAR 10:031 establishes standards that are "minimum requirements that apply to all surface waters in the Commonwealth of Kentucky in order to maintain and protect them for designated uses." The pathogen-related WQC in 401 KAR 10:031 are based upon those proposed by USEPA (U.S. EPA, 1986).

The term pathogen refers to bacteria, viruses, or other biological agents (such as parasites) that can cause disease. Because it is currently resource intensive, difficult, and a potential health hazard to detect most pathogens in water, other organisms are used to indicate whether the presence of pathogens is likely in waters. Like USEPA's proposed criteria, Kentucky uses *Escherichia coli* (*E. coli*) or fecal coliform as an indicator organism of pathogens. *E. coli* and fecal coliform are found in the fecal waste of humans and warm-blooded animals (birds and mammals). The presence of these bacteria in a waterbody indicates that contamination from human or animal wastes has likely occurred and that pathogens may be present.

2.1 Watershed Description

The Upper Cypress Creek watershed is located entirely in Muhlenberg County. The majority of the watershed is west of South Carrollton and Central City and north of Powderly. The Western Kentucky Parkway traverses the southern portion of the watershed while US 62 and 431 traverse the eastern portion. A map depicting the location of the Upper Cypress Creek watershed is shown in Figure 2.1.

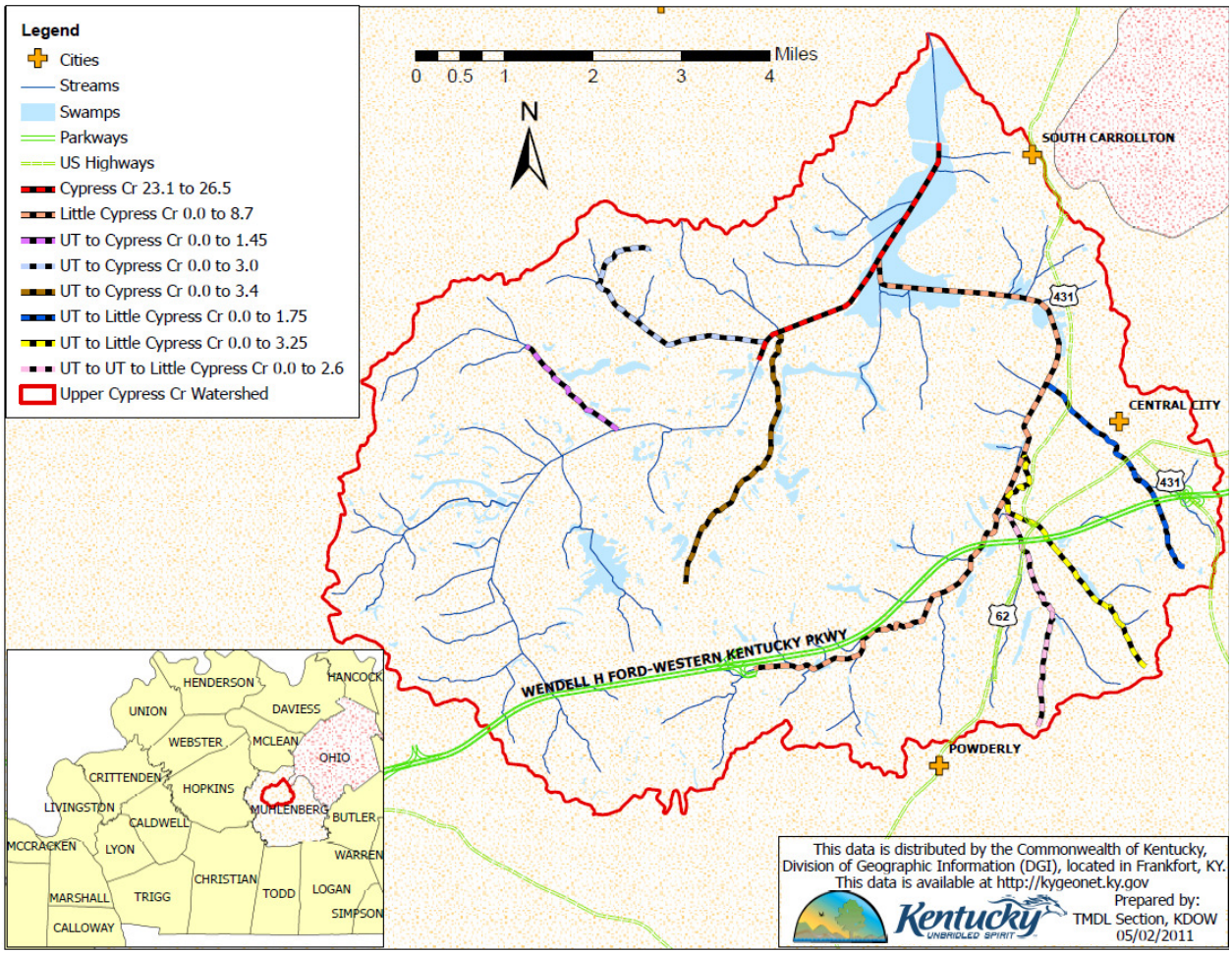

Figure 2.1 Location of Upper Cypress Creek Watershed

2.2 303(d) Listing History

Cypress Creek from river miles (RM) 23.1 to 25.4 was first listed for pathogens on the 2006-303(d) Report (KDOW, 2007). The RMs for this listing were updated to 23.1 to 26.5 on the 2008-303(d) report in order to reflect the National Hydrography Data Set and the pathogen impairment was more correctly identified as the bacteria indicator assayed, fecal coliform (KDOW, 2008).

To facilitate TMDL development, KDOW staff intensively sampled the Upper Cypress Creek watershed during the 2009 PCR season (May–October) for *E. coli*. This monitoring resulted in the identification of seven additional segments as impaired and revisal of the fecal coliform listing for Cypress Creek 23.1 to 25.4 to an *E. coli* listing on the draft 2010-303(d) Report (KDOW, 2010). The *E. coli* impaired segments for which TMDLs are developed in this document are listed in Table 2.1 while the location of these impaired segments is shown above in Figure 2.1.

Table 2.1 *E. coli* Impaired Segments in Upper Cypress Creek River Watershed

Waterbody Name	Pollutant	County	Waterbody Identification Number	Suspected Sources	Impaired Use (Support Status)[1]
Cypress Creek 23.1 to 26.5	*E. coli*	Muhlenberg	KY490526_02	Source Unknown	PCR (NS)
Little Cypress Creek 0.0 to 8.7	*E. coli*	Muhlenberg	KY496701_01	Source Unknown	PCR (NS)
UT of Cypress Creek 0.0 to 3.4	*E. coli*	Muhlenberg	KY490526-26.1_01	Source Unknown	PCR (NS)
UT to Cypress Creek 0.0 to 1.45	*E. coli*	Muhlenberg	KY490526-28.6_01	Source Unknown	PCR (PS)
UT to Cypress Creek 0.0 to 3.0	*E. coli*	Muhlenberg	KY490526-26.3_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 1.75	*E. coli*	Muhlenberg	KY496701-3.1_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 3.25	*E. coli*	Muhlenberg	KY496701-4.0_01	Source Unknown	PCR (NS)
UT to UT to Little Cypress Creek 0.0 to 2.6	*E. coli*	Muhlenberg	KY496701-0.9-4.0_01	Source Unknown	PCR (NS)

Note: [1]NS indicates that the stream segment is nonsupport of the PCR use while PS indicates partial support.

3.0 Physical Setting

The Upper Cypress Creek watershed (approximately 56 square miles in area) is located in Muhlenberg County and contains the parts of the cities South Carrollton, Central City, and Powderly along its eastern border. The Upper Cypress Creek watershed is in the Green River Basin, United States Geological Survey (USGS) 8-digit hydrologic unit code (HUC) # 05110006, of the Green/Tradewater Basin Management Unit. The system of HUCs was developed by the USGS to identify specific watersheds and includes all the land area that drains to a particular stream (USGS, 2004). The larger the HUC number, the smaller the watershed and the more specific the identification of a watershed to one particular stream. The HUC 14s that are in the Upper Cypress Creek watershed are identified in Table 3.1 and are shown in Figure 3.1.

Table 3.1 HUC 14s in Upper Cypress Creek Watershed

HUC 14	HUC 14 NAME	ACRES
05110006-090-010	Cypress Creek	2453
05110006-090-020	Little Cypress Creek	15692
05110006-090-030	Cypress Creek	18414

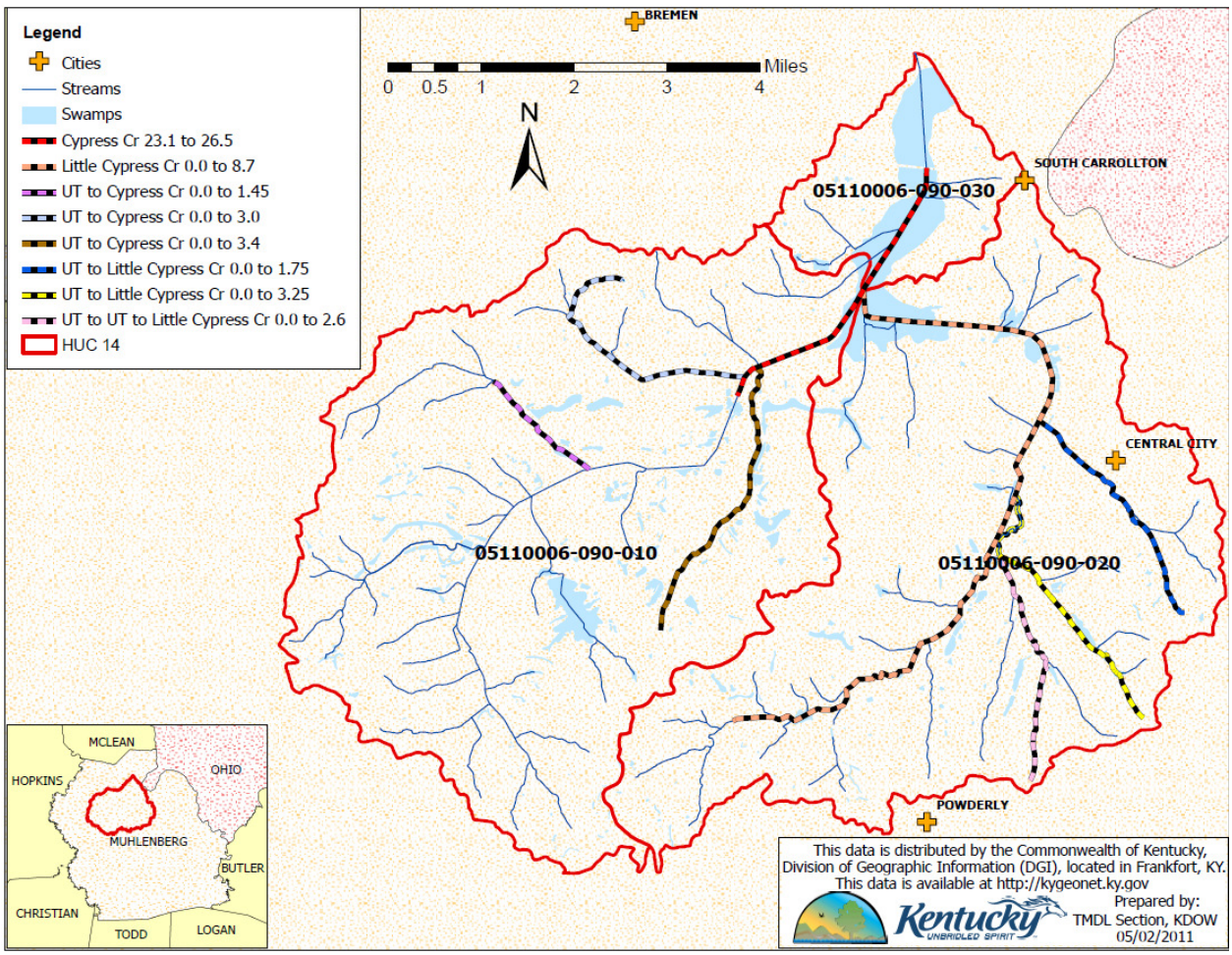

Figure 3.1 Location of HUC 14s in Upper Cypress Creek Watershed

Cypress Creek and Little Cypress Creek headwaters are to the west of the city of Powderly. From these headwaters, the streams flow northward to their confluence at river mile (RM) 24.65 of Cypress Creek. Cypress Creek continues to flow northward and east of the city of South Carrollton, out of the Upper Cypress Creek watershed.

3.1 Geology

The Upper Cypress Creek watershed is in the Western Coal Field physiographic region and the Green River-Southern Wabash Lowlands Level IV Ecoregion (Figure 3.2). Information from Woods, et. al. (2002) indicates that the Green River-Southern Wabash Lowlands are dominated by wide, poorly drained, low gradient valleys and low hills with extensive agriculture (cropland and pastureland) and coal mining (underground and surface).

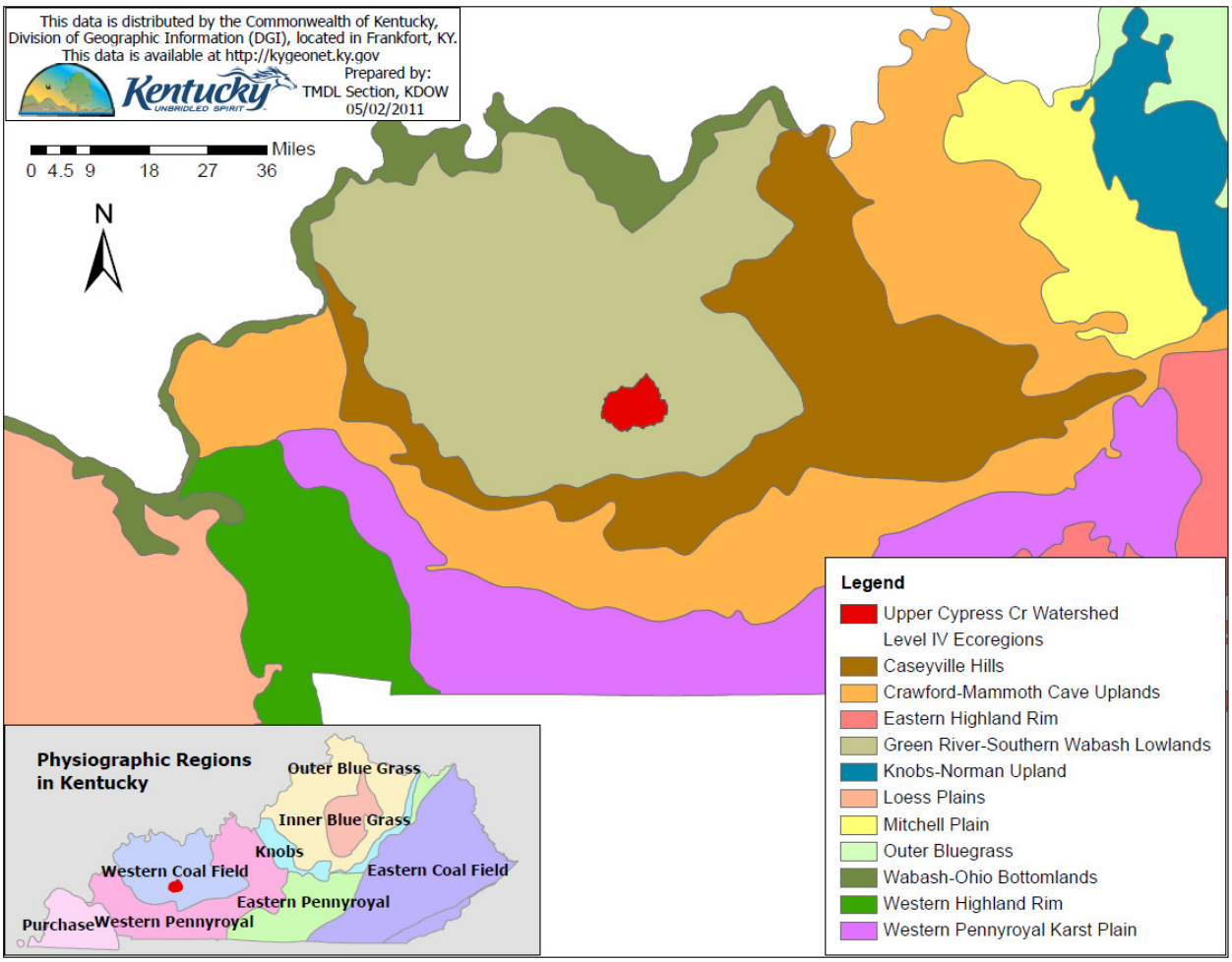

Figure 3.2 Physiographic Regions and Level IV Ecoregions

The Upper Cypress Creek watershed is underlain by Pennsylvanian strata of the Carbondale and Sturgis Formations and alluvium (Figure 3.3). The Carbondale Formation is approximately 400 feet thick and consists of siltstone, shale and some sandstone units with thin limestone and thicker coal beds, while the Sturgis Formation is approximately 2000 feet thick and consists of interbedded sandstone, siltstone, shale, limestone, and coal (McDowell, 1986). Information

about the Pennsylvanian deposits can be found at: http://pubs.usgs.gov/pp/p1151h/penn.html (McDowell, 1986).

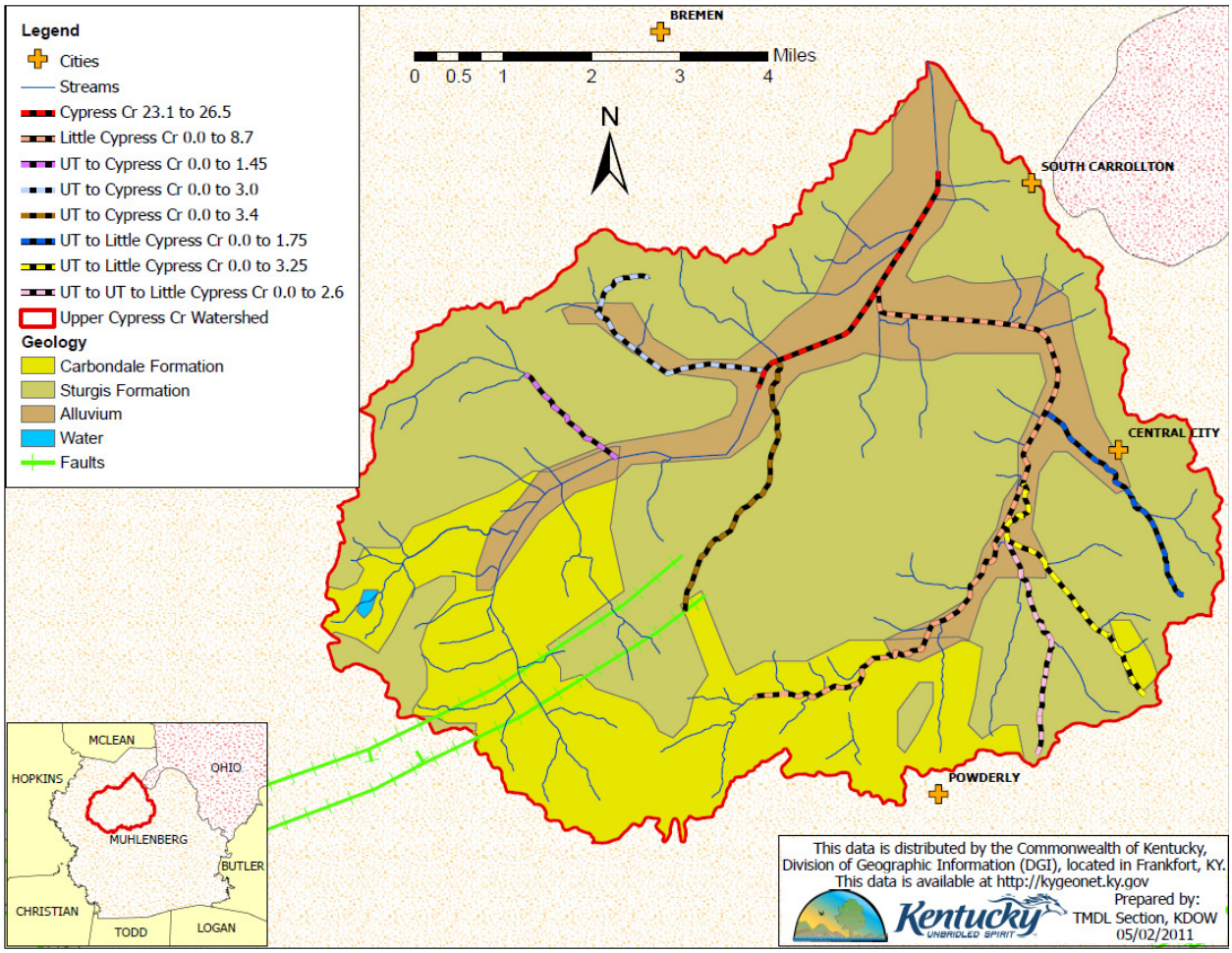

Figure 3.3 Geology in the Upper Cypress Creek Watershed

The rock formations in the watershed are not prone to karst; however a few faults are present in the watershed (Figure 3.3). The presence of faults in a watershed has the potential to influence groundwater/surface water flow. Typically, surface water flow will parallel a fracture zone for a distance before sinking off a non-soluble bedrock into a soluble limestone bedrock, near a fault. In the same way, groundwater flow may parallel a fracture zone for a distance before emerging as a spring near the contact (fault) between the soluble limestone and non-soluble bedrock. KDOW is not aware of any studies that specifically address bacteria movement along fault zones and site-specific investigation into the groundwater and bacteria flow in faults was beyond the scope of this document.

Silt loams are the predominant soil type in the Upper Cypress Creek watershed (Figure 3.4). Once deposited on or in soils, enteric bacteria can die-off or re-grow. A review of factors important in the survival of enteric bacteria in soils showed, in general, longer bacteria survival time with greater soil moisture content (survival of days in dry soils versus longer than 1.5 months in wet soils), lower temperatures (with a doubling of the die-off rate for each 10° Celsius

increase in temperature), alkaline soils (survival of days in acidic soils versus weeks in alkaline soils, with neutral soils optimal), decreased sunlight (ultraviolet light is bactericidal), and increased organic material (a nutrient source for the bacteria) (reviewed in Gerba et. al., 1975). In soils, bacteria can adhere to soil particles, particularly clay particles, and either be retained in the soil or move with water flow via erosional processes (reviewed in Reddy, et. al., 1981). Bacteria that do not adsorb to a soil particle can remain bound to fecal waste particles and move with those particles in runoff or, rarely, be unbound in the soil pore water and move in an unbound state (reviewed in Reddy, et. al., 1981). Erosion and runoff can both move bacteria to a stream or to groundwater. Determining the fate and transport of bacteria in the soils of Upper Cypress Creek watershed was beyond the scope of this document; however information on soils can be obtained from the U.S. Department of Agriculture (USDA) Web Soil Survey at URL: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. It is known that suitability for septic tanks is very limited or not rated for the majority of soils in the watershed (Figure 3.5).

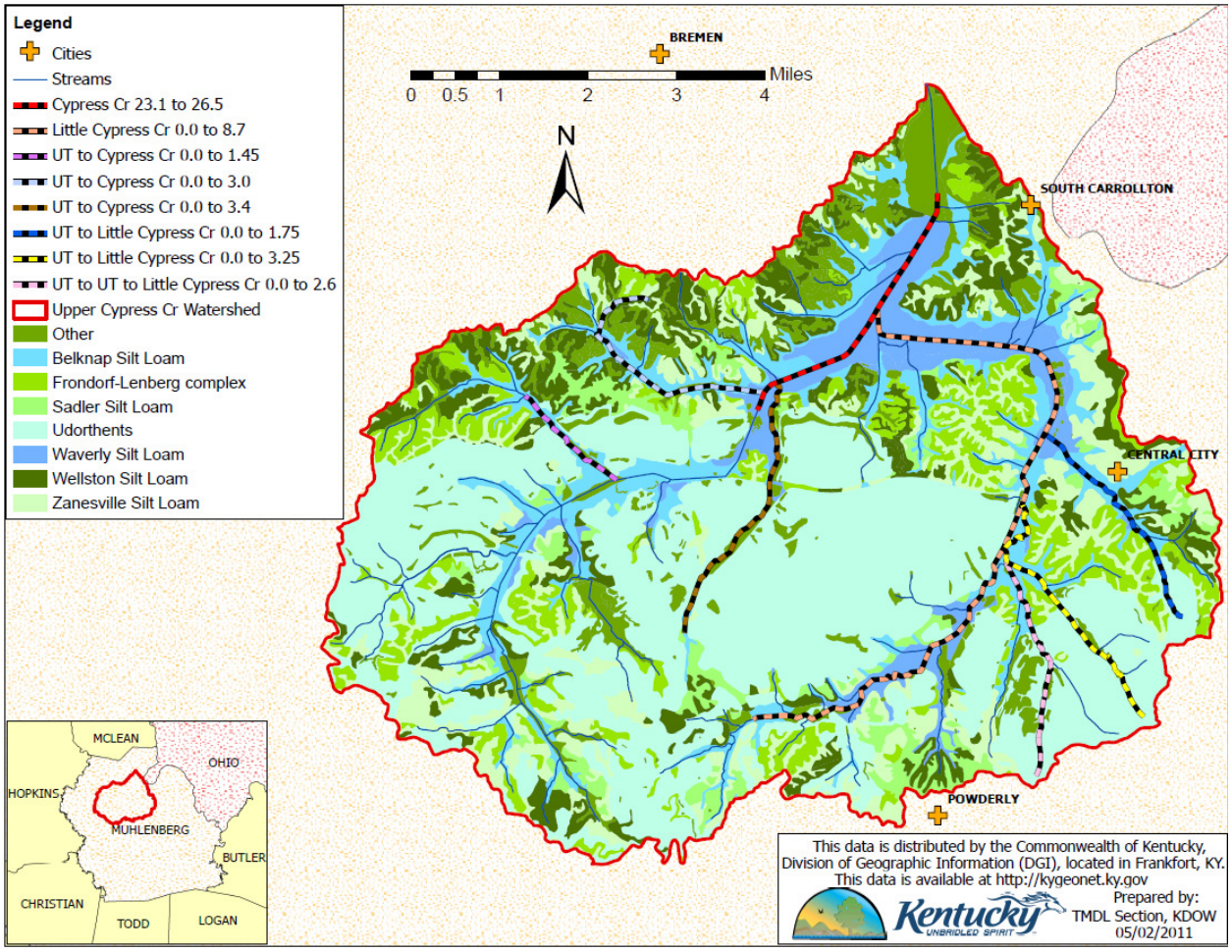

Figure 3.4 Soils in the Upper Cypress Creek Watershed

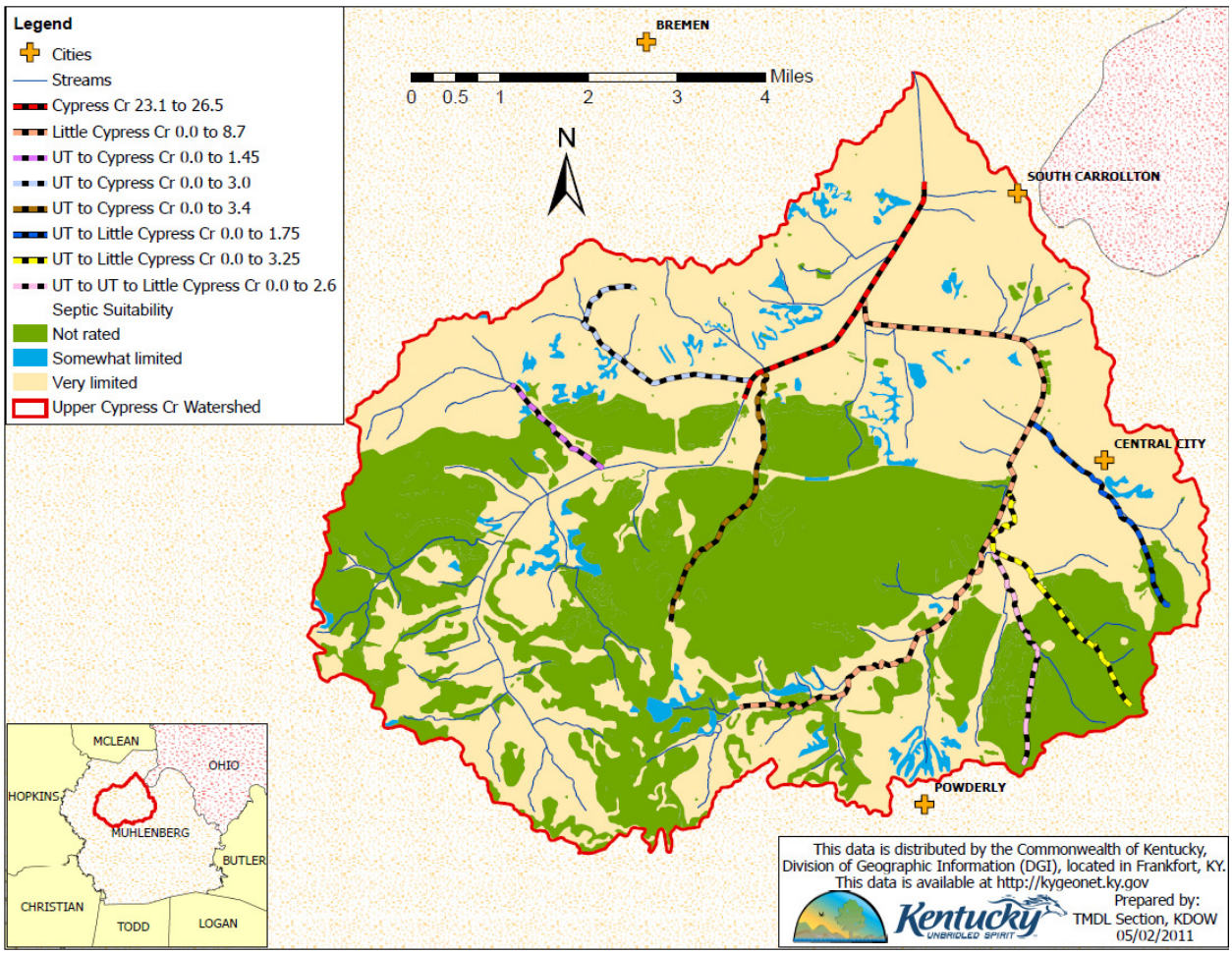

Figure 3.5 Soil Suitability for Septic Tanks

3.2 Hydrology

KDOW follows the Strahler (1952) method for stream order determination where small upstream segments with no tributaries are first order. When two first order streams merge, they form a second order stream segment; two second order segments merge to form a third order segment; and so on. In this method, a first order segment merging with a second order segment results in a continuation of the second order segment; order only increases when segments with the same order merge or if a tributary to a main segment has a larger order. First order streams tend to be small and carry little flow except during wet weather events while larger stream orders indicate larger systems with greater flow. At a 1:100 scale, Little Cypress Creek at RM 0.0 is a third order stream while Cypress Creek at RM 23.1 is fourth order (Figure 3.6).

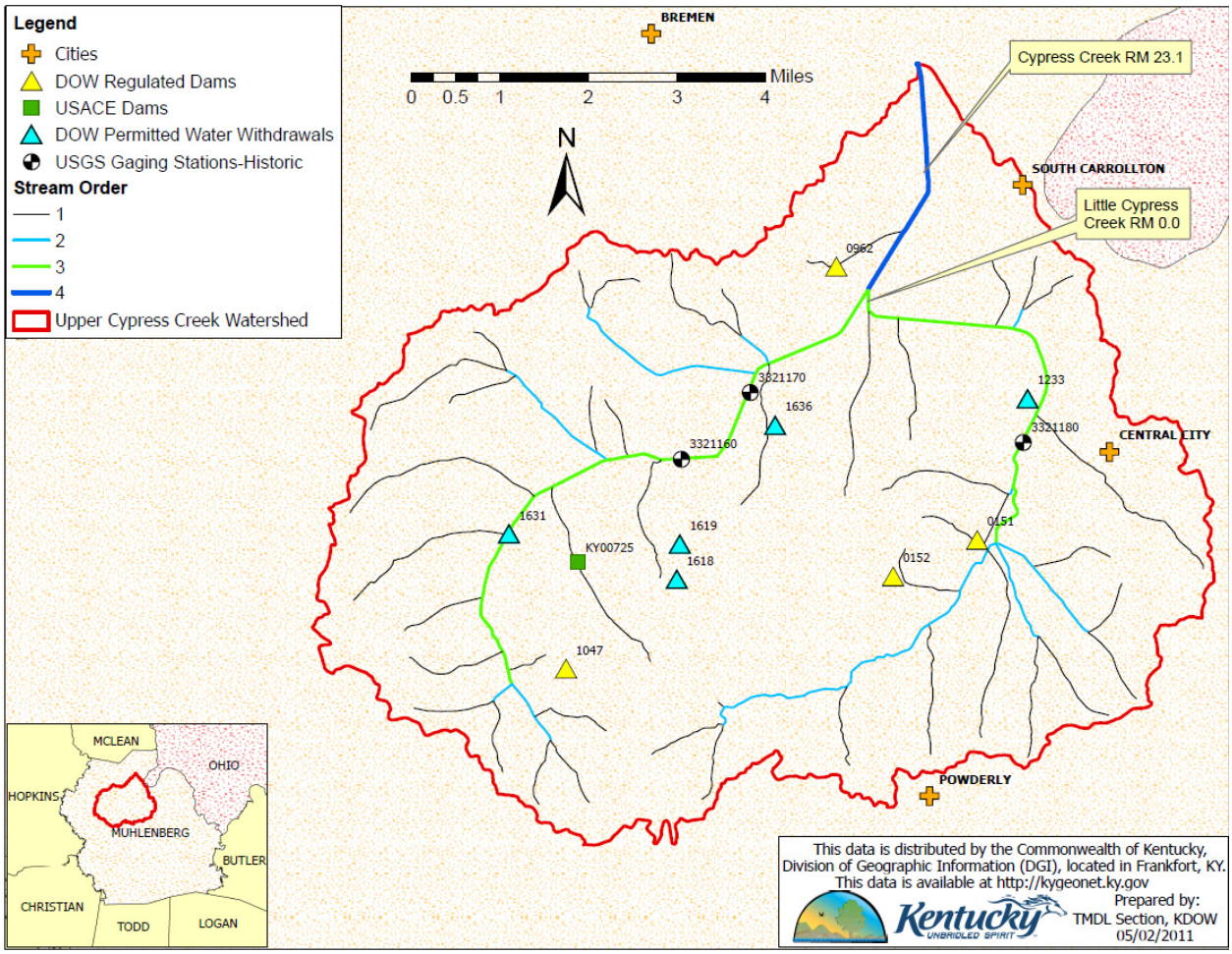

Figure 3.6 Hydrologic Features and Stream Order in the Upper Cypress Creek Watershed

There are five permitted water withdrawals in the Upper Cypress Creek watershed. Table 3.2 displays KDOW water withdrawal permit information, including permitted amount of withdrawal, while Figure 3.6 shows the location of the withdrawals.

There are four KDOW regulated dams and one United States Army Corps of Engineers (USACE) dam in the watershed. Table 3.3 shows the information for these dams while Figure 3.6 shows their location.

There are three historic USGS gages in the watershed. Table 3.4 shows the information for these gages while Figure 3.6 shows their location.

Table 3.2 KDOW Permitted Water Withdrawals in Upper Cypress Creek Watershed

Permit #	1618	1619	1631	1636	1233
Name	COVOL FUELS NO 2 MINUTEMAN PLANT	COVOL FUELS NO 2 PORTABLE ROCK CRUSHER PLANT	COVOL FUELS NO 2 LLC MINUTEMAN PLANT	COVOL FUELS NO 2 LLC MINUTEMAN PLANT	CENTRAL CITY COUNTRY CLUB
Water Source	SURFACE	GROUND	SURFACE	SURFACE	SURFACE
Latitude	37.272	37.27778	37.279008	37.2975	37.3025
Longitude	-87.21164	-87.21111	-87.246171	-87.19195	-87.14028
Use Category	MINING	MINING	MINING	MINING	COMMERCIAL
Jan Amount	0.288	3.56	2.4	3.56	0
Feb Amount	0.288	3.56	3.3	3.56	0
Mar Amount	0.288	3.56	3.1	3.56	0
Apr Amount	0.288	3.56	2.4	3.56	0
May Amount	0.288	3.56	0.73	3.56	0.1
Jun Amount	0.288	3.56	0.26	3.56	0.1
Jul Amount	0.288	3.56	0.16	3.56	0.1
Aug Amount	0.288	3.56	0.1	3.56	0.1
Sep Amount	0.288	3.56	0.15	3.56	0.1
Oct Amount	0.288	3.56	0.07	3.56	0.1
Nov Amount	0.288	3.56	0.48	3.56	0
Dec Amount	0.288	3.56	1.6	3.56	0
Description	WITHDRAWALS FROM PEABODY PONDS LOCATED IN THE KY ARMY RESERVE NATIONAL GUARD WENDELL H FORD TRAINING CENTER LOCATED IN MUHLENBERG COUNTY	WITHDRAWALS FROM FIELD OF EIGHT WELLS LOCATED IN MUHLENBERG COUNTY	WITHDRAWALS FROM MILE 30.1 OF CYPRESS CREEK IN MUHLENBERG COUNTY	WITHDRAWALS FROM RENO LAKE LOCATED IN MUHLENBERG	WITHDRAWALS FROM THE NO. 8 LAKE, WHICH IS LOCATED 850 FT NE OF RM 3.0 OF LITTLE CYPRESS CREEK

Table 3.3 Dams in Upper Cypress Creek Watershed

DAM ID	DAM NAME	LATITUDE	LONGITUDE
1047	STEWART CREEK FRS NO 2	37.257	-87.23405
0152	CENTRAL CITY RES	37.272988	-87.167324
0151	CENTRAL CITY RES DAM	37.279174	-87.1502
0962	WESTERN KENTUCKY POULTRY LAKE DAM NO 1	37.323707	-87.179925
KY00725	PEABODY COAL: NEW RIVER QUEEN SLURRY DAM	37.274444	-87.231944

Table 3.3 Historic USGS Gages in Upper Cypress Creek Watershed

STATION	NAME	LATITUDE	LONGITUDE
03321160	CYPRESS CREEK NEAR MIDLAND, KY.	37.291710	-87.211107
03321180	LITTLE CYPRESS CREEK AT CENTRAL CITY, KY.	37.2953211	-87.141107
03321170	CYPRESS CREEK NEAR CENTRAL CITY, KY.	37.30282135	-87.1972185

3.3 Land Cover Distribution

The 2001 National Land Cover Dataset (USGS, 2003) was used to determine the land cover within the Upper Cypress Creek watershed. The 2001 National Land Cover Database (NLCD) Land Cover Class Definitions are in Appendix A. Table 3.4 lists the percent land cover by class within the watershed. For the land cover tables, all forms of developed area (i.e., high-, medium- and low-intensity developed area, as well as developed open space), were aggregated, as were all forms of forest and shrubland. This was done to simplify the source analysis. Land cover is shown graphically in Figure 3.7. The land cover indicates that over half the watershed is forest and shrublands (57.5%), while 14.4% is devoted to agricultural practices and 7.9% is developed. Additionally, there are a very high percentage of wetlands (7.5%) in this watershed.

Table 3.4 Amount of Land Cover Class in Upper Cypress Creek Watershed

Land Cover	% of Total Area	Acres	Watershed Square Miles
Developed	7.9	2827	4.4
Agriculture (total)	14.4	5121	8.0
Pasture	7.7	2750	4.3
Row Crop	6.6	2371	3.7
Forest	57.5	20504	32.0
Natural Grassland	10.5	3754	5.9
Water	2.0	718	1.1
Wetland	7.5	2679	4.2
Barren	0.1	49	0.1
Total	100.0	35652	55.7

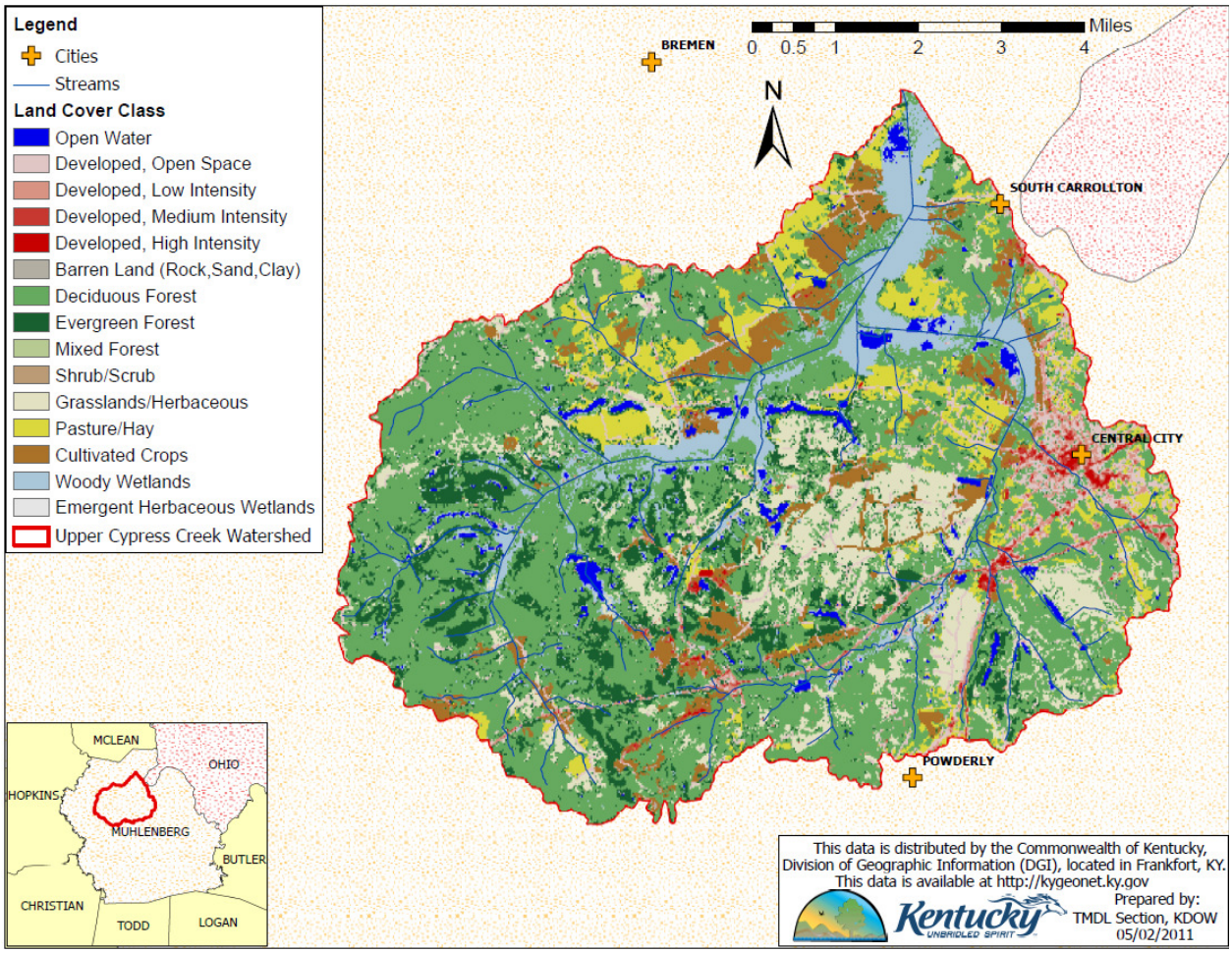

Figure 3.7 Land Cover in the Upper Cypress Creek Watershed

4.0 Monitoring

This section summarizes the recent monitoring in the Upper Cypress Creek watershed. Only bacteria sites with data that passed KDOW quality assurance procedures and validation tests are shown in the figure and summarized in the table below. Additional data that failed the sample validation process are available for some sites but are not summarized in this Section. The full data sets for each sample site are presented in Appendix B.

To facilitate TMDL development, KDOWs TMDL staff collected *E. coli* at twelve sites during the 2009 PCR season. These data are summarized in Table 4.1 while the site locations are shown in Figure 4.1. These data were used in TMDL development for the impaired segments. This monitoring effort resulted in the identification of eight stream segments as impaired (Table 4.2) and three segments as fully supporting (Table 4.3) of the PCR use for pathogen indicators. Data from sites in the fully supporting segments are presented in Appendix B. Table 4.4 indicates the site(s) used to determine the current support status of each segment and, for pathogen indicator impaired segments, the sites used in TMDL development.

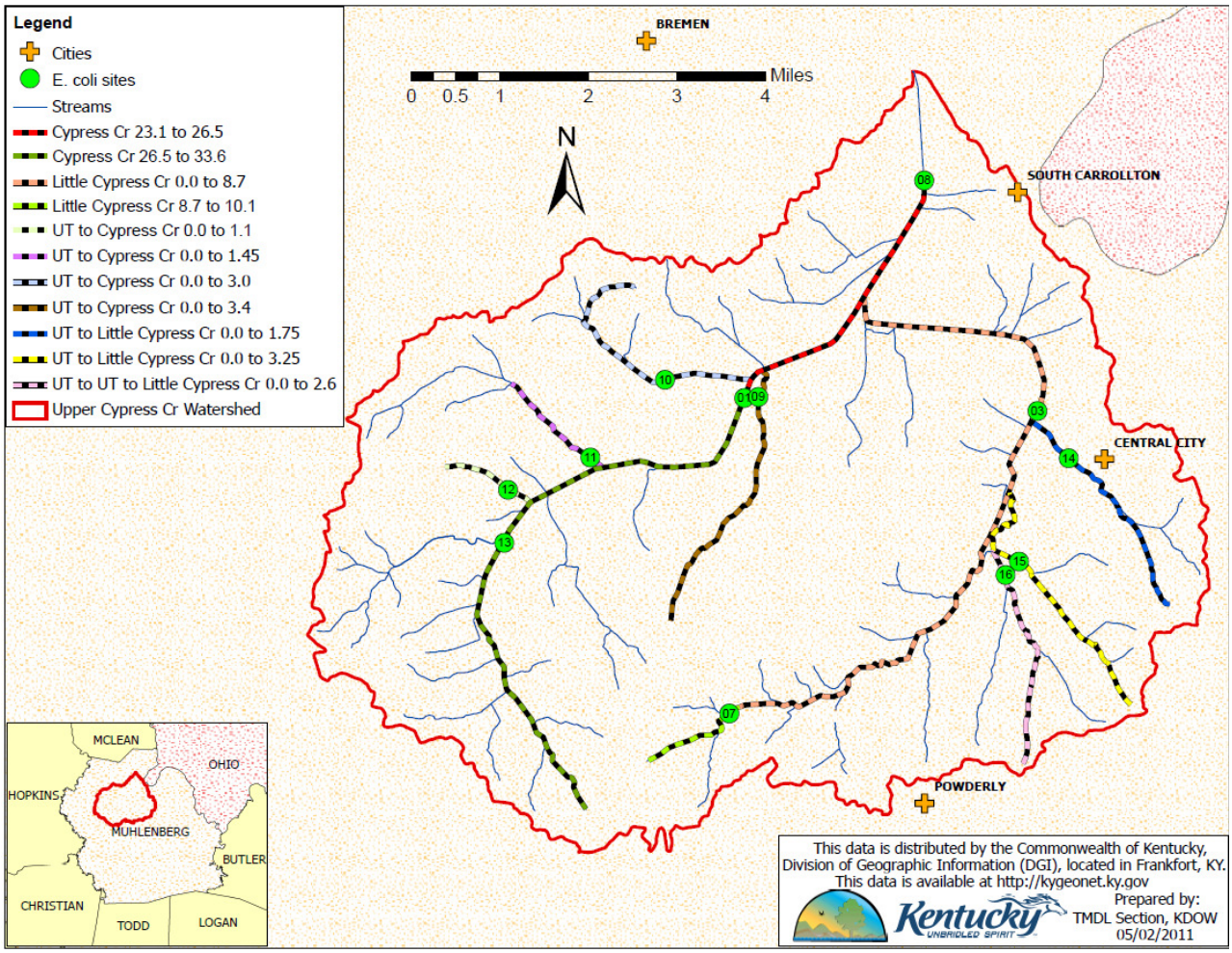

Figure 4.1 *E. coli* Assessed Segments in the Upper Cypress Creek Watershed

Table 4.1 TMDL Sample Data Summary

Station Name	Number of Observations	% Exceeding WQC (240 colonies/100ml)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
01	12	16.7	7	579	122
03	11	45.5	34	>2420	562
07	9	0	<1	160	31
08	12	41.7	6	1046	281
09	12	41.7	21	>2420	429
10	12	58.3	48	>2420	736
11	8	25	45	548	194
12	9	0	30	172	68
13	6	0	17	131	43
14	12	91.7	133	>2420	987
15	12	33.3	46	1414	374
16	9	66.7	46	1120	410

Table 4.2 *E. coli* Impaired Segments in Upper Cypress Creek Watershed

Waterbody Name	Pollutant	County	Waterbody Identification Number	Suspected Sources	Impaired Use (Support Status)
Cypress Creek 23.1 to 26.5	*E. coli*	Muhlenberg	KY490526_02	Source Unknown	PCR (NS)
Little Cypress Creek 0.0 to 8.7	*E. coli*	Muhlenberg	KY496701_01	Source Unknown	PCR (NS)
UT to Cypress Creek 0.0 to 1.45	*E. coli*	Muhlenberg	KY490526-28.6_01	Source Unknown	PCR (PS)
UT to Cypress Creek 0.0 to 3.0	*E. coli*	Muhlenberg	KY490526-26.3_01	Source Unknown	PCR (NS)
UT of Cypress Creek 0.0 to 3.4	*E. coli*	Muhlenberg	KY490526-26.1_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 1.75	*E. coli*	Muhlenberg	KY496701-3.1_01	Source Unknown	PCR (NS)
UT to Little Cypress Creek 0.0 to 3.25	*E. coli*	Muhlenberg		Source Unknown	PCR (NS)
UT to UT to Little Cypress Creek 0.0 to 2.6	*E. coli*	Muhlenberg	KY496701-0.9-4.0_01	Source Unknown	PCR (NS)

Table 4.3 *E. coli* Fully Support Segments

Waterbody Name	County	Waterbody ID
Cypress Creek 26.5 to 33.6	Muhlenberg	KY490526_03
Little Cypress Creek 8.7 to 10.1	Muhlenberg	KY496701_02
UT to Cypress Creek 0.0 to 1.1	Muhlenberg	KY490526-29.5_01

Table 4.4 Sites Associated with Each Assessed Segment

Stream Segment	Station Number	Latitude	Longitude	Sample Site RM
Cypress Creek 23.1 to 26.5	08	37.33923	-87.16118	23.1
Cypress Creek 26.5 to 33.6	01	37.30308	-87.19738	26.5
Cypress Creek 26.5 to 33.6	13	37.27870	-87.24609	30.1
Little Cypress Creek 0.0 to 8.7	03	37.30168	-87.13723	2.95
Little Cypress Creek 8.7 to 10.1	07	37.25126	-87.19942	8.9
UT to Cypress Creek 0.0 to 1.1	12	37.28740	-87.24551	0.3
UT to Cypress Creek 0.0 to 1.45	11	37.29292	-87.22874	0.2
UT to Cypress Creek 0.0 to 3.0	10	37.30585	-87.21368	1.0
UT of Cypress Creek 0.0 to 3.4	09	37.30328	-87.19448	0.35
UT to Little Cypress Creek 0.0 to 1.75	14	37.29398	-87.13068	0.6
UT to Little Cypress Creek 0.0 to 3.25	15	37.27691	-87.14053	1.15
UT to UT to Little Cypress Creek 0.0 to 2.6	16	37.27469	-87.14326	0.3

5.0 Source Identification

For regulatory purposes, the sources of fecal coliform and *E. coli* in a watershed can be placed into two categories: KPDES-permitted and non KPDES-permitted sources. A KPDES-permitted source requires a Kentucky Pollutant Discharge Elimination System (KPDES) discharge permit, a storm water permit, or a Municipal Separate Storm Sewer System (MS4) permit from the KDOW. KPDES discharge permits include wastewater treatment facilities that discharge directly to a stream, facilities discharging storm water, and some agricultural operations (e.g. Concentrated Animal Feeding Operations (CAFOS) with an individual discharge permit). KPDES is not the only permitting program that may affect water quality or quantity within a watershed; other permitting examples include water withdrawal permits, permits to build structures within a floodplain, permits to construct an on-site sewage treatment disposal system (OSTDS), and permits to land apply waste from sewage treatment plants. However, within the framework of the TMDL process a KPDES-permitted source is defined as one regulated under the KPDES program. Non KPDES-permitted sources include nonpoint sources of pollution. Nonpoint sources of pollution are often caused by runoff from precipitation over and/or through the ground and are correlated to land use.

5.1 KPDES-Permitted Sources

KPDES- permitted sources include all sources regulated by the KPDES permitting program. KPDES permit and point source are defined in 401 KAR 10:001. A Wasteload Allocation (WLA) is assigned to KPDES-permitted sources.

5.1.1 Sanitary Wastewater Systems

Sanitary Wastewater Systems (SWSs) include all facilities with a design flow which are permitted to discharge fecal coliform or *E. coli*. This includes Wastewater Treatment Plants (WWTPs), Sewage Treatment Plants (STPs), package plants and home units. Although there is a WWTP in the watershed, there are no SWS outfalls located in the Upper Cypress Creek watershed.

The Upper Cypress Creek Watershed is in the Pennyrile Area Development District. Kentucky regulation 401 KAR 5:006 specifies wastewater planning requirements for regional planning areas. Municipal wastewater treatment facilities are required to prepare 20-year regional planning documents under certain conditions as described in regulation.

There are two wastewater-planning areas in the Upper Cypress Creek watershed, Central City Municipal Water and Sewer System and Greenville Utilities Commission as shown in Figure 5.1. The Central City planning area covers the eastern portion of the watershed from an area north of Powderly, through Central City and north to South Carrolton. The Greenville Utilities Commission planning area extends into the south west part of Upper Cypress Creek watershed.

Sewer lines, under the responsibility of the Central City Municipal Water and Sewer System, extend from an area south of Central City to the Central City WWTP and to the Central City WWTP outfall. The city of Powderly (portions of which exist in the Upper Cypress Creek watershed) has a Kentucky Inter-System Operational Permit (KISOP) to transfer wastewater from Powderly to the Greenville Sewer System. Sewer lines extend from the city of Powderly to the Greenville Sewer System and its outfall and the Greenville Utilities Commission is responsible for these sewer lines.

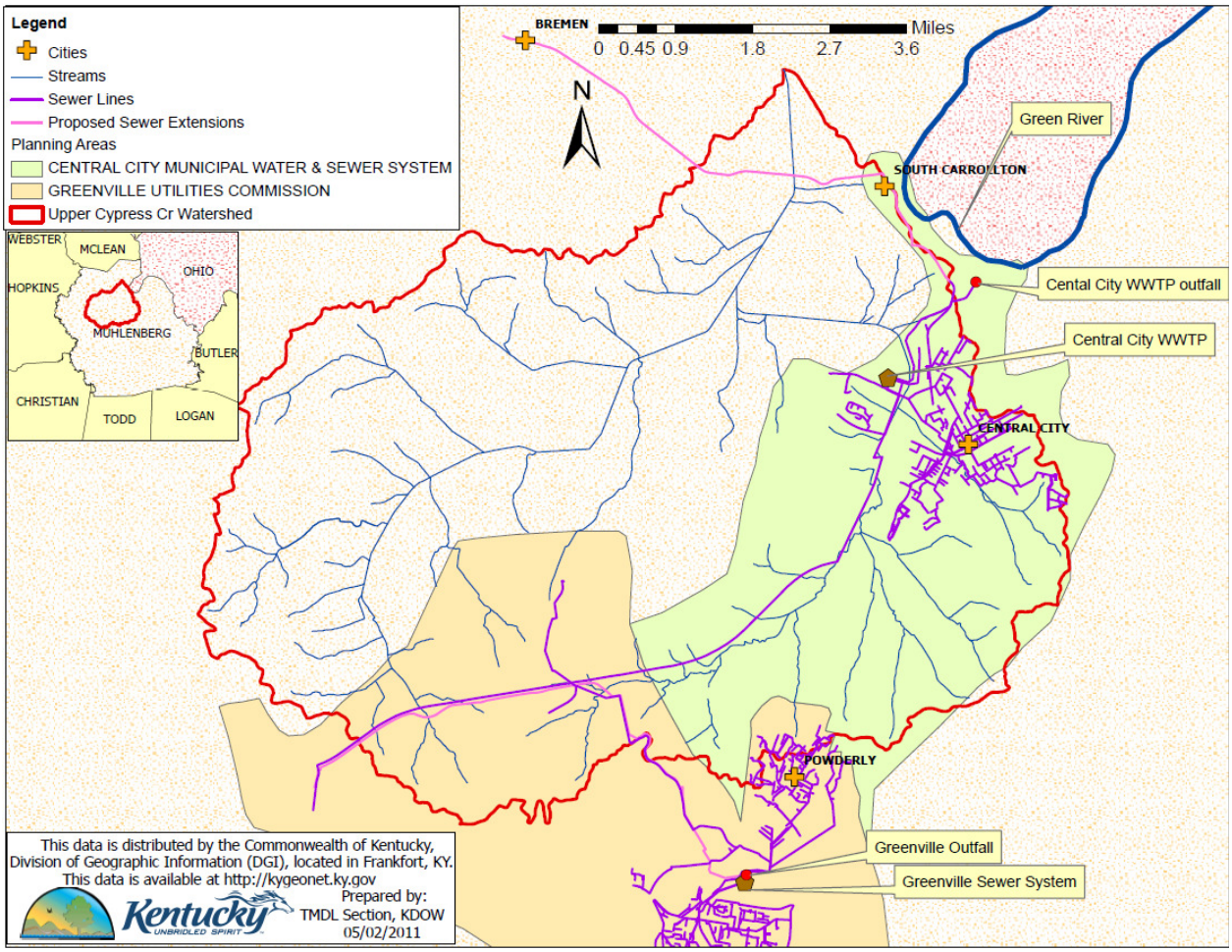

Figure 5.1 Wastewater Planning Areas in Upper Cypress Creek Watershed

5.1.2 MS4 Sources

MS4s are defined in 401 KAR 5:002. USEPA has categorized MS4s into three categories: small, medium, and large. The medium and large categories are regulated under the Phase I Storm Water program. Large systems, such as the cities of Lexington and Louisville, have populations in excess of 250,000. Medium systems have populations in excess of 100,000 but less than 250,000; however, there are currently no medium-sized systems in Kentucky. Phase I systems have five-year permitting cycles and have annual reporting requirements. The small MS4 category includes all MS4s not covered under Phase I. Since this category covers a large number of systems, only a select group are regulated under the Phase II rule, either being automatically

included based on population (i.e., having a total population over 10,000 or a population per square mile in excess of 1000) or on a case-by-case basis due to the potential to cause adverse impact on surface water. Water quality monitoring is not a requirement of Phase II MS4s, unless the waterbody has an approved TMDL and the MS4 causes or contributes to the impairment for which the TMDL was written. A WLA is assigned to all MS4 permit holders, including the Kentucky Transportation Cabinet (KYTC), universities and military bases. There are no MS4 permitted entities in the Upper Cypress Creek Watershed.

5.1.3 Concentrated Animal Feeding Operations (CAFOs)

Operations that are defined as a CAFO pursuant to 401 KAR 5:002 are required to obtain a KPDES permit. Once defined as a CAFO, the operation can be permitted under a KPDES General Permit or a KPDES Individual Permit depending upon the nature of the operation. Conditions of both types of permits include no discharge to surface waters; however, holders of a KPDES Individual Permit may discharge to surface waters during a 25-year (24-hour) or greater storm event. There are no CAFOs in the Upper Cypress Creek watershed.

5.2 Non KPDES-permitted Sources

Non KPDES-permitted sources include all sources not permitted by the KPDES permitting program and are often associated with land use. The loads to surface water from non-KPDES permitted sources are regulated by laws such as the Kentucky Agricultural Water Quality Act (AWQA, KRS 224.71-100 through 224.71-145, i.e., implementation of individual agriculture water quality plans and corrective measures), the federal Clean Water Act (i.e., the TMDL process) and 401 KAR 5:037 (Groundwater Protection Plans (GPPs)), among others. Unlike KPDES-permitted sources, non KPDES-permitted sources typically discharge pollutants to surface water in response to rain events. Figure 5.2 shows precipitation from a nearby climate station in Hopkins County (Station ERLN, Latitude 37.271439, Longitude -87.481127, located approximately 11 miles west of Upper Cypress Creek watershed) for May 1 through Oct 31, 2009-when samples were collected for TMDL development (Kentucky Mesonet, 2011). Section 3.1 provided information about the movement of bacteria in runoff. In addition to movement of bacteria to a stream via erosion or runoff, higher flows during rainfall events can re-suspend bacteria which are adhered to soil particles that have settled along the bottom of a stream. For seven out of eight sites on the impaired segments, the greatest sample concentration was measured on June 23, 2009, when KDOW's field data sheets indicate 1.07 inches of rain within 24 hours preceding sample collection. This rainfall event is not evident in the data shown in Figure 5.2. A Load Allocation (LA) is assigned to non KPDES-permitted sources.

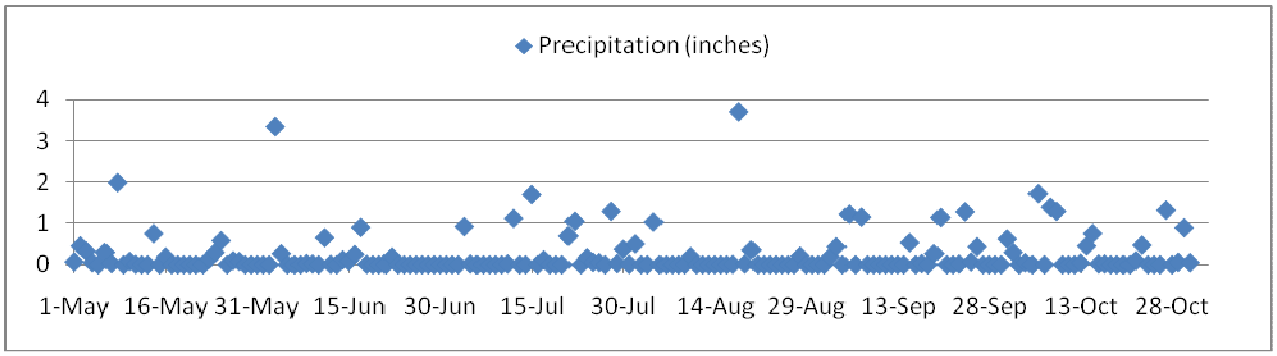

Figure 5.2 Precipitation near Madisonville, Hopkins County during the PCR Season 2009 (from Kentucky Mesonet, 2011)

Note: While many aspects of the Kentucky Mesonet are functional, the development of systems, procedures, and controls necessary to produce and deliver operational data continues. While Mesonet data are adequate for many purposes, any data displayed from the network should be considered experimental until the time that the State Climatologist declares them to be of operational quality. Data should not be published in any manner without including this notice.

5.2.1 Kentucky No Discharge Operating Permits

As stated in 401 KAR 5:005, facilities with agricultural waste handling systems or that dispose of their effluent by spray irrigation but do not discharge to surface waters are required to obtain a Kentucky No Discharge Operating Permit (KNDOP) from the KDOW prior to construction and operation. Animal Feeding Operations (AFOs) receive KNDOP permits. These operations handle liquid waste in a storage component of the operation (e.g. lagoon, pit, or tank) and may land apply the waste via spray irrigation or injection to cropped acreages. Land application of the waste that results in runoff to a stream is prohibited. Facilities that handle animal waste as a liquid are required to submit a Short Form B, construction plans, and a Comprehensive Nutrient Management Plan to the KDOW. Also included in KNDOP requirements are golf courses that land apply treated wastewater via spray irrigation, typically from a holding pond - some industrial operations also spray-irrigate. Two KNDOPs exist in the watershed as shown in Figure 5.3 and summarized in Table 5.1.

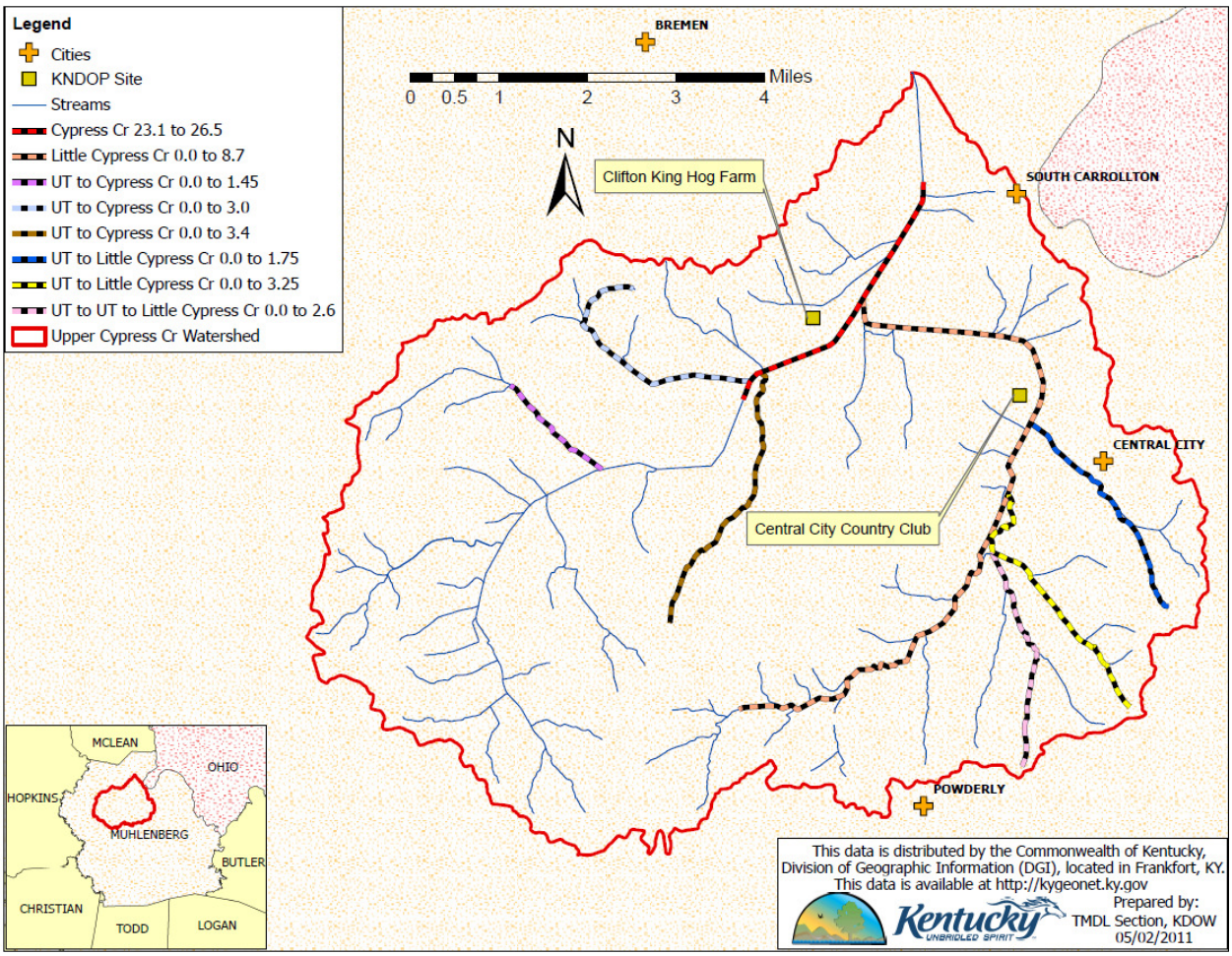

Figure 5.3 KNDOP in Upper Cypress Creek Watershed

Table 5.1 Summary of KNDOPs in Upper Cypress Creek Watershed

Facility Name	Permit #	County	# of Animals	Type of Animal	Longitude	Latitude	AI
Central City Country Club	03005035	Muhlenberg	N/A	N/A	-87.140707	37.304492	3216
Clifton King Hog Farm	03010039	Muhlenberg	120	Swine	-87.18333	37.31667	10535

Note: N/A indicates that treated wastewater is land applied.

5.2.2 Agriculture

The Kentucky AWQA was passed by the 1994 General Assembly. The law focuses on the protection of surface water and groundwater resources from agricultural and silvicultural

activities. The Act created the Kentucky Agriculture Water Quality Authority (KAWQA), a 15-member peer group comprising farmers and representatives from various agencies and organizations. The Act requires farms greater than 10 acres in size to adhere to the Best Management Practices (BMPs) specified in the Kentucky Agriculture Water Quality Plan. Specific BMPs have been designated for all operations.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture. Selected agricultural data from the latest Census of Agriculture reports for Muhlenberg County are listed in Table 5.2 (USDA, 2009). These data are based on county-wide data with no assumptions made on a watershed level. The percentage of agricultural types of land cover is calculated for each sub-watershed in Table 3.4 (Section 3.3).

Table 5.2 2007 Agricultural Statistics for Muhlenberg County

Statistic	Muhlenberg County 2007
Farms [# farms (acres)]	636 (140,834)
Cattle and Calves Inventory [#farms (total # animals)]	301 (13,246)
Beef [#farms (total # animals)]	297 (D)
Milk Cows [#farms (total # animals)]	2 (D)
Hogs and Pigs [#farms (total # animals)]	7 (D)
Sheep and Lambs [#farms (total # animals)]	9 (145)
Layers 20 weeks old or older [#farms (total # animals)]	25 (D)
Broilers & other meat-type chickens sold [#farms (total # animals)]	13 (5,458,316)
Total Cropland [#farms (total acres)]	529 (74,483)
Corn for grain [#farms (total acres)]	63 (22,838)
Wheat for grain [#farms (total acres)]	8 (1292)
Corn for silage [#farms (total acres)]	4 (118)
Soybeans for beans [#farms (total acres)]	48 (15,486)
Tobacco [#farms (total acres)]	34 (615)
Forage [#farms (total acres)]	333 (16,215)

D = Withheld by USDA to avoid disclosing data for individual farms.

5.2.3 Wildlife

Wildlife undoubtedly contributes bacteria to the watershed, noting the high percentage of forest in the watershed. Table 5.3 shows the estimates of deer population and density in 2006 and 2007 in Muhlenberg County (Kentucky Department of Fish and Wildlife Resources, 2007). Estimates on numbers of other types of wildlife are not available; however, there is one Wildlife Management Area, Peabody Wildlife Management Area, that extends into the watershed (Figure 5.4). Although wildlife contributes bacteria to surface water, such contributions represent natural background conditions.

Table 5.3 Estimated Deer Population and Density
Based on Deer Harvest Model Results in 2007 and 2008 (Kentucky Dept. of Fish and Wildlife)

County	Estimated Deer Population		Estimated Deer Density (#/mi^2)	
	2007	2008	2007	2008
Muhlenberg	9,343	5,281	23	13

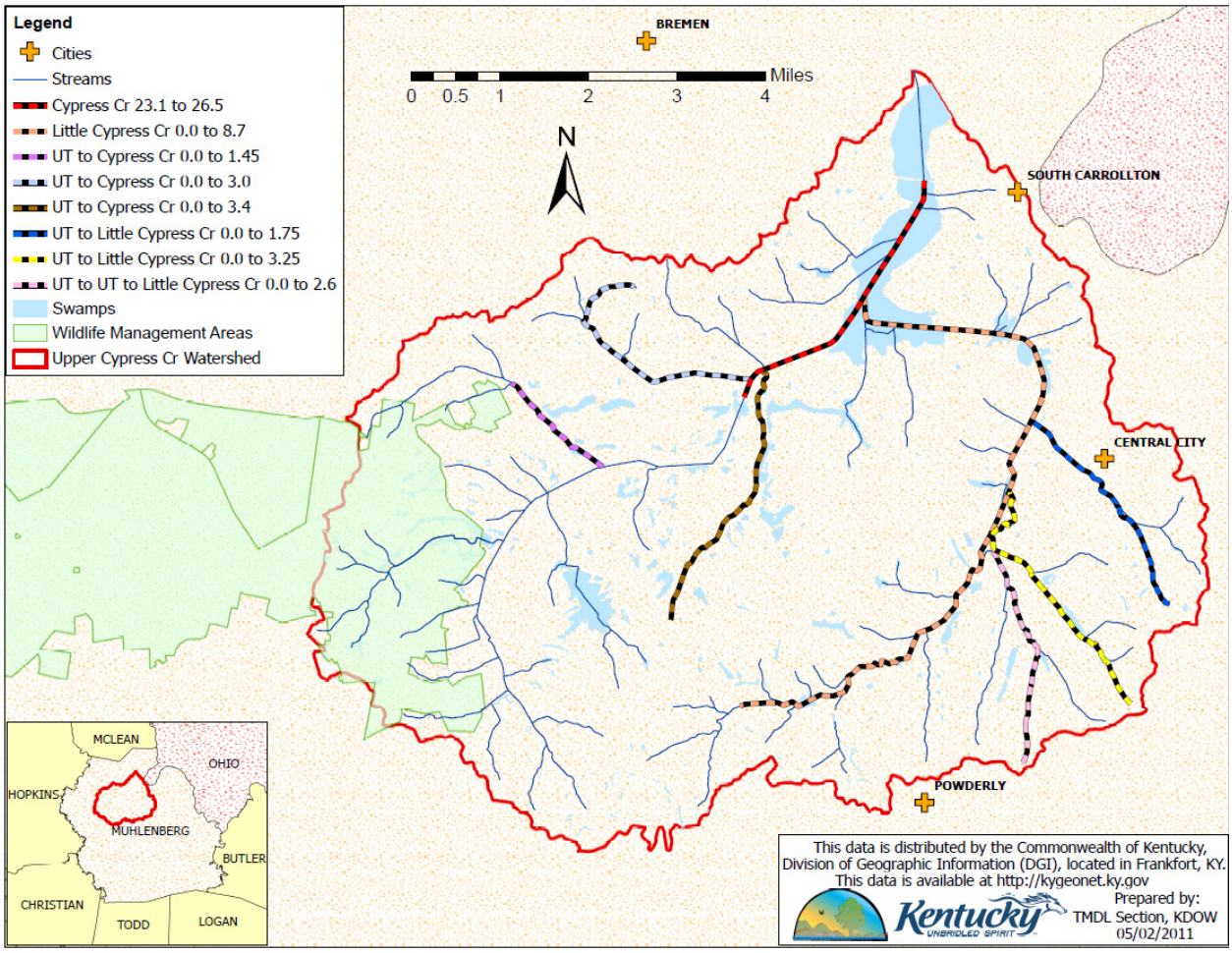

Figure 5.4 Wildlife Management Area in Upper Cypress Creek Watershed

5.2.4 Human Waste

Human waste disposal is of particular concern in rural areas. Areas not served by sewers either employ an On Site Sewage Treatment and Disposal Systems (OSTDSs) or do not treat their sewage and dispose of wastewater via straight pipes. OSTDS, including septic tank systems, are commonly used in areas where providing a centralized sewage collection and treatment system is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, septic systems are an effective means of disposing and treating domestic waste. The

effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, they can be a source of *E. coli* to both groundwater and surface water, see Section 5.3, Illegal Sources, for further information.

A Kentucky Infrastructure Authority (KIA, 2010) report estimated a 1999 population of 32,037 (12,944 households) in Muhlenberg County with 35% on public sewer systems. The KIA report further estimated a 2020 population of 34,112 (14,566 households) for Muhlenberg County with 45% on public sewer systems (KIA, 2000). The 2010 Census reported a population of 31,499 (13,699 housing units) in Muhlenberg County with populations of 5978 (2325 housing units) in Central City, 745 (358 housing units) in Powderly, and 184 (86 housing units) in South Carrollton (US Census, 2010). The KIA document reported about 8,400 households in Muhlenberg County with on-site wastewater treatment and noted approximately 71 households with failing septic systems in South Carrollton (KIA, 2000).

5.2.5 Household Pets

Although household pets undoubtedly exist in this watershed, their contribution to the LA is deemed to be minimal compared to other sources. Pet waste may, however, be a larger contributor to bacteria runoff in areas where there is a higher density of households and less-permeable surfaces.

5.3 Illegal Sources

Both KPDES-permitted and non KPDES-permitted sources can discharge bacteria to surface water illegally. This includes sources that are illegal simply by their existence, such as straight-pipes, leaking sewer lines, and sanitary sewer overflows (SSOs), which receive no allocation. There may also be legal sources that are operating illegally (e.g., outside of regulations, permit limits or conditions, etc.), such as a WWTP bypass or a failing OSTDSs, which receive no allocation above that of a properly functioning system (see Section 7.0 for TMDL allocations).

Another potential illegal source is livestock on farms that have no BMPs (as required under the AWQA) as well as farms where BMPs are present but are insufficient or failing in a manner that causes or contributes to surface water impairment; such farms receive no allocation above that of a farm with properly installed and functioning BMPs. Also included are KNDOPs, AFOs and CAFOs not in compliance with the appropriate regulations that cause or contribute to a surface water impairment.

KDOW expects implementation of these TMDLs to begin with the elimination of illegal sources. This is intended to prevent legally operating sources from having to effect reductions in order to accommodate the pollutant loading of illegal sources. Note this Section of the TMDL is not intended to summarize the universe of potential illegal sources that may discharge pollutants into surface waters, nor does it attempt to summarize the universe of legal sources that may be operating illegally. Instead, it gives examples of illegal sources known to be present or that could be present in the watersheds (e.g., straight-pipes).

6.0 Water Quality Criterion

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR use are based on both fecal coliform and *E. coli*. Per 401 KAR 10:031:

"The following criteria shall apply to waters designated as primary contact recreation use during the primary contact recreation season of May 1 through October 31: Fecal coliform content or Escherichia coli content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for Escherichia coli."

There are insufficient *E. coli* measurements to calculate a 5-sample, 30-day geometric mean, so the instantaneous criterion of 240 colonies/100 ml was applied to calculate allowable loadings to bring the watershed into compliance with the PCR designated use. See Section 7.0 for TMDL loading calculations.

7.0 Total Maximum Daily Load

7.1 TMDL Equation and Definitions

A TMDL calculation is performed as follows:

$$TMDL = WLA + LA + MOS$$
(Equation 1)

The WLA has three components:

$$WLA = SWS\text{-}WLA + MS4\text{-}WLA + Future\ Growth\text{-}WLA$$
(Equation 2)

Definitions:

TMDL: the WQC, expressed as a load. The WQC is defined in Section 6.0 as an instantaneous concentration of 240 colonies/100 ml for *E. coli*.
MOS: the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality.
TMDL Target: the TMDL minus the MOS.
WLA: the Wasteload Allocation, which is the allowable loading of pollutants into the stream from KPDES-permitted sources, such as SWSs and MS4s.
SWS-WLA: the WLA for KPDES-permitted sources, which have discharge limits for pathogen indicators (including wastewater treatment plants, package plants and home units).
Future Growth-WLA: the allowable loading for future KPDES-permitted sources, including new SWSs, expansion of existing SWSs, new storm water sources, and growth of existing storm water sources (such as MS4s). Also includes the allocation for the KPDES-permitted sources that existed but were not known at the time the TMDL was written.
Remainder: the TMDL minus the MOS and minus the SWS-WLA (also equal to Future Growth-WLA plus the MS4-WLA and the LA).
MS4-WLA: the WLA for KPDES-permitted municipal separate storm water sewer systems (including cities, counties, roads and right-of-ways owned by the KYTC, universities and military bases).
LA: the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
Seasonality: yearly factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses.
Critical Condition: the time period when the pollutant conditions are expected to be at their worst.
MAF: the Mean Annual Flow as defined by USGS.
Adjusted MAF: the MAF plus SWS-WLA design flows.

Critical Flow: the flow used to calculate the TMDL as a load (is equivalent to the Adjusted MAF for MAF TMDLs)
Existing Conditions: the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment.
Percent Reduction: the reduction needed to bring the existing conditions in line with the TMDL Target.
Load: concentration * flow * conversion factor
Concentration: colonies per 100 milliliters (colonies/100ml)
Flow (i.e. stream discharge): cubic feet per second (cfs)
Conversion Factor: the value that converts the product of concentration and flow to load (in units of colonies per day); it is derived from the calculation of the following components: (28.31685 L/f^3 * 86400 seconds/day * 1000 ml/L)/(100ml) and is equal to 24,465,758.4.

Calculation Procedure:

1) The MOS, if an explicit value, is calculated and subtracted from the TMDL first, giving the TMDL Target;
2) Percent reductions are calculated to show the difference between Existing Conditions and the TMDL Target;
3) The SWS-WLA (if any) is calculated and subtracted from the TMDL Target, leaving the Remainder;
4) The Future Growth-WLA is calculated and subtracted from the Remainder;
5) If there is a MS4 present upstream of the impaired segment, the MS4-WLA is subtracted from the Remainder based on percent land use, leaving the LA.

7.2 Margin of Safety

There are two methods for incorporating a MOS in the TMDL analysis: implicitly include the MOS using conservative assumptions, or explicitly designate a (numerical) portion of the TMDL as the MOS and divide the remainder of the allowable load (i.e., the TMDL Target load) between the LA and WLA. For this TMDL, a 10% explicit MOS (i.e., 10% of the WQC, or 24 colonies/100ml, but expressed as a load where possible) was reserved to address uncertainties involving loading from non-SWS sources. The explicit MOS load was calculated using the following equation:

$$\underset{\text{(colonies/100ml)}}{24} \times \underset{\text{(cfs)}}{\text{Critical Flow}} \times \underset{24{,}465{,}758.4}{\text{Conversion Factor}} = \text{MOS (colonies/day)}$$

7.3 WLA

The WLA is the portion of the TMDL allocated to KPDES-permitted sources within the watershed(s).

7.3.1 SWS-WLA

There are no SWS-sources within in the Upper Cypress Creek watershed; therefore there is no SWS-WLA.

7.3.2 Remainder

The Remainder is not part of the TMDL; however, it is used in the TMDL calculations. It is calculated as the Target Load minus the sum of all individual SWS-WLAs. Because there are no SWS-WLAs, the remainder is equal to the Target Load for TMDLs in this document.

7.3.3 Future Growth-WLA

Because the WLA must account for all KPDES-permitted sources, often a TMDL will account for future growth of these sources (i.e., an increase in the number of WLA sources or in the loading per discharger) in order to avoid having to re-open the TMDL and change the WLA when new sources come online. Future growth is represented by a portion of the Remainder which is set aside (i.e., is not part of the LA nor is it part of the WLA for current/known sources). It can also account for existing storm water sources which are later discovered to discharge the pollutant of concern, even though this fact was not known at the time the TMDL was written. Of course, any and all of the sources mentioned above must meet the WQC and KDOW's permitting requirements. The amount set aside for future growth is determined using Table 7.1, which assumes that growth occurs more rapidly in developed areas (which is determined by the sum of developed open space, developed low intensity, developed medium intensity and developed high intensity areas as defined by the USGS NLCD) than in rural areas:

Table 7.1 Future Growth

Percent Developed Area in the Subwatershed	Future Growth WLA Percentage
≥25%	5%
≥20% – <25%	4%
≥15% – <20%	3%
≥10% – <15%	2%
≥5% – <10%	1%
<5%	0.5%

The Future Growth WLA is calculated using the following formula:

$$\text{Remainder} \times \text{Future Growth-WLA percentage} = \text{Future Growth-WLA}$$

7.3.4 MS4-WLA

If there was a MS4 within the upstream area of the impaired segment, a MS4-WLA would be calculated however; no MS4 entities exist in the Upper Cypress Creek watershed.

7.4 LA

The LA is where non KPDES-permitted sources (i.e., nonpoint sources, or those sources not permitted by KPDES) receive their allocation within the TMDL. Non KPDES-permitted sources include properly functioning OSTDS (i.e. septic systems), wildlife, household pets and facilities (e.g., farms, landfarms for municipal STP sludge) with properly functioning BMPs. The LA is calculated using the following equation:

$$\text{Remainder} \quad - \quad \begin{matrix}\text{Future Growth} \\ \text{WLA}\end{matrix} \quad = \quad \text{LA}$$

Because there are no SWS-WLAs in the Upper Cypress Creek watershed, the TMDL Target is equal to the Remainder. The available sampling data were insufficient to apportion the existing loading among the various LA sources; therefore, it is attributed to all LA sources.

7.5 Seasonality

Yearly factors such as temporal variations on source behavior and stream loading than can affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses. This TMDL addresses seasonality by only using samples collected within the PCR season (May - October).

7.6 Critical Condition

The critical condition for nonpoint source bacteria loadings is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, bacteria builds up on the land surface, and are washed off by subsequent rainfall. Conversely, the critical condition for point source loading typically occurs during periods of low streamflow when dilution is minimized. The Upper Cypress Creek watershed contains both types of sources; therefore the critical condition for each bacteria-impaired segment is defined by the MAF.

7.7 Existing Conditions

The maximum exceedance of all samples was selected to represent existing conditions. This concentration was converted to a load using the following equation:

Maximum Exceedance (colonies/100ml)	×	Critical Flow (cfs)	×	Conversion Factor 24,465,758.4	=	Existing Load (colonies/day)

7.8 Calculation of Percent Reductions

A 'percent reduction' was calculated for informational purposes only to illustrate the difference between existing conditions and the TMDL Target at the time the streams were sampled. The percent reduction for each impaired segment is provided and discussed in Section 8.2.

7.9 TMDLs Calculated as a Daily Load

Federal guidelines of the Clean Water Act require a TMDL to be expressed in terms of a daily load. Due to the limited amount of data available, particularly the absence of stream gages, a method was developed utilizing the WQC and MAF. The USGS has generated a MAF value for streams across Kentucky. The MAF values were calculated using the equation found in the USGS Water-Resources Investigations Report 02-4206 "Estimating Mean Annual Streamflow of Rural Streams in Kentucky" (http://ky.water.usgs.gov/pubs/wrir_2002_4206.pdf). The MAF values can be found on the Hydrology of Kentucky webpage (http://kygeonet.ky.gov/kyhydro/main.htm). Once obtained, these were designated as the critical flow. The critical flow is then multiplied by the WQC minus the MOS (10%) times the appropriate conversion factors to obtain the TMDL Target (i.e., the allowable daily load).

8.0 TMDL Calculations

8.1 Data Validation

Data validation was performed as follows:

- Quality Analysis/Quality Control Samples (e.g., duplicates) were excluded from data analysis.
- Some samples were reported using either the *less than* (denoted using the "<") symbol or the *greater than* (denoted using the ">") symbol, indicating the true concentration was unknown but it was either below or above the reported value, respectively. For samples *less than* the reported value, the reported value was used verbatim. For *greater than* values, the values were used verbatim because all showed exceedances of the WQC. While in such cases the exact value of the exceedance is unknown and likely higher than the number reported, the sample still gave insight into the status of the waterbody at the time the sample was taken.
- Some samples were reported as 1U (undetected). For these samples, a value of 1 was used for data analysis.

See Appendix B for the full datasets from each site.

8.2 Individual Stream Segment Analysis

Data from various sources (including Federal, State and local government and public entities) were collected and analyzed for each individually listed stream segment and its associated drainage area. Most of the data collected for the development of this document can be accessed and downloaded from the KYGEONET (http://kygeonet.ky.gov/kyhydro/main.htm)

Subwatersheds were delineated using HUC14 or HUC12 boundaries if the impaired stream segment ended at a HUC boundary. Otherwise, best professional judgment was used to delineate the subwatershed. In areas of braiding, relict channels, canals, and swamps, this delineation may be slightly off.

In the subsections below, descriptions of each impaired segment are presented in alphabetic order. Included are tables of general subwatershed information, sample site information, watershed land cover, validated sample data, and TMDL allocations. Stream order is based upon a 1:100 scale. A Waterbody Identification Number (WBID) is included in the table of general information about the impaired segment. This number is a unique identifier assigned to all assessed waters in KY. The land cover table for each segment includes the percentage used to calculate the Future Growth WLA. For all sample data tables, a red highlight indicates an exceedance of the instantaneous WQS (240 *E. coli* colonies/100 ml) while a dark green highlight (noted with "Greatest Exceedance") indicates the sample used in the Existing Load calculation (note that this sample is listed twice in the data table, once in the row next to the date it was collected and once in the Greatest Exceedance row).

In addition to stream segment analysis, site specific analysis is performed at sample site locations within an impaired segment. The site specific TMDL allocations are presented in Appendix C.

8.2.1 TMDL Summary for Cypress Creek 23.1 to 26.5

Cypress Creek at RM 23.1 is a fourth order stream located in Muhlenberg County (Figure 8.1). Information about Cypress Creek 23.1 to 26.5, including its WBID and MAF is shown in Table 8.1. Site information is presented in Table 8.2. The subwatershed for the impaired segment has a total drainage area of approximately 54.4 square miles. The land cover in this subwatershed is predominantly forested (58.2%) followed by agriculture (14.1%) while urban/residential development accounts for 8% (Table 8.3). There is a high percentage of wetlands (6.9%) in this subwatershed. Sampling data from site 08 are presented in Table 8.4 and the TMDL allocations in Table 8.5.

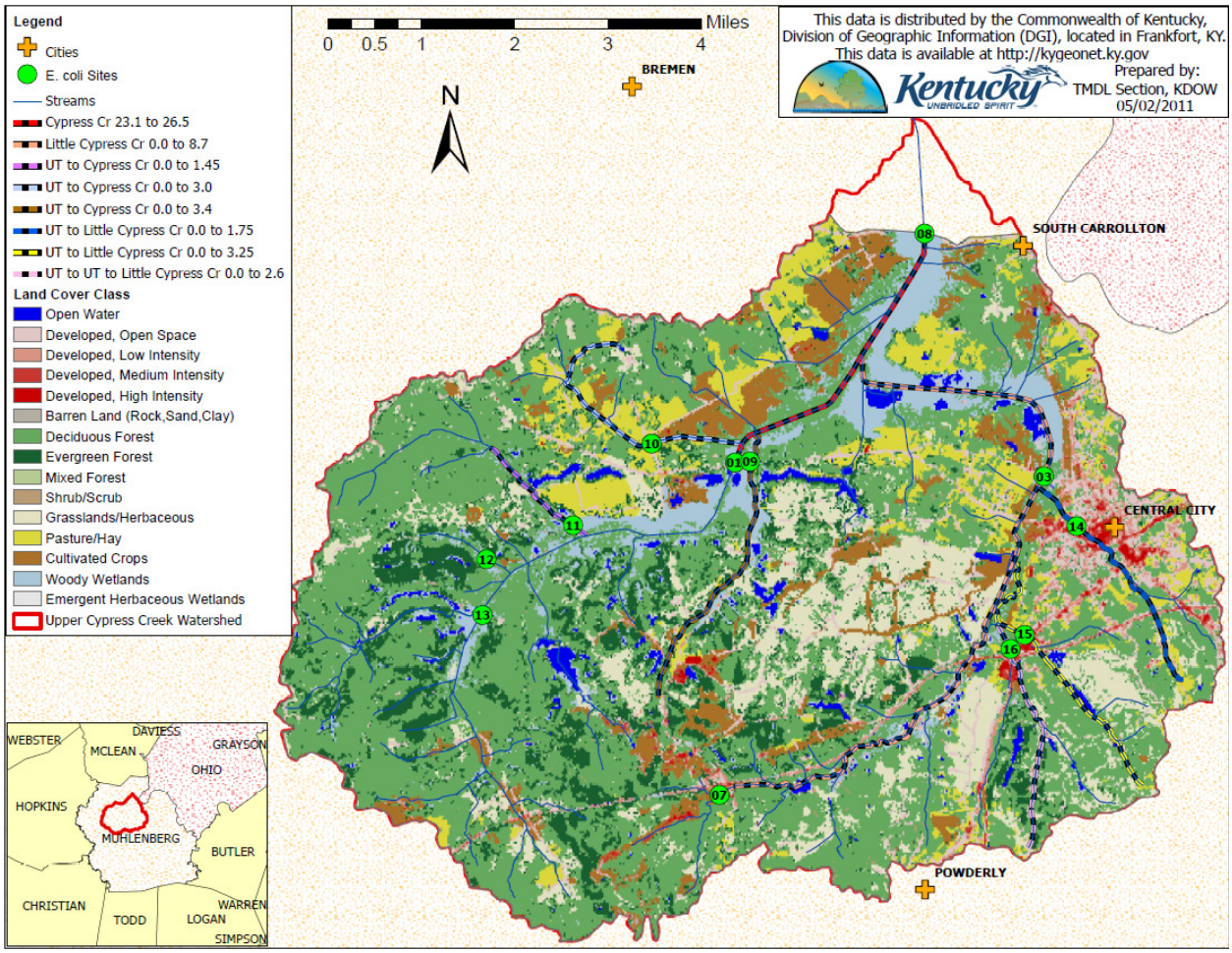

Figure 8.1 Cypress Creek 23.1 to 26.5 Subwatershed

Table 8.1 Cypress Creek 23.1 to 26.5 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
Cypress Creek 23.1 to 26.5	KY490526_02	Muhlenberg	34,847	54.4	4th	66.3	23.1

Table 8.2 Cypress Creek 23.1 to 26.5 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
08	37.33923	-87.16118	23.1

Table 8.3 Cypress Creek 23.1 to 26.5 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	1.93	672.64	1.05	
Developed	8.04	2803.04	4.38	1
Barren Land	0.14	48.78	0.08	
Forest/Shrubland	58.15	20262.74	31.66	
Grassland/Herbaceous	10.74	3742.73	5.85	
Agriculture (total)	14.12	4921.41	7.69	
Pasture/Hay	7.49	2609.49	4.08	
Cultivated Crops	6.63	2311.92	3.61	
Wetlands	6.87	2395.67	3.74	
Totals	100.00	34847.02	54.45	

Table 8.4 Cypress Creek 23.1 to 26.5 Data (Site 08)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	6
26-May-09	24
9-Jun-09	73
23-Jun-09	1046
8-Jul-09	36
24-Jul-09	16
4-Aug-09	31
31-Aug-09	22
8-Sep-09	488
23-Sep-09	980
8-Oct-09	345
27-Oct-09	308
Greatest Exceedance	1046

Table 8.5 TMDL Allocations for Cypress Creek 23.1 to 26.5

E. coli (colonies/day)	
1.70E+12	Existing Load
3.89E+11	**Total TMDL**
3.89E+10	**MOS**
3.50E+11	TMDL Target
79.3%	% reduction
3.50E+11	remainder
3.50E+09	**Future Growth WLA[(1)]**
3.47E+11	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.2 TMDL Summary for Little Cypress Creek 0.0 to 8.7

Little Cypress Creek at RM 0.0 is a third order stream located in Muhlenberg County (Figure 8.2). Information about Little Cypress Creek 0.0 to 8.7, including its WBID and MAF is shown in Table 8.6. Site information is presented in Table 8.7. The subwatershed for the impaired segment has a total drainage area of approximately 24.5 square miles. The land cover in this subwatershed is predominantly forested (49.4%) followed by agriculture (14.6%) while urban/residential development accounts for 13.9% (Table 8.8). There is a high percentage of wetlands (5.5%) in this subwatershed. Sampling data from site 03 are presented in Table 8.9 and the TMDL allocations in Table 8.10.

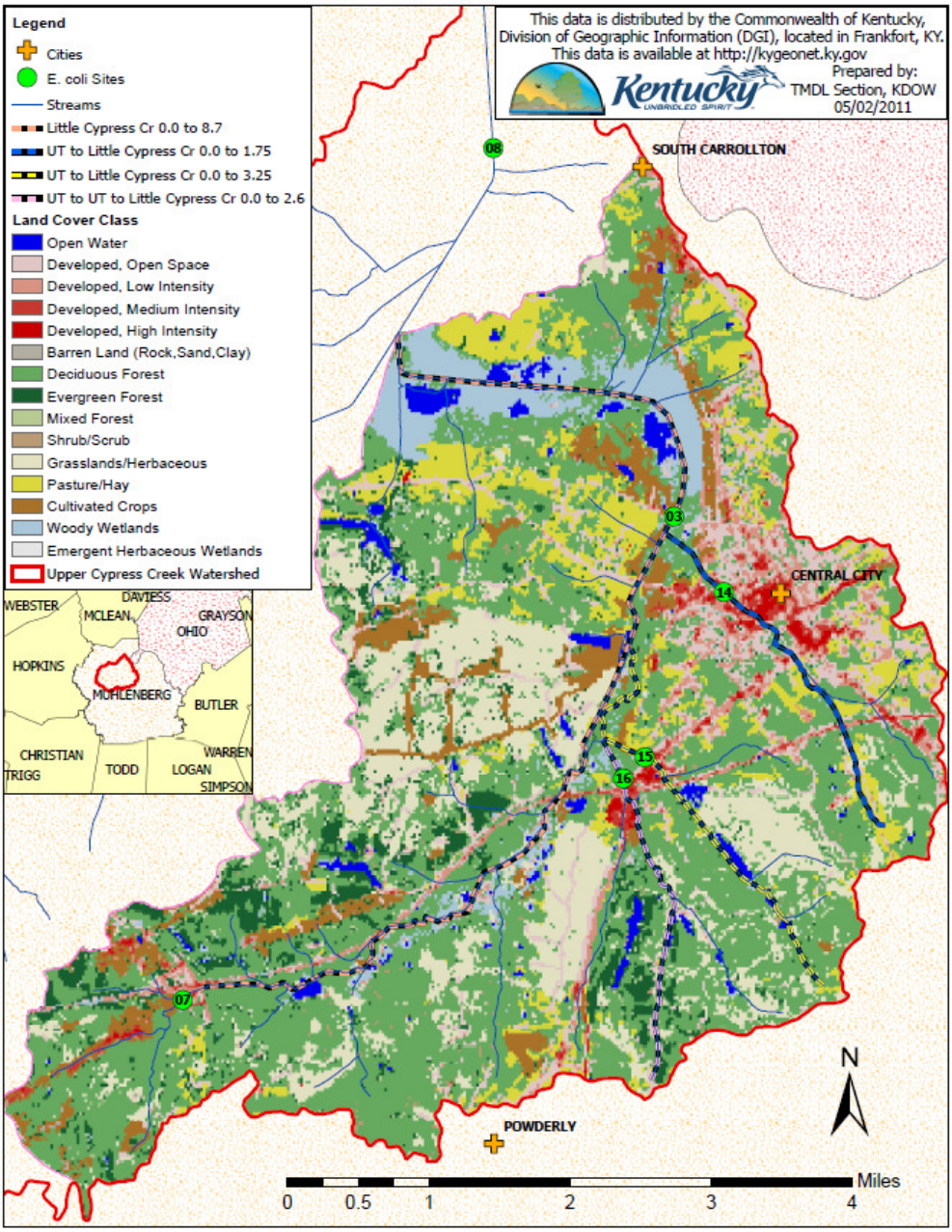

Figure 8.2 Little Cypress Creek 0.0 to 8.7 Subwatershed

Table 8.6 Little Cypress Creek 0.0 to 8.7 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
Little Cypress Creek 0.0 to 8.7	KY496701_01	Muhlenberg	15,704	24.5	3rd	29.7	0

Table 8.7 Little Cypress Creek 0.0 to 8.7 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
03	37.3017	-87.137	2.95

Table 8.8 Little Cypress Creek 0.0 to 8.7 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	2.04	319.89	0.50	
Developed	13.89	2180.66	3.41	2
Barren Land	0.14	21.83	0.03	
Forest/Shrubland	49.36	7751.60	12.11	
Grassland/Herbaceous	14.48	2274.00	3.55	
Agriculture (total)	14.62	2296.50	3.59	
Pasture/Hay	8.75	1373.80	2.15	
Cultivated Crops	5.88	922.70	1.44	
Wetlands	5.47	859.21	1.34	
Totals	100.00	15703.68	24.54	

Table 8.9 Little Cypress Creek 0.0 to 8.7 Data (Site 03)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	90
26-May-09	249
9-Jun-09	133
23-Jun-09	2420
7-Jul-09	118
24-Jul-09	308
4-Aug-09	124
31-Aug-09	139
23-Sep-09	1986
8-Oct-09	579
27-Oct-09	34
Greatest Exceedance	2420

Table 8.10 TMDL Allocations for Little Cypress Creek 0.0 to 8.7

E. coli (colonies/day)	
1.76E+12	Existing Load
1.74E+11	**Total TMDL**
1.74E+10	**MOS**
1.57E+11	TMDL Target
91.1%	% reduction
1.57E+11	remainder
3.14E+09	**Future Growth WLA**[(1)]
1.54E+11	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.3 TMDL Summary for UT to Cypress Creek 0.0 to 1.45

UT to Cypress Creek at RM 0.0 is a second order stream located in Muhlenberg County (Figure 8.3). Information about UT to Cypress Creek 0.0 to 1.45, including its WBID and MAF is shown in Table 8.11. Site information is presented in Table 8.12. The subwatershed for the impaired segment has a total drainage area of approximately 2.9 square miles. The land cover in this subwatershed is predominantly forested (80.3%) followed by agriculture (6.0%) while urban/residential development accounts for 3.6% (Table 8.13). Sampling data from site 11 are presented in Table 8.14 and the TMDL allocations in Table 8.15.

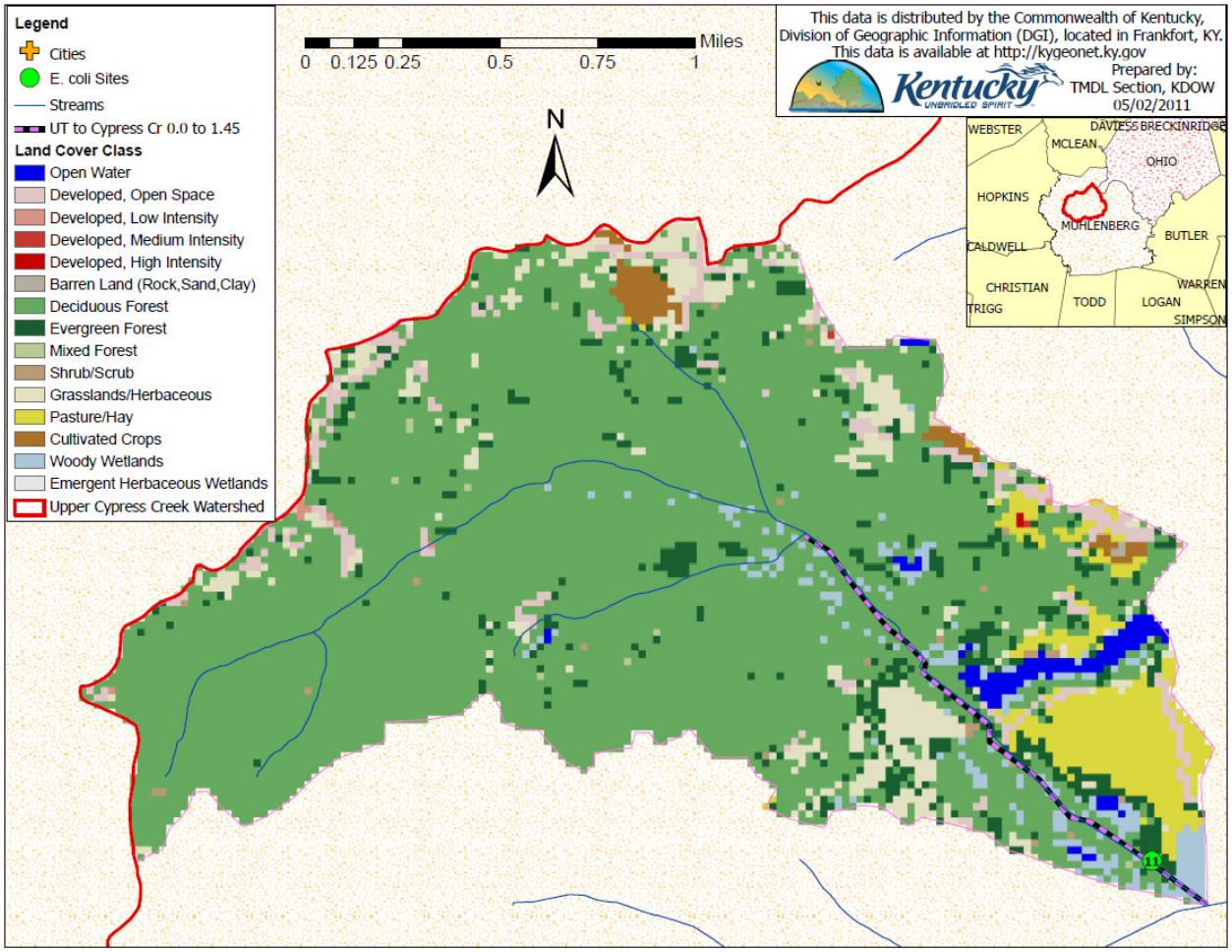

Figure 8.3 UT to Cypress Creek 0.0 to 1.45 Subwatershed

Table 8.11 UT to Cypress Creek 0.0 to 1.45 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Cypress Creek 0.0 to 1.45	KY490526-28.6_01	Muhlenberg	1,862	2.9	2nd	3.6	0

Table 8.12 UT to Cypress Creek 0.0 to 1.45 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
11	37.2929	-87.229	0.2

Table 8.13 UT to Cypress Creek 0.0 to 1.45 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	1.34	24.94	0.04	
Developed	3.61	67.25	0.11	0.5
Barren Land	0.04	0.67	0.00	
Forest/Shrubland	80.30	1495.41	2.34	
Grassland/Herbaceous	5.87	109.34	0.17	
Agriculture (total)	6.00	111.79	0.17	
Pasture/Hay	4.90	91.31	0.14	
Cultivated Crops	1.10	20.49	0.03	
Wetlands	2.83	52.78	0.08	
Totals	100.00	1862.19	2.91	

Table 8.14 UT to Cypress Creek 0.0 to 1.45 Data (Site 11)

Collection Date	*E. coli* (colonies/100 ml)
13-May-09	90
27-May-09	159
10-Jun-09	161
23-Jun-09	548
8-Jul-09	81
23-Jul-09	387
31-Aug-09	45
8-Sep-09	84
Greatest Exceedance	548

Table 8.15 TMDL Allocations for UT to Cypress Creek 0.0 to 1.45

E. coli (colonies/day)	
4.83E+10	Existing Load
2.11E+10	**Total TMDL**
2.11E+09	**MOS**
1.90E+10	TMDL Target
60.6%	% reduction
1.90E+10	remainder
9.51E+07	**Future Growth WLA** [(1)]
1.89E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.4 TMDL Summary for UT to Cypress Creek 0.0 to 3.0

UT to Cypress Creek at RM 0.0 is a second order stream located in Muhlenberg County (Figure 8.4). Information about UT to Cypress Creek 0.0 to 3.0, including its WBID and MAF is shown in Table 8.16. Site information is presented in Table 8.17. The subwatershed for the impaired segment has a total drainage area of approximately 2.6 square miles. The land cover in this subwatershed is predominantly forested (52.7%) followed by agriculture (36.2%) while urban/residential development accounts for 5.1% (Table 8.18). Sampling data from site 10 are presented in Table 8.19 and the TMDL allocations in Table 8.20.

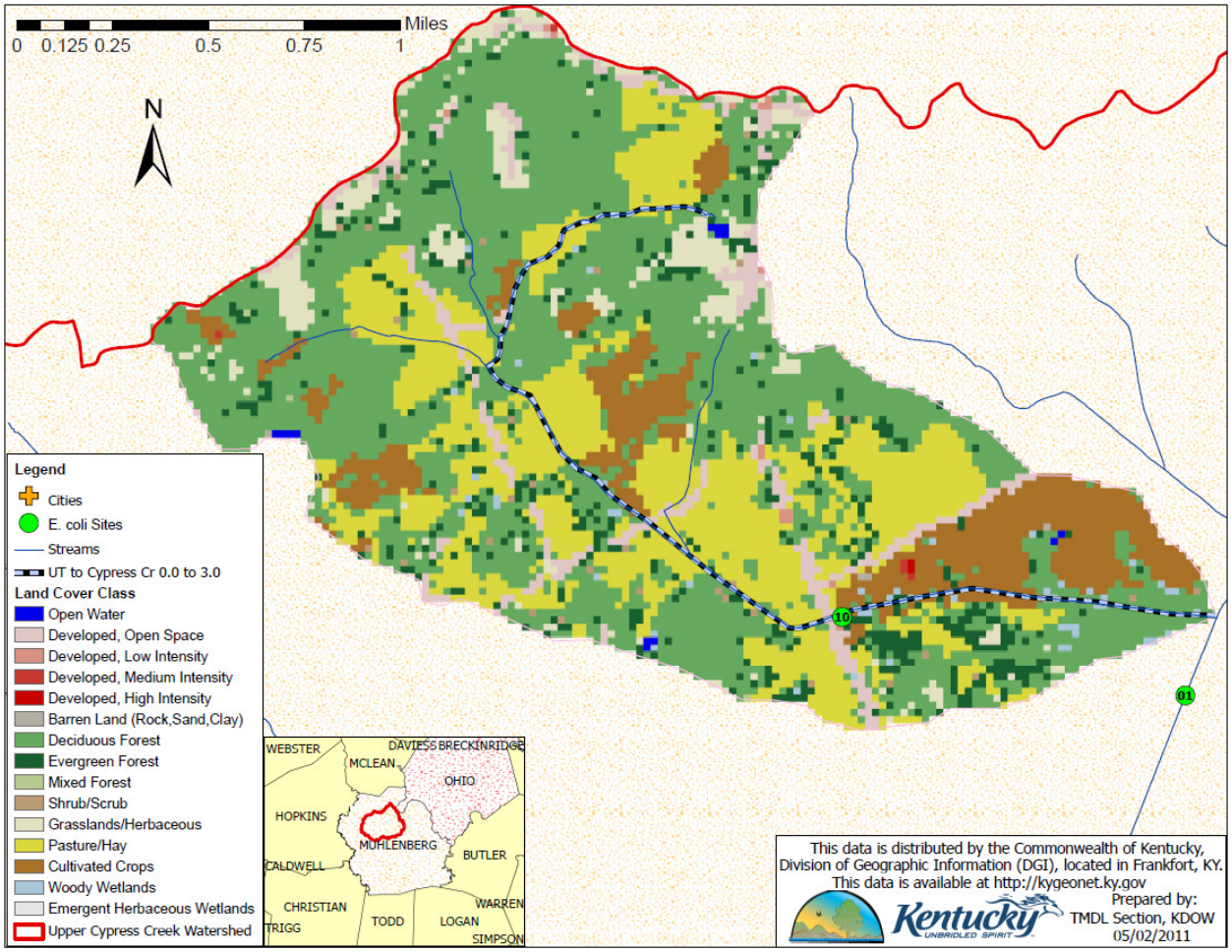

Figure 8.4 UT to Cypress Creek 0.0 to 3.0 Subwatershed

Table 8.16 UT to Cypress Creek 0.0 to 3.0 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Cypress Creek 0.0 to 3.0	KY490526-26.3_01	Muhlenberg	1,680	2.6	2nd	3.2	0

Table 8.17 UT to Cypress Creek 0.0 to 3.0 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
10	37.30585	-87.214	1

Table 8.18 UT to Cypress Creek 0.0 to 3.0 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	0.19	3.11	0.00	
Developed	5.11	85.80	0.13	1
Barren Land	0.05	0.89	0.00	
Forest/Shrubland	52.70	885.09	1.38	
Grassland/Herbaceous	5.03	84.46	0.13	
Agriculture (total)	36.22	608.36	0.95	
Pasture/Hay	24.95	418.99	0.65	
Cultivated Crops	11.28	189.38	0.30	
Wetlands	0.70	11.78	0.02	
Totals	100.00	1679.50	2.62	

Table 8.19 UT to Cypress Creek 0.0 to 3.0 Data (Site 10)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	81
26-May-09	78
9-Jun-09	162
23-Jun-09	2420
7-Jul-09	816
23-Jul-09	980
4-Aug-09	326
31-Aug-09	48
8-Sep-09	411
23-Sep-09	2420
8-Oct-09	866
27-Oct-09	228
Greatest Exceedance	2420

Table 8.20 TMDL Allocations for UT to Cypress Creek 0.0 to 3.0

E. coli (colonies/day)	
1.89E+11	Existing Load
1.88E+10	**Total TMDL**
1.88E+09	**MOS**
1.69E+10	TMDL Target
91.1%	% reduction
1.69E+10	remainder
1.69E+08	**Future Growth WLA**[(1)]
1.67E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.5 TMDL Summary for UT to Cypress Creek 0.0 to 3.4

UT to Cypress Creek at RM 0.0 is a first order stream located in Muhlenberg County (Figure 8.5). Information about UT to Cypress Creek 0.0 to 3.4, including its WBID and MAF is shown in Table 8.21. Site information is presented in Table 8.22. The subwatershed for the impaired segment has a total drainage area of approximately 3.6 square miles. The land cover in this subwatershed is predominantly forested (48%) followed by grasslands (24.9%) while urban/residential development accounts for 6% (Table 8.23). There is a high percentage of wetlands (8%) in this subwatershed. Sampling data from site 09 are presented in Table 8.24 and the TMDL allocations in Table 8.25.

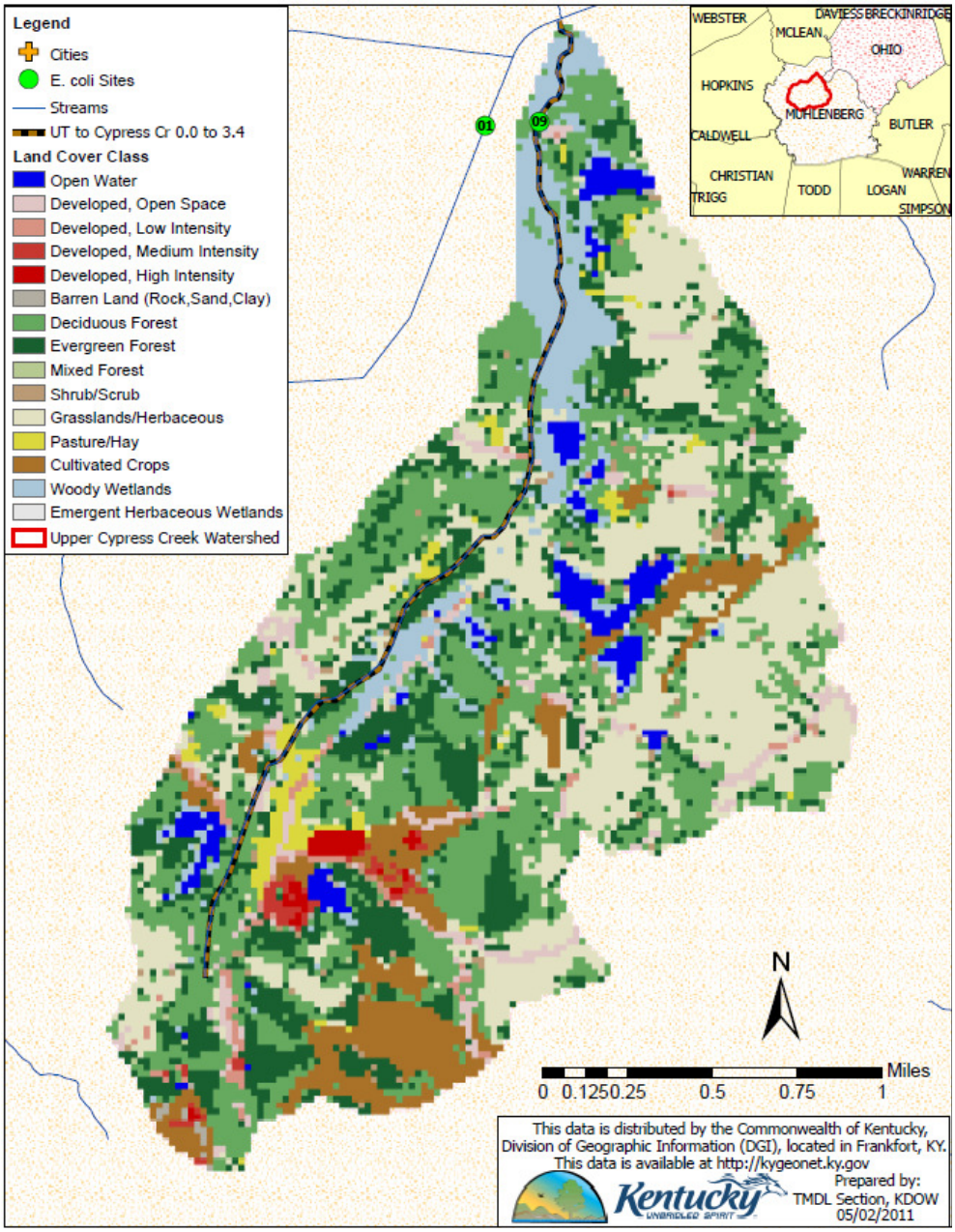

Figure 8.5 UT to Cypress Creek 0.0 to 3.4 Subwatershed

Table 8.21 UT to Cypress Creek 0.0 to 3.4 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT of Cypress Creek 0.0 to 3.4	KY490526-26.1_01	Muhlenberg	2,328	3.6	1st	4.7	0

Table 8.22 UT to Cypress Creek 0.0 to 3.4 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
09	37.3033	-87.194	0.35

Table 8.23 UT to Cypress Creek 0.0 to 3.4 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	3.20	74.57	0.12	
Developed	5.98	139.14	0.22	1
Barren Land	0.29	6.66	0.01	
Forest/Shrubland	48.05	1118.48	1.75	
Grassland/Herbaceous	24.86	578.77	0.90	
Agriculture (total)	9.67	225.03	0.35	
Pasture/Hay	1.98	46.16	0.07	
Cultivated Crops	7.68	178.87	0.28	
Wetlands	7.95	185.08	0.29	
Totals	100.00	2327.73	3.64	

Table 8.24 UT to Cypress Creek 0.0 to 3.4 Data (Site 09)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	30
26-May-09	21
9-Jun-09	29
23-Jun-09	214
7-Jul-09	33
24-Jul-09	980
4-Aug-09	64
31-Aug-09	268
8-Sep-09	2420
23-Sep-09	517
8-Oct-09	411
27-Oct-09	162
Greatest Exceedance	2420

Table 8.25 TMDL Allocations for UT to Cypress Creek 0.0 to 3.4

E. coli (colonies/day)	
2.78E+11	Existing Load
2.76E+10	**Total TMDL**
2.76E+09	**MOS**
2.48E+10	TMDL Target
91.1%	% reduction
2.48E+10	remainder
2.48E+08	**Future Growth WLA**[(1)]
2.46E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.6 TMDL Summary for UT to Little Cypress Creek 0.0 to 1.75

UT to Little Cypress Creek at RM 0.0 is a first order stream located in Muhlenberg County (Figure 8.6). Information about UT to Little Cypress Creek 0.0 to 1.75, including its WBID and MAF is shown in Table 8.26. Site information is presented in Table 8.27. The subwatershed for the impaired segment has a total drainage area of approximately 3 square miles. The land cover in this subwatershed is predominantly urban/residential development (44.3%) in the area of Central City followed by forested (38.4%) (Table 8.28). Sampling data from site 14 are presented in Table 8.29 and the TMDL allocations in Table 8.30.

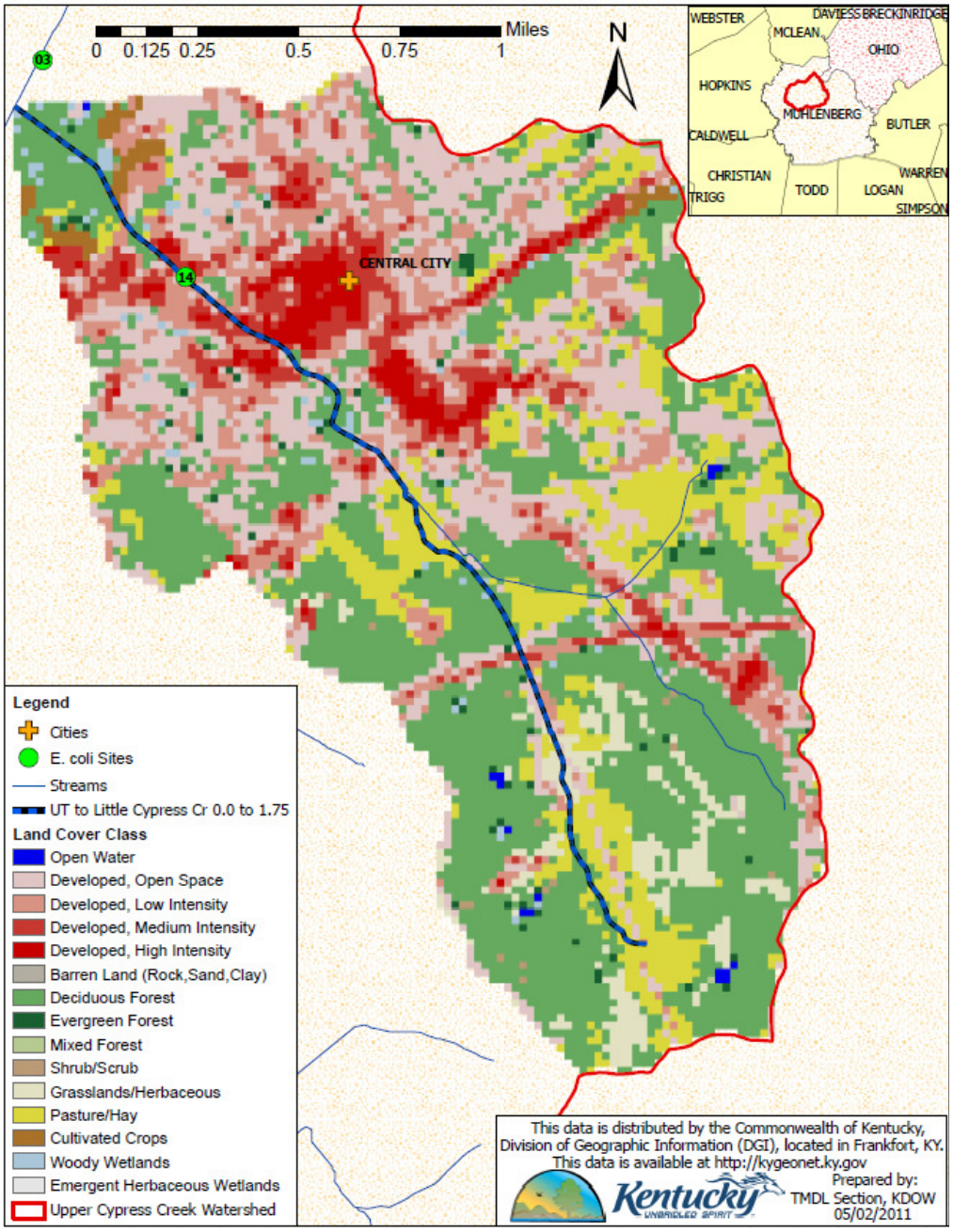

Figure 8.6 UT to Little Cypress Creek 0.0 to 1.75 Subwatershed

Table 8.26 UT to Little Cypress Creek 0.0 to 1.75 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Little Cypress Creek 0.0 to 1.75	KY496701-3.1_01	Muhlenberg	1,929	3.0	1st	3.5	0

Table 8.27 UT to Little Cypress Creek 0.0 to 1.75 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
14	37.294	-87.131	0.6

Table 8.28 UT to Little Cypress Creek 0.0 to 1.75 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	0.18	3.56	0.01	
Developed	44.33	855.38	1.34	5
Barren Land	0.02	0.44	0.00	
Forest/Shrubland	38.43	741.48	1.16	
Grassland/Herbaceous	3.47	66.96	0.10	
Agriculture (total)	12.64	243.82	0.38	
Pasture/Hay	11.69	225.58	0.35	
Cultivated Crops	0.95	18.24	0.03	
Wetlands	0.92	17.80	0.03	
Totals	100.00	1929.44	3.01	

Table 8.29 UT to Little Cypress Creek 0.0 to 1.75 Data (Site 14)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	1500
26-May-09	1500
9-Jun-09	1553
23-Jun-09	2420
7-Jul-09	816
23-Jul-09	1046
4-Aug-09	613
31-Aug-09	133
8-Sep-09	687
23-Sep-09	435
8-Oct-09	649
27-Oct-09	488
Greatest Exceedance	2420

Table 8.30 TMDL Allocations for UT to Little Cypress Creek 0.0 to 1.75

E. coli (colonies/day)	
2.07E+11	Existing Load
2.06E+10	**Total TMDL**
2.06E+09	**MOS**
1.85E+10	TMDL Target
91.1%	% reduction
1.85E+10	remainder
9.25E+08	**Future Growth WLA**[(1)]
1.76E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.7 TMDL Summary for UT to Little Cypress Creek 0.0 to 3.25

UT to Little Cypress Creek at RM 0.0 is a third order stream located in Muhlenberg County (Figure 8.7). Information about UT to Little Cypress Creek 0.0 to 3.25, including its WBID and MAF is shown in Table 8.31. Site information is presented in Table 8.32. The subwatershed for the impaired segment has a total drainage area of approximately 4.6 square miles. The land cover in this subwatershed is predominantly forested (56%) followed by grasslands (20.7%) while urban/residential development accounts for 13% (Table 8.33). Sampling data from site 15 are presented in Table 8.34 and the TMDL allocations in Table 8.35.

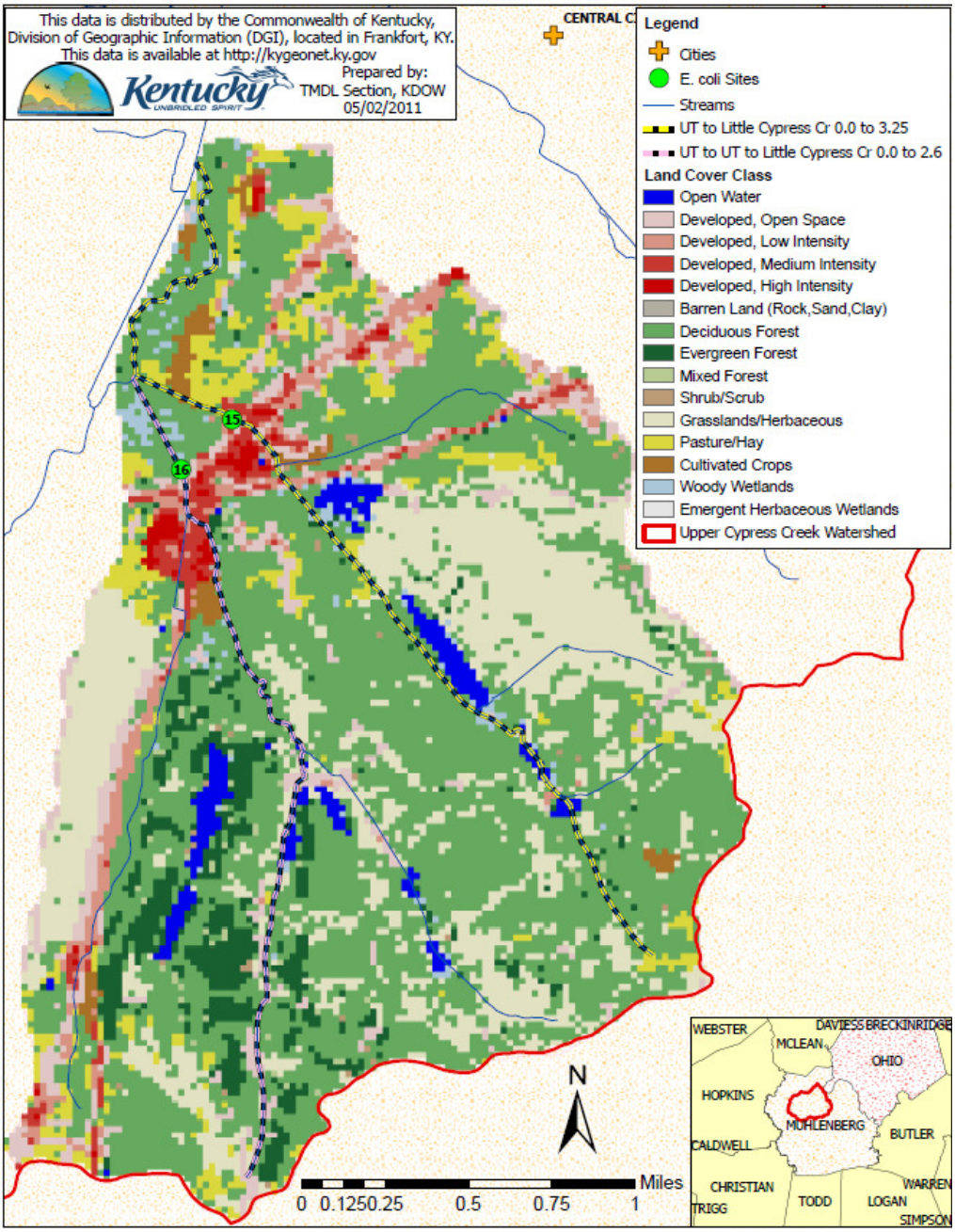

Figure 8.7 UT to Little Cypress Creek 0.0 to 3.25 Subwatershed

Table 8.31 UT to Little Cypress Creek 0.0 to 3.25 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Little Cypress Creek 0.0 to 3.25	KY496701-4.0_01	Muhlenberg	2,959	4.6	3rd	5.6	0

Table 8.32 UT to Little Cypress Creek 0.0 to 3.25 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
15	37.2769	-87.141	1.15

Table 8.33 UT to Little Cypress Creek 0.0 to 3.25 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	2.22	65.84	0.10	
Developed	12.98	384.09	0.60	2
Barren Land	0.03	0.89	0.00	
Forest/Shrubland	55.97	1656.21	2.59	
Grassland/Herbaceous	20.69	612.18	0.96	
Agriculture (total)	6.83	201.98	0.32	
Pasture/Hay	5.61	166.04	0.26	
Cultivated Crops	1.21	35.93	0.06	
Wetlands	1.29	38.16	0.06	
Totals	100.00	2959.35	4.62	

Table 8.34 UT to Little Cypress Creek 0.0 to 3.25 Data (Site 15)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	99
27-May-09	105
10-Jun-09	84
23-Jun-09	1414
8-Jul-09	46
23-Jul-09	649
4-Aug-09	53
31-Aug-09	161
8-Sep-09	162
23-Sep-09	387
8-Oct-09	1203
27-Oct-09	119
Greatest Exceedance	1414

Table 8.35 TMDL Allocations for UT to Little Cypress Creek 0.0 to 3.25

E. coli (colonies/day)	
1.94E+11	Existing Load
3.29E+10	**Total TMDL**
3.29E+09	**MOS**
2.96E+10	TMDL Target
84.7%	% reduction
2.96E+10	remainder
5.92E+08	**Future Growth WLA[(1)]**
2.90E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.2.8 TMDL Summary for UT to UT to Little Cypress Creek 0.0 to 2.6

UT to UT to Little Cypress Creek at RM 0.0 is a second order stream located in Muhlenberg County (Figure 8.8). Information about UT to UT to Little Cypress Creek 0.0 to 2.6, including its WBID and MAF is shown in Table 8.36. Site information is presented in Table 8.37. The subwatershed for the impaired segment has a total drainage area of approximately 2.3 square miles. The land cover in this subwatershed is predominantly forested (60.5%) followed by grasslands (19.4%) while urban/residential development accounts for 2.3% (Table 8.38). Sampling data from site 16 are presented in Table 8.39 and the TMDL allocations in Table 8.40.

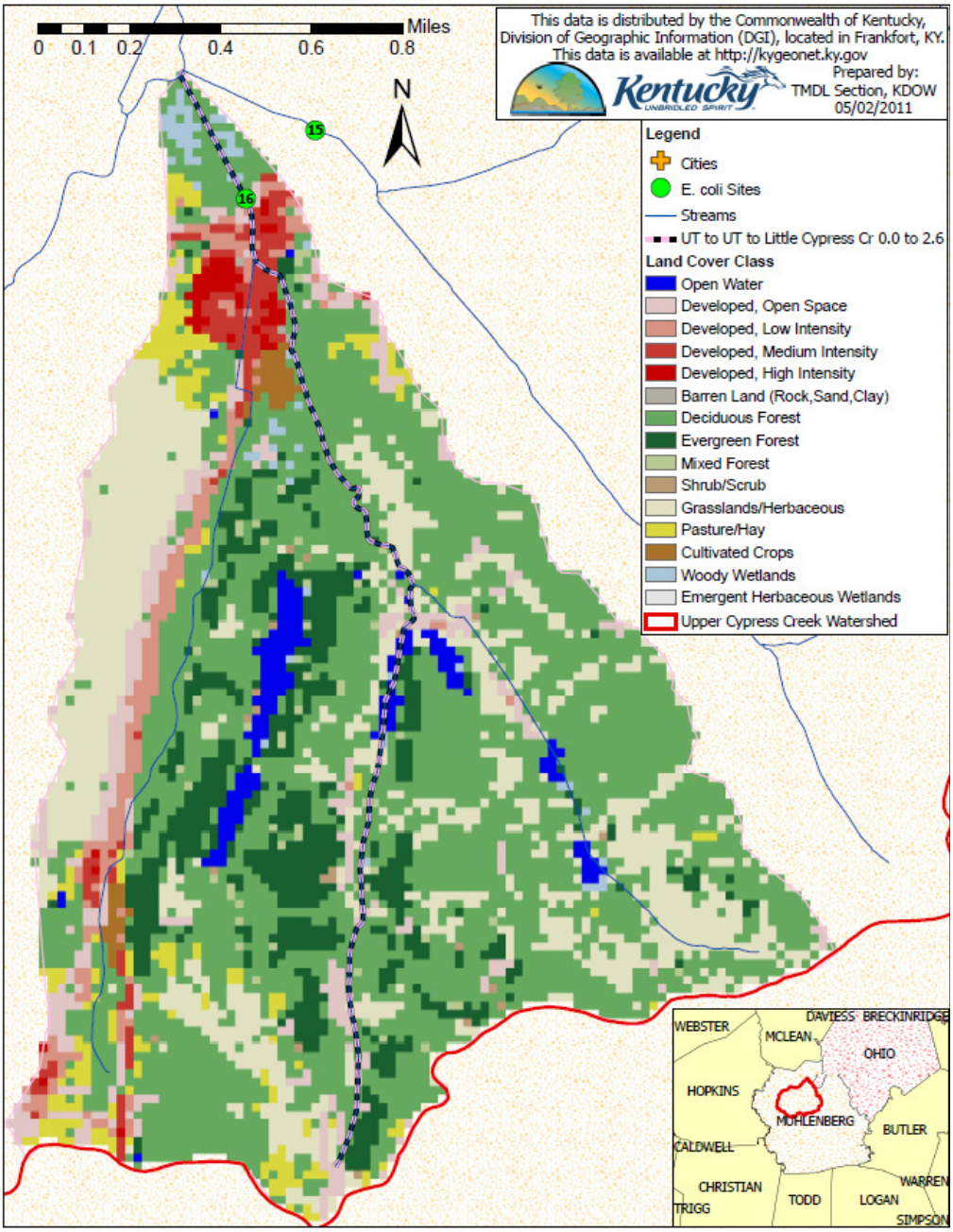

Figure 8.8 UT to UT to Little Cypress Creek 0.0 to 2.6 Subwatershed

Table 8.36 UT to UT to Little Cypress Creek 0.0 to 2.6 Segment Information

Stream Segment	WBID #	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to UT to Little Cypress Creek 0.0 to 2.6	KY496701-0.9-4.0_01	Muhlenberg	1,495	2.3	2nd	2.8	0

Table 8.37 UT to UT to Little Cypress Creek 0.0 to 2.6 Site information

Site Number	Sample Site Latitude	Sample Site Longitude	Sample Point RM
16	37.2747	-87.143	0.3

Table 8.38 UT to UT to Little Cypress Creek 0.0 to 2.6 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	2.34	35.01	0.05	
Developed	12.30	183.81	0.29	2
Barren Land	0.05	0.67	0.00	
Forest/Shrubland	60.45	903.56	1.41	
Grassland/Herbaceous	19.41	290.19	0.45	
Agriculture (total)	4.46	66.66	0.10	
Pasture/Hay	3.71	55.43	0.09	
Cultivated Crops	0.75	11.22	0.02	
Wetlands	0.99	14.81	0.02	
Totals	100.00	1494.72	2.34	

Table 8.39 UT to UT to Little Cypress Creek 0.0 to 2.6 Data (Site 16)

Collection Date	*E. coli* (colonies/100 ml)
12-May-09	54
27-May-09	279
10-Jun-09	727
23-Jun-09	1120
23-Jul-09	197
8-Sep-09	249
23-Sep-09	649
8-Oct-09	365
27-Oct-09	46
Greatest Exceedance	1120

Table 8.40 TMDL Allocations for UT to UT to Little Cypress Creek 0.0 to 2.6

E. coli (colonies/day)	
7.67E+10	Existing Load
1.64E+10	**Total TMDL**
1.64E+09	**MOS**
1.48E+10	TMDL Target
80.7%	% reduction
1.48E+10	remainder
2.96E+08	**Future Growth WLA**[(1)]
1.45E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.3 Summary for all TMDLs and Allocations

A summary table of the TMDL allocations for each segment is presented in Table 8.41.

Table 8.41 TMDL Summary Table

Stream Segment	Existing Load (*E. coli* colonies/ day)	**Total TMDL** (*E. coli* colonies/ day)	**MOS** (*E. coli* colonies/ day)	TMDL Target (*E. coli* colonies/ day)	% reduction	remainder (*E. coli* colonies/ day)	**Future Growth WLA**[(1)] (*E. coli* colonies/ day)	**LA** (*E. coli* colonies/ day)
Cypress Creek 23.1 to 26.5	1.70E+12	**3.89E+11**	**3.89E+10**	3.50E+11	79.3%	3.50E+11	**3.50E+09**	**3.47E+11**
Little Cypress Creek 0.0 to 8.7	1.76E+12	**1.74E+11**	**1.74E+10**	1.57E+11	91.1%	1.57E+11	**3.14E+09**	**1.54E+11**
UT to Cypress Creek 0.0 to 1.45	4.83E+10	**2.11E+10**	**2.11E+09**	1.90E+10	60.6%	1.90E+10	**9.51E+07**	**1.89E+10**
UT to Cypress Creek 0.0 to 3.0	1.89E+11	**1.88E+10**	**1.88E+09**	1.69E+10	91.1%	1.69E+10	**1.69E+08**	**1.67E+10**
UT to Cypress Creek 0.0 to 3.4	2.78E+11	**2.76E+10**	**2.76E+09**	2.48E+10	91.1%	2.48E+10	**2.48E+08**	**2.46E+10**
UT to Little Cypress Creek 0.0 to 1.75	2.07E+11	**2.06E+10**	**2.06E+09**	1.85E+10	91.1%	1.85E+10	**9.25E+08**	**1.76E+10**
UT to Little Cypress Creek 0.0 to 3.25	1.94E+11	**3.29E+10**	**3.29E+09**	2.96E+10	84.7%	2.96E+10	**5.92E+08**	**2.90E+10**
UT to UT to Little Cypress Creek 0.0 to 2.6	7.67E+10	**1.64E+10**	**1.64E+09**	1.48E+10	80.7%	1.48E+10	**2.96E+08**	**1.45E+10**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

8.4 Translation of WLAs into Permit Limits

If any future SWS sources are approved in the watershed, their WLAs (from the Future Growth WLA) will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average.

9.0 Implementation Options

Section 303(e) of the Clean Water Act and 40 CFR Part 130, Section 130.5, require states to have a continuing planning process (CPP) composed of several parts specified in the Act and the regulation. The CPP provides an outline of agency programs and the available authority to address water issues. Under the CPP umbrella, the Watershed Management Branch of KDOW will be available to provide assistance with technical support for developing and implementing watershed plans to address water quality and quantity problems and threats. Developing watershed plans enables more effective targeting of limited restoration funds and resources, thus improving environmental benefit, protection and recovery.

Watershed plans provide an integrative approach for identifying and describing how, when, who and what actions should be taken in order to meet water quality standards. At this time, a comprehensive watershed restoration plan for the Upper Cypress Creek watershed has not been developed. This TMDL provides bacteria allocations and reduction goals that may assist with developing a detailed watershed plan to guide watershed restoration efforts.

A watershed plan for the Upper Cypress Creek watershed should address both point and nonpoint sources of pollution in the watershed and should build on existing efforts as well as evaluate new approaches. Because of the specific landscape and location of the impairments in the Upper Cypress Creek watershed, a watershed plan should incorporate all available restoration and protection mechanisms, including Groundwater Protection Plans, and storm water and wastewater KPDES permits. A comprehensive watershed plan should consider both voluntary and regulatory approaches to meet water quality standards. When such a plan is developed, pollutant trading may be a viable management strategy to consider for meeting the TMDL load reduction goals.

9.1 Kentucky Watershed Management Framework

A Watershed Management Framework approach to Water Quality Management (WQM) was adopted by the KDOW in 1998. The plan divides Kentucky's major drainage basins into five groups of basins which are cycled through a five year staggered process which involves monitoring, assessment, prioritization, plan development, and plan implementation. The major basin that the Upper Cypress Creek watershed lies within is the Green River basin. The first phase of the process for the Green River basin began in 2000. As part of the process, a basin coordinator is assigned to each river basin to work with the citizens of the basin to develop a local Watershed Management Team associated with each priority watershed. For more information about the Green River basin see:
http://www.water.ky.gov/watershed/Pages/GreenandTradewaterRiversBasin.aspx

9.2 Non-Governmental Organizations

There are a couple Non-Governmental Organizations (NGO) operating in the Upper Cypress Creek watershed that may help to implement the TMDL, particularly with regard to nonpoint source issues. These organizations include the Tradewater/Lower Green Watershed Watch and Kentucky Waterways Alliance.

9.2.1 Tradewater/Lower Green Watershed Watch

The Tradewater/Lower Green Watershed Watch is a citizen's water monitoring effort that relies on volunteers to provide administration, training, and volunteer and equipment coordination. The volunteers measure basic parameters of stream health to determine whether streams meet important "uses" under the Clean Water Act including aquatic life, human recreation, and drinking water.

Several water quality parameters have been monitored by the Tradewater/Lower Green Watershed Watch. Three times per year, water samples are collected from seven sites on in the Upper Cypress Creek watershed. Volunteers collect physical measurements, such as temperature, pH, dissolved oxygen, and conductivity. Stream monitoring also includes macroinvertebrate and habitat assessments. Once annually, water samples are tested for bacteria (*E. coli*), selected pesticides (triazine), turbidity, chlorides and nitrates. Data from annual monitoring are routinely used to help identify problems in the watershed, and assist with prioritizing streams for restoration and protection activities.

9.2.1 Kentucky Waterways Alliance

The formation of Kentucky Waterways Alliance (KWA) was the result of a series of meetings sponsored by the Kentucky Environmental Quality Commission. The KWA has a mission to protect and restore Kentucky's waterways and their watersheds through alliances for watershed stewardship. This includes strengthening community and governmental stewardship for the restoration and preservation of Kentucky's water resources. The Alliance promotes networking, communication and mutual support among groups, government agencies, and businesses working on waterway issues.

10.0 Public Participation

This TMDL document was published for a 30-day public comment period. A public notice was sent to all newspapers in the Commonwealth of Kentucky and an advertisement was purchased in The Times-Argus. Additionally, the public notice was distributed electronically through the 'Press Release' mailing list maintained by the Governor's Office of media outlets across the Commonwealth. No comments were received during the public notice period.

11.0 References

33 U.S.C. § 1251, Section 303(d). 1972. Clean Water Act.

401 KAR 5:002. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 5:005. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 5:006. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

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Appendix A. Land Cover Definitions

Table A.1 National Land-Cover Database Class Descriptions
(taken from Homer et. al., 2004)

11. **Open Water** - All areas of open water, generally with less than 25% cover of vegetation or soil.

21. **Developed, Open Space** - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes

22. **Developed, Low Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.

23. **Developed, Medium Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.

24**. Developed, High Intensity** - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.

31. **Barren Land (Rock/Sand/Clay)** - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

41. **Deciduous Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

42. **Evergreen Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. **Mixed Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

52. **Shrub/Scrub** - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.

71. **Grassland/Herbaceous** - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

81. **Pasture/Hay** - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. **Cultivated Crops** - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

90. **Woody Wetlands** - Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

95. **Emergent Herbaceous Wetlands** - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Appendix B. Monitoring Data

Tables B.1 through B.12 display the monitoring data summarized in Section 4. For the data tables, a red highlight indicates an exceedance of the instantaneous WQC (240 *E. coli* colonies/100 ml), an orange highlight across a row indicates a sample that failed the data validation process, and the "RPD exceeded" under the Note column indicates a sample and its duplicate that exceeded the relative percent difference (RPD). The non-duplicate sample that exceeded the RPD was summarized in Section 4 and was used in TMDL calculations. Samples that did not pass the validation process are not included in the data summary in Section 4 nor are they used in TMDL calculations. Samples were collected on Central Standard Time (CST). A ** under the flow column indicates that the water was too deep or inaccessible to measure flow while N/A indicates that a duplicate flow was not measured..

Table B.1 Site 01 Monitoring Data

Site 01	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	10:20	**	18		
	12-May-09	10:20	**	21	Duplicate (QA/QC sample)	
	26-May-09	09:30	**	39		
	9-Jun-09	10:25	**	24		
	23-Jun-09	11:35	**	39		
	7-Jul-09	09:30	**	24		
	23-Jul-09	11:30	**	53		
	4-Aug-09	11:10	**	7		
	31-Aug-09	11:45	**	8		
	8-Sep-09	09:30	**	76		
	23-Sep-09	09:00	**	579		
	8-Oct-09	10:30	**	548		
	8-Oct-09	10:30	N/A	488	Duplicate (QA/QC sample)	
	27-Oct-09	09:25	**	46		

Table B.2 Site 03 Monitoring Data

Site 03	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	09:25	**	90		
	26-May-09	08:50	**	249		
	26-May-09	08:50	N/A	291	Duplicate (QA/QC sample)	
	9-Jun-09	09:30	**	133		
	23-Jun-09	11:55	**	> 2420		

Site 03	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	7-Jul-09	08:35	**	118		
	24-Jul-09	08:50	**	308		
	4-Aug-09	09:15	**	124		RPD exceeded
	4-Aug-09	09:15	**	96	Duplicate (QA/QC sample)	RPD exceeded
	31-Aug-09	12:00	**	139		
	23-Sep-09	08:40	**	1986		
	8-Oct-09	09:10	**	579		
	27-Oct-09	09:05	**	34		

Table B.3 Site 07 Monitoring Data

Site 07	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	13-May-09	09:50	1.60	9		
	27-May-09	10:45	0.84	< 3		
	10-Jun-09	10:45	0.95	3		
	23-Jun-09	09:15	1.15	160		
	8-Jul-09	09:45	0.56	< 1		
	23-Jul-09	08:35	2.29	20		
	31-Aug-09	08:35	0.37	1 U		
	23-Sep-09	09:55	**	81		
	27-Oct-09	10:20	**	3		RPD exceeded
	27-Oct-09	10:20	N/A	2	Duplicate (QA/QC sample)	RPD exceeded

Table B.4 Site 08 Monitoring Data

Site 08	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	09:10	**	6		
	26-May-09	08:35	**	24		
	9-Jun-09	09:15	**	73		
	23-Jun-09	12:05	**	1046		
	8-Jul-09	11:05	**	36		
	8-Jul-09	11:05	N/A	36	Duplicate (QA/QC sample)	
	24-Jul-09	09:00	**	16		
	4-Aug-09	09:00	**	31		

Site 08	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	31-Aug-09	12:10	**	22		
	8-Sep-09	09:00	**	488		
	23-Sep-09	08:25	**	980		RPD exceeded
	23-Sep-09	08:25	N/A	1203	Duplicate (QA/QC sample)	RPD exceeded
	8-Oct-09	09:00	**	345		
	27-Oct-09	08:50	**	308		

Table B.5 Site 09 Monitoring Data

Site 09	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	10:10	**	30		
	26-May-09	09:25	**	21		
	9-Jun-09	10:20	**	29		
	23-Jun-09	11:40	**	214		RPD exceeded
	23-Jun-09	11:40	N/A	161	Duplicate (QA/QC sample)	RPD exceeded
	7-Jul-09	09:25	**	33		
	24-Jul-09	08:35	**	980		
	4-Aug-09	11:00	**	64		
	31-Aug-09	11:50	**	268		
	8-Sep-09	09:25	**	> 2420		
	23-Sep-09	09:05	**	517		
	8-Oct-09	10:25	**	411		
	27-Oct-09	09:30	**	162		

Table B.6 Site 10 Monitoring Data

Site 10	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	10:40	**	81		
	26-May-09	09:40	**	78		
	9-Jun-09	10:35	**	162		
	23-Jun-09	11:25	**	> 2420		
	7-Jul-09	09:40	**	816		
	23-Jul-09	11:20	**	980		
	4-Aug-09	11:20	**	326		
	31-Aug-09	11:35	**	48		

Site 10	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	8-Sep-09	09:40	**	411		
	23-Sep-09	08:55	**	> 2420		
	8-Oct-09	10:50	**	866		
	27-Oct-09	09:15	**	228		

Table B.7 Site 11 Monitoring Data

Site 11	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	13-May-09	08:05	3.63	90		
	27-May-09	08:35	1.50	159		
	10-Jun-09	08:45	1.79	161		
	23-Jun-09	08:45	1.94	548		
	8-Jul-09	08:50	1.38	81		
	23-Jul-09	09:20	4.12	387		
	31-Aug-09	09:40	0.05	45		
	8-Sep-09	11:05	0.48	84		
	8-Sep-09	11:05	N/A	102	Duplicate (QA/QC sample)	

Table B.8 Site 12 Monitoring Data

Site 12	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	13-May-09	08:30	3.08	84		
	27-May-09	09:00	**	54		
	10-Jun-09	09:30	1.38	36		
	23-Jun-09	11:00	2.57	172		
	8-Jul-09	09:15	1.31	31		
	23-Jul-09	11:10	**	46		
	23-Jul-09	11:10	N/A	46	Duplicate (QA/QC sample)	
	31-Aug-09	11:25	**	38		
	8-Sep-09	09:55	**	30		
	8-Oct-09	11:00	**	119		

Table B.9 Site 13 Monitoring Data

Site 13	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	27-May-09	09:25	**	21		
	10-Jun-09	08:15	3.33	17		

Site 13	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	23-Jun-09	08:10	14.55	28		
	8-Jul-09	08:05	5.58	28		
	23-Jul-09	09:50	**	131		
	31-Aug-09	09:10	2.10	35		
	8-Sep-09	10:35	7.04	48		

Table B.10 Site 14 Monitoring Data

Site 14	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	09:40	2.44	> 1500		
	26-May-09	09:05	1.59	> 1500		
	9-Jun-09	09:45	0.95	1553		RPD exceeded
	9-Jun-09	09:45	N/A	1230	Duplicate (QA/QC sample)	RPD exceeded
	23-Jun-09	10:30	3.54	> 2420		
	7-Jul-09	08:55	1.15	816		
	23-Jul-09	10:50	**	1046		
	4-Aug-09	09:35	**	613		
	31-Aug-09	10:50	0.63	133		
	8-Sep-09	11:50	0.87	687		
	23-Sep-09	09:15	**	435		
	8-Oct-09	09:25	**	649		
	27-Oct-09	09:40	**	488		

Table B.11 Site 15 Monitoring Data

Site 15	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	11:15	1.40	99		
	27-May-09	10:05	1.05	105		
	10-Jun-09	10:10	0.67	84		
	23-Jun-09	10:15	**	1414		
	8-Jul-09	10:30	0.86	46		
	23-Jul-09	10:40	**	649		
	4-Aug-09	10:00	**	53		
	31-Aug-09	10:25	**	161		
	31-Aug-09	10:25	N/A	172	Duplicate (QA/QC sample)	
	8-Sep-09	12:35	**	162		

Site 15	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	23-Sep-09	09:30	**	387		
	8-Oct-09	09:45	0.88	1203		
	27-Oct-09	09:55	**	119		

Table B.12 Site 16 Monitoring Data

Site 16	Collection Date	Time (CST)	Flow (cfs)	*E. coli* (colonies/100 ml)	Reason not Validated	Note
	12-May-09	11:00	**	54		
	27-May-09	10:25	**	279		
	10-Jun-09	10:30	**	727		
	23-Jun-09	09:55	**	1120		
	23-Jul-09	10:30	**	197		
	8-Sep-09	12:50	**	249		
	23-Sep-09	09:40	**	649		
	8-Oct-09	10:10	**	365		
	27-Oct-09	10:00	**	46		

Appendix C. Site Specific TMDL Allocations

In the subsections below, site specific watershed analysis and TMDL calculations for sites on impaired segments are presented. In two cases, the sample site used to represent the impaired segment was essentially coterminous with the downstream end of the impaired segment (Sites 08 and 11). For these two sites, no additional calculations were performed. The criterion used to determine that a site was coterminous with the end of an impaired segment was that the ratio of the sample site watershed area to that the segment was < .01 and that the MAF was the same for the end of the impaired segment and the sample site.

C.1 Site 3

Site 3 is located on the Little Cypress Creek 0.0 to 8.7 segment at RM 2.95. The stream at this location is third order (Figure C.1). The subwatershed above site 3 has a total drainage area of approximately 18.6 square miles (Table C.1). The land cover in this subwatershed is predominantly forested (52.5%) followed by grasslands (17.1%) while urban/residential development accounts for 15.6% (Table C.2). The TMDL allocations at site 3 are shown in Table C.3 while data from site 3 were presented in Table 8.9.

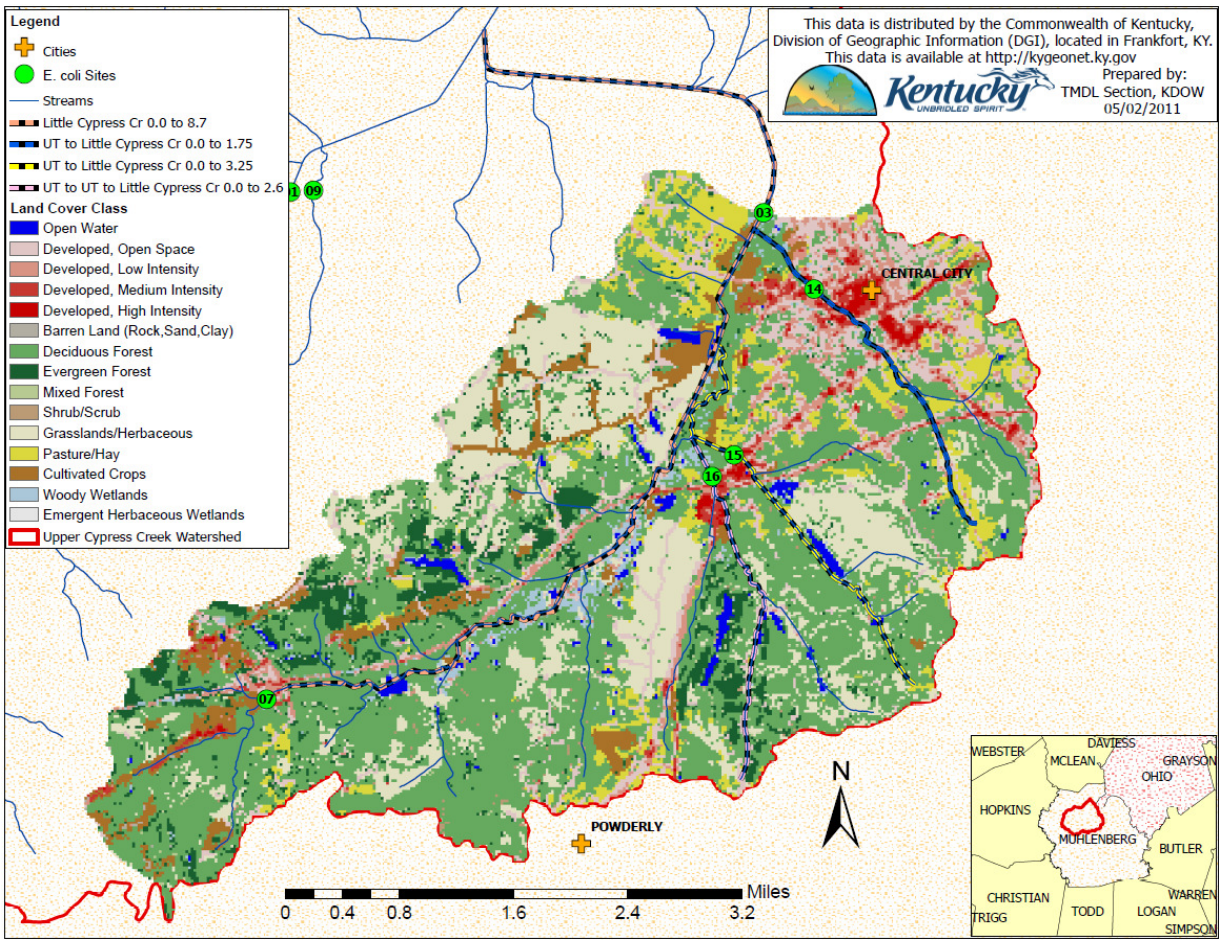

Figure C.1 Site 3 Subwatershed

Table C.1 Site 3 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
Little Cypress Creek 0.0 to 8.7	Muhlenberg	11,897	18.6	3rd	22.7	2.95

Table C.2 Site 3 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	1.35	160.70	0.25	
Developed	15.63	1859.28	2.91	3
Barren Land	0.11	13.60	0.02	
Forest/Shrubland	52.48	6243.37	9.76	
Grassland/Herbaceous	17.13	2037.59	3.18	
Agriculture (total)	11.38	1354.01	2.12	
Pasture/Hay	6.37	757.58	1.18	
Cultivated Crops	5.01	596.43	0.93	
Wetlands	1.92	228.23	0.36	
Totals	100.00	11896.77	18.59	

Table C.3 TMDL Allocations for Site 3

E. coli (colonies/day)	
1.34E+12	Existing Load
1.33E+11	**Total TMDL**
1.33E+10	**MOS**
1.20E+11	TMDL Target
91.1%	% reduction
1.20E+11	remainder
3.60E+09	**Future Growth WLA**[(1)]
1.16E+11	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

C. 2 Site 9

Site 9 is located on the UT to Cypress Creek 0.0 to 3.4 segment at RM 0.35. The stream at this location is first order (Figure C.2). The subwatershed above site 9 has a total drainage area of approximately 3.6 square miles (Table C.4). The land cover in this subwatershed is predominantly forested (48.1%) followed by grasslands (25.3%) while urban/residential development accounts for 6.1% (Table C.5). The TMDL allocations at site 9 are shown in Table C.6 while data from site 9 were presented in Table 8.24.

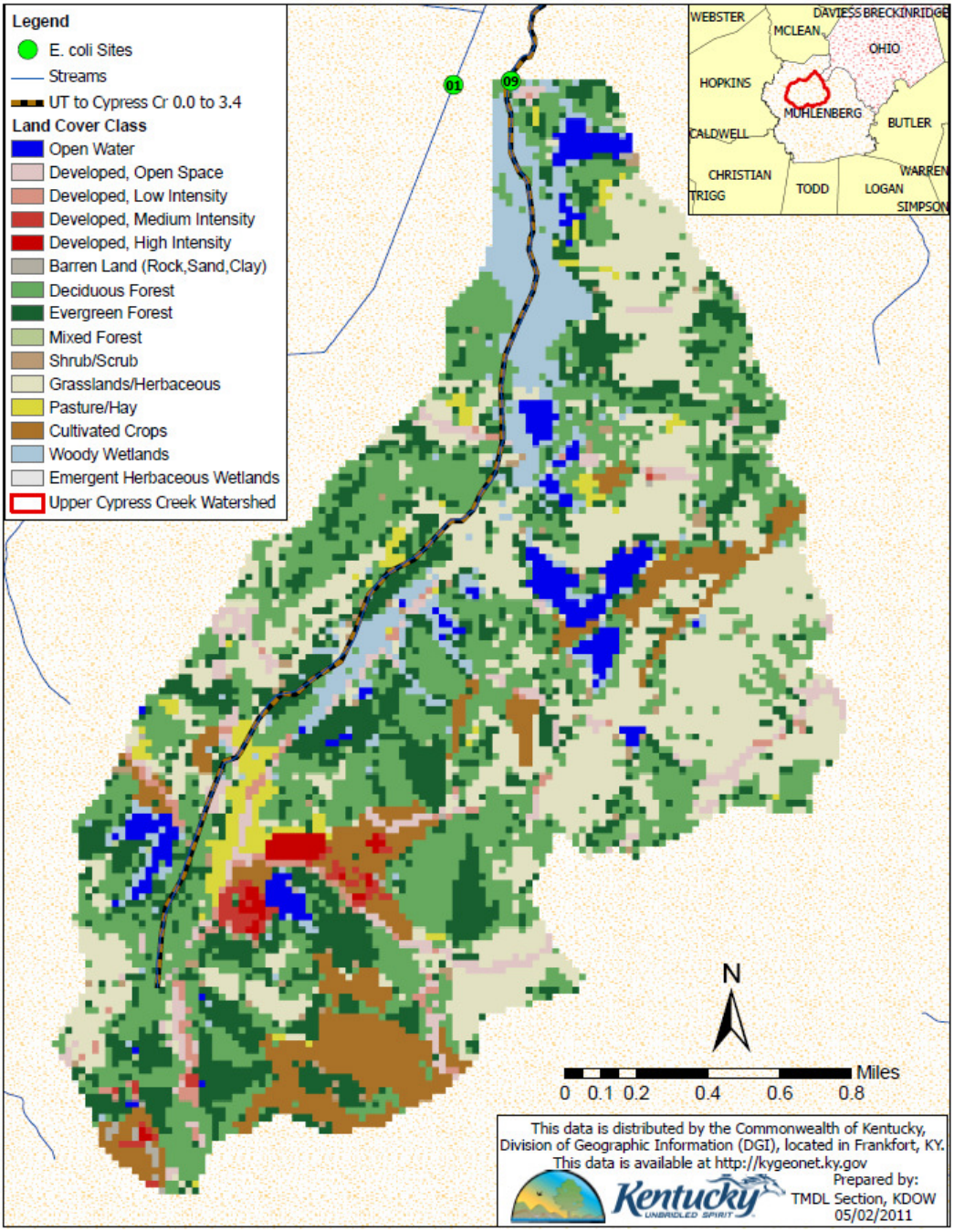

Figure C.2 Site 9 Subwatershed

Table C.4 Site 9 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Cypress Creek 0.0 to 3.4	Muhlenberg	2,288	3.6	1st	4.6	0.35

Table C.5 Site 9 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	3.28	74.98	0.12	
Developed	6.09	139.28	0.22	1
Barren Land	0.29	6.67	0.01	
Forest/Shrubland	48.09	1100.44	1.72	
Grassland/Herbaceous	25.34	579.81	0.91	
Agriculture (total)	9.85	225.38	0.35	
Pasture/Hay	2.02	46.28	0.07	
Cultivated Crops	7.83	179.11	0.28	
Wetlands	7.07	161.75	0.25	
Totals	100.00	2288.32	3.58	

Table C.6 TMDL Allocations for Site 9

E. coli (colonies/day)	
2.72E+11	Existing Load
2.70E+10	**Total TMDL**
2.70E+09	**MOS**
2.43E+10	TMDL Target
91.1%	% reduction
2.43E+10	remainder
2.43E+08	**Future Growth WLA**[(1)]
2.41E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

C.3 Site 10

Site 10 is located on the UT to Cypress Creek 0.0 to 3.0 segment at RM 1.0. The stream at this location is second order (Figure C.3). The subwatershed above site 10 has a total drainage area of approximately 2.0 square miles (Table C.7). The land cover in this subwatershed is predominantly forested (55.9%) followed by agriculture (31.9%) while urban/residential development accounts for 5.4% (Table C.8). The TMDL allocations at site 10 are shown in Table C.9 while data from site 10 were presented in Table 8.19.

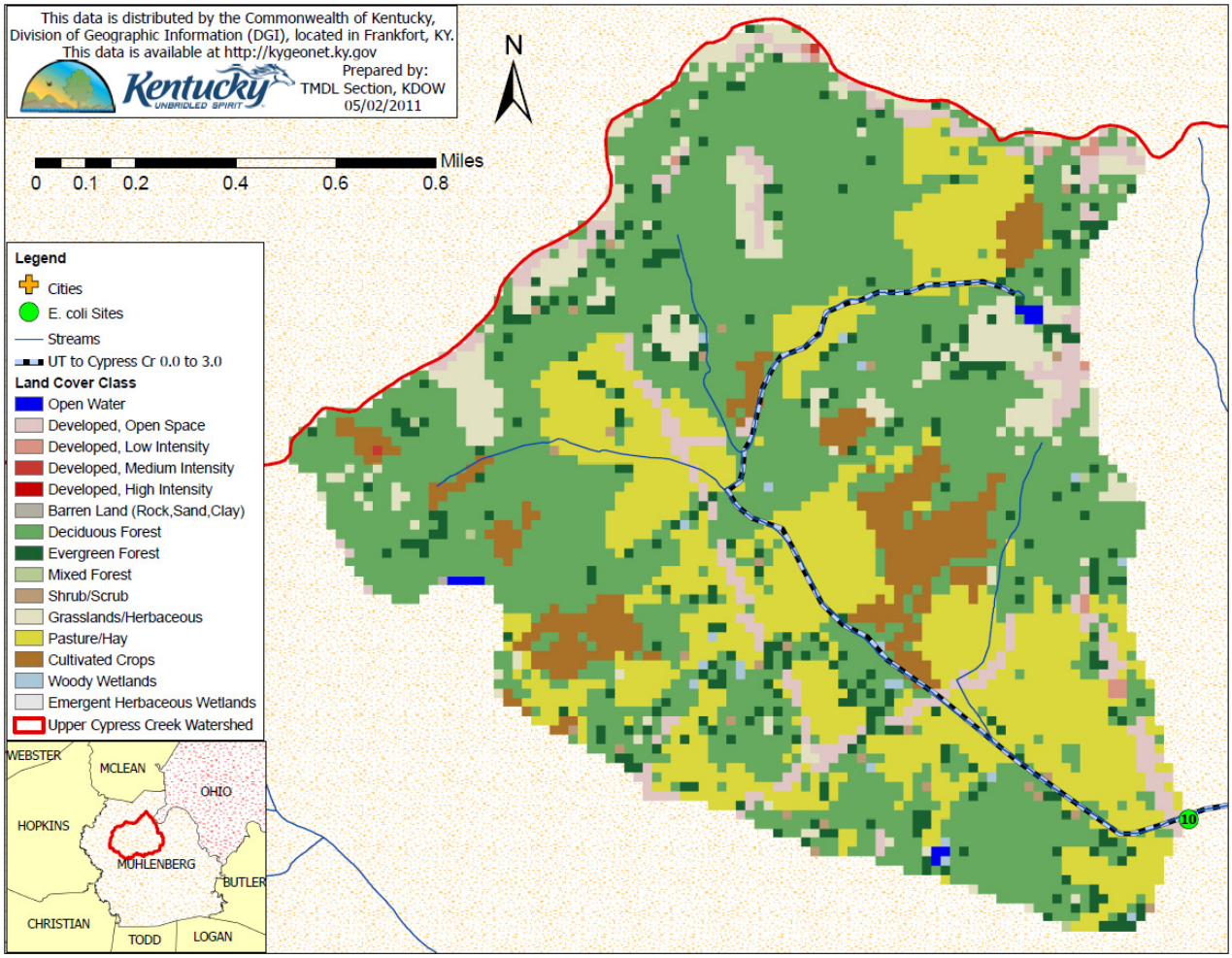

Figure C.3 Site 10 Subwatershed

Table C.7 Site 10 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Cypress Creek 0.0 to 3.0	Muhlenberg	1,263	2.0	2nd	2.6	1

Table C.8 Site 10 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	0.21	2.67	0.00	
Developed	5.39	68.09	0.11	1
Barren Land	0.02	0.22	0.00	
Forest/Shrubland	55.86	705.40	1.10	
Grassland/Herbaceous	6.27	79.22	0.12	
Agriculture (total)	31.89	402.77	0.63	
Pasture/Hay	25.48	321.77	0.50	
Cultivated Crops	6.41	81.00	0.13	
Wetlands	0.35	4.45	0.01	
Totals	100.00	1262.83	1.97	

Table C.9 TMDL Allocations for Site 10

E. coli (colonies/day)	
1.54E+11	Existing Load
1.53E+10	**Total TMDL**
1.53E+09	**MOS**
1.37E+10	TMDL Target
91.1%	% reduction
1.37E+10	remainder
1.37E+08	**Future Growth WLA**[(1)]
1.36E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

C.4 Site 14

Site 14 is located on the UT Little Cypress Creek 0.0 to 1.75 segment at RM 0.6. The stream at this location is first order (Figure C.4). The subwatershed above site 14 has a total drainage area of approximately 2.6 square miles (Table C.10). The land cover in this subwatershed is a mixture of developed (41.8%) and forested (40.2%) (Table C.11). The TMDL allocations at site 14 are shown in Table C.12 while data from site 14 were presented in Table 8.29.

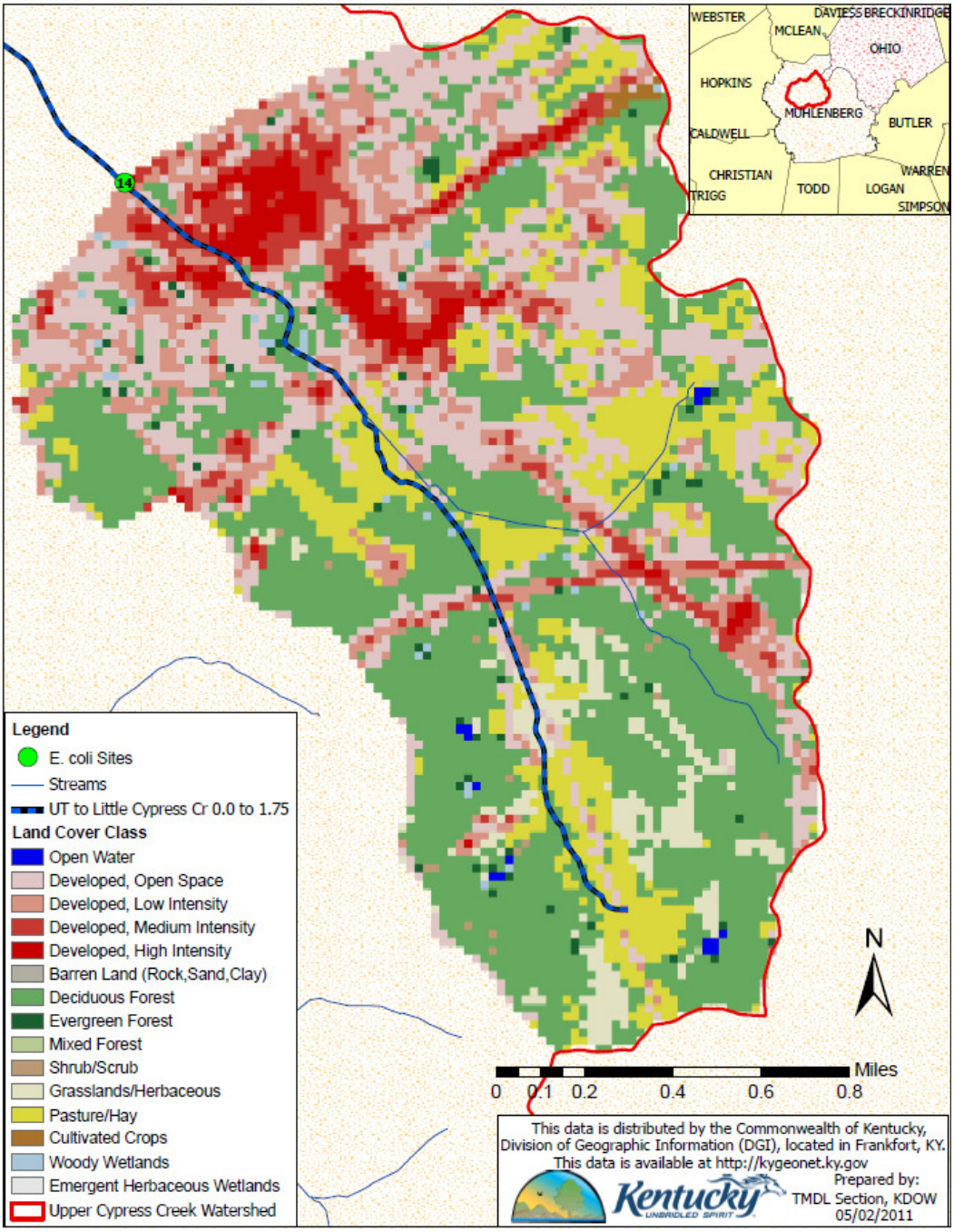

Figure C.4 Site 14 Subwatershed

Table C.10 Site 14 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Little Cypress Creek 0.0 to 1.75	Muhlenberg	1,681	2.6	1st	3.1	0.6

Table C.11 Site 14 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	0.20	3.34	0.01	
Developed	41.77	702.28	1.10	5
Barren Land	0.03	0.45	0.00	
Forest/Shrubland	40.21	675.98	1.06	
Grassland/Herbaceous	3.91	65.75	0.10	
Agriculture (total)	13.30	223.54	0.35	
Pasture/Hay	13.08	219.98	0.34	
Cultivated Crops	0.21	3.57	0.01	
Wetlands	0.58	9.81	0.02	
Totals	100.00	1681.15	2.63	

Table C.12 TMDL Allocations for Site 14

E. coli (colonies/day)	
1.84E+11	Existing Load
1.82E+10	**Total TMDL**
1.82E+09	**MOS**
1.64E+10	TMDL Target
91.1%	% reduction
1.64E+10	remainder
8.19E+08	**Future Growth WLA**[(1)]
1.56E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

C.5 Site 15

Site 15 is located on the UT to Little Cypress Creek 0.0 to 3.25 segment at RM 1.15. The stream at this location is second order (Figure C.5). The subwatershed above site 15 has a total drainage area of approximately 1.8 square miles (Table C.13). The land cover in this subwatershed is predominantly forested (52.3%) followed by grassland (27.2%) while urban/residential development accounts for 11.8% (Table C.14). The TMDL allocations at site 15 are shown in Table C.15 while data from site 15 were presented in table 8.34.

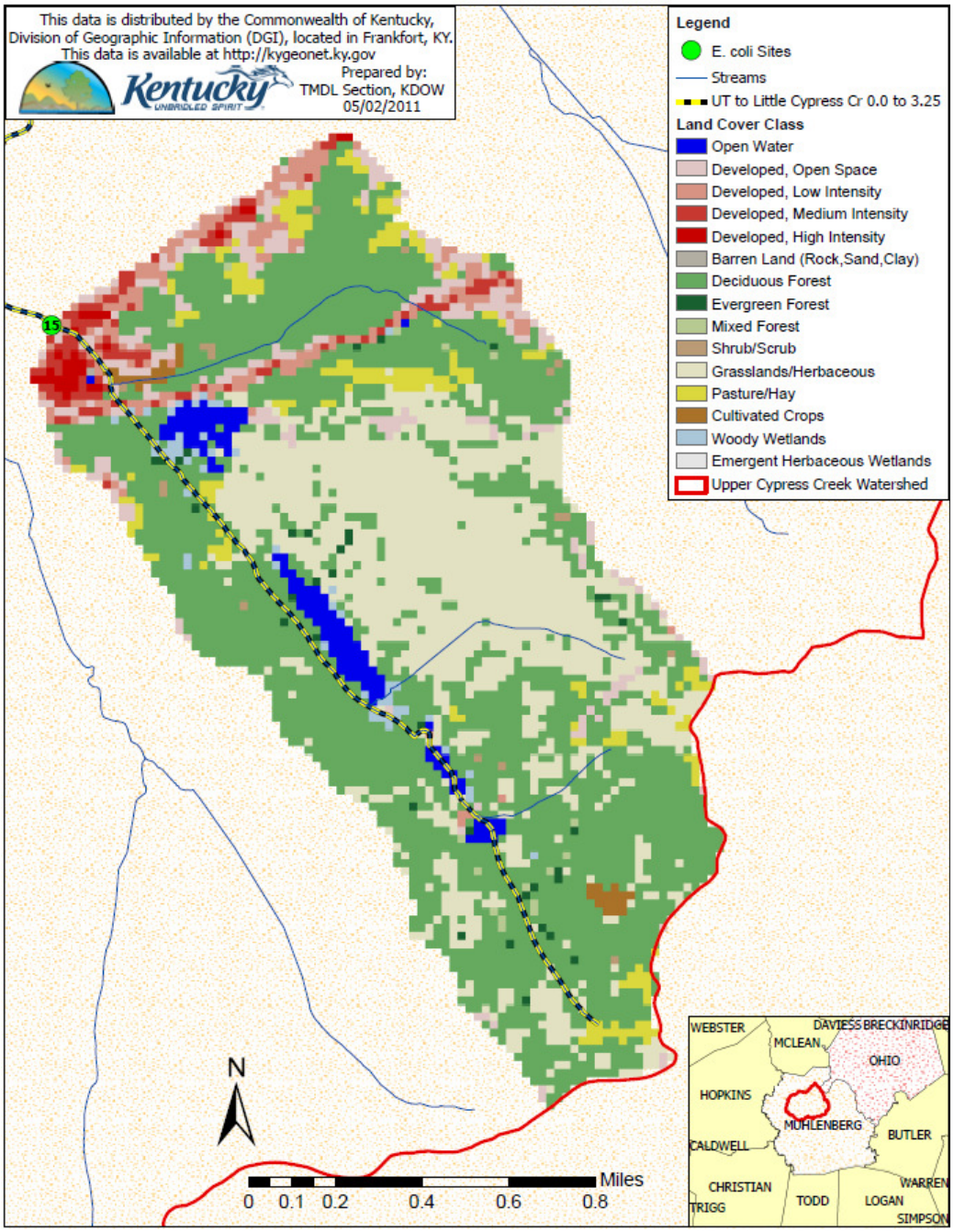

Figure C.5 Site 15 Subwatershed

Table C.13 Site 15 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to Little Cypress Creek 0.0 to 3.25	Muhlenberg	1,164	1.8	2nd	2.4	1.15

Table C.14 Site 15 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	2.66	30.94	0.05	
Developed	11.82	137.57	0.21	2
Barren Land	0.02	0.22	0.00	
Forest/Shrubland	52.31	608.82	0.95	
Grassland/Herbaceous	27.20	316.54	0.49	
Agriculture (total)	4.95	57.65	0.09	
Pasture/Hay	4.32	50.31	0.08	
Cultivated Crops	0.63	7.35	0.01	
Wetlands	1.03	12.02	0.02	
Totals	100.00	1163.77	1.82	

Table C.15 TMDL Allocations for Site 15

E. coli (colonies/day)	
8.30E+10	Existing Load
1.41E+10	**Total TMDL**
1.41E+09	**MOS**
1.27E+10	TMDL Target
84.7%	% reduction
1.27E+10	remainder
2.54E+08	**Future Growth WLA**[(1)]
1.24E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.

C.6 Site 16

Site 16 is located on the UT to UT to Little Cypress Creek 0.0 to 2.6 segment at RM 0.3. The stream at this location is second order (Figure C.6). The subwatershed above site 16 has a total drainage area of approximately 2.3 square miles (Table C.16). The land cover in this subwatershed is predominantly forested (60.3%) followed by grassland (20.1%) while urban/residential development accounts for 12.4% (Table C.17). The TMDL allocations at site 16 are shown in Table C.18 while data from site 16 were presented in table 8.39.

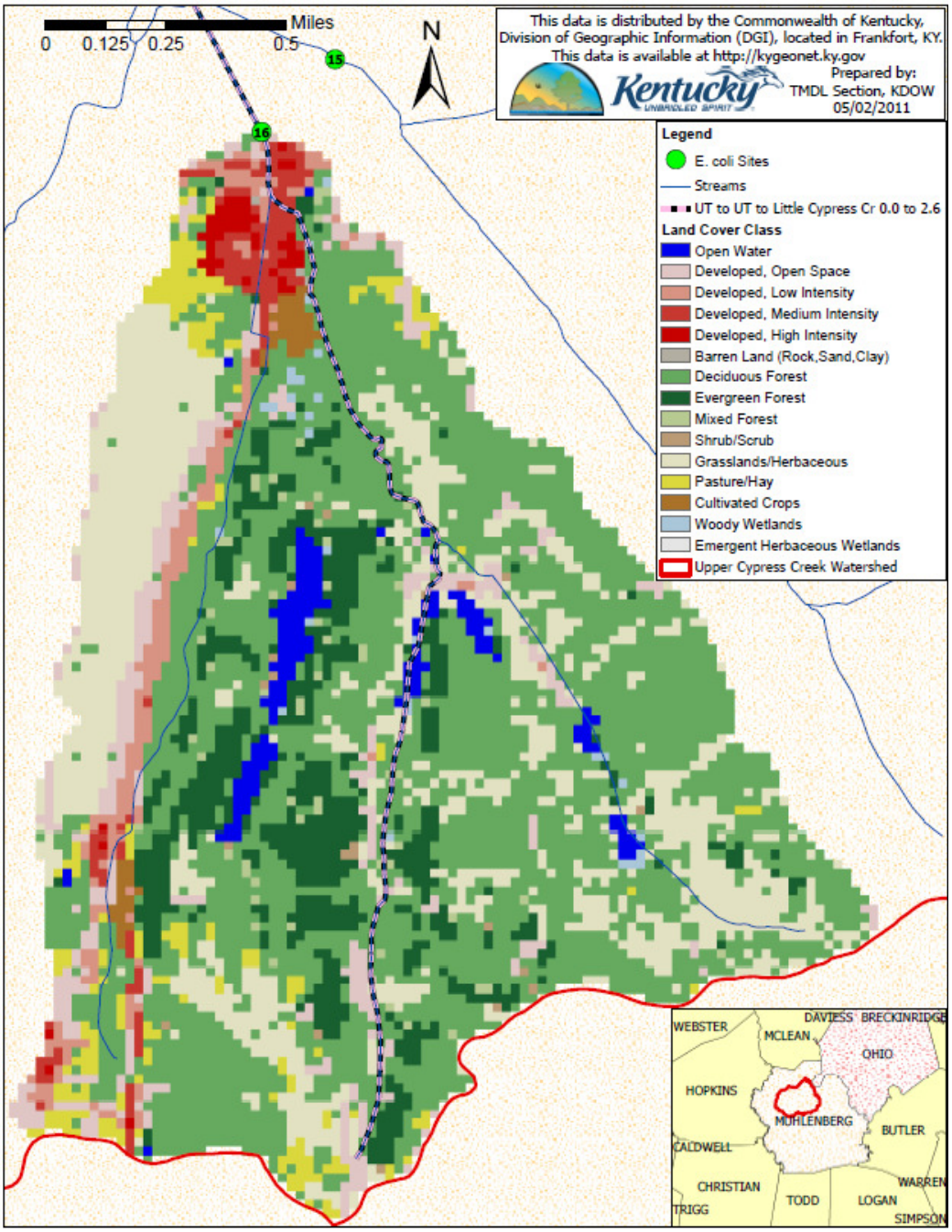

Figure C.6 Site 16 Subwatershed

Table C.16 Site 16 Subwatershed Information

Stream Segment	County	Acres	Square Miles	Stream Order	MAF-Critical Flow (cfs)	RM of MAF Determination
UT to UT to Little Cypress Creek 0.0 to 2.6	Muhlenberg	1,455	2.3	2nd	2.8	0.3

Table C.17 Site 16 Subwatershed Land Cover

Land Cover	% of Total Area	Watershed Acres	Watershed Square Miles	Future Growth WLA %
Open Water	2.40	34.86	0.05	
Developed	12.36	179.88	0.28	2
Barren Land	0.05	0.67	0.00	
Forest/Shrubland	60.27	876.84	1.37	
Grassland/Herbaceous	20.06	291.83	0.46	
Agriculture (total)	4.39	63.91	0.10	
Pasture/Hay	3.62	52.74	0.08	
Cultivated Crops	0.77	11.17	0.02	
Wetlands	0.48	6.93	0.01	
Totals	100.00	1454.92	2.27	

Table C.18 TMDL Allocations for Site 16

E. coli (colonies/day)	
7.67E+10	Existing Load
1.64E+10	**Total TMDL**
1.64E+09	**MOS**
1.48E+10	TMDL Target
80.7%	% reduction
1.48E+10	remainder
2.96E+08	**Future Growth WLA[(1)]**
1.45E+10	**LA**

Note: [(1)]Any future KPDES-permitted point source will receive its WLA from the Future Growth WLA and must meet permit limits based on the Water Quality Standards in 401 KAR 10:031.