Final
Total Maximum Daily Load for Bacteria
10 Stream Segments within the Carr Fork Watershed
Knott County, Kentucky
June, 2013

Submitted to:
United States Environmental Protection Agency
Region IV
Atlanta Federal Building
61 Forsyth Street SW
Atlanta, GA 30303-1534

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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

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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
CPP	Continuing Planning Process
ft^3	Cubic feet
GIS	Geographic Information System
GNIS	Geographic Names Information System
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
KAR	Kentucky Administrative Regulations
KDOW	Kentucky Division of Water
KGS	Kentucky Geological Survey
KRS	Kentucky Revised Statutes
KNDOP	Kentucky No Discharge Operating Permit
KPDES	Kentucky Pollution Discharge Elimination System
L	Liter
LA	Load Allocation
MGD	Million Gallons per Day
ml	milliliter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NASS	National Agricultural Statistics Service
NLCD	National Landcover Database
NRCS	Natural Resources Conservation Service
OSTDS	On Site Sewage Treatment and Disposal System
PCR	Primary Contact Recreation
QAPP	Quality Assurance Project Plan
RM	River Mile
SCR	Secondary Contact Recreation
SOP	Standard Operating Procedures
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
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: Kentucky
USGS HUC8: 05100201
County: Knott
Impaired Use(s): Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR)
Pollutant of Concern: *E. coli*, fecal coliform

The Carr Fork watershed above the Carr Fork Reservoir dam is located entirely in southern Knott County, east of the city of Vicco and south of Hindman and Pippa Passes. State Highways 1231, 3391, 1393, 15, 160, and 1410 all traverse portions of the watershed, mainly along Carr Fork Reservoir and its tributaries (Figure S.1).

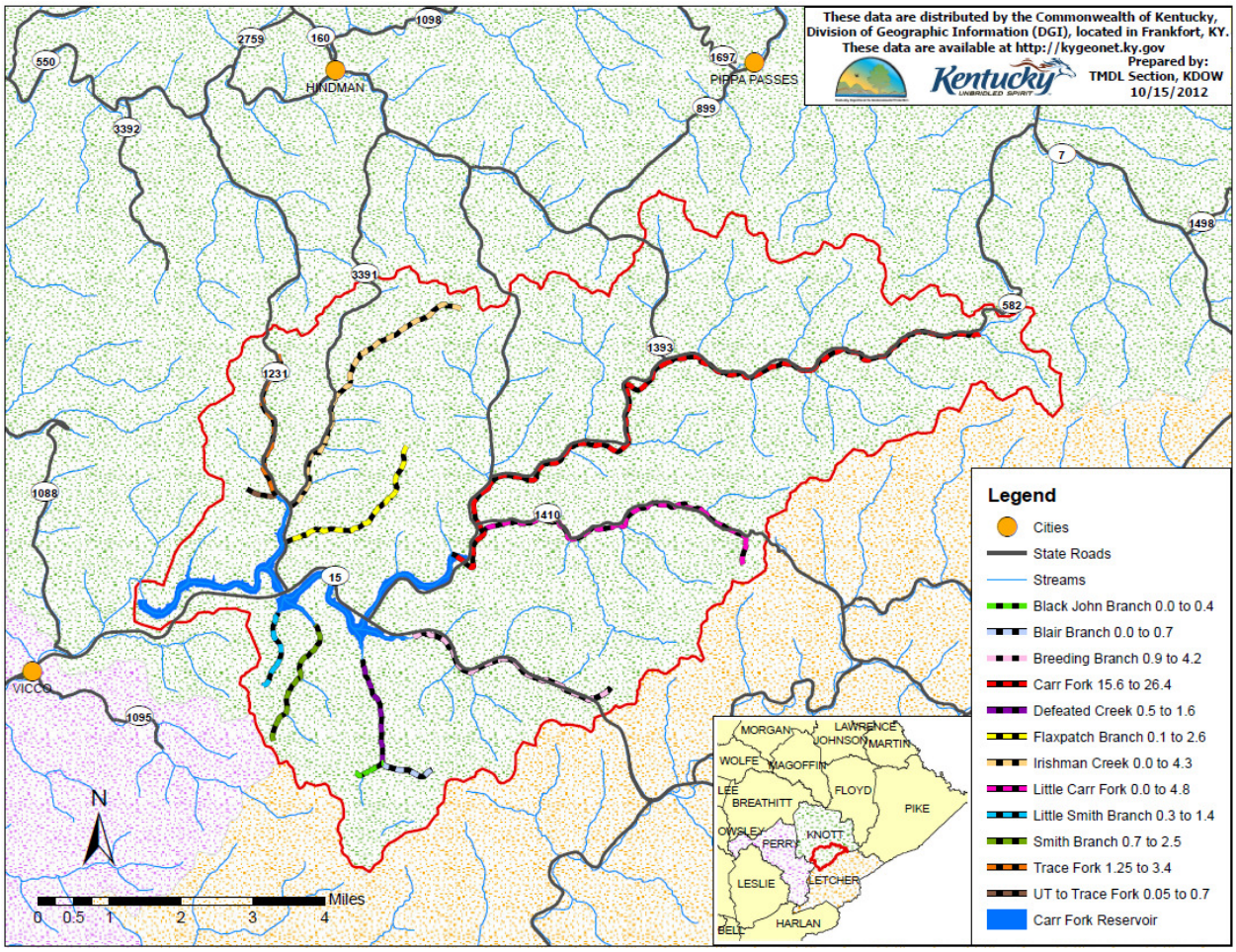

Figure S.1 Location of Carr Fork Watershed in Knott County

Kentucky Division of Water (KDOW) and US Army Corps of Engineers (USACE) staff jointly sampled the tributaries of Carr Fork Reservoir for the pathogen indicator Escherichia coli (*E. coli*) during the 2007 and 2008 PCR seasons. This document contains the monitoring results and describes Total Maximum Daily Load (TMDL) development for pathogen indicators in the Carr

Fork watershed as required under Section 303(d) of the Clean Water Act (33 U.S.C., 1972). Table S.1 indicates the pollutant/waterbody combinations for which bacteria TMDLs are developed in this document. Note that two stream segments are listed twice, due to impairment of both the PCR and SCR uses.

Table S.1 Pollutant/Waterbody Combinations Addressed in this TMDL Document

Waterbody Name	Pollutant	County	Waterbody ID	Suspected Source(s)	Impaired Use (Support Status)
Blair Branch 0.0 to 0.7	*E. coli*	Knott	KY487435_01	Unspecified Domestic Waste	PCR (nonsupport)
Breeding Branch 0.9 to 4.2	*E. coli*	Knott	KY487857_01	Unspecified Domestic Waste	PCR (nonsupport)
Carr Fork 15.6 to 26.4	*E. coli*	Knott	KY511230_03	Unspecified Domestic Waste	PCR (nonsupport)
Carr Fork 15.6 to 26.4	Fecal coliform	Knott	KY511230_03	Source Unknown	SCR (nonsupport)
Defeated Creek 0.5 to 1.6	Fecal coliform	Knott	KY490786_01	Unspecified Domestic Waste	PCR (nonsupport)
Flaxpatch Branch 0.1 to 2.6	*E. coli*	Knott	KY492233_01	Unspecified Domestic Waste	PCR (nonsupport)
Irishman Creek 0.0 to 4.3	*E. coli*	Knott	KY495004_01	Unspecified Domestic Waste	PCR (partial support)
Little Carr Fork 0.0 to 4.8	*E. coli*	Knott	KY496662_01	Unspecified Domestic Waste	PCR (nonsupport)
Little Smith Branch 0.3 to 1.4	*E. coli*	Knott	KY496864_01	Unspecified Domestic Waste	PCR (nonsupport)
Trace Fork 1.25 to 3.4	*E. coli*	Knott	KY505441_01	Unspecified Domestic Waste	PCR (partial support)
Trace Fork 1.25 to 3.4	Fecal coliform	Knott	KY505441_01	Source Unknown	SCR (nonsupport)
UT to Trace Fork 0.05 to 0.7	*E. coli*	Knott	KY505441-1.25_01	Unspecified Domestic Waste	PCR (partial support)

Kentucky Water Quality Criterion (WQC):

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR and SCR uses 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."

Additionally:

"The following criteria shall apply to waters designated for secondary contact recreation use during the entire year: Fecal coliform content shall not exceed 1000 colonies per 100 ml as a thirty (30) day geometric mean based on not less than five (5) samples; nor exceed 2000 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period."

Allowable loadings were calculated based upon the impaired designated use and the bacteria indicator causing the use impairment. For *E. coli* PCR impairments, the instantaneous criterion of 240 colonies/100 ml was applied to calculate allowable loadings. For fecal coliform PCR impairments, the instantaneous criterion of 400 colonies/100 ml was used. For fecal coliform SCR impairments, the instantaneous criterion of 2000 colonies/100 ml was applied.

TMDL Components and Target:

A TMDL calculation is performed as follows:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$
(Equation 1)

The WLA has two components:

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

Definitions:
TMDL: the WQC, expressed as a load.
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 bacteria (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).
Remainder: the TMDL minus the MOS and minus the SWS-WLA (also equal to Future Growth-WLA plus the LA).
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 period when the pollutant conditions are expected to be at their worst.
Critical Flow: the flow used to calculate the TMDL as a load.
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 in colonies per day (colonies/day)
Concentration: colonies per 100 milliliters (colonies/100ml)
Flow (i.e. stream discharge): cubic feet per second (cfs)
Conversion Factor: the value which 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/cf * 86400sec/day * 1000ml/L)/ (100 ml) and is equal to 24465758.4.

Calculation Procedure:

1. The MOS 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 is calculated and subtracted from the TMDL Target, leaving the Remainder;
4. The Future Growth-WLA is calculated and subtracted from the Remainder; leaving the LA

The TMDL for each bacteria impaired segment is shown in Tables S.2-S.4.

Table S.2 *E. coli* PCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Blair Branch 0.0 to 0.7	2.94E+08	2.94E+07	0.00E+00	1.32E+06	2.63E+08	93.8
Breeding Branch 0.9 to 4.2	3.43E+10	3.43E+09	0.00E+00	3.08E+08	3.05E+10	98.2
Carr Fork 15.6 to 26.4	3.58E+10	3.58E+09	2.73E+08	3.20E+08	3.16E+10	93.3
Flaxpatch Branch 0.1 to 2.6	5.65E+08	5.65E+07	0.00E+00	2.54E+06	5.06E+08	95.7
Irishman Creek 0.0 to 4.3	5.60E+09	5.60E+08	0.00E+00	5.04E+07	4.99E+09	88.6
Little Carr Fork 0.0 to 4.8	7.16E+09	7.16E+08	0.00E+00	6.44E+07	6.38E+09	95.3
Little Smith Branch 0.3 to 1.4	1.78E+09	1.78E+08	0.00E+00	1.60E+07	1.58E+09	93.8
Trace Fork 1.25 to 3.4	3.16E+09	3.16E+08	0.00E+00	2.85E+07	2.82E+09	85.6
UT to Trace Fork 0.05 to 0.7	2.84E+08	2.84E+07	0.00E+00	1.28E+06	2.54E+08	76.0

Table S.3 Fecal Coliform PCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Defeated Creek 0.5 to 1.6	9.38E+09	9.38E+08	0.00E+00	4.22E+07	8.40E+09	72.3

Table S.4 Fecal Coliform SCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Carr Fork 15.6 to 26.4	4.39E+12	4.39E+11	4.54E+08	3.95E+10	3.91E+12	80.0
Trace Fork 1.25 to 3.4	3.17E+11	3.17E+10	0.00E+00	2.85E+09	2.83E+11	52.6

Translation of WLAs into Permit Limits:

All KPDES-permitted point sources must meet permit limits based on the Water Quality Standards in 401 KAR 10:031. SWS-WLAs 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 or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average.

1.0 Introduction

Section 303(d) of the Clean Water Act (33 U.S.C. §1251, 1972) requires states to identify waters within their boundaries that have been assessed and are not currently meeting their designated uses (per 401 KAR [Kentucky Administrative Regulations] 10:026 and 10:031) and that require 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 produce a list of this information termed 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 *Final 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], 2011a) and can be obtained at: http://water.ky.gov. The public notice draft 2012-303(d) list was available for public comment until December 15, 2012 (KDOW, 2012a). Following USEPA approval, the final 2012-303(d) Report will be available at: http://water.ky.gov.

States are required to develop TMDLs for the listed pollutants that cause a waterbody to fail to meet its designated uses. The TMDL process establishes the allowable amount (i.e. "load") of pollutant a 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) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. This total load is then divided among different sources of the pollutant in a watershed. Information from USEPA on TMDLs can be found at: http://www.epa.gov/owow/tmdl (USEPA, 2012a).

This document contains the monitoring results and describes TMDL development for bacteria indicators in the Carr Fork watershed as required under Section 303(d) of the Clean Water Act. 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 include primary contact recreation (PCR) and secondary contact recreation (SCR). 401 KAR 10:001 defines PCR or SCR waters as those "waters suitable for full body contact recreation during the recreation season of May 1 through October 31" or "waters suitable for partial body recreation, with minimal threat to public health due to water quality", respectively. 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 (USEPA, 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*) and fecal coliform bacteria as indicator organisms 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 Carr Fork watershed above the Carr Fork Reservoir dam is located entirely in southern Knott County, east of the city of Vicco and south of Hindman and Pippa Passes. State Highways 1231, 3391, 1393, 15, 160, and 1410 all traverse portions of the watershed, mainly along Carr Fork Reservoir and its tributaries (Figure 2.1).

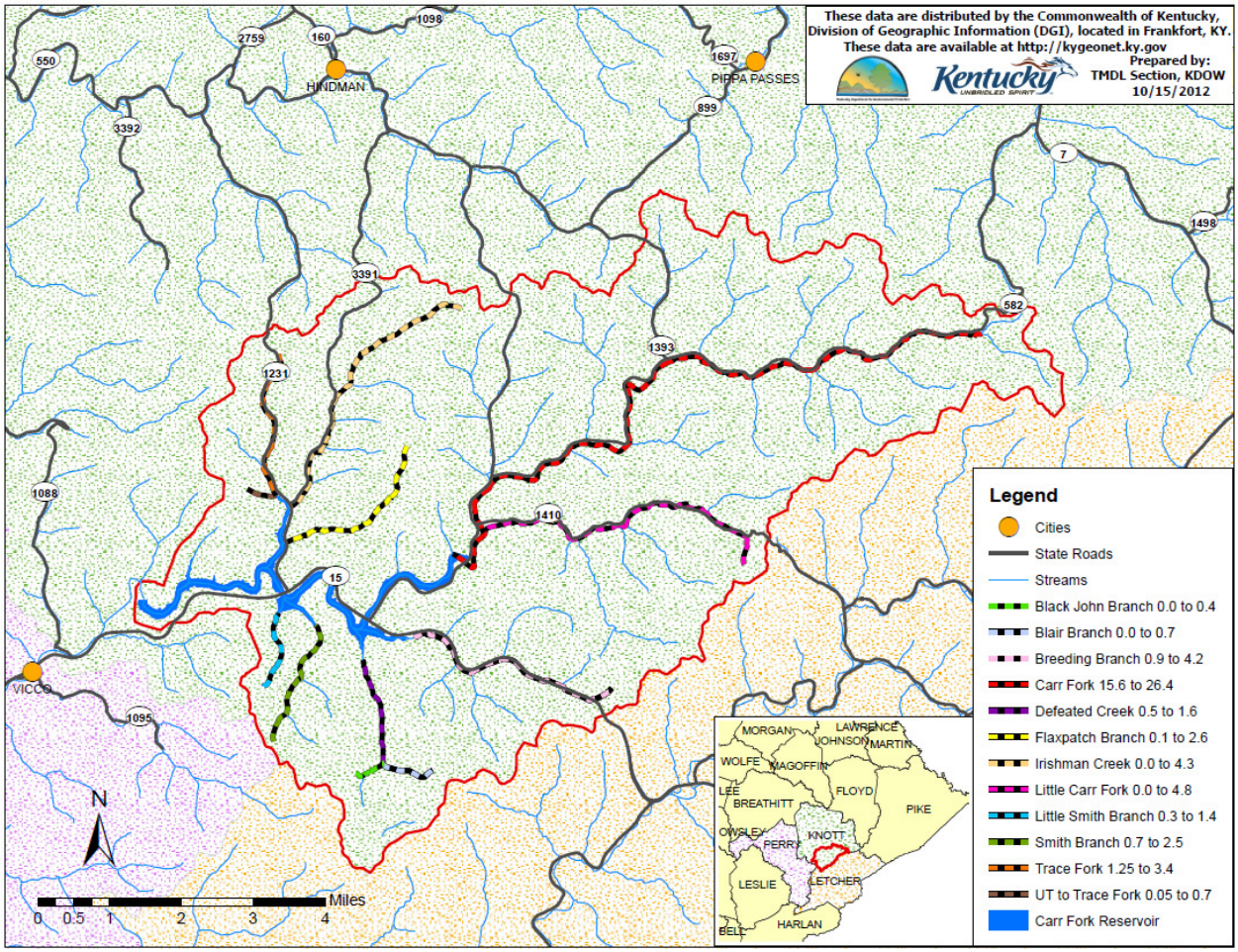

Figure 2.1 Location of Carr Fork Watershed in Knott County

2.2 303(d) Listing History

Carr Fork from river miles (RM) 15.6 to 26.4, Defeated Creek RM 0.4 to 1.6, and Trace Fork RM 0.2 to 2.4 were first listed as impaired for the PCR and SCR uses due to pathogens on the 2006-303(d) list (KDOW, 2007). During the 2008 listing cycle, these pathogen listings were more correctly identified with the indicator organism used, fecal coliform, and the river miles for Defeated Creek were corrected to RM 0.15 to 2.4 to reflect the National Hydrography Data Set (KDOW, 2008). Following TMDL sampling of the watershed in 2007 and 2008, the listings for PCR impairment due to fecal coliform on Carr Fork and Trace Fork were updated to *E. coli* impairments (KDOW, 2011a). Additionally, the RMs for Defeated Creek were adjusted to 0.5 to 1.6, while the RMs for Trace Fork were adjusted to 1.25 to 3.4, and seven additional segments were listed for PCR impairment due to *E. coli* (KDOW, 2011a). These listings were carried forward on the draft 2012-303(d) list, yielding the listings shown in Table 2.1 (KDOW, 2012a). The SCR listing for Defeated Creek was determined to be an error due to lack of SCR exceedances; thus, a delisting request will be submitted for it. Figure 2.1 shows the location of the impaired segments in the watershed.

Table 2.1 Draft 2012-303(d) Listings for Bacteria-indicators in the Carr Fork Watershed

Waterbody Name	Pollutant	County	Waterbody ID	Suspected Source(s)	Impaired Use (Support Status)
Blair Branch 0.0 to 0.7	*E. coli*	Knott	KY487435_01	Unspecified Domestic Waste	PCR (nonsupport)
Breeding Branch 0.9 to 4.2	*E. coli*	Knott	KY487857_01	Unspecified Domestic Waste	PCR (nonsupport)
Carr Fork 15.6 to 26.4	*E. coli*	Knott	KY511230_03	Unspecified Domestic Waste	PCR (nonsupport)
Carr Fork 15.6 to 26.4	Fecal coliform	Knott	KY511230_03	Source Unknown	SCR (nonsupport)
Defeated Creek 0.5 to 1.6	Fecal coliform	Knott	KY490786_01	Unspecified Domestic Waste	PCR (nonsupport)
Flaxpatch Branch 0.1 to 2.6	*E. coli*	Knott	KY492233_01	Unspecified Domestic Waste	PCR (nonsupport)
Irishman Creek 0.0 to 4.3	*E. coli*	Knott	KY495004_01	Unspecified Domestic Waste	PCR (partial support)
Little Carr Fork 0.0 to 4.8	*E. coli*	Knott	KY496662_01	Unspecified Domestic Waste	PCR (nonsupport)
Little Smith Branch 0.3 to 1.4	*E. coli*	Knott	KY496864_01	Unspecified Domestic Waste	PCR (nonsupport)
Trace Fork 1.25 to 3.4	*E. coli*	Knott	KY505441_01	Unspecified Domestic Waste	PCR (partial support)
Trace Fork 1.25 to 3.4	Fecal coliform	Knott	KY505441_01	Source Unknown	SCR (nonsupport)
UT to Trace Fork 0.05 to 0.7	*E. coli*	Knott	KY505441-1.25_01	Unspecified Domestic Waste	PCR (partial support)

3.0 Physical Setting

The Carr Fork watershed above the Carr Fork Reservoir dam is approximately 58 square miles in area and is located entirely in southern Knott County, east of the city of Vicco and south of Hindman and Pippa Passes (Figure 2.1). The Carr Fork watershed headwaters begin in Knott County near its southeastern boundary with Letcher County and flow westward to the Carr Fork Reservoir dam. The watershed is in the Kentucky River Basin, United States Geological Survey (USGS) 6-digit hydrologic unit code (HUC) # 051002. The system of HUCs was developed by the USGS to identify specific watersheds (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 HUC14s in the Carr Fork watershed are shown in Figure 3.1 and the areas of each are listed in Table 3.1.

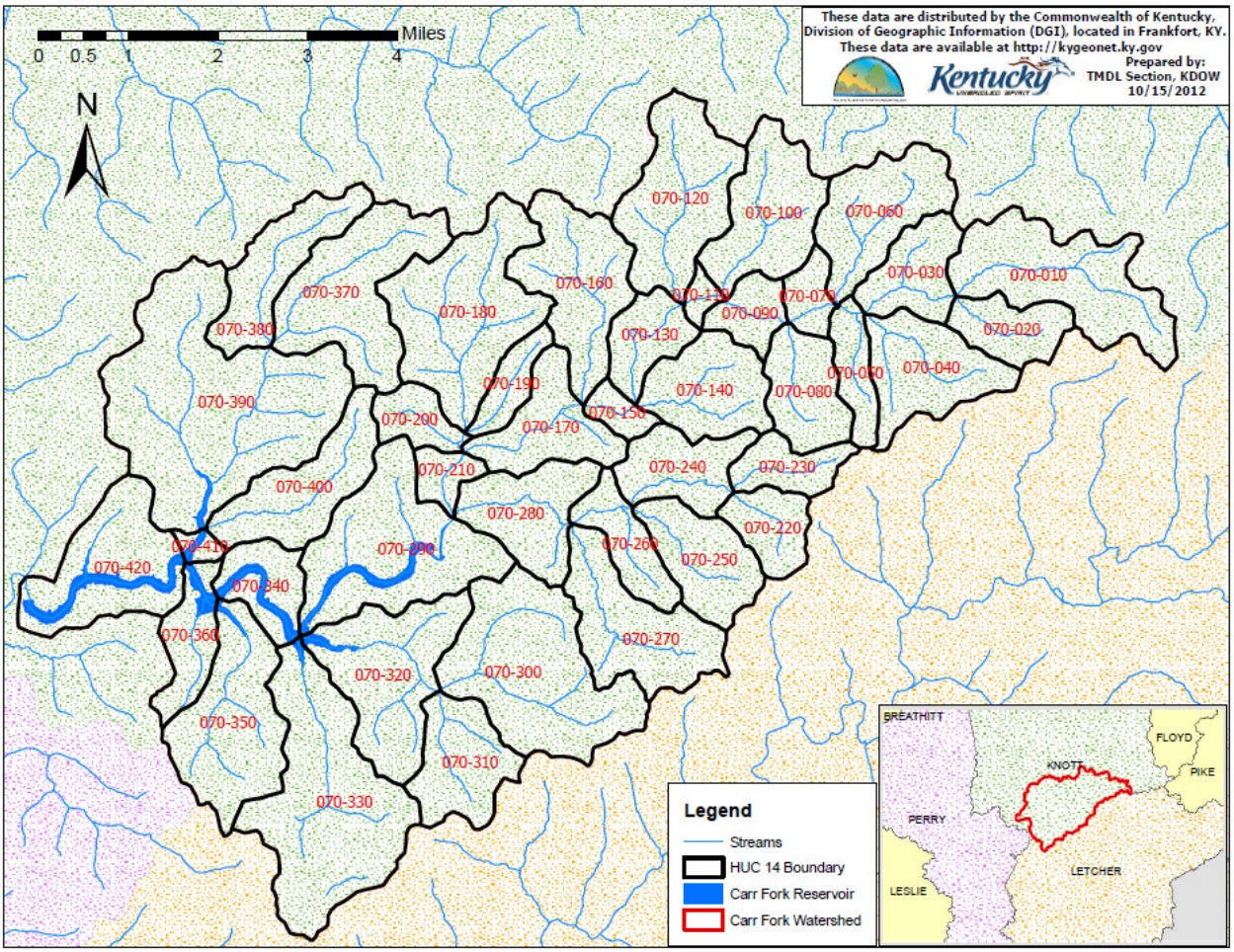

Figure 3.1 Location of HUC 14s in the Carr Fork Watershed
Note: Only the last 6 digits of the HUC 14s are labeled on the map

Table 3.1 HUC 14s in the Carr Fork Watershed

HUC 14	Name	Square Miles	Acres
05100201-070-010	Carr Fork	2.2	1437
05100201-070-020	Meadow Branch	0.8	507
05100201-070-030	Carr Fork	0.9	600
05100201-070-040	Collins Branch	1.4	926
05100201-070-050	Carr Fork	0.6	378
05100201-070-060	Nealy Branch	1.5	983
05100201-070-070	Carr Branch	0.4	262
05100201-070-080	Willard Branch	1.0	659
05100201-070-090	Carr Fork	0.5	345
05100201-070-100	Mallet Branch	1.6	1038
05100201-070-110	Carr Fork	0.2	111
05100201-070-120	Branhams Branch	2.0	1302
05100201-070-130	Carr Fork	0.8	482
05100201-070-140	Steer Fork	1.3	841
05100201-070-150	Carr Fork	0.3	193
05100201-070-160	Smith Branch	1.8	1155
05100201-070-170	Carr Fork	1.2	775
05100201-070-180	Betty Troublesome Creek	2.6	1688
05100201-070-190	Deadman Branch	0.5	313
05100201-070-200	Betty Troublesome Creek	0.5	345
05100201-070-210	Carr Fork	0.4	243
05100201-070-220	Little Carr Fork	0.7	458
05100201-070-230	Wolfpen Branch	0.6	413
05100201-070-240	Little Carr Fork	1.0	661
05100201-070-250	Big Doubles Branch	1.2	770
05100201-070-260	Little Carr Fork	0.8	506
05100201-070-270	Wolfpen Creek	1.8	1148
05100201-070-280	Little Carr Fork	1.3	846
05100201-070-290	Carr Fork	2.7	1698
05100201-070-300	Breeding Branch	3.0	1908
05100201-070-310	Hale Branch	1.3	808
05100201-070-320	Breeding Branch	2.1	1346
05100201-070-330	Defeated Creek	3.4	2174
05100201-070-340	Carr Fork	0.8	519
05100201-070-350	Smith Branch	2.1	1340
05100201-070-360	Carr Fork	0.8	520
05100201-070-370	Irishman Creek	2.2	1428
05100201-070-380	Madden Fork	1.3	818
05100201-070-390	Irishman Creek	4.8	3094
05100201-070-400	Flaxpatch Branch	1.5	972
05100201-070-410	Irishman Creek	0.2	98
05100201-070-420	Carr Fork	1.9	1236
Totals		58.4	37345

3.1 Geology

The Carr Fork watershed is in the Eastern Coal Field physiographic region, in the Level III Ecoregion of the Central Appalachians and Level IV Ecoregion of the Dissected Appalachian Plateau (Figure 3.2). Information from Woods, et al. (2002) indicates that the Central Appalachians consist of rugged terrain with mixed mysophytic forests and moderate to high gradient streams; surface and underground coal mines are common.

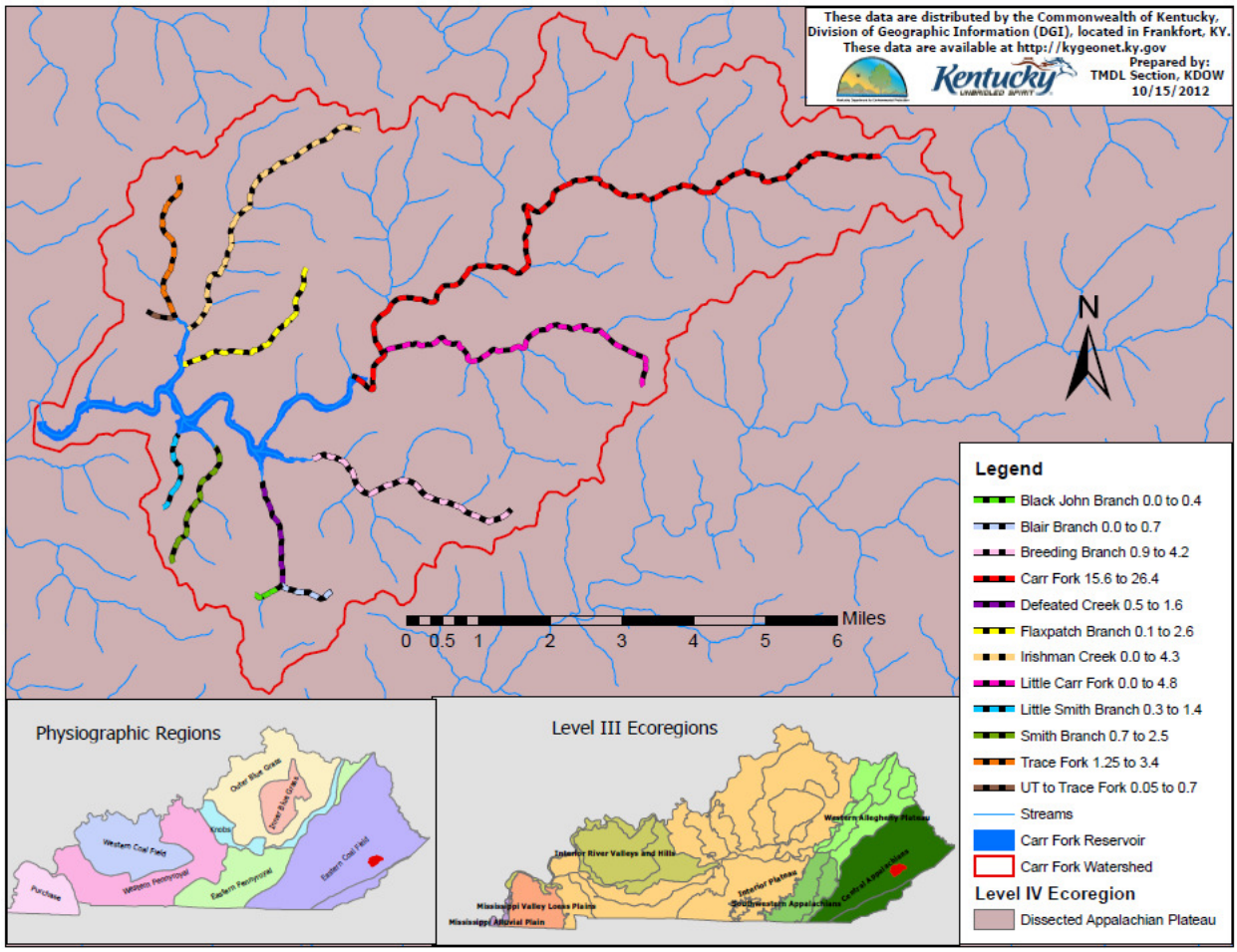

Figure 3.2 Level IV Ecoregion for Carr Fork Watershed

The watershed is underlain by the Breathitt Formation (Figure 3.3) from the Pennsylvanian Period which formed between 325 to 290 million years ago and consists of "interbedded shale, sandstone, conglomerates, and coals" (Kentucky Geological Survey [KGS] 2012a, available at: http://www.uky.edu/KGS/geoky/pennsylvanian.html). The KGS has developed a land-use planning map for Knott County to inform individuals of the general geologic bedrock condition that can affect a site and its intended uses (KGS, 2012b, available at: http://kgs.uky.edu/kgsweb/olops/pub/kgs/mc171_12.pdf).

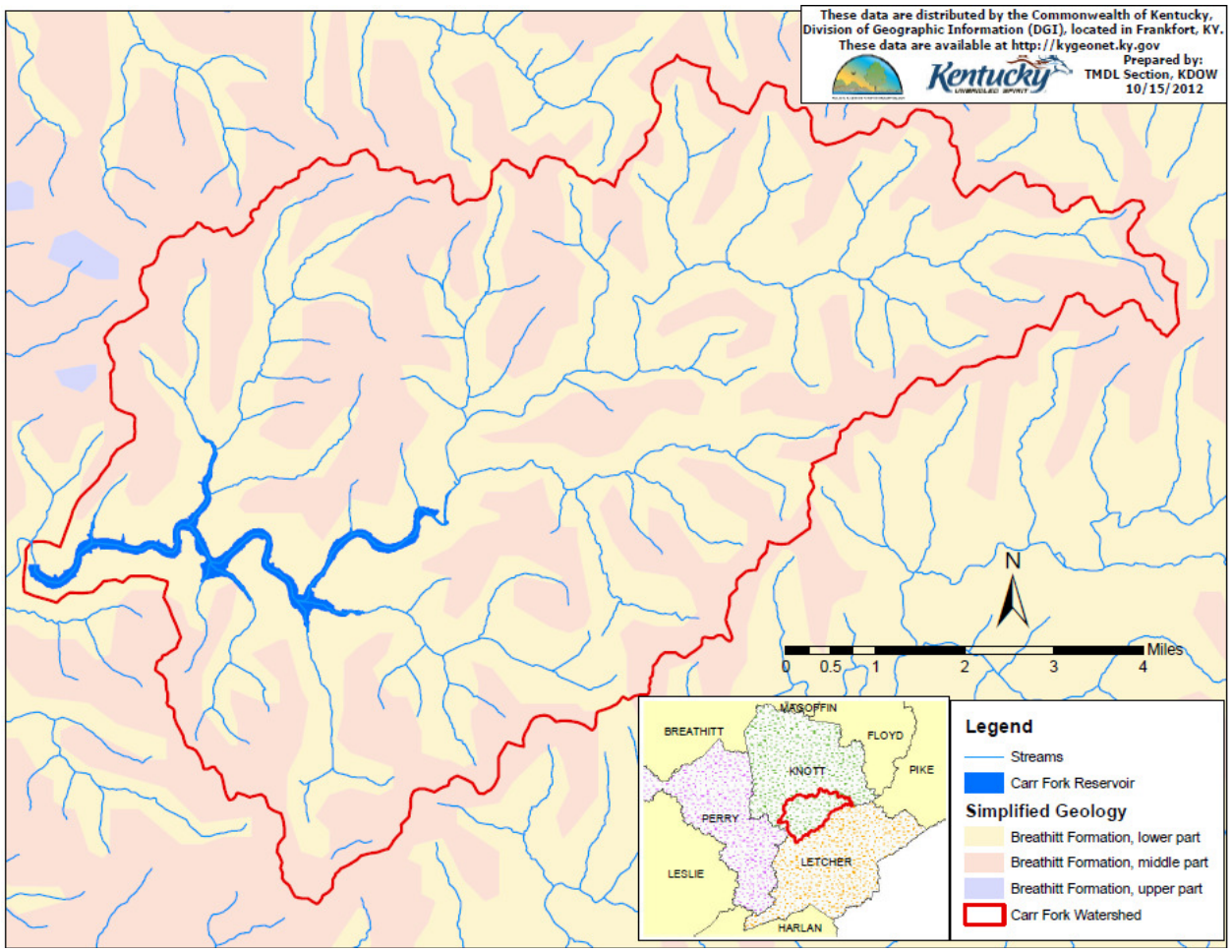

Figure 3.3 Geology in the Carr Fork Watershed

The soils in the Carr Fork watershed are varied, but consist mostly of the Cloverlick-Kimper-Highsplint and the Shelocta-Highsplint complexes in the lower watershed and Cloverlick-Shelocta-Kimper and Fedscreek-Shelocta-Handshoe complexes in the upper watershed (Figure 3.4). Once deposited on or in soils, fecal bacteria can die-off or re-grow. A review of factors important in the survival of fecal bacteria in soils showed, in general, longer bacteria survival time with 1.) greater soil moisture content - survival of days in dry soils versus longer than 1.5 months in wet soils, 2.) lower temperatures - with a doubling of the die-off rate for each 10° Celsius increase in temperature, 3.) alkaline soils - survival of days in acidic soils versus weeks in alkaline soils, with neutral soils optimal, 4.) decreased sunlight - ultraviolet light is bactericidal, and 5.) increased organic material - a nutrient source for the bacteria (reviewed in Gerba et. al., 1975).

Bacteria can adhere to soil particles, particularly clay particles, and either be retained in the soil or move with water flow via erosion 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). Determining the fate and transport of bacteria in the soils of Carr Fork 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.

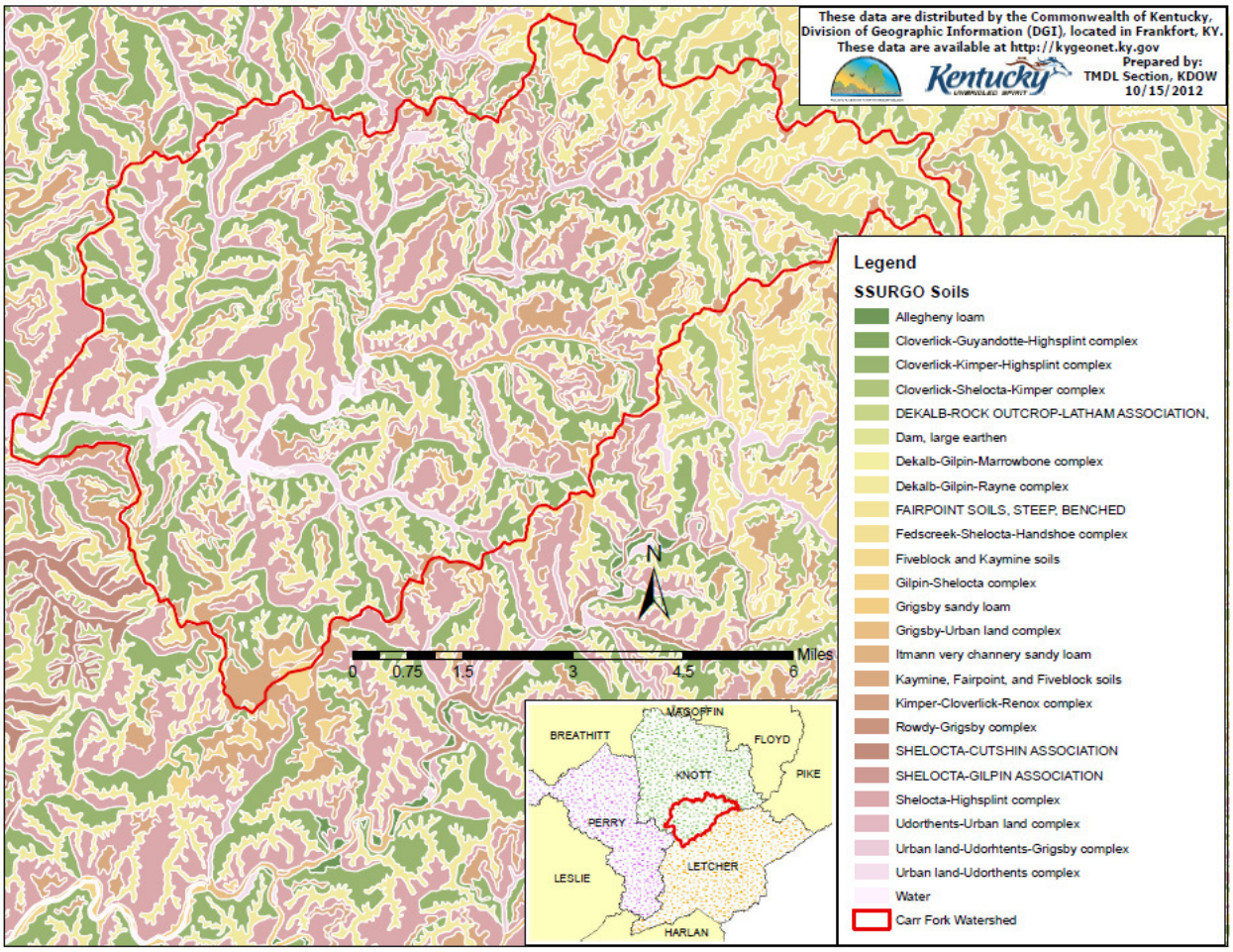

Figure 3.4 Soil Types in the Carr Fork Watershed

Soil erosion and water runoff can both move bacteria to a stream or to groundwater. The hydrologic soil groups (HSG) in Carr Fork are group A and B as shown in Figure 3.5. The HSG is used to relay information about the runoff potential of a soil when thoroughly wet. HSGs A and B are rated as low and moderately low for runoff potential, respectively (USDA-NRCS, 2009).

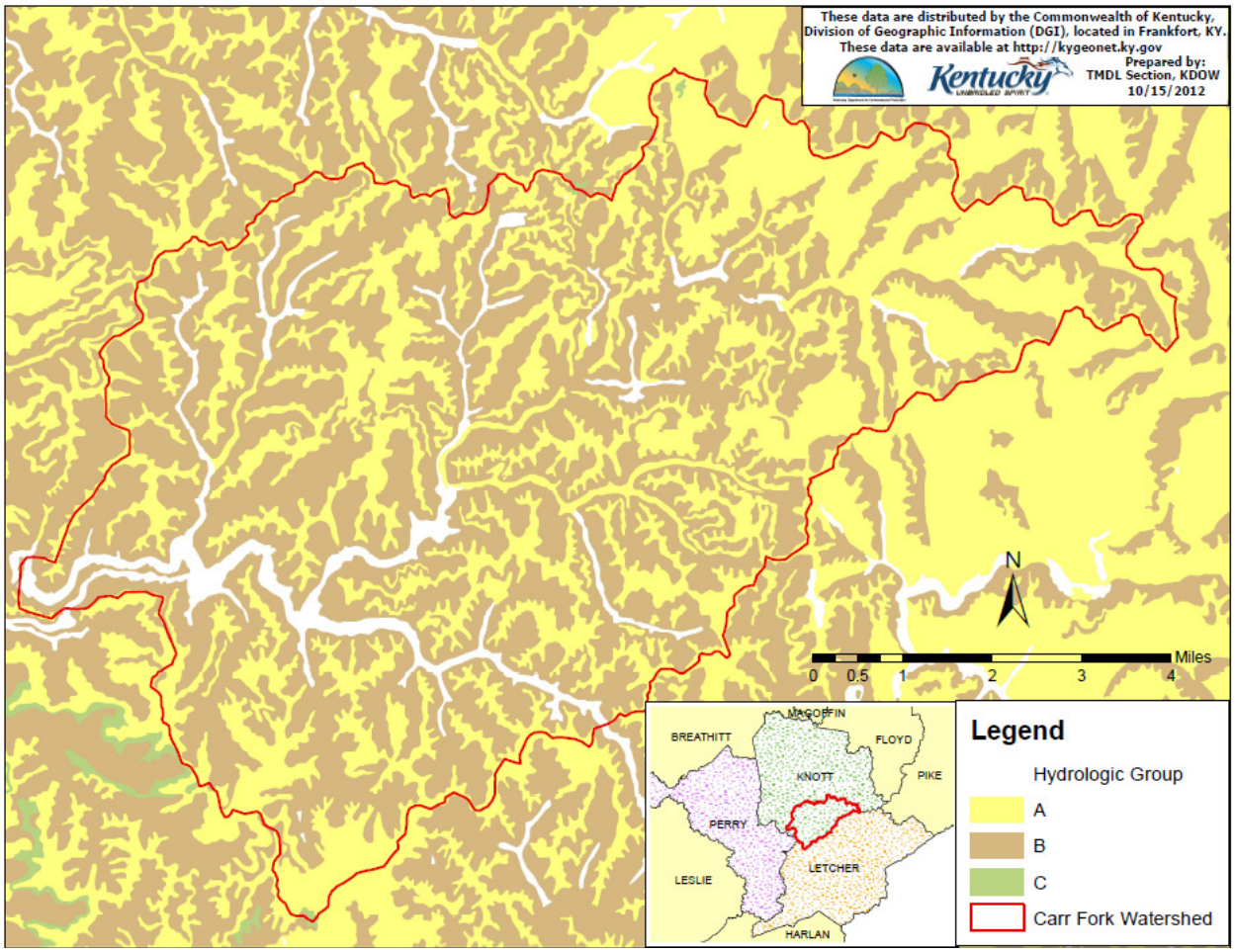

Figure 3.5 Hydrologic Soil Groups in Carr Fork Watershed

The USDA Natural Resources Conservation Service (NRCS) rates the performance of septic tank absorption fields. Soil ratings are based on soil properties, site features, and the observed performance of the soils - permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of septic tank effluents. The soils in Carr Fork watershed are rated as very limited for septic tank suitability as shown in Figure 3.6.

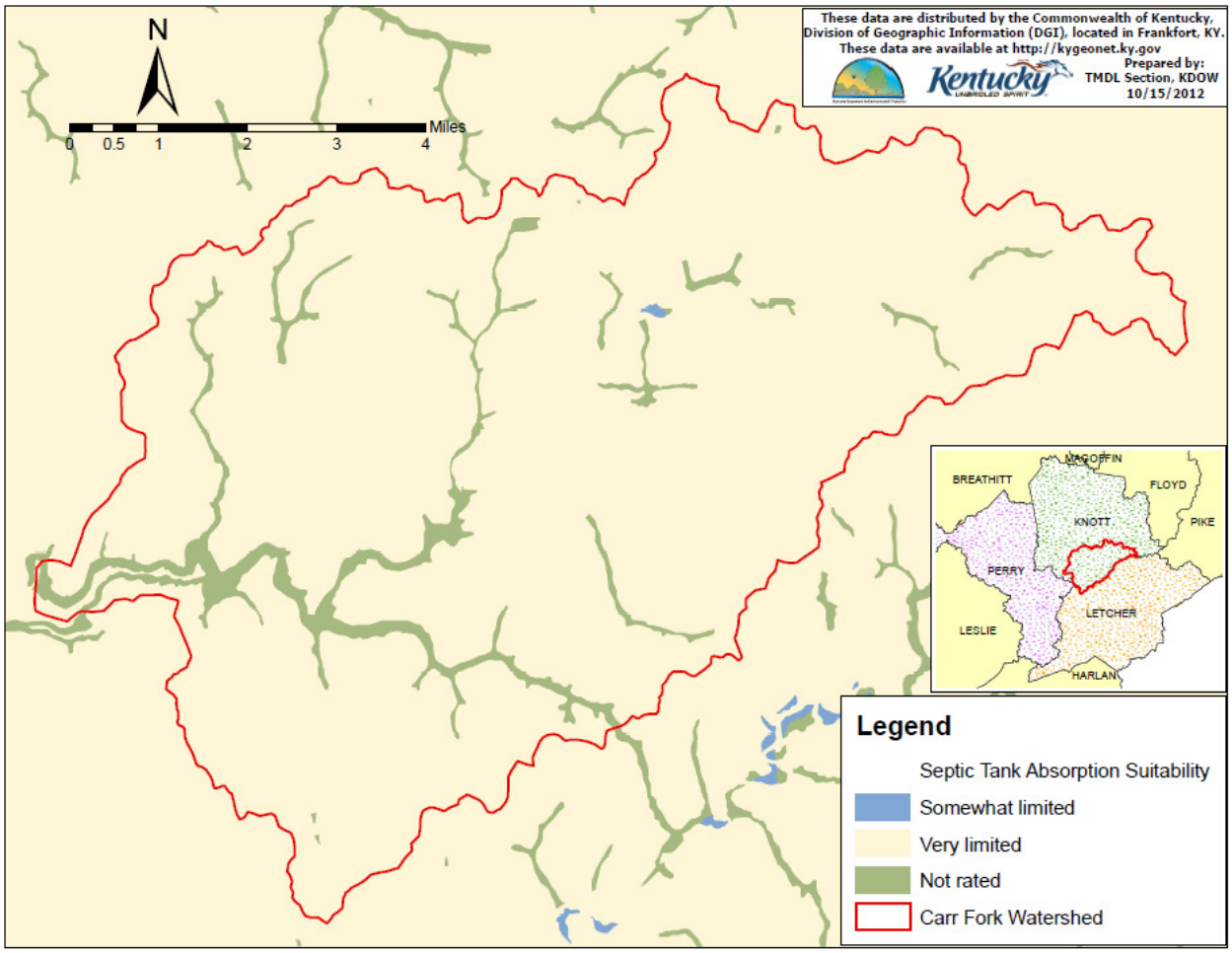

Figure 3.6 Soil Suitability for Septic Tanks in Carr Fork Watershed

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 the dam, Carr Fork is a third order stream (Figure 3.7).

There are two water withdrawals in the Carr Fork watershed (see Figure 3.7 and Table 3.2). There is one USGS gaging station located above the dam (03277446) and one below the dam (03277450) (USGS 2012a, USGS, 2012b. See Figure 3.7 and Table 3.3).

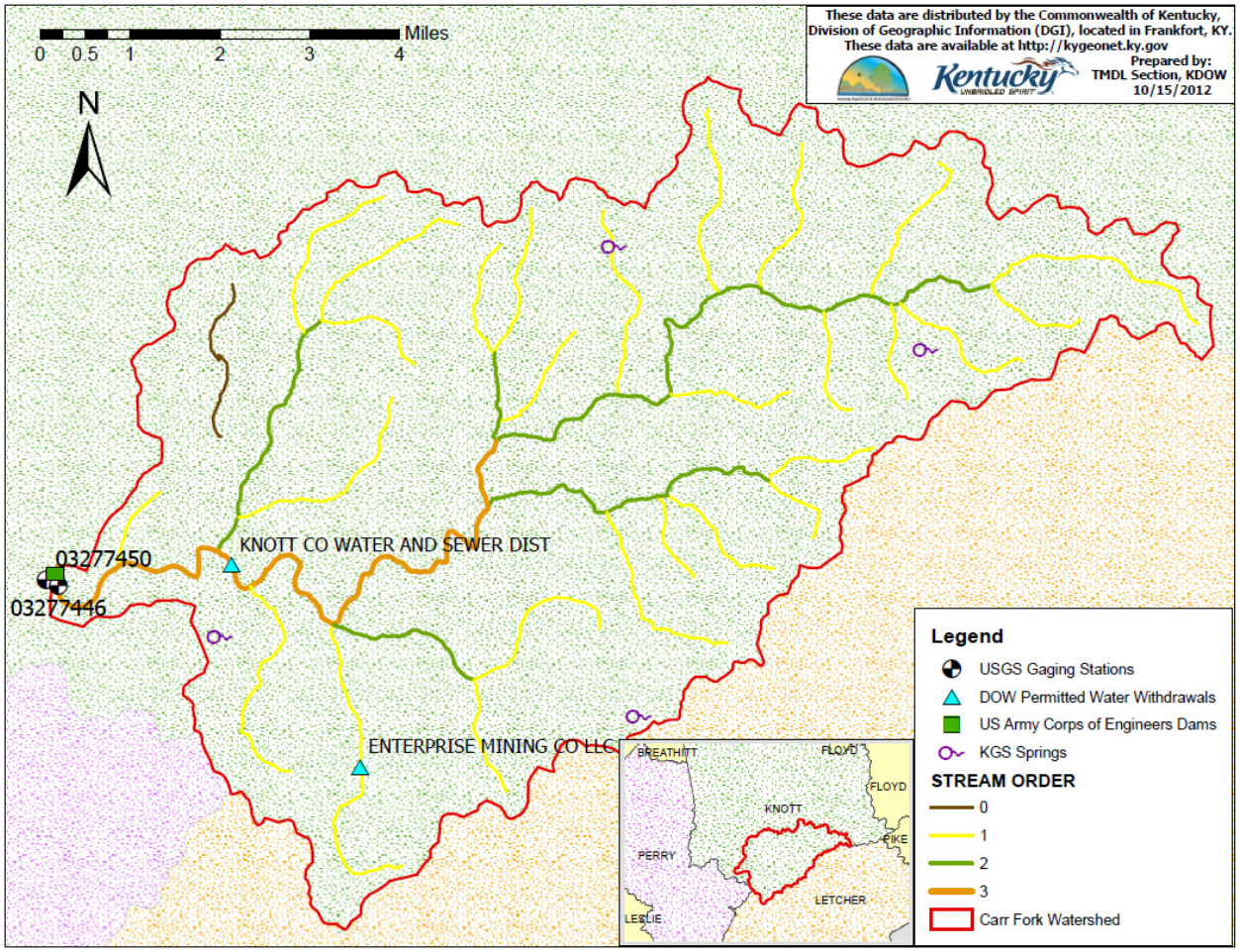

Figure 3.7 Stream Order, Dam, Spring, Gage and Water Withdrawal Locations

Table 3.2 Water Withdrawal Permit Information

AI #	Name	Latitude	Longitude	Use Category	Permitted Withdrawal (MGD)	Withdrawal Location
102156	KNOTT CO WATER AND SEWER DIST	37.2328	-82.9987	WATER SUPPLIER	2	WITHDRAWALS FROM CARR CREEK LAKE
2516	ENTERPRISE MINING CO LLC	37.1994	-82.9739	MINING	0.06	WITHDRAWALS FROM STREAM MILE 1.7 OF DEFEATED CREEK

Table 3.3 USGS Gages in Carr Fork Watershed

Gage ID	NAME	Latitude	Longitude	Link
03277446	Carr Fork Lake Tower	37.23028	-83.033611	http://waterdata.usgs.gov/ky/nwis/inventory/?site_no=03277446
03277450	Carr Fk nr Sassafras	37.23111	-83.036111	http://waterdata.usgs.gov/ky/nwis/inventory/?site_no=03277450

3.3 Land Cover Distribution

The 2001 National Land Cover Dataset (USGS, 2003) was used to determine the land cover within the Carr Fork 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. This was done to simplify the source analysis. The watershed consists primarily of forest and natural grassland. Land cover is shown graphically in Figure 3.8.

Table 3.4 Amount of Land Cover Class in Carr Fork Watershed

Land Cover	% of Total Area	Acres	Watershed Square Miles
Developed	6.04	2255	3.5
Agriculture (total)	0.14	53	0.1
Pasture	0.13	50	0.1
Row Crop	0.01	2	0.0
Forest	79.19	29574	46.2
Natural Grassland	11.46	4281	6.7
Water	1.39	519	0.8
Wetland	0.00	2	0.0
Barren	1.77	662	1.0
Total	100.00	37345	58.4

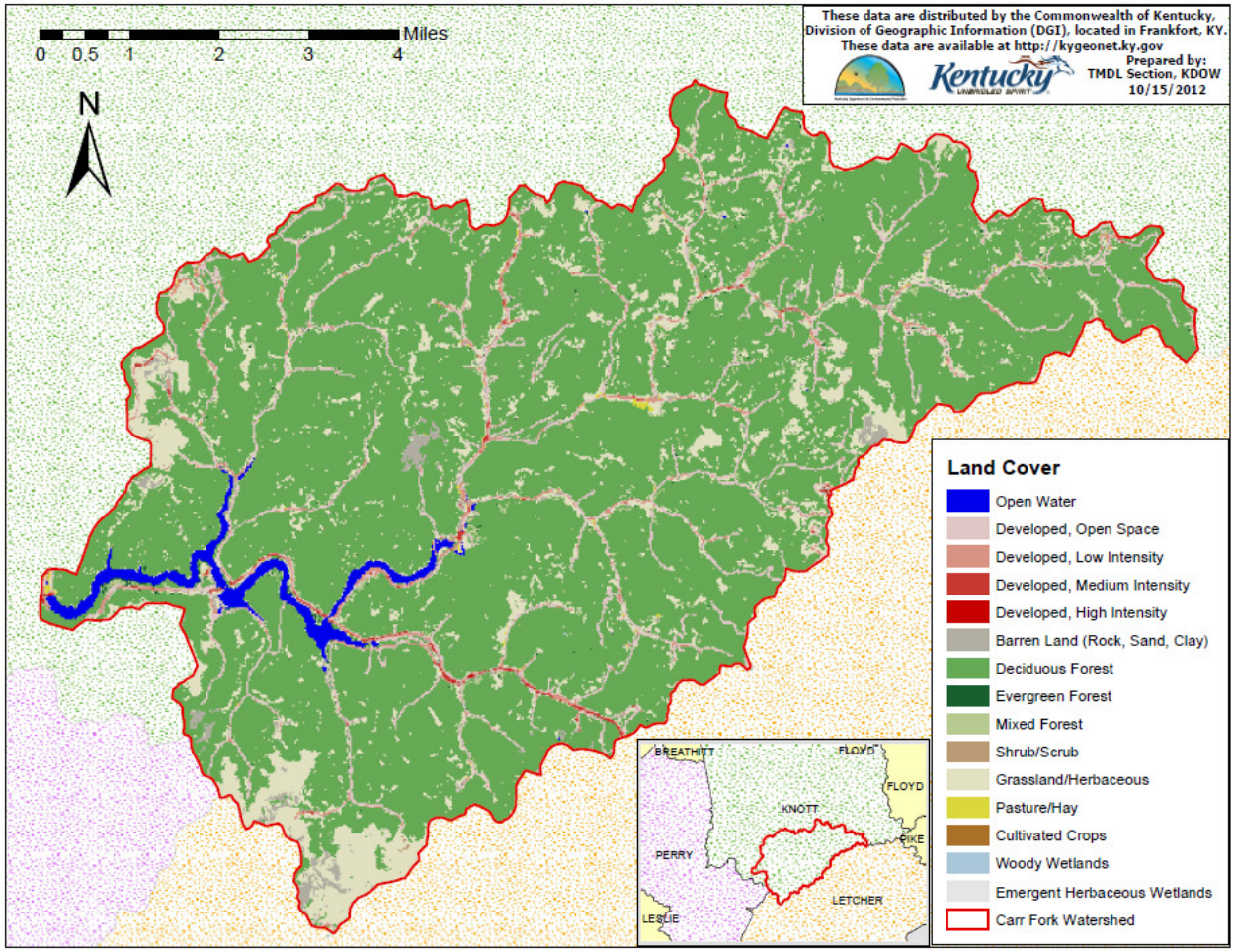

Figure 3.8 Land Cover in the Carr Fork Watershed

4.0 Monitoring

This section summarizes historical and recent monitoring in the Carr Fork watershed. The full data sets are presented in Appendix B.

4.1 Historical Monitoring

The USACE Huntington District has several historical sample sites on Carr Fork and its tributaries that were monitored for fecal coliform during the 1970's and 80's (STORET, 2012). Sampling station locations are summarized in Table 4.1, while sample site locations are shown in Figure 4.1. Data collected from the reservoir itself are shown for informational purposes and are not on an impaired segment. Data are summarized in Table 4.2. Data from these sampling efforts were not used to develop bacteria TMDLs.

Table 4.1 USACE Historical Sites in Carr Fork Watershed

Station Name	Latitude	Longitude	Stream Segment	RM
2CFK10000	37.233333	-83.034444	(Carr Fork Reservoir) Carr Fork	8.6
2CFK10007	37.251389	-82.945	Carr Fork 15.6 to 26.4	17.35
2CFK11203	37.254444	-83.001389	Trace Fork 1.25 to 3.4	1.6
2CFK13002	37.210278	-82.975833	Defeated Creek 0.5 to 1.6	0.9
2CFK14001	37.221389	-82.975833	(Carr Fork Reservoir) Breeding Creek	0.2
2CFK20001	37.226944	-83.025833	(Carr Fork Reservoir) Carr Fork	9.4
2CFK20005	37.236111	-82.949722	(Carr Fork Reservoir) Carr Fork	16.1

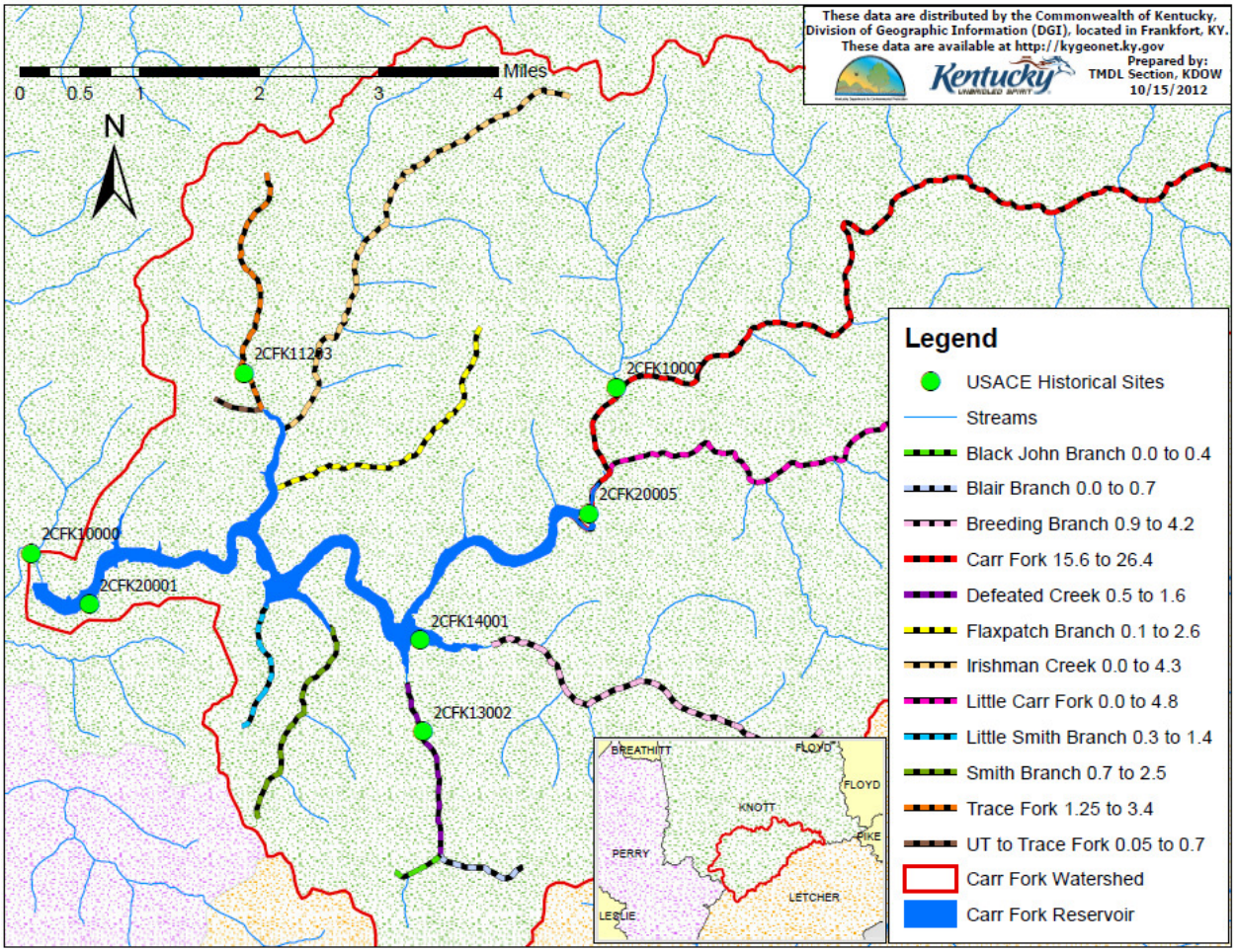

Figure 4.1 Location of USACE Historical Sites in Carr Fork Watershed

Table 4.2 USACE Historical Sample Data Summary

Station Name	Number of Observations	% Exceeding WQC (400 colonies/100 ml)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
2CFK10000	9	0.0	10	210	80
2CFK10007	33	63.6	5	20000	3469
2CFK11203	3	0.0	10	220	143
2CFK13002	3	33.3	10	420	210
2CFK14001	1	0.0	160	160	N/A
2CFK20001	87	4.6	1	900	44
2CFK20005	8	25.0	2	1200	272

During 2003, the USACE collected fecal coliform data at four sites in the Carr Fork watershed from April through December. Sampling station locations are summarized in Table 4.3, while sample site locations are shown in Figure 4.2. Data collected from the reservoir itself are shown for informational purposes and are not on an impaired segment. The fecal coliform data are summarized in Table 4.4. Data from these sampling efforts was used for the initial listing of Carr Fork, Trace Fork, and Defeated Creek as impaired and were used to develop fecal coliform TMDLs for the SCR listings on Carr Fork 15.6 to 26.4 and Trace Fork 1.25 to 3.4 and for the PCR listing on Defeated Creek 0.5 to 1.6.

Table 4.3 2003 USACE Sample Sites in Carr Fork Watershed

Station Name	Latitude	Longitude	Stream Segment	RM
2CFK10000	37.233333	-83.034444	(Carr Fork Reservoir) Carr Fork	8.6
2CFK10008	37.25491	-82.92938	Carr Fork 15.6 to 26.4	18.35
2CFK11203	37.254444	-83.001389	Trace Fork 1.25 to 3.4	1.6
2CFK13002	37.210278	-82.975833	Defeated Creek 0.5 to 1.6	0.9

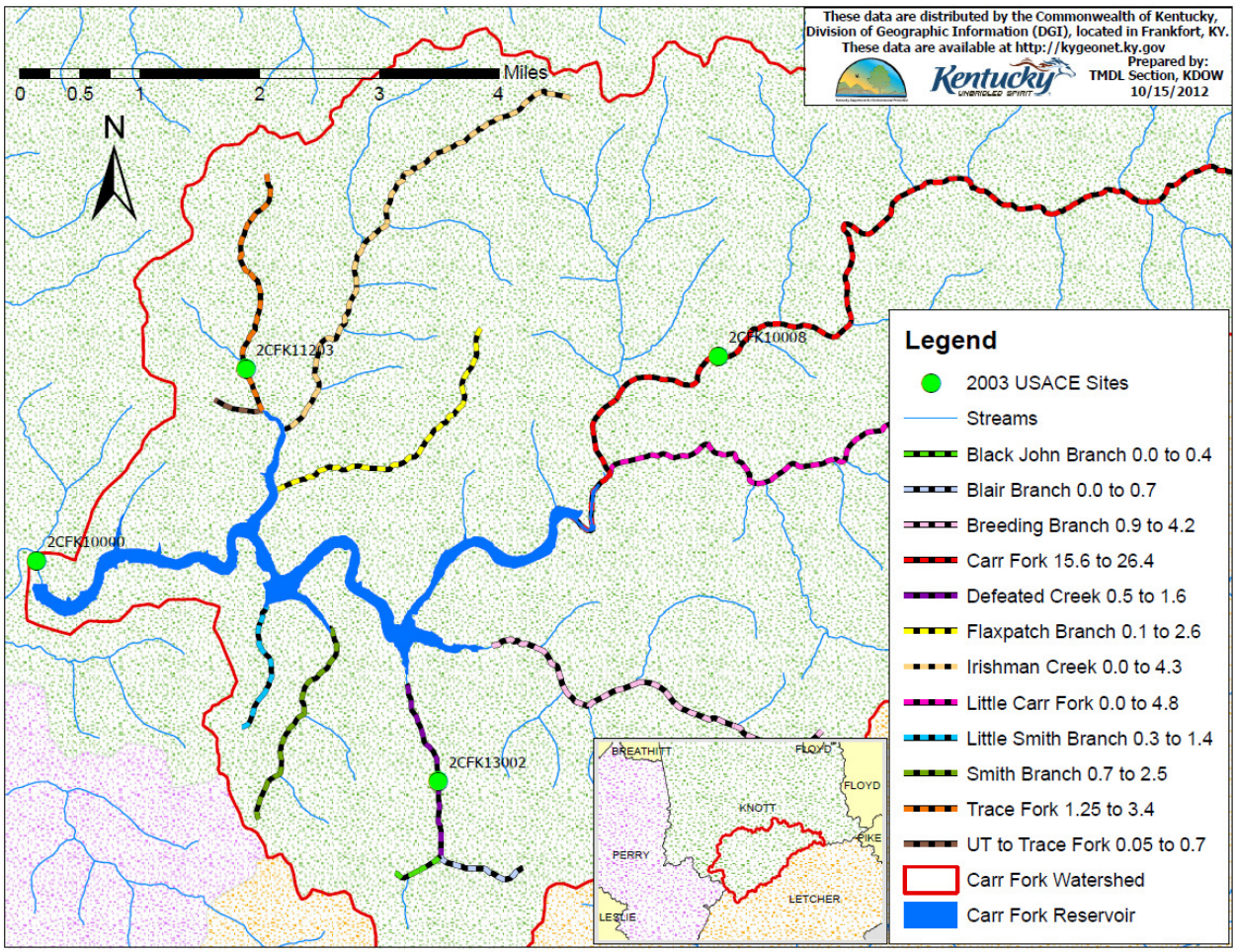

Figure 4.2 Location of 2003 USACE Sample Sites in Carr Fork Watershed

Table 4.4 2003 USACE Sample Data Summary

Station Name	Number of Observations	[1]% Exceeding WQC (400 colonies/100 ml)	% Exceeding WQC (2000 colonies/100 ml)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
2CFK10000	8	20	0	10	600	139
2CFK10008	8	80	25	10	9000	2701
2CFK11203	8	80	62.5	100	3800	2338
2CFK13002	8	40	0	10	1300	450

Note: [1]The percent exceeding the WQC of 400 colonies/100ml was determined from samples collected from May 1 through Oct 31, not from samples collected outside of the PCR season.

4.2 TMDL Monitoring

During the PCR seasons of 2007 and 2008, as a joint effort by the KDOW and the USACE Louisville District, *E. coli* data were collected from fourteen sites on Carr Fork Reservoir and its tributaries. Sampling station locations are summarized in Table 4.5, while sample site locations are shown in Figure 4.3. Data collected from the reservoir itself are shown for informational purposes and are not on an impaired segment. The *E. coli* data are summarized in Table 4.6. Data from these sampling efforts were used to assess the segments shown in Table 4.7 as fully supporting and the segments shown in Table 4.8 as impaired for the PCR use due to *E. coli*. Defeated Creek 0.5 to 1.6 did not show PCR impairment due to *E. coli* but remained PCR impaired due to fecal coliform. Data from the sites shown in Table 4.8 were used in TMDL development.

Table 4.5 TMDL Sample Sites in Carr Fork Watershed

Station Name	Latitude	Longitude	Stream Segment	RM
DOW04057002	37.21317	-82.99431	Smith Branch 0.7 to 2.5	1.5
DOW04057003	37.22058	-82.99945	Little Smith Branch 0.3 to 1.4	0.7
DOW04057004	37.20432	-82.97376	Defeated Creek 0.5 to 1.6	1.4
DOW04057005	37.20897	-82.97590	Defeated Creek 0.5 to 1.6	1.0
DOW04057006	37.19494	-82.97385	Black John Branch 0.0 to 0.4	0.05
DOW04057007	37.19495	-82.97380	Blair Branch 0.0 to 0.7	0.05
DOW04057008	37.23250	-83.03361	(Carr Fork Reservoir) Carr Creek	8.7
DOW04057009	37.24270	-82.98892	Flaxpatch Branch 0.1 to 2.6	0.55
DOW04057010	37.25909	-82.98685	Irishman Creek 0.0 to 4.3	1.1
DOW04057011	37.25514	-83.00108	Trace Fork 1.25 to 3.4	1.6
DOW04057012	37.24980	-83.00031	UT to Trace Fork 0.05 to 0.7	0.1
DOW04058001	37.24309	-82.93851	Little Carr Fork 0.0 to 4.8	0.5
DOW04058002	37.25491	-82.92938	Carr Fork 15.6 to 26.4	18.4
DOW04058003	37.21661	-82.95489	Breeding Branch 0.9 to 4.2	1.65

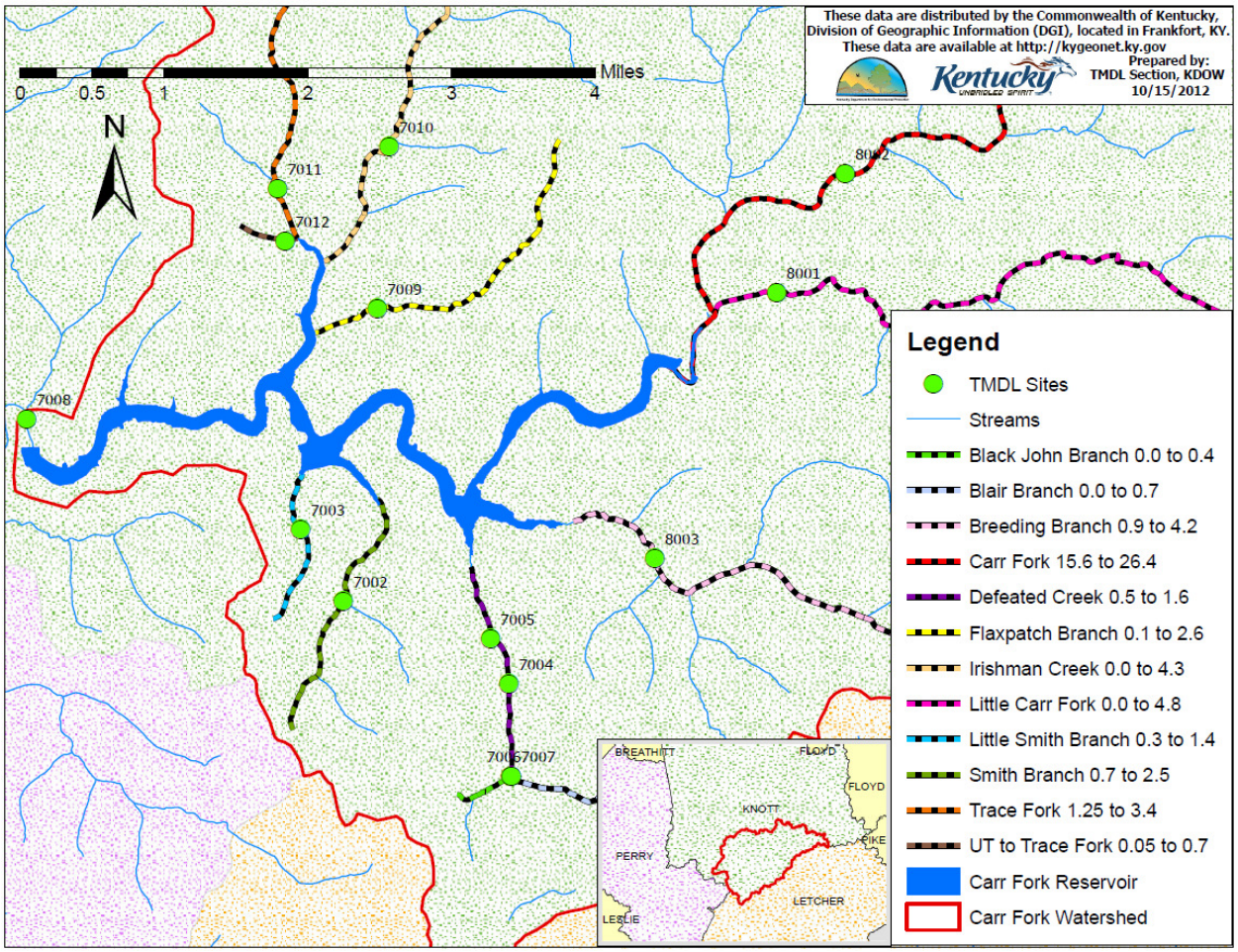

Figure 4.3 Locations of TMDL Sample Sites in Carr Fork Watershed
Note: Only the last four digits of the site number are shown on the map

Table 4.6 TMDL Sample Site Data Summary

Station Name	Number of Observations	% Exceeding WQC (240 colonies/100 ml)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW04057002	7	14.3	10	500	147
DOW04057003	7	71.4	10	3500	877
DOW04057004	7	14.3	10	250	97
DOW04057005	7	14.3	10	2300	381
DOW04057006	7	14.3	10	1500	236
DOW04057007	7	42.9	80	1500	457
DOW04057008	6	0	10	170	36.7
DOW04057009	8	75	20	5000	1139
DOW04057010	8	25	10	1900	446
DOW04057011	8	25	30	1500	323
DOW04057012	8	25	20	900	275
DOW04058001	8	37.5	50	4600	743
DOW04058002	8	37.5	20	3200	549
DOW04058003	7	85.7	10	12000	2337

Table 4.7 Bacteria PCR Fully Supporting Segments in Carr Fork Watershed

Station Name	Stream Segment
DOW04057002	Smith Branch 0.7 to 2.5
DOW04057006	Black John Branch 0.0 to 0.4

Table 4.8 *E. coli* PCR Impaired Segments in Carr Fork Watershed

Station Name	Stream Segment
DOW04057003	Little Smith Branch 0.3 to 1.4
DOW04057007	Blair Branch 0.0 to 0.7
DOW04057009	Flaxpatch Branch 0.1 to 2.6
DOW04057010	Irishman Creek 0.0 to 4.3
DOW04057011	Trace Fork 1.25 to 3.4
DOW04057012	UT to Trace Fork 0.05 to 0.7
DOW04058001	Little Carr Fork 0.0 to 4.8
DOW04058002	Carr Fork 15.6 to 26.4
DOW04058003	Breeding Branch 0.9 to 4.2

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 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 onsite 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

Permitted sources include all sources regulated by the KPDES permitting program. In 401 KAR 10:001, KDOW adopted the definition of a point source per 33 U.S.C. 1362(14) as "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, or concentrated animal feeding operation or vessel or other floating craft, from which pollutants are or may be discharged." However, 401 KAR 10:001 exempts "agricultural storm water run-off or return flows from irrigated agriculture" from the definition of a point source. A Waste Load 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.

Two KPDES-permitted sanitary wastewater dischargers are located in the subwatershed draining to Carr Fork 15.6 to 26.4 (Table 5.1 and Figure 5.1). These facilities receive an SWS-WLA. There are no KPDES-permitted sanitary wastewater dischargers to the other impaired segments. Information about permitted sources was obtained from the application for permit submitted by the permitted entity and from the KPDES-permit. Discharge Monitoring Report (DMR) information was obtained from the USEPA Permit Compliance System database and the Integrated Compliance Information System databases in Envirofacts (USEPA, 2012b) and the TEMPO database maintained by the Department for Environmental Protection. DMR records for permitted entities are available upon request from the KDOW records custodian. Information on the Kentucky Open Records Act is available at http://water.ky.gov (KDOW, 2012b).

USCOE-Carr Creek Campground, permit # KY0027201 (effective 1/1/2013 to 12/31/2017)
The Carr Creek campground is a seasonal facility owned by the USACE, Louisville District that has forty-one campsites, two shower houses, and three restrooms to serve 600 people on peak days. The wastewater is treated by grinding, activated sludge, settling, and ultraviolet disinfection and is discharged to RM 15.7 of Carr Fork. This facility has monthly DMRs reporting *E. coli* colonies/100 ml since July 2007. The facility often has no discharge during the winter season and has no exceedances of the 240 weekly and only one exceedance of the 130 monthly average permit limit from July 2007 to October 2012.

Carr Creek Elementary School, permit # KY0089192 (effective 6/1/2012 to 5/31/2017)
The Carr Creek Elementary School's package plant is owned by the Knott County Board of Education and serves about 340 people. The wastewater is treated by activated sludge, aeration, and chlorination, followed by dechlorination and is discharged to an unnamed tributary of Carr Fork at RM 16.5. This facility has monthly DMRs reporting E. coli colonies/100 ml since May 2007. The facility has no exceedances of either the 240 weekly or the 130 monthly average permit limit from May 2007 to July 2012.

Table 5.1 KPDES-permitted SWS-dischargers on Carr Fork 15.6 to 26.4

AI #	KPDES #	Facility Name	Facility Design Flow (MGD)	Permit Limit *E. coli* colonies/ 100 ml weekly average	Permit Limit *E. coli* colonies/ 100 ml monthly average	Latitude	Longitude
50471	KY0027201	USCOE-Carr Creek Campground	0.02	240	130	37.236796	-82.953387
52407	KY0089192	Carr Creek Elementary School	0.01	240	130	37.241667	-82.949167

Note: AI # indicates Agency Interest number, an internal identification number

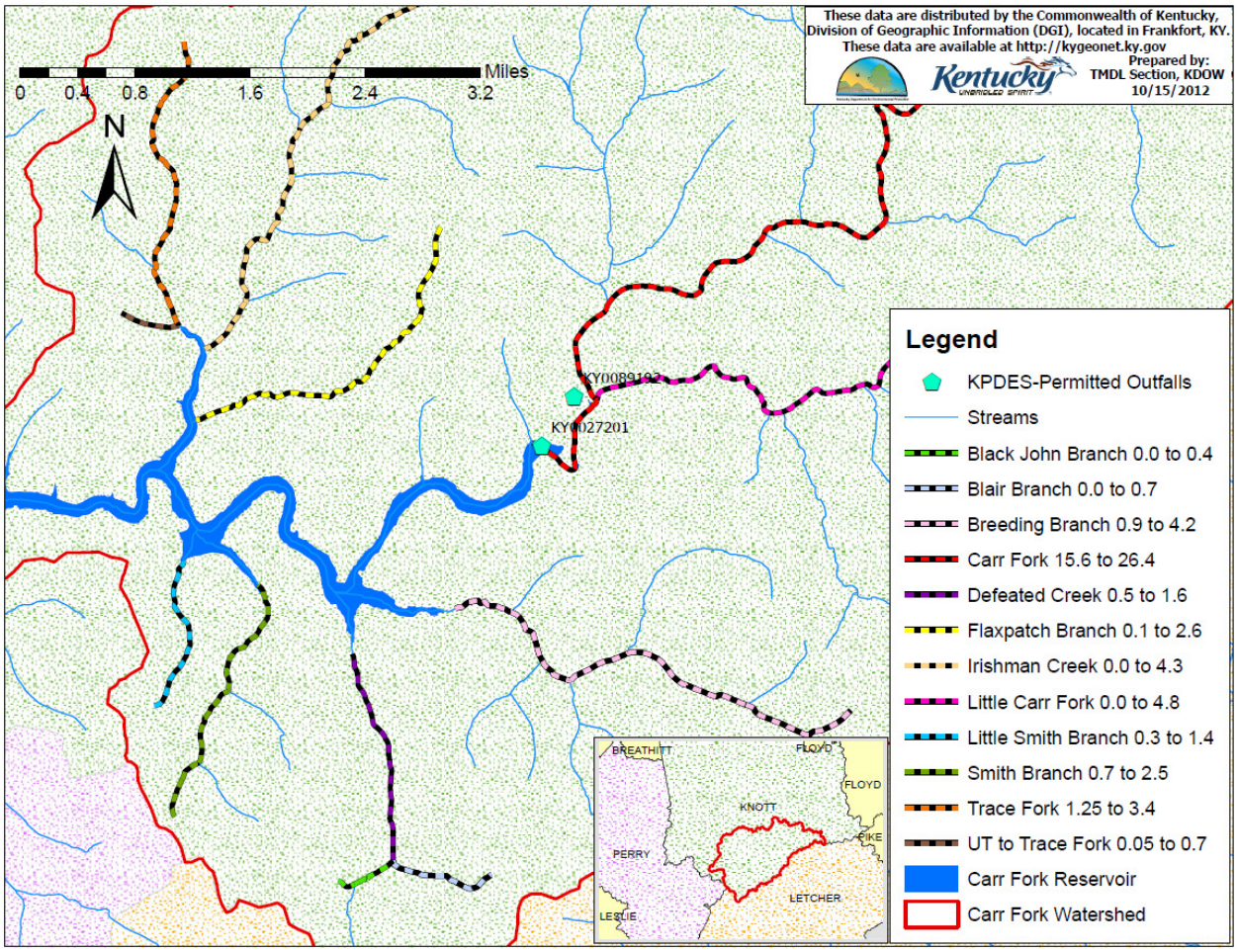

Figure 5.1 Location of KPDES-permitted SWS-dischargers on Carr Fork 15.6 to 26.4

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 cities and counties, universities, military bases and Kentucky Transportation Cabinet. There are no MS4 entities in the Carr Fork 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 known CAFOs in the Carr Fork 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. A Load Allocation (LA) is assigned to non KPDES-permitted sources.

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. There are no KNDOPs in Carr Fork watershed.

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 (USDA, 2007). Selected agricultural data from the latest Census of Agriculture reports for Knott County are listed in Table 5.2. 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 subwatershed in Table 3.4 (Section 3.3).

Table 5.2 Agricultural Statistics from the 2007 USDA Agricultural Census

	Knott
Farms (number/acres)	46/6937
Total Cropland (acres)	2,704
Cattle and Calves Inventory (total number)	695
Beef Cows (total number)	(D)
Milk Cows (total number)	(D)
Horses and Ponies (total number)	262
Goats (total number)	171
Hogs and Pigs (total number)	0
Sheep and Lamb (total number)	(D)
Poultry Layers (total number)	120
Poultry Broilers (total number)	36
Corn for grain (acres)	0
Wheat for grain (acres)	0
Corn for Silage (acres)	0
Forage (acres)	603

(D) = data withheld to avoid disclosing data for individual farms

5.2.3 Wildlife

Wildlife undoubtedly contributes bacteria to the Carr Fork watershed, noting the high percentage of forest. Table 5.3 shows the estimates of deer population and density in Knott County, as provided by the Kentucky Department of Fish and Wildlife Resources (Kentucky Department of Fish and Wildlife Resources, 2006). Estimates on numbers of other types of animals are not available; however, a wildlife management area (WMA) exists around the Carr Fork Reservoir (Figure 5.2). Although wildlife contributes bacteria to surface water, such contributions represent natural background conditions, and do not receive a reduction as part of the TMDL.

Table 5.3 Number of Deer in Knott County

County	Deer, per square mile	Total number of deer
Knott	8	2,701

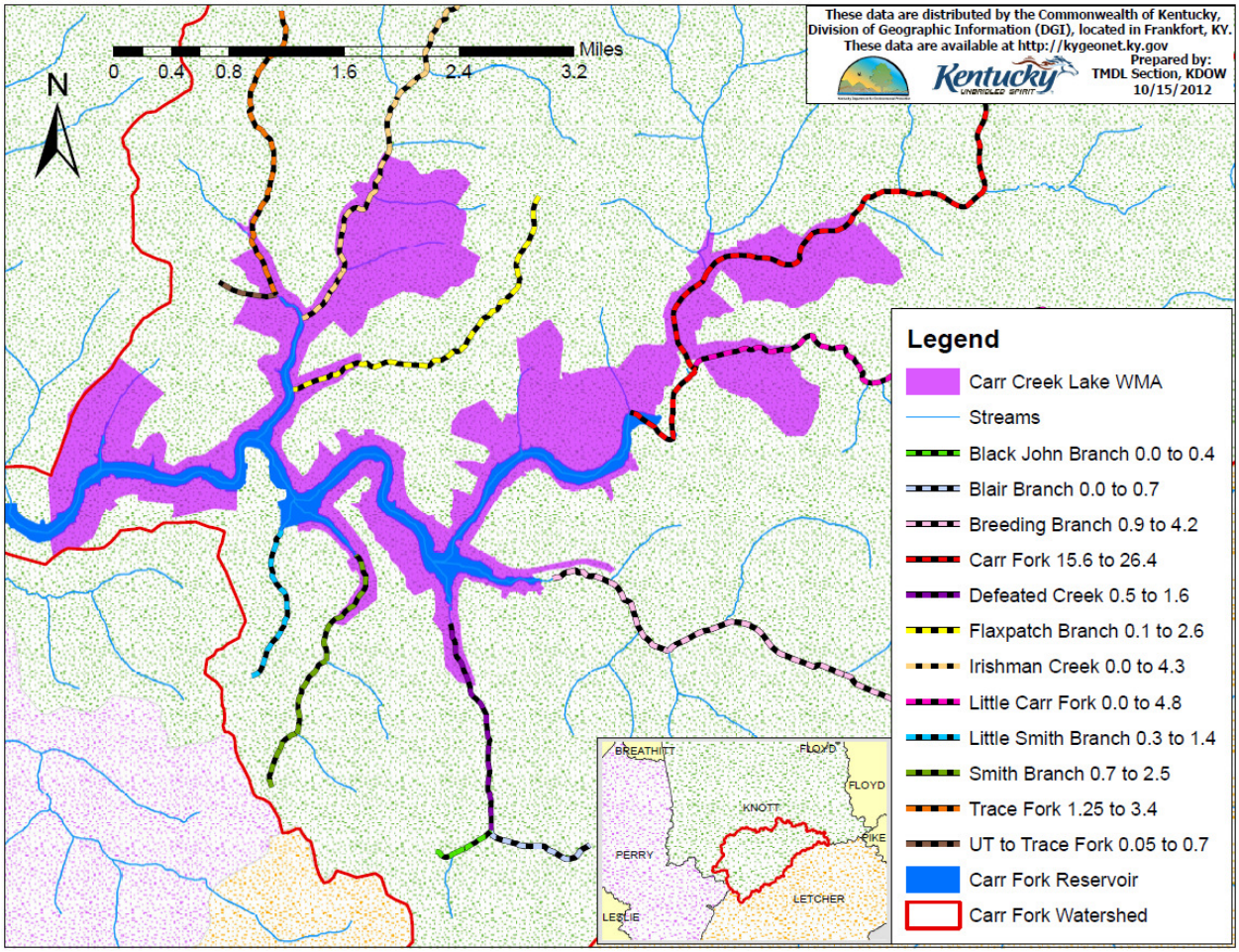

Figure 5.2 Wildlife Management Area (WMA) along Carr Fork Reservoir

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 System (OSTDS) or do not treat their sewage. OSTDSs, 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 fecal bacteria to both groundwater and surface water, see Section 5.3, Illegal Sources, for further discussion of failing OSTDSs. Another type of non KPDES-permitted source that may exist in the watershed is straight pipes, which are discrete conveyances that discharge sewage, gray water (i.e., water from household sinks, laundry, etc.), and storm water to the surface waters of the Commonwealth without treatment.

The 2010 census data includes census blocks of population (Figure 5.3). Because there are no sewer lines or wastewater treatment plants in the Carr Fork watershed, the entire population is estimated to be served by OSTDSs or to have no sewage treatment (i.e. use straight pipes).

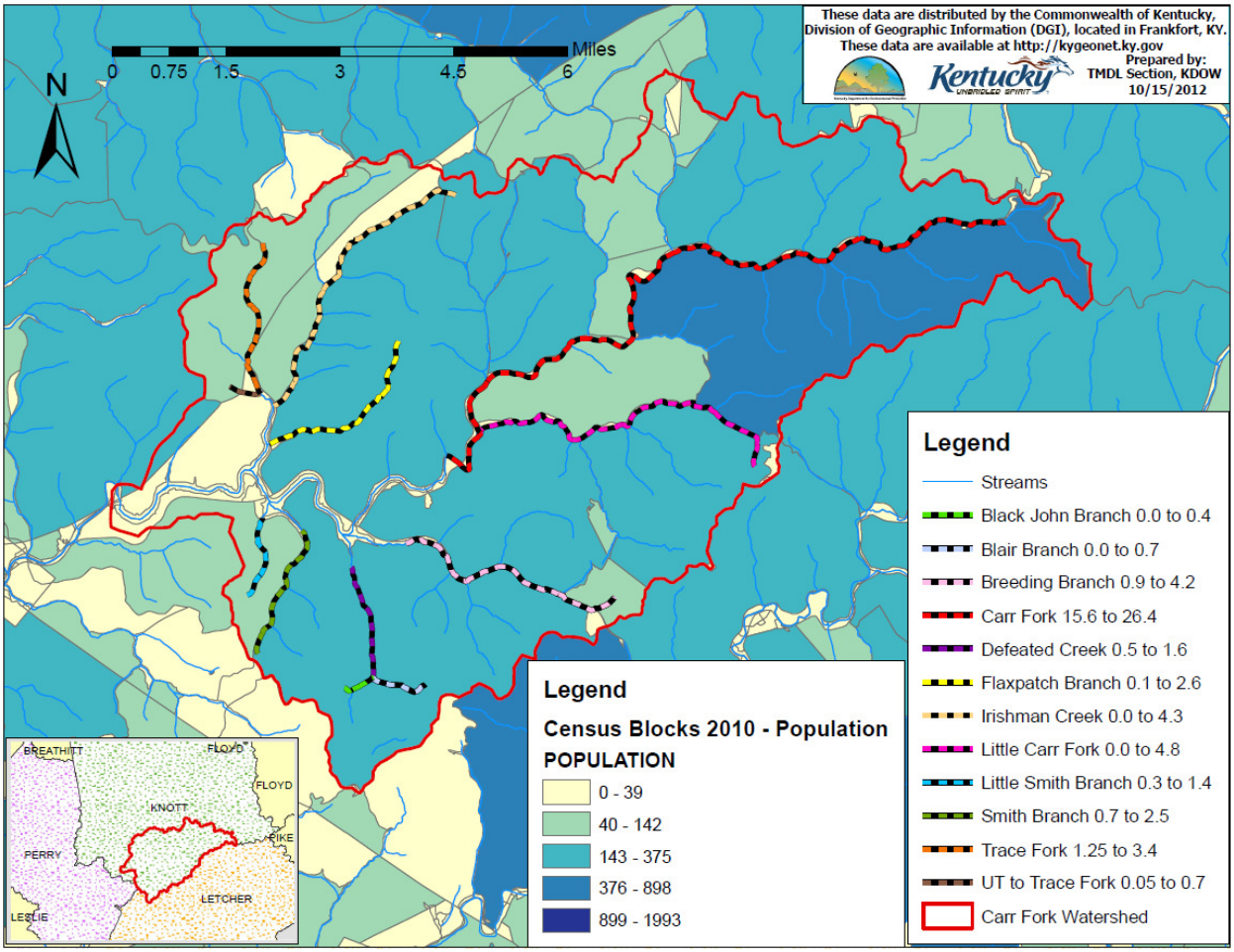

Figure 5.3 2010 Population Blocks in Carr Fork Watershed

5.2.5 Household Pets

Although household pets undoubtedly exist in this watershed, their contribution to the LA in rural areas 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 larger areas of impermeable surfaces.

5.3 Illegal Sources

Both KPDES-permitted and non KPDES-permitted sources can discharge fecal bacteria to surface water illegally. This includes sources that are illegal simply by their existence, such as straight pipes and 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 failing OSTDSs, which receive no allocation above that of a properly functioning system (see Section 7.0 for information on 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 and SCR use are based on both fecal coliform and *E. coli*. 401 KAR 10:031 states:

"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*."*

Additionally:

"The following criteria shall apply to waters designated for secondary contact recreation use during the entire year: Fecal coliform content shall not exceed 1000 colonies per 100 ml as a thirty (30) day geometric mean based on not less than five (5) samples; nor exceed ***2000*** *colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period."*

There are insufficient *E. coli* or fecal coliform measurements to calculate a 5-sample, 30-day geometric mean, so the instantaneous criterion was applied to calculate allowable loadings to bring the watershed into compliance with the PCR or SCR designated use. See Section 7.0 for TMDL loading calculations. Allowable loadings were calculated based upon the impaired designated use and the bacteria-indicator causing the use-impairment. For *E. coli* PCR impairments, the instantaneous criterion of 240 colonies/100 ml was applied to calculate allowable loadings. For fecal coliform PCR impairments, the instantaneous criterion of 400 colonies/100 ml was used. For fecal coliform SCR impairments, the instantaneous criterion of 2000 colonies/100 ml was applied. When multiple sample sites were located within an impaired segment, the site with the greatest bacteria exceedance was used to establish the TMDL. TMDLs for the impaired stream segments within Carr Fork watershed can be found in Section 8.2 of this document.

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 two components:

WLA = SWS WLA + Future Growth WLA
(Equation 2)

Definitions:
TMDL: the WQC, expressed as a load.
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). It 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).
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.
Critical Flow: the flow used to calculate the TMDL as a load
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 loading reduction needed to bring the existing condition 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: ($28.31685 L/f^3$ * 86400seconds/day * 1000ml/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 is calculated and subtracted from the TMDL Target, leaving the Remainder;
4. The Future Growth WLA is calculated and subtracted from the Remainder; leaving the LA

The TMDL calculation must take into account seasonality and other factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses. Once a critical flow is obtained (see Section 7.6), it is then multiplied by the Water-Quality Criteria (WQC) minus the MOS (10%) times the appropriate conversion factors to obtain the TMDL Target load. Allowable loadings from KPDES-permitted sources (if present) are then subtracted from the Target load to produce the Remainder. Future Growth calculations are then performed and subtracted from the Remainder, leaving the LA.

Regardless of the procedure used to calculate the TMDL, reductions from existing conditions ultimately must be effected within the watershed only until all stream segments meet the PCR and SCR uses.

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, expressed as a load) was reserved to address uncertainties involving loading from non-SWS sources. SWS sources have an implicit MOS based on the fact that they seldom operate at their design flow. The explicit MOS load was calculated using the following equation:

$$\text{WQC x 10\% (colonies/100ml)} \times \text{Critical Flow (cfs)} \times \text{Conversion Factor } 24{,}465{,}758.4 = \text{MOS (colonies/day)} \quad \text{(Equation 3)}$$

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

The SWS WLA load was calculated using the following equation:

$$\text{WQC (colonies/100ml)} \times \text{Design Flow (cfs)} \times \text{Conversion Factor 24,465,758.4} = \text{WLA (colonies/day)}$$

(Equation 4)

The individual SWS WLAs for each facility that discharges above or to an impaired segment are summed to create a final SWS WLA for that segment.

Equation 4 was used to set the WLA for all continuous bacteria dischargers (SWSs). Because KPDES permitting sets the discharge limit at the WQC for SWSs, the SWS WLA does not receive an explicit MOS. However, it does receive an implicit MOS because SWSs typically do not discharge at their design capacity.

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.

7.3.3 Future Growth-WLA

Because the WLA must include all KPDES-permitted sources, often a TMDL will anticipate 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 begin discharging. Future growth is represented by a portion of the Remainder that 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 include existing storm water sources that are later discovered to discharge the pollutant of concern, even though this fact was not known at the time the TMDL was written. The amount reserved 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:

The Future Growth WLA is calculated using the following formula:

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

(Equation 5)

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%

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 OSTDSs (e.g., 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:

$$\text{Remainder} - \text{Future Growth WLA} = \text{LA}$$
(Equation 7)

The available sampling data were insufficient to apportion the existing loading among the various LA sources; therefore, it was attributed to all LA sources.

7.5 Seasonality

Seasonality is defined as the yearly factors such as temporal variations on source behavior and stream loading that 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 (i.e., May through October) to calculate PCR TMDLs and using year-round data to calculate SCR TMDLs. See Section 6.0 for a citation of Kentucky's WQSs for the PCR and SCR seasons.

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 build 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. Carr Creek watershed contains both types of sources; therefore, the critical condition for each bacteria-impaired segment is defined by the flow for the sample showing the highest exceedance from the appropriate WQC.

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)

(Equation 8)

7.8 Calculation of Percent Reductions

TMDLs were calculated for each flow duration zone within the LDC of each impaired segment. A percent reduction necessary to achieve the TMDL target load was calculated for each zone where samples exceeded the WQC. The LDCs that follow in Section 8.2 show a graphical display of the data relative to the TMDL. Data used to generate these graphs are presented in Appendix B. Not every zone had a sample (or samples) within it, and not all of the samples showed exceedances of the WQC. Calculation of the TMDL, target loads, and percent reductions (where applicable) followed the methodology found in KDOW's *Pathogen Indicator TMDL SOP* (KDOW, 2011b).

7.9 TMDLs Calculated as a Daily Load

The CWA requires a TMDL to be expressed in terms of a daily load. The TMDL is represented by a continuous curve on the LDC graph while observed loads (i.e., sample data) are expressed as point data, thus samples that plot above the curve exceed the TMDL and those below are less than the WQC.

The *Pathogen Indicator TMDL SOP* (KDOW, 2011b) states, "If there is an appropriate USGS flow gage with which to generate a flow record for the sampling station(s) used in the TMDL, this will be used in conjunction with the [LDC method]… to set the TMDL Target and allocate loads." See Section 8.0 for an explanation of the LDC procedure. Because an appropriate USGS gage was available, the LDC approach was used to display the existing conditions, the critical conditions and allowable loading for TMDLs in each LDC flow zone.

The LDCs (and TMDL allocations) were calculated at the individual sampling stations; see Section 8.2 for allocation tables for each station. However, USEPA requires that loading calculations reflect the entire listed segment, not only the portion of the segment represented by (i.e., upstream of) a given sampling station. This is necessary because there may be additional sources of the pollutant of concern below the sampling station but still within the watershed area of the impaired segment. Therefore, upon completion of the station TMDLs, the allocations were extrapolated from the station to the bottom of each impaired segment using the proportional area method. This involves dividing the upstream drainage area at the end of the impaired segment by the upstream drainage area of the station, then multiplying the TMDL allocations (including the existing conditions) at the station by this ratio of areas. These segment-based allocations represent the final TMDLs for this report. Section 8.2 contains LDCs and TMDL allocations for each bacteria-impaired segment. In the case where two or more stations existed within one

impaired segment, the station with the highest exceedance was used to set TMDL allocations for that segment.

In one case, the station used to represent the impaired segment was coterminous with the bottom of the impaired segment. In such cases, no additional calculations are necessary to extend the loading allocations to the bottom of the segment. If the ratio of the upstream watershed areas of the segment to the station was greater than or equal to 1.01 (i.e., the difference in areas was greater than or equal to 1%), calculations to extrapolate the station data to the segment were performed. Details of this calculation are included in the individual segment descriptions in Section 8.2. Note the percent reduction required at a given station is only based on the difference in concentration between the maximum exceedance and the WQC; therefore, extrapolating the load based on the maximum exceedance by multiplying it by any ratio of drainage areas does not change the percent reduction required.

8.0 TMDL Calculations

A Load Duration Curve approach was utilized for development of these bacteria TMDLs. The best available data from various sources was analyzed and spatial analysis was performed within a Geographic Information System (GIS) framework to assess KPDES-permitted and non-KPDES-permitted sources, and appropriately assign TMDL loads. Development of these TMDLs follows the procedures outlined in Kentucky's *Quality Assurance Project Plan (QAPP) for Data Analysis for TMDL Development* and maintains the guidelines set in the *Pathogen TMDL Standard Operating Procedures* for evaluating the TMDL approach (KDOW, 2009; KDOW, 2011b).

The *Kentucky Pathogen TMDL SOP* (KDOW, 2011b) states if there is an appropriate USGS flow gage with which to generate a flow record for the sampling station(s) used in the TMDL, flow data from this gage is to be used to develop the LDC, set the TMDL Target, and allocate loads. The appropriateness of a given USGS gage to generate a flow record for the sampling stations in the watershed is evaluated based on the how well the following conditions are met: 1) the flows at the sampling station and the flows at the gage should be from the same dates and times and are well correlated (i.e., there is a high 'R^2' coefficient), 2) the watershed area upstream of the gage is within 0.5 to 1.9 times the area of the watershed upstream of the sampling station, 3) there are no flow regulating structures present above either the sampling station or the gage, 4) the landuse upstream of the station is similar to that upstream of the gage, 5) the sampling station and gage are in the same major watershed, and 6) there is a sufficiently long period of record available at the gage to smooth out the effects of very wet and/or very dry years. In practice, it is difficult or impossible to meet all of the above conditions explicitly. Because USGS gages are often placed on larger streams and streams of all sizes can be impaired (and require TMDLs), the ratio of the watershed area to the gage area is unlikely to fall within the 0.5 to 1.9 range specified. The *Kentucky Pathogen TMDL SOP* (KDOW, 2011b) specifies that, if in the best professional judgment of KDOW an appropriate gage is available, a load duration curve will be generated using flows from this gage.

The two USGS gages in the Carr Fork watershed were deemed to be inappropriate for generation of load duration curves because they are located below the lake and are impacted by the dam and flow regulation of the dam. However, another nearby gage was deemed appropriate to generate LDCs. Table 8.1 presents the gage used in representing flow for stations used in TMDL analysis while Figure 8.1 shows the location of this gage and its watershed in relation to the Carr Fork watershed (USGS, 2012c). If in-stream flow data was collected at the time of the maximum exceedance sample collection, the measured in-stream flow was used; otherwise, the gage was used to estimate the critical flow.

Table 8.1 USGS Gage Used to Represent Flow at the TMDL Sample Sites

Gage ID	NAME	Latitude	Longitude	Drainage Area (square miles)	Link
03277300	North Fork Kentucky River at Whitesburg, KY	37.1175	-82.82472	66.4	http://waterdata.usgs.gov/ky/nwis/inventory/?site_no=03277300

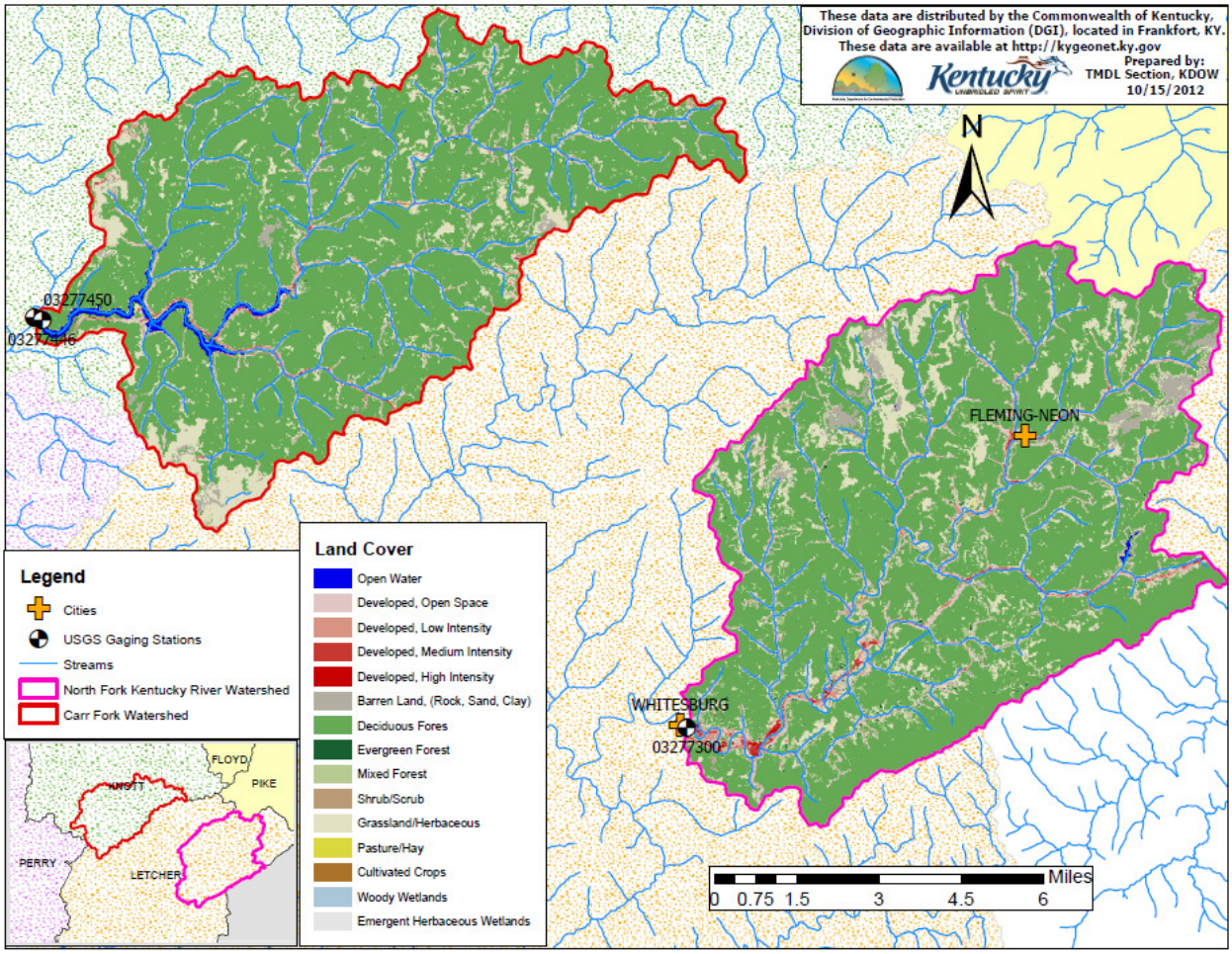

Figure 8.1 Location of Carr Fork Watershed and Gage Watershed

The flows at the gage were normalized to represent the catchment area of sampling stations on the TMDL streams. The Area-Weighted Flow (AWF) at each sampling station was determined by dividing the upstream drainage area of the sampling station by the upstream drainage area of the gage then multiplying the average daily flows at the gage by this ratio of areas.

According to *Kentucky Pathogen TMDL SOP*, a Flow Duration Curve (FDC) must be constructed first. Creating a FDC involves finding all recorded flow values within a creek at a particular sampling station and calculating the percent rank of each value. This percent rank is plotted on the X-axis of a graph, and the corresponding flow is plotted on the Y-axis using a log10 scale. This procedure displays higher flows on the left part of the graph, and lower flows (and the period where the creek goes dry, if any) on the right part of the graph. The FDC is divided into five flow zones (also called flow conditions); High Flows (which are flows that are not exceeded for more than 10% of the period of record on the far left part of the graph), Moist Conditions (with flows exceeded between 10% and 40% of the period of record), Mid-Range Flows (which are exceeded between 40% and 60% of the period of record), Dry Conditions (with flows exceeded between 60% and 90% of the period of record), and Low Flows (which are exceeded between 90% and 100% of the period of record, on the far right part of the graph).

The FDC was then converted to a LDC by multiplying all flows by the WQC and by a conversion factor to convert the units from (colonies-ft^3)/(100 ml-second) to colonies per day. To complete the LDC, the sample results were plotted at their corresponding flow values, thus exceedances of the WQC plotted above the curve, and vice versa. The critical condition was defined as the sample (plotted as a load) with the highest exceedance of the WQC.

For PCR use impairments, only the recreational season's flows were used to build the FDCs for each impaired segment. Using only May through October gage data to construct the FDC has the effect of deleting the (mostly higher) winter flows, which artificially shifts the FDC to the left. As a result, a sample that was taken during the Low Flow period may erroneously plot to the left, inside the Dry Conditions zone, etc. This can hamper TMDL implementation, since each zone tends to be associated with a different group of sources (although overlap does occur). For instance, point sources and cattle standing in the creek most often produce their greatest impact at the lowest flows, and any sample taken on a Low Flow day should be plotted as such so an initial list of potential source types can be inferred. Therefore, the x-axis location of the vertical lines on the graph that denote the flow zones were calculated using the entire year's flows, and then plotted on the FDC showing only May through October flows.

The TMDL Target load was calculated for each flow zone within the LDC. However, existing conditions and the percent reduction (to bring existing conditions in line with the TMDL Target load) were only calculated for zones with samples exceeding the WQC. Two different methods were used to set the TMDL Target load within each zone (and to calculate existing conditions and a percent reduction, if applicable):

<u>No exceedances within a zone</u>: If there were no samples showing exceedances within a flow zone at a station, the TMDL Target load for that zone was set at the 90th percentile of the TMDL Target loads for each percent Flow Rank within that zone. Since no samples exceed the WQC, no existing conditions or percent reductions were calculated. This is denoted by an "*" in the Site TMDL Tables in Section 8.2.

<u>One or more exceedances within a zone</u>: The existing condition was set at the highest exceedance of all sample loads from within the zone. The TMDL Target load for the zone was also set using the flow associated with the sample showing the highest exceedance within the zone (the TMDL Target load is the load at the sample's flow multiplied by the TMDL target concentration (i.e., the TMDL minus the MOS) and by the conversion factor.

The critical condition was decided based on the flow zone with the greatest percent reduction required (i.e., the zone with the greatest exceedance of the WQC). The critical condition zone determines the overall TMDL, TMDL Target and percent reduction for the impaired segment.

Sample points are often labeled on Load Duration Curves in a way that illustrates whether a sample was taken during the runoff portion of a storm's hydrograph. This allows further insight into critical conditions: For instance, although the high-flow portion of the duration curve might be the period with the greatest loading from a source, it may also be that samples taken during high-flow conditions subsequent to rain events show more loading than samples taken during high-flow conditions which are not immediately connected with rain events. This information

can point to the types of BMPs that would best address the delivery of pollutant loading to the system.

To determine whether a sample is taken during the runoff portion of a storm hydrograph, the percent stormflow was calculated using the Hydrograph Separation (or HYSEP) method developed by the USGS (1996). HYSEP includes different mathematical protocols to separate baseflow from stormflow on a given day, and KDOW used the Sliding Interval approach, see USGS (1996) for further discussion. After subtracting baseflow, HYSEP determines the flow on a given day compared to the lowest flow in a 5-day period around that day, and if this change is greater than 50%, the sample taken on that day is considered to be from the runoff portion of a storm's hydrograph.

Load Duration Curves can assist in the identification of potential sources impacting water quality in a watershed. Table 8.2 shows flow zones under which different sources are expected to have high or medium impacts (Table from USEPA, 2007).

Table 8.2 Sources Associated with Flow Zones

Contributing Source Area	Duration Curve Zone				
	High Flow	Moist	Mid-Range	Dry	Low Flow
Point Source				*M*	*H*
On-site wastewater systems			*H*	*M*	
Riparian Areas		*H*	*H*	*H*	
Storm water: Impervious Areas		*H*	*H*	*H*	
Combined sewer overflows	*H*	*H*	*H*		
Storm water: Upland	*H*	*H*	*M*		
Bank erosion	*H*	*M*			

Note: Potential relative importance of source area to contribute loads under given hydrologic condition *(H: High; M: Medium)*

It should be noted that a Load Duration Curve must be well populated with sample data to determine potential sources impacting an upstream watershed. If exceedances are not identified within a flow zone, it could be due to a lack of sufficient sample collection within that flow zone and source contributions from that zone could be occurring.

8.1 Data Validation

Data collected for this TMDL were validated as follows:

- Samples collected outside the PCR months of May through October were eliminated from the data sets for PCR TMDL calculations but were used for SCR TMDL calculations.
- Quality Assurance/Quality Control Samples (e.g., duplicates) were not considered during TMDL 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 was either below or above the reported value, respectively. For these samples, the reported value was used verbatim. For *greater than* values, the exact value of the exceedance is unknown and likely higher than the number reported, however the sample still provides insight into the status of the waterbody at the time the sample was taken.

See Appendix B for the full dataset.

8.2 Individual Stream Segment Analysis

Data collection and analysis from various sources (including Federal, State and local government and public entities) was carried out 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). In this section, descriptions of each impaired subwatershed are presented along with tables of land cover, general subwatershed information and TMDL allocations. The land cover table for each segment includes the percentage used to calculate the Future Growth WLA. The 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. It is based upon the USGS Geographic Names Information System (GNIS) (USGS, 1999) with a KY in front of the GNIS number and a _## where ## is a segment identification number. To save space, the "KY" has been left off the beginning of the WBID #.

8.2.1 TMDL Summary for Blair Branch RM 0.0 to 0.7

Blair Branch at RM 0.7 is located in the southwest portion of Carr Fork Watershed (Figure 8.2). Blair Branch 0.0 to 0.7 does not support the PCR use due to *E. coli*. Information about Blair Branch 0.0 to 0.7, including its WBID is shown in Table 8.3.The subwatershed for the impaired segment has a total drainage area of approximately 0.7 square miles. Blair Branch does not display on a 1:100K map, therefore its stream order is listed as N/A at this scale. There are no KPDES-permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is predominantly forested (73.4%), followed by natural grassland (23.1%) and urban/residential development (3.2%) as shown in Table 8.4.

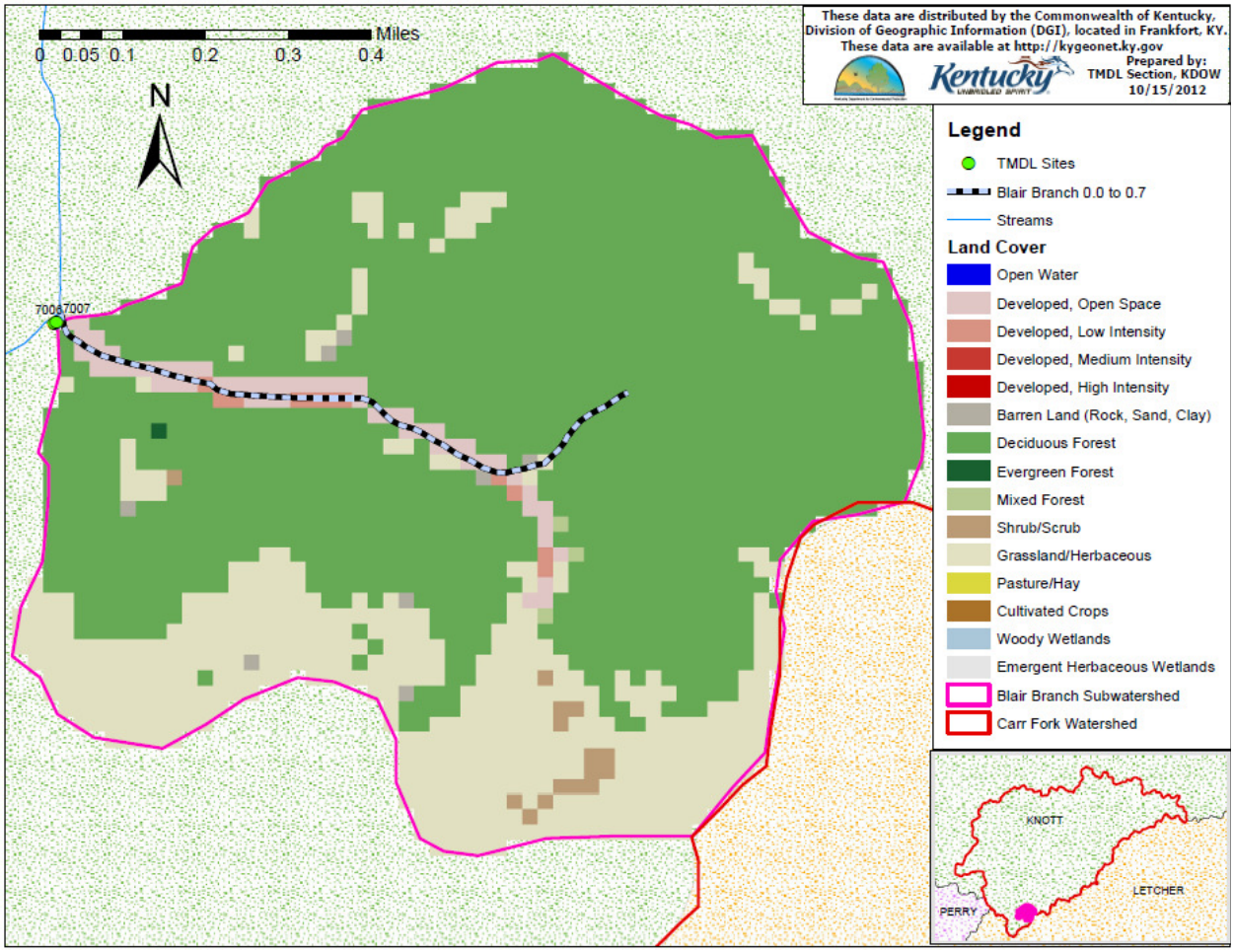

Figure 8.2 Land Cover and TMDL Site Location in the Blair Branch 0.0 to 0.7 Subwatershed

Table 8.3 Blair Branch 0.0 to 0.7 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Blair Branch 0.0 to 0.7	KY487435_01	455	0.7	N/A

Note: N/A indicates that the stream does not display at the 1:100K scale.

Table 8.4 Land Cover in the Blair Branch 0.0 to 0.7 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	3.16	14	0.0	0.5
Agriculture (total)	0.00	0	0.0	
Pasture	0.00	0	0.0	
Row Crop	0.00	0	0.0	
Forest	73.37	334	0.5	
Natural Grassland	23.08	105	0.2	
Water	0.00	0	0.0	
Wetland	0.00	0	0.0	
Barren	0.39	2	0.0	
Total	100	455	0.7	

Site information is shown in Table 8.5; site DOW04057007 was used to develop the *E. coli* LDC (Figure 8.3). The critical condition was the low flow zone although exceedances were found in other zones. Table 8.6 shows the TMDLs for the flow zones associated *E. coli* at site DOW04057007 (the yellow highlight indicates the critical condition TMDL).

Table 8.5 Information for Sample Site DOW04057007

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057007	37.19495	-82.9738	0.05	0.71	0.07

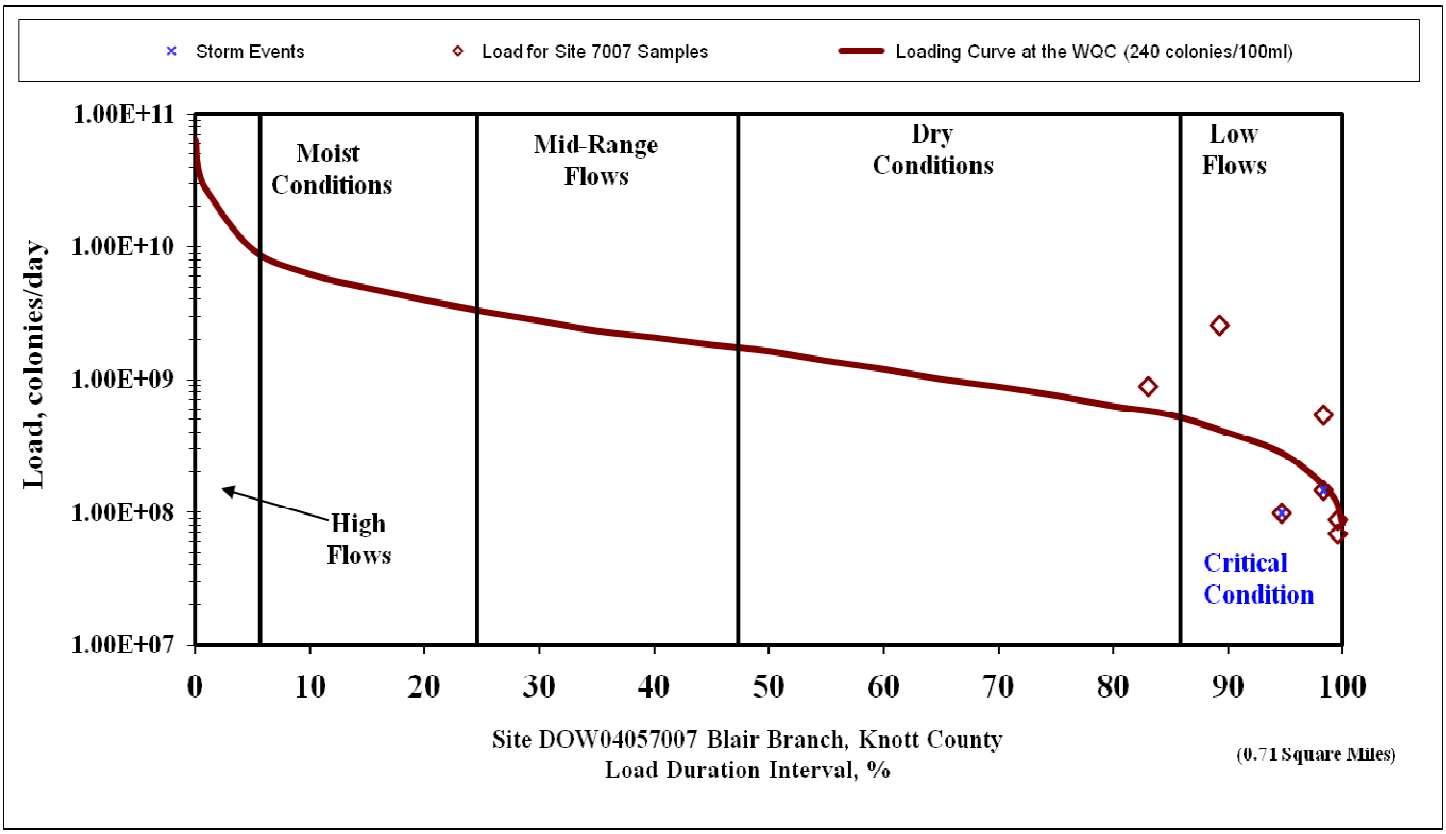

Figure 8.3 PCR *E. coli* LDC for Site DOW04057007

Table 8.6 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057007

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	3.21E+10	3.21E+09	2.89E+10	*	0.00E+00	2.89E+10
Moist	*	7.78E+09	7.78E+08	7.00E+09	*	0.00E+00	7.00E+09
Mid	*	3.08E+09	3.08E+08	2.77E+09	*	0.00E+00	2.77E+09
Dry	1.25E+09	5.87E+08	5.87E+07	5.28E+08	57.6	0.00E+00	5.28E+08
Low	4.28E+09	2.94E+08	2.94E+07	2.64E+08	93.8	0.00E+00	2.64E+08

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Both Blair Branch at RM 0.0 and site DOW04057007 have upstream watershed areas of 0.71 square miles; therefore, the segment Existing Load and TMDL allocations were identical to that for the site (Table 8.7).

Table 8.7 *E. coli* PCR TMDL Allocations for Blair Branch 0.0 to 0.7

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	4.28E+09
TMDL (colonies/day)	2.94E+08
MOS (colonies/day)	2.94E+07
TMDL Target (colonies/day)	2.64E+08
Percent Reduction (%)	93.8
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	2.64E+08
Future Growth-WLA (colonies/day)	1.32E+06
LA (colonies/day)	2.63E+08

8.2.2 TMDL Summary for Breeding Branch 0.9 to 4.2

Breeding Branch at RM 0.9 is a 2nd order stream located in the southern portion of the Carr Fork watershed (Figure 8.4). Breeding Branch 0.9 to 4.2 does not support the PCR use due to *E. coli*. Information about Breeding Branch 0.9 to 4.2, including its WBID is shown in Table 8.8. The subwatershed for the impaired segment has a total drainage area of approximately 5.8 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (85.6%) followed by developed (6.8%) and natural grassland (6.2%) as shown in Table 8.9.

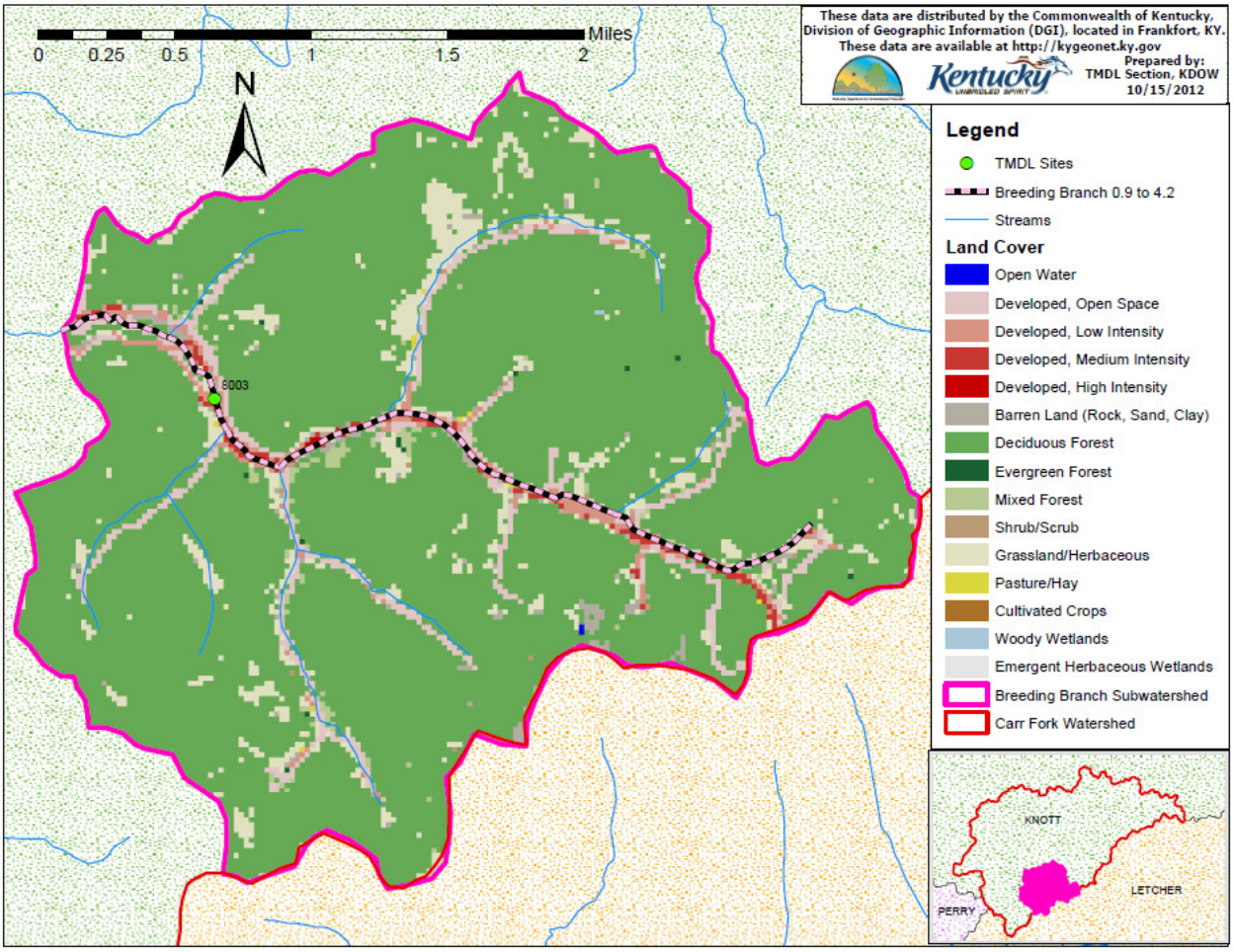

Figure 8.4 Land Cover and TMDL Site Location in the Breeding Branch 0.9 to 4.2 Subwatershed

Table 8.8 Breeding Branch 0.9 to 4.2 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Breeding Branch 0.9 to 4.2	KY487857_01	3702	5.8	2nd

Table 8.9 Land Cover in the Breeding Branch 0.9 to 4.2 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	6.84	253	0.4	1.0
Agriculture (total)	0.08	3	0.0	
Pasture	0.08	1	0.0	
Row Crop	0.00	0	0.0	
Forest	85.55	3166	4.9	
Natural Grassland	6.18	229	0.4	
Water	0.01	0	0.0	
Wetland	0.02	1	0.0	
Barren	1.32	49	0.1	
Total	100.00	3702	5.8	

Site information is shown in Table 8.10; site DOW04058003 was used to develop the *E. coli* LDC (Figure 8.5). The critical condition was the moist flow zone, although exceedances were found in other zones. Table 8.11 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04058003 (the yellow highlight indicates the critical condition TMDL).

Table 8.10 Information for Sample Site DOW04058003

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04058003	37.21661	-82.95489	1.65	5.1	5.13

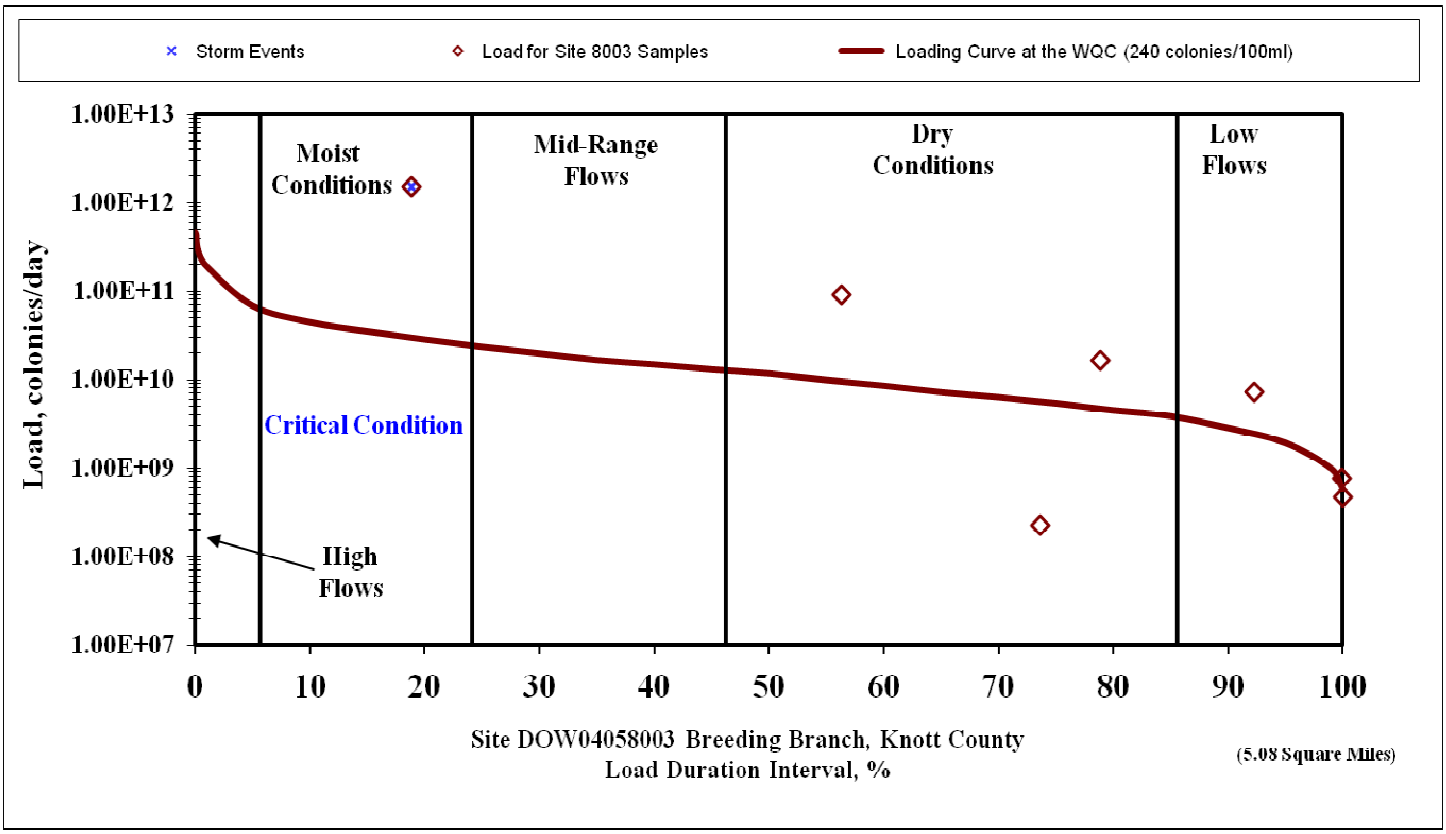

Figure 8.5 PCR *E. coli* LDC for Site DOW04058003

Table 8.11 PCR *E. coli* TMDLs by Flow Zone for Site DOW04058003

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	2.30E+11	2.30E+10	2.07E+11	*	0.00E+00	2.07E+11
Moist	1.51E+12	3.01E+10	3.01E+09	2.71E+10	98.2	0.00E+00	2.71E+10
Mid	*	2.20E+10	2.20E+09	1.98E+10	*	0.00E+00	1.98E+10
Dry	9.04E+10	9.86E+09	9.86E+08	8.88E+09	90.2	0.00E+00	8.88E+09
Low	7.26E+09	2.52E+09	2.52E+08	2.27E+09	68.7	0.00E+00	2.27E+09

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Breeding Branch at RM 0.9 has an upstream watershed area of 5.8 square miles while site DOW04058003 has an upstream watershed area of 5.1 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.14) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.12).

Table 8.12 *E. coli* PCR TMDL Allocations for Breeding Branch 0.9 to 4.2

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	1.71E+12
TMDL (colonies/day)	3.43E+10
MOS (colonies/day)	3.43E+09
TMDL Target (colonies/day)	3.08E+10
Percent Reduction (%)	98.2
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	3.08E+10
Future Growth-WLA (colonies/day)	3.08E+08
LA (colonies/day)	3.05E+10

8.2.3 TMDL Summary for Carr Fork 15.6 to 26.4

Carr Fork at RM 15.6 is a third order stream located in the eastern part of the Carr Fork watershed (Figure 8.6). Carr Fork 15.6 to 26.4 does not support the PCR use due to *E. coli* and the SCR use due to fecal coliform; therefore, two TMDLs were calculated. Information about Carr Fork 15.6 to 26.4, including its WBID is shown in Table 8.13. The subwatershed for the impaired segment has a total drainage area of approximately 30.9 square miles. There are two KPDES permitted SWS dischargers within the subwatershed boundary (see Table 8.19). The land cover in this subwatershed is a primarily forested (81.7%) followed by natural grassland (10.4%) and developed (6.3%) as shown in Table 8.14.

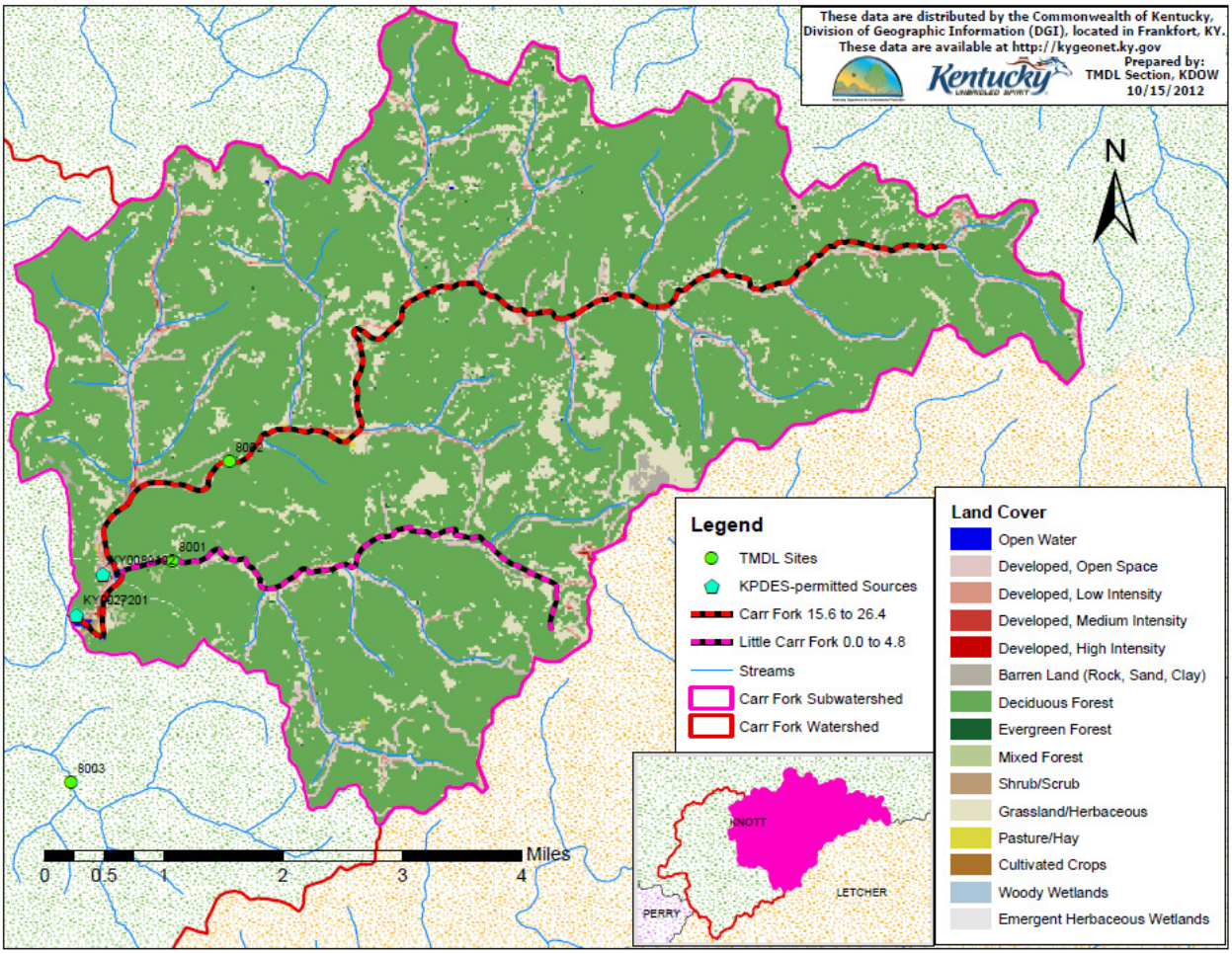

Figure 8.6 Land Cover and TMDL Site Location in the Carr Fork 15.6 to 26.4 Subwatershed

Table 8.13 Carr Fork 15.6 to 26.4 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Carr Fork 15.6 to 26.4	KY511230_03	19719	30.9	3rd

Table 8.14 Land Cover in the Carr Fork 15.6 to 26.4 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	6.31	1244	1.9	1.0
Agriculture (total)	0.16	32	0.0	
Pasture	0.16	2	0.0	
Row Crop	0.00	0	0.0	
Forest	81.73	16114	25.2	
Natural Grassland	10.44	2058	3.2	
Water	0.08	16	0.0	
Wetland	0.00	1	0.0	
Barren	1.28	252	0.4	
Total	100.00	19719	30.9	

Site information is shown in Table 8.15; site DOW04058002 was used to develop the *E. coli* LDC (Figure 8.7) while site 2CFK10008 was used to develop the fecal coliform LDC (Figure 8.8) . The critical conditions were the dry flow zone and the high flow zone for the *E. coli* and fecal coliform TMDLs, respectively. Table 8.16 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04058002 while Table 8.17 shows the same for fecal coliform at site 2CFK10008 (the yellow highlight indicates the critical condition TMDLs).

Table 8.15 Information for Sample Sites DOW04058002 and 2CFK10008

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04058002	37.25491	-82.92938	18.4	18.3	3.62
2CFK10008	37.25491	-82.92938	18.4	18.3	53.16

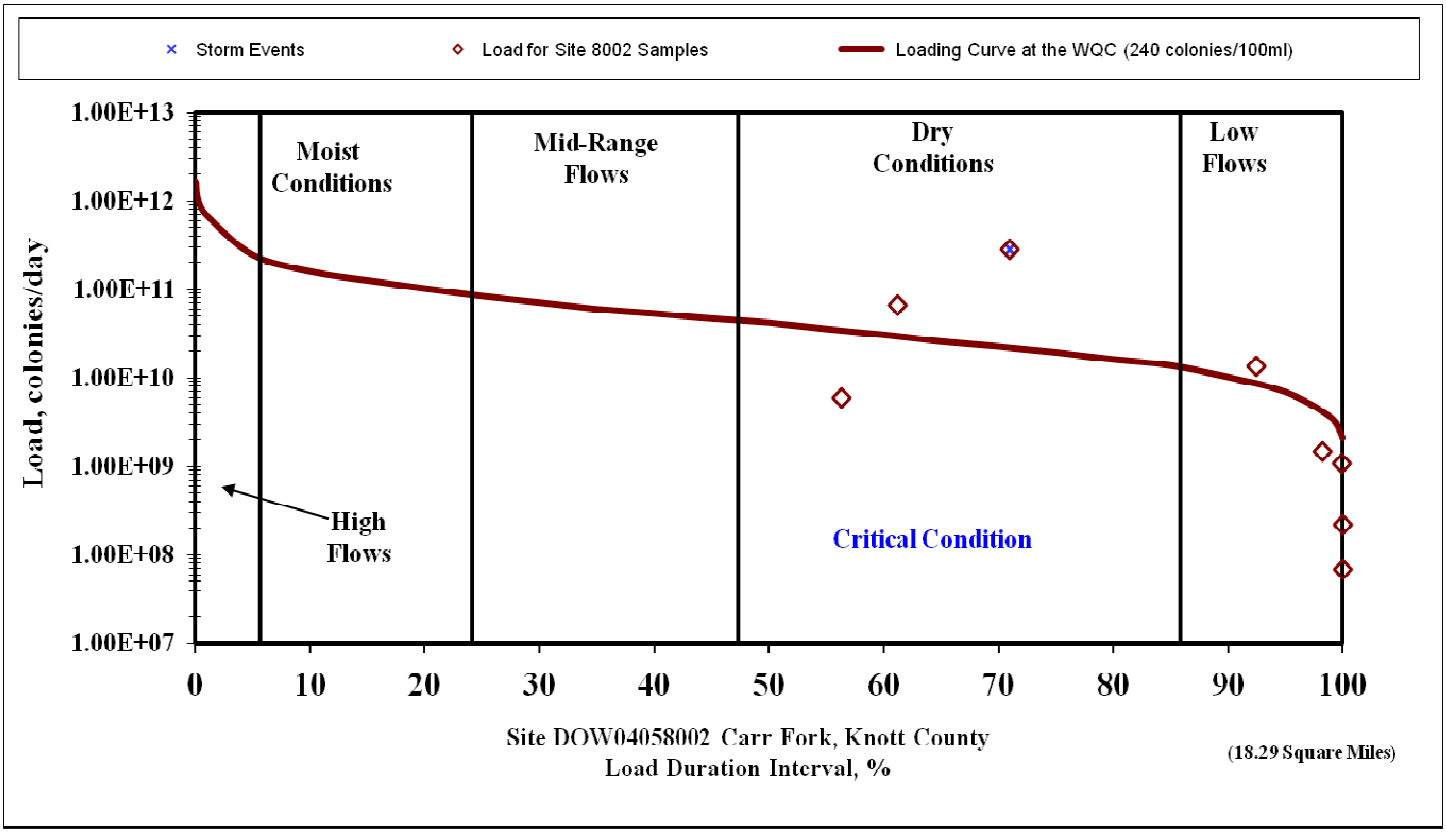

Figure 8.7 PCR *E. coli* LDC for Site DOW04058002

Table 8.16 PCR *E. coli* TMDLs by Flow Zone for Site DOW04058002

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	8.27E+11	8.27E+10	7.44E+11	*	0.00E+00	7.44E+11
Moist	*	2.00E+11	2.00E+10	1.80E+11	*	0.00E+00	1.80E+11
Mid	*	7.93E+10	7.93E+09	7.14E+10	*	0.00E+00	7.14E+10
Dry	2.83E+11	2.13E+10	2.13E+09	1.92E+10	93.3	0.00E+00	1.92E+10
Low	1.37E+10	8.90E+09	8.90E+08	8.01E+09	41.6	0.00E+00	8.01E+09

*No exceedances within a zone—See Section 8.0

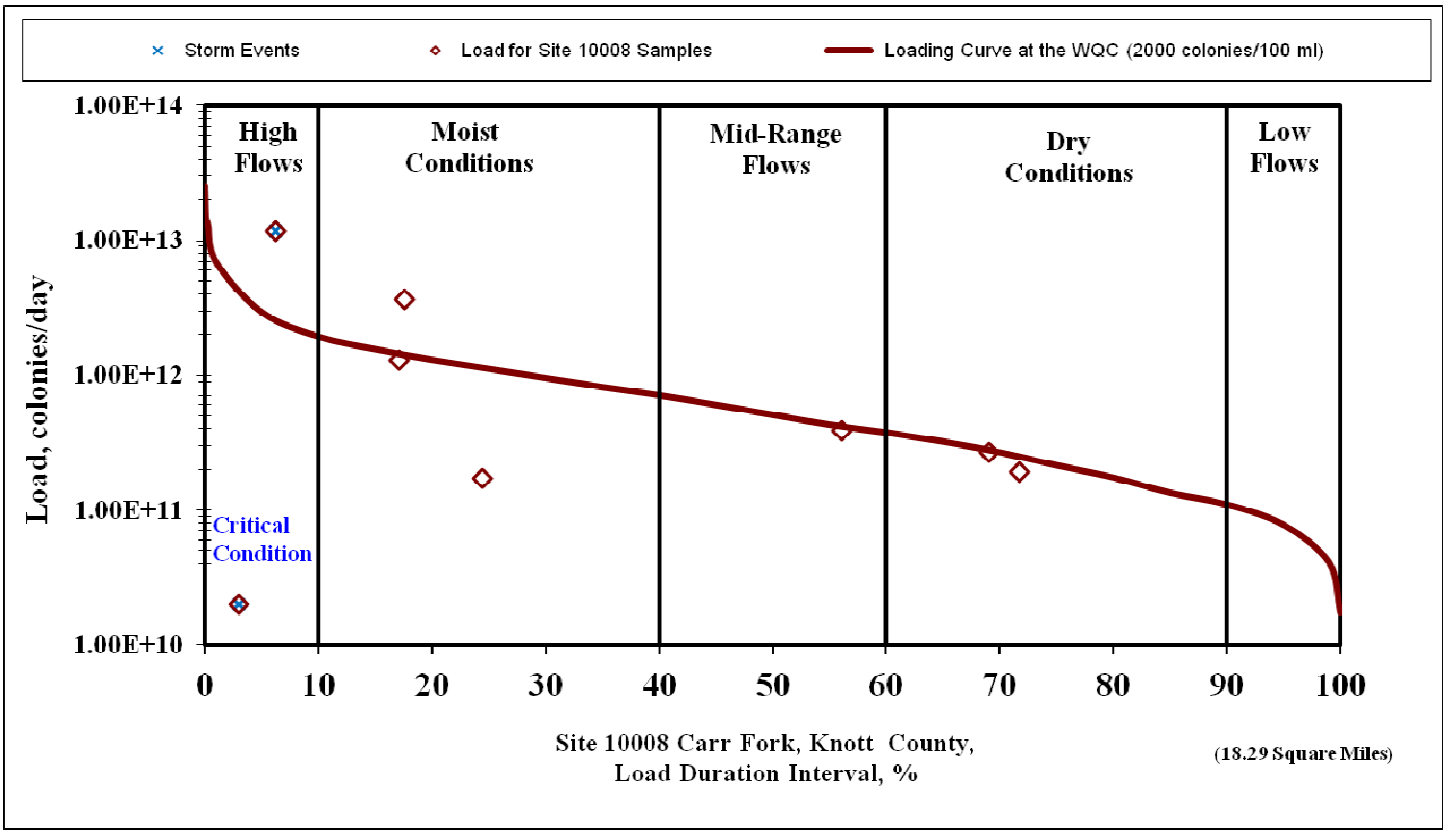

Figure 8.8 SCR Fecal Coliform LDC for Site 2CFK10008

Table 8.17 SCR Fecal Coliform TMDLs by Flow Zone for Site 2CFK10008

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	1.17E+13	2.60E+12	2.60E+11	2.34E+12	80.0	0.00E+00	2.34E+12
Moist	3.64E+12	1.40E+12	1.40E+11	1.26E+12	65.4	0.00E+00	1.26E+12
Mid	*	6.60E+11	6.60E+10	5.94E+11	*	0.00E+00	5.94E+11
Dry	*	3.37E+11	3.37E+10	3.03E+11	*	0.00E+00	3.03E+11
Low	*	1.05E+11	1.05E+10	9.45E+10	*	0.00E+00	9.45E+10

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Carr Fork at RM 15.6 has an upstream watershed area of 30.9 square miles while sites DOW04058002 and 2CFK10008 have an upstream watershed area of 18.3 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.69) and the SWS-WLAs were included to generate the final *E. coli* and fecal coliform TMDL allocations for the impaired

segment (Table 8.18). The breakdown of WLAs assigned to permitted entities is presented in Table 8.19.

Table 8.18 *E. coli* PCR and Fecal Coliform SCR TMDL Allocations for Carr Fork 15.6 to 26.4

Pollutant (Use)	*E. coli* (PCR)	Fecal Coliform (SCR)
Existing Load (colonies/day)	4.77E+11	1.98E+13
TMDL (colonies/day)	3.58E+10	4.39E+12
MOS (colonies/day)	3.58E+09	4.39E+11
TMDL Target (colonies/day)	3.22E+10	3.95E+12
Percent Reduction (%)	93.3	80.0
SWS-WLA (colonies/day)	2.73E+08	4.54E+08
Remainder (colonies/day)	3.20E+10	3.95E+12
Future Growth-WLA (colonies/day)	3.20E+08	3.95E+10
LA (colonies/day)	3.16E+10	3.91E+12

Table 8.19 WLAs Assigned to Permitted Entities in Carr Fork 15.6 to 26.4 Subwatershed

KPDES Permit Number	Permitted Entity	Facility Design Flow (mgd)	Facility Design Flow (cfs)	*E. coli* WLA (colonies/ day)	Fecal coliform WLA (colonies/ day)
KY0089192	Carr Creek Elementary School	0.01	1.55E-02	9.08E+07	1.51E+08
KY0027201	USCOE Carr Creek Lk Littcarr	0.02	3.09E-02	1.82E+08	3.03E+08

8.2.4 TMDL Summary for Defeated Creek 0.5 to 1.6

Defeated Creek at RM 0.5 is a 1st order stream located in the southeastern portion of the Carr Fork watershed (Figure 8.9). Defeated Creek 0.5 to 1.6 does not support the PCR use due to fecal coliform. Information about Defeated Creek 0.5 to 1.6, including its WBID is shown in Table 8.20. The subwatershed for the impaired segment has a total drainage area of approximately 3.2 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a mixture of forested (55.6%) and natural grassland (35.2%) followed by barren (6.5%) and developed (2.8%) as shown in Table 8.21.

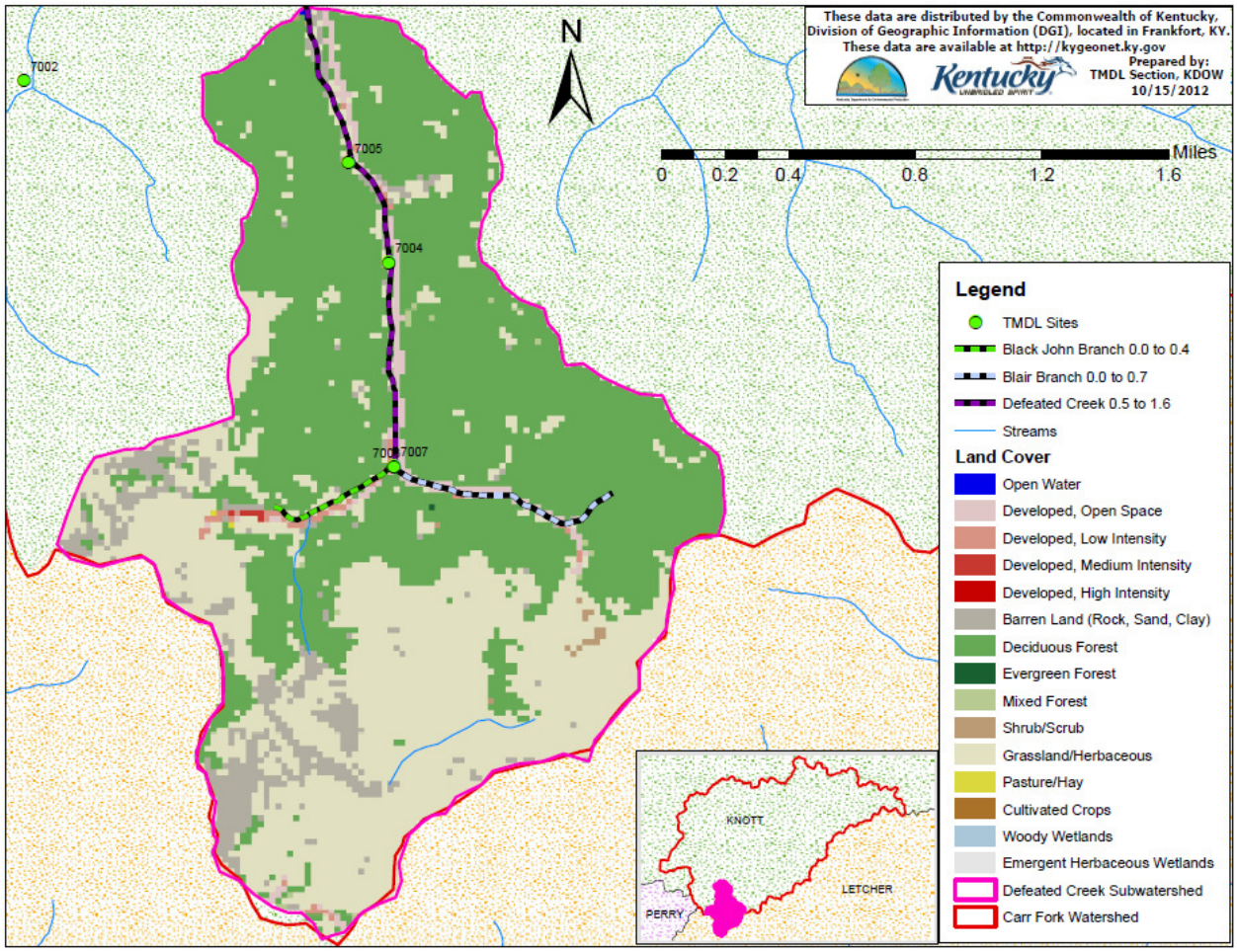

Figure 8.9 Land Cover and TMDL Site Location in the Defeated Creek 0.5 to 1.6 Subwatershed

Table 8.20 Defeated Creek 0.5 to 1.6 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Defeated Creek 0.5 to 1.6	KY490786_01	2026	3.2	1st

Table 8.21 Land Cover in the Defeated Creek 0.5 to 1.6 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	2.76	56	0.1	0.5
Agriculture (total)	0.02	0	0.0	
Pasture	0.02	0	0.0	
Row Crop	0.00	0	0.0	
Forest	55.57	1126	1.8	
Natural Grassland	35.17	713	1.1	
Water	0.03	1	0.0	
Wetland	0.00	0	0.0	
Barren	6.46	131	0.2	
Total	100.00	2026	3.2	

Site information is shown in Table 8.22; site 2CFK13002 was used to develop the fecal coliform LDC (Figure 8.10). The critical condition was the dry flow zone, although exceedances were found in other zones. Table 8.23 shows the TMDLs for the flow zones associated with fecal coliform at site 13002 (the yellow highlight indicates the critical condition TMDL).

Table 8.22 Information for Sample Site 2CFK13002

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
2CFK13002	37.210278	-82.975833	0.9	2.91	0.88

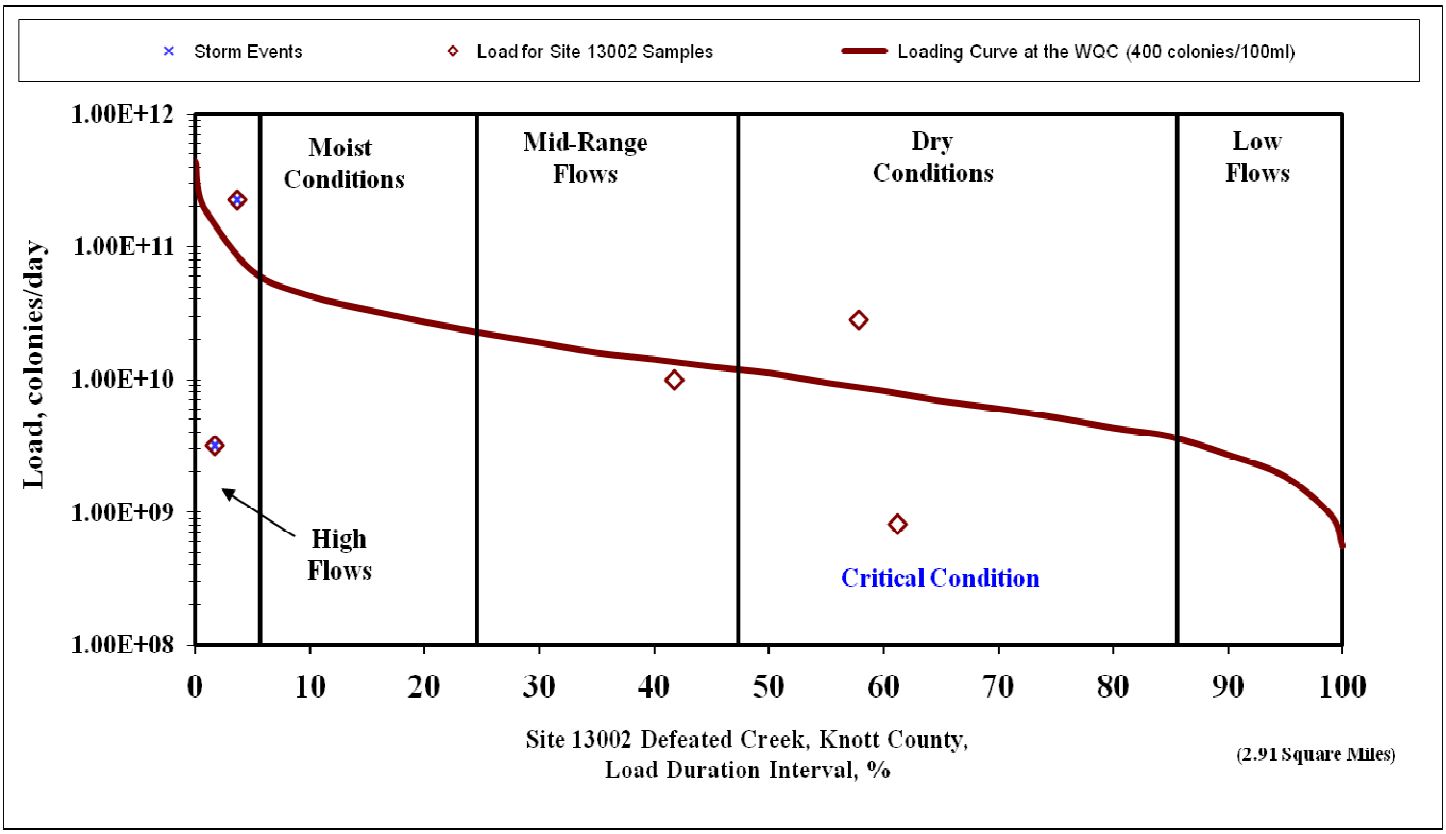

Figure 8.10 PCR Fecal Coliform LDC for Site 2CFK13002

Table 8.23 PCR Fecal Coliform TMDLs by Flow Zone for Site 2CFK13002

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	2.28E+11	8.28E+10	8.28E+09	7.45E+10	67.3	0.00E+00	7.45E+10
Moist	*	5.31E+10	5.31E+09	4.78E+10	*	0.00E+00	4.78E+10
Mid	*	2.10E+10	2.10E+09	1.89E+10	*	0.00E+00	1.89E+10
Dry	2.80E+10	8.61E+09	8.61E+08	7.75E+09	72.3	0.00E+00	7.75E+09
Low	*	3.34E+09	3.34E+08	3.01E+09	*	0.00E+00	3.01E+09

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Defeated Creek at RM 0.5 has an upstream watershed area of 3.2 square miles while site 2CFK13002 has an upstream watershed area of 2.9 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.10) to generate the final fecal coliform TMDL allocations for the impaired segment (Table 8.24).

Table 8.24 Fecal Coliform PCR TMDL Allocations for Defeated Creek 0.5 to 1.6

Pollutant (Use)	Fecal Coliform (PCR)
Existing Load (colonies/day)	3.05E+10
TMDL (colonies/day)	9.38E+09
MOS (colonies/day)	9.38E+08
TMDL Target (colonies/day)	8.44E+09
Percent Reduction (%)	72.3
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	8.44E+09
Future Growth-WLA (colonies/day)	4.22E+07
LA (colonies/day)	8.40E+09

8.2.5 TMDL Summary for Flaxpatch Branch 0.1 to 2.6

Flaxpatch Branch at RM 0.1 is a 1st order stream located in the middle portion of the Carr Fork watershed (Figure 8.11). Flaxpatch Branch 0.1 to 2.6 does not support the PCR use due to *E. coli*. Information about Flaxpatch Branch 0.1 to 2.6, including its WBID is shown in Table 8.25. The subwatershed for the impaired segment has a total drainage area of approximately 1.5 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (88.6%) followed by natural grassland (7.2%) and developed (3.7%) as shown in Table 8.26.

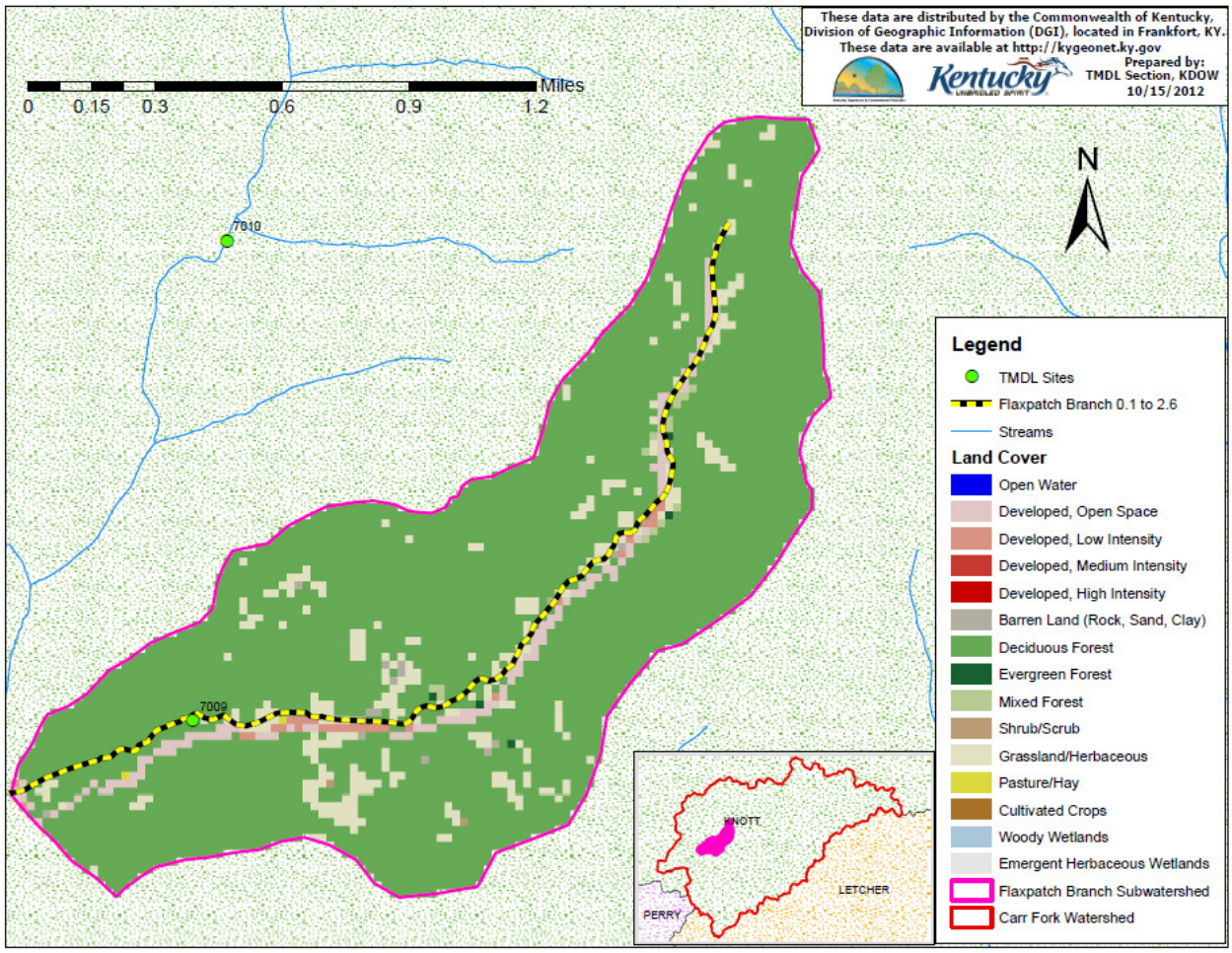

Figure 8.11 Land Cover and TMDL Site Location in the Flaxpatch Branch 0.1 to 2.6 Subwatershed

Table 8.25 Flaxpatch Branch 0.1 to 2.6 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Flaxpatch Branch 0.1 to 2.6	KY492233_01	970	1.5	1st

Table 8.26 Land Cover in the Flaxpatch Branch 0.1 to 2.6 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	3.74	36	0.1	0.5
Agriculture (total)	0.05	0	0.0	
Pasture	0.05	0	0.0	
Row Crop	0.00	0	0.0	
Forest	88.61	859	1.3	
Natural Grassland	7.22	70	0.1	
Water	0.00	0	0.0	
Wetland	0.00	0	0.0	
Barren	0.39	4	0.0	
Total	100.00	970	1.5	

Site information is shown in Table 8.27; site DOW04057009 was used to develop the *E. coli* LDC (Figure 8.12). The critical condition was the low flow zone, although exceedances were found in other zones. Table 8.28 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04057009 (the yellow highlight indicates the critical condition TMDL).

Table 8.27 Information for Sample Site DOW04057009

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057009	37.2427	-82.98892	0.55	1.33	0.08

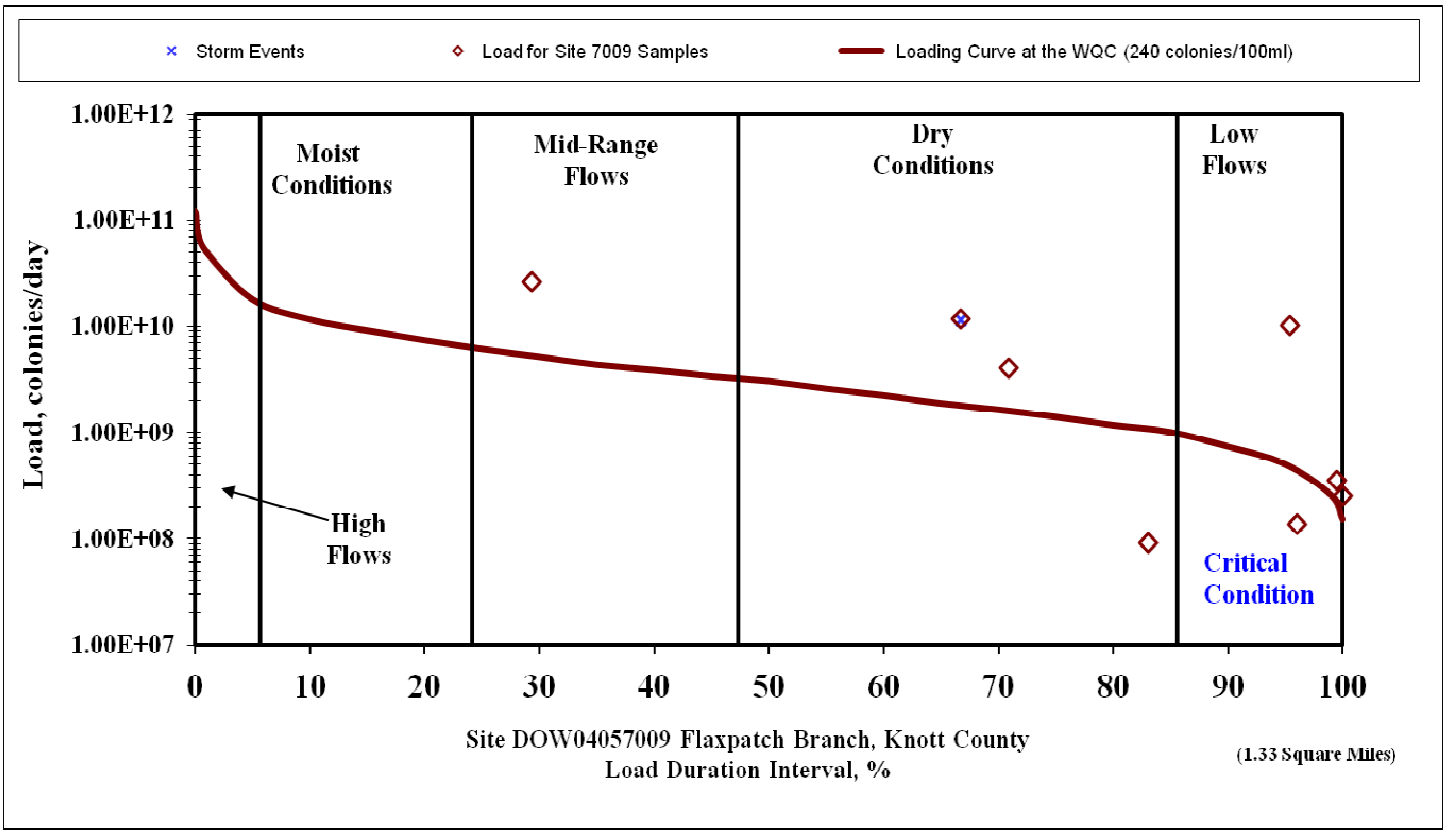

Figure 8.12 PCR *E. coli* LDC for Site DOW04057009

Table 8.28 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057009

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	6.02E+10	6.02E+09	5.41E+10	*	0.00E+00	5.41E+10
Moist	*	1.46E+10	1.46E+09	1.31E+10	*	0.00E+00	1.31E+10
Mid	2.64E+10	5.28E+09	5.28E+08	4.76E+09	82.0	0.00E+00	4.76E+09
Dry	1.17E+10	1.88E+09	1.88E+08	1.69E+09	85.6	0.00E+00	1.69E+09
Low	1.04E+10	4.98E+08	4.98E+07	4.48E+08	95.7	0.00E+00	4.48E+08

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Flaxpatch Branch at RM 0.1 has an upstream watershed area of 1.51 square miles while site DOW04057009 has an upstream watershed area of 1.33 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.14) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.29).

Table 8.29 *E. coli* PCR TMDL Allocations for Flaxpatch Branch 0.1 to 2.6

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	1.18E+10
TMDL (colonies/day)	5.65E+08
MOS (colonies/day)	5.65E+07
TMDL Target (colonies/day)	5.09E+08
Percent Reduction (%)	95.7
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	5.09E+08
Future Growth-WLA (colonies/day)	2.54E+06
LA (colonies/day)	5.06E+08

8.2.6 TMDL Summary for Irishman Creek 0.0 to 4.3

Irishman Creek at RM 0.0 is a 2nd order stream located in the northeastern portion of the Carr Fork watershed (Figure 8.13). Irishman Creek 0.0 to 4.3 does not support the PCR use due to *E. coli*. Information about Irishman Creek 0.0 to 4.3, including its WBID is shown in Table 8.30. The subwatershed for the impaired segment has a total drainage area of approximately 5.4 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (86.2%) followed by natural grassland (8.0%) and developed (5.1%) as shown in Table 8.31.

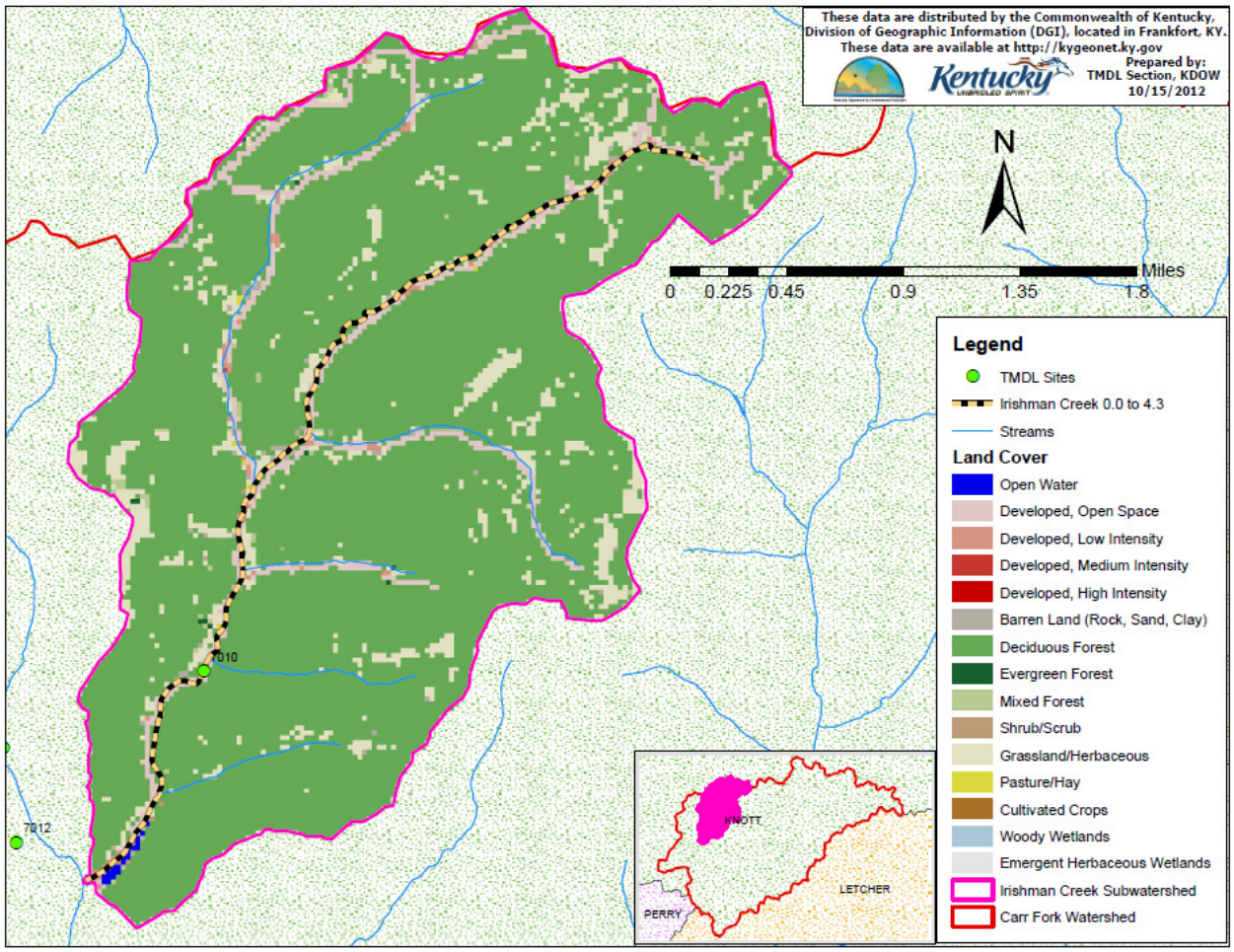

Figure 8.13 Land Cover and TMDL Site Location in the Irishman Creek 0.0 to 4.3 Subwatershed

Table 8.30 Irishman Creek 0.0 to 4.3 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Irishman Creek 0.0 to 4.3	KY495004_01	3466	5.4	2nd

Table 8.31 Land Cover in the Irishman Creek 0.0 to 4.3 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	5.08	176	0.3	1.0
Agriculture (total)	0.07	2	0.0	
Pasture	0.07	1	0.0	
Row Crop	0.00	0	0.0	
Forest	86.21	2987	4.7	
Natural Grassland	8.03	278	0.4	
Water	0.14	5	0.0	
Wetland	0.00	0	0.0	
Barren	0.47	16	0.0	
Total	100.00	3466	5.4	

Site information is shown in Table 8.32; site DOW04057010 was used to develop the *E. coli* LDC (Figure 8.14). The critical condition was the dry flow zone, although exceedances were found in other zones. Table 8.33 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04057010 (the yellow highlight indicates the critical condition TMDL).

Table 8.32 Information for Sample Site DOW04057010

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057010	37.25909	-82.98685	1.1	4.7	0.82

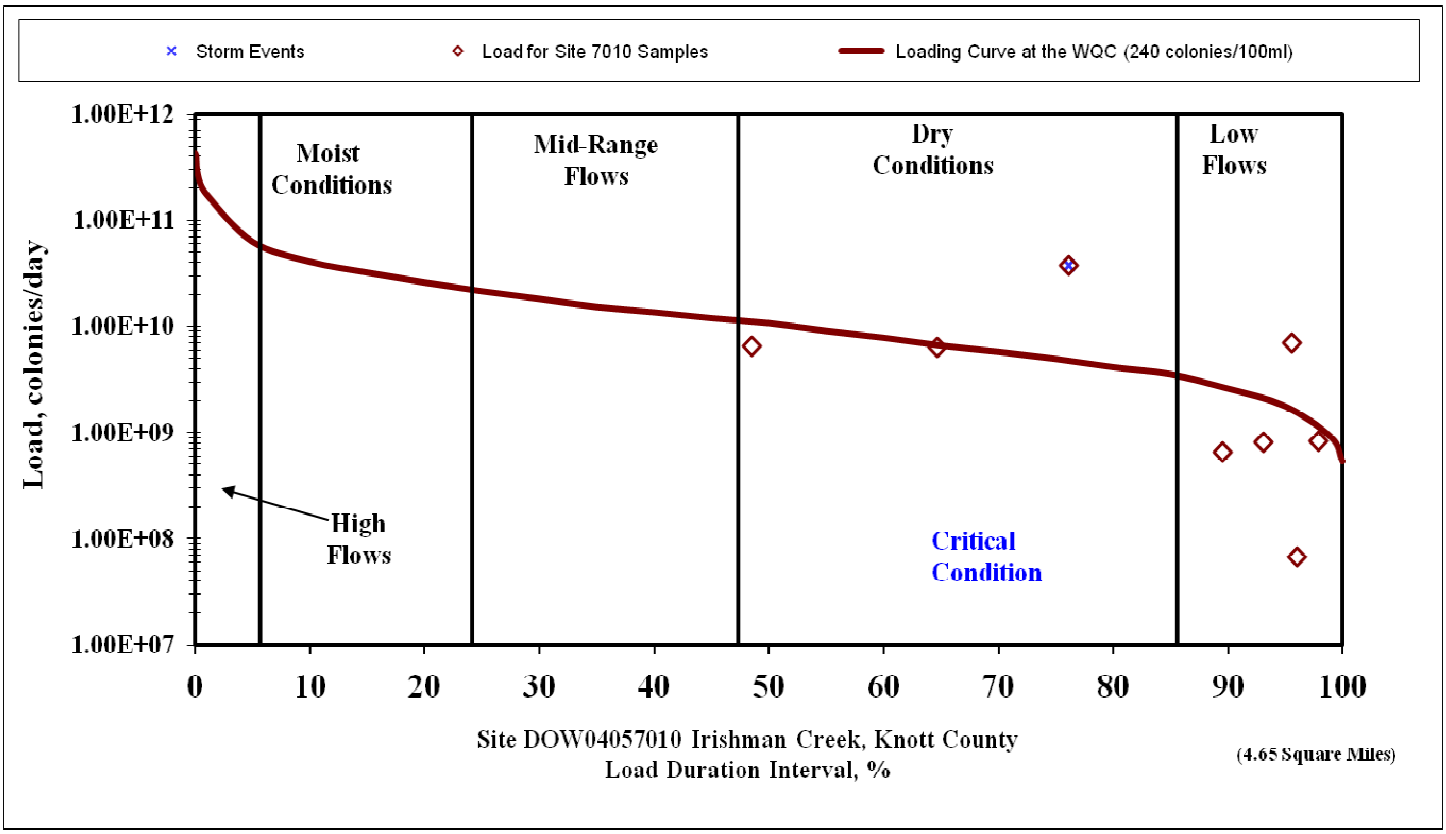

Figure 8.14 PCR *E. coli* LDC for Site DOW04057010

Table 8.33 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057010

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	2.10E+11	2.10E+10	1.89E+11	*	0.00E+00	1.89E+11
Moist	*	5.09E+10	5.09E+09	4.58E+10	*	0.00E+00	4.58E+10
Mid	*	2.01E+10	2.01E+09	1.81E+10	*	0.00E+00	1.81E+10
Dry	3.81E+10	4.81E+09	4.81E+08	4.33E+09	88.6	0.00E+00	4.33E+09
Low	7.10E+09	1.70E+09	1.70E+08	1.53E+09	78.4	0.00E+00	1.53E+09

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Irishman Creek at RM 0.0 has an upstream watershed area of 5.41 square miles while site DOW04057010 has an upstream watershed area of 4.65 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.16) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.34).

Table 8.34 *E. coli* PCR TMDL Allocations for Irishman Creek 0.0 to 4.3

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	4.43E+10
TMDL (colonies/day)	5.60E+09
MOS (colonies/day)	5.60E+08
TMDL Target (colonies/day)	5.04E+09
Percent Reduction (%)	88.6
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	5.04E+09
Future Growth-WLA (colonies/day)	5.04E+07
LA (colonies/day)	4.99E+09

8.2.7 TMDL Summary for Little Carr Fork 0.0 to 4.8

Little Carr Fork at RM 0.0 is a 2nd order stream located in the southern portion of the Carr Fork watershed (Figure 8.15). Little Carr Fork 0.0 to 4.8 does not support the PCR use due to *E. coli*. Information about Little Carr Fork 0.0 to 4.8, including its WBID is shown in Table 8.35. The subwatershed for the impaired segment has a total drainage area of approximately 7.5 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (82.3%) followed by natural grassland (9.9%) and developed (6.8%) as shown in Table 8.36.

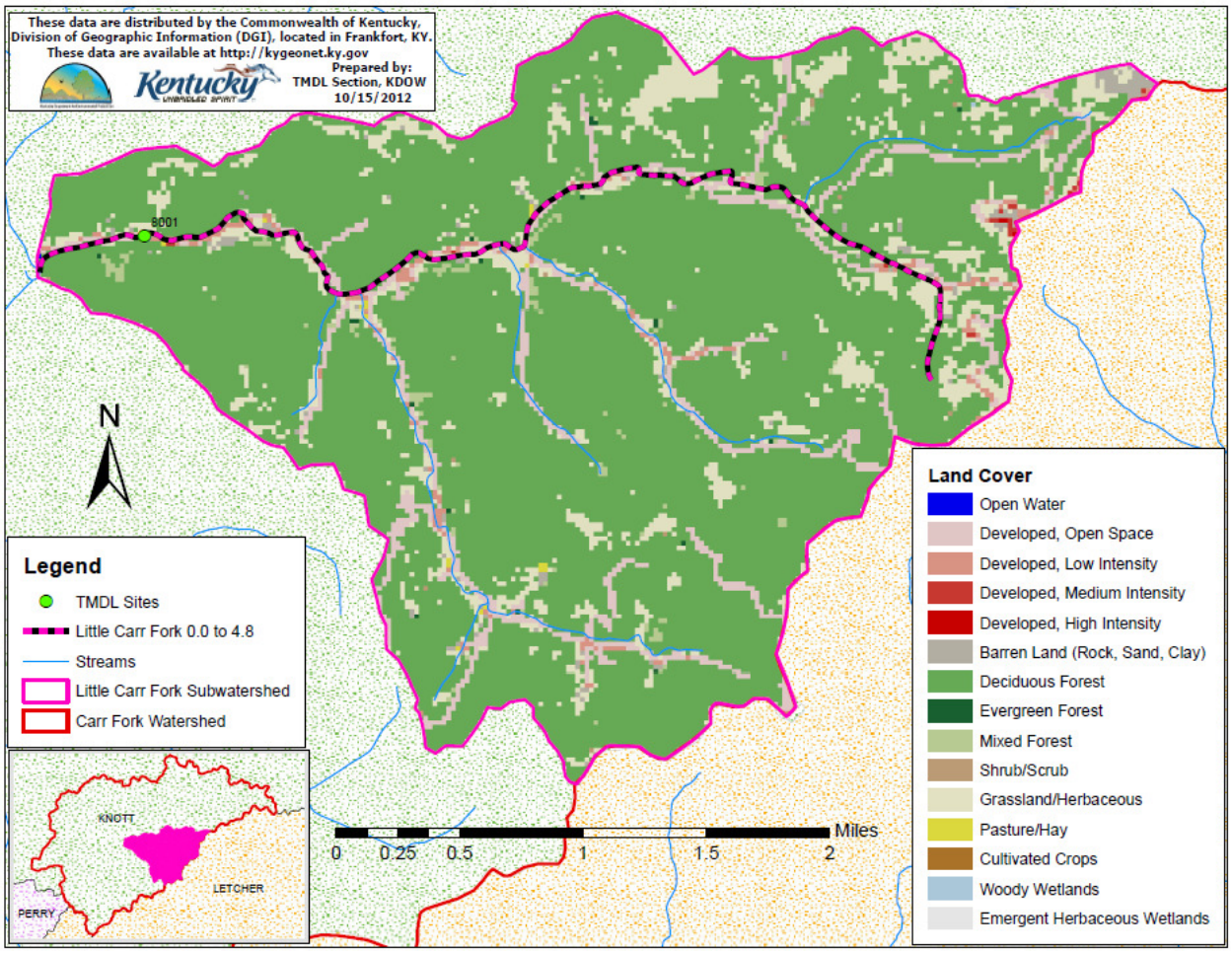

Figure 8.15 Land Cover and TMDL Site Location in the Little Carr Fork 0.0 to 4.8 Subwatershed

Table 8.35 Little Carr Fork 0.0 to 4.8 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Little Carr Fork 0.0 to 4.8	KY496662_01	4792	7.5	2nd

Table 8.36 Land Cover in the Little Carr Fork 0.0 to 4.8 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	6.81	326	0.5	1.0
Agriculture (total)	0.09	4	0.0	
Pasture	0.09	2	0.0	
Row Crop	0.00	0	0.0	
Forest	82.28	3942	6.2	
Natural Grassland	9.89	474	0.7	
Water	0.00	0	0.0	
Wetland	0.00	0	0.0	
Barren	0.91	44	0.1	
Total	100.00	4792	7.5	

Site information is shown in Table 8.37; site DOW04058001 was used to develop the *E. coli* LDC (Figure 8.16). The critical condition was the dry flow zone, although exceedances were found in other zones. Table 8.38 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04058001 (the yellow highlight indicates the critical condition TMDL).

Table 8.37 Information for Sample Site DOW04058001

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04058001	37.24309	-82.93851	0.5	7.24	1.18

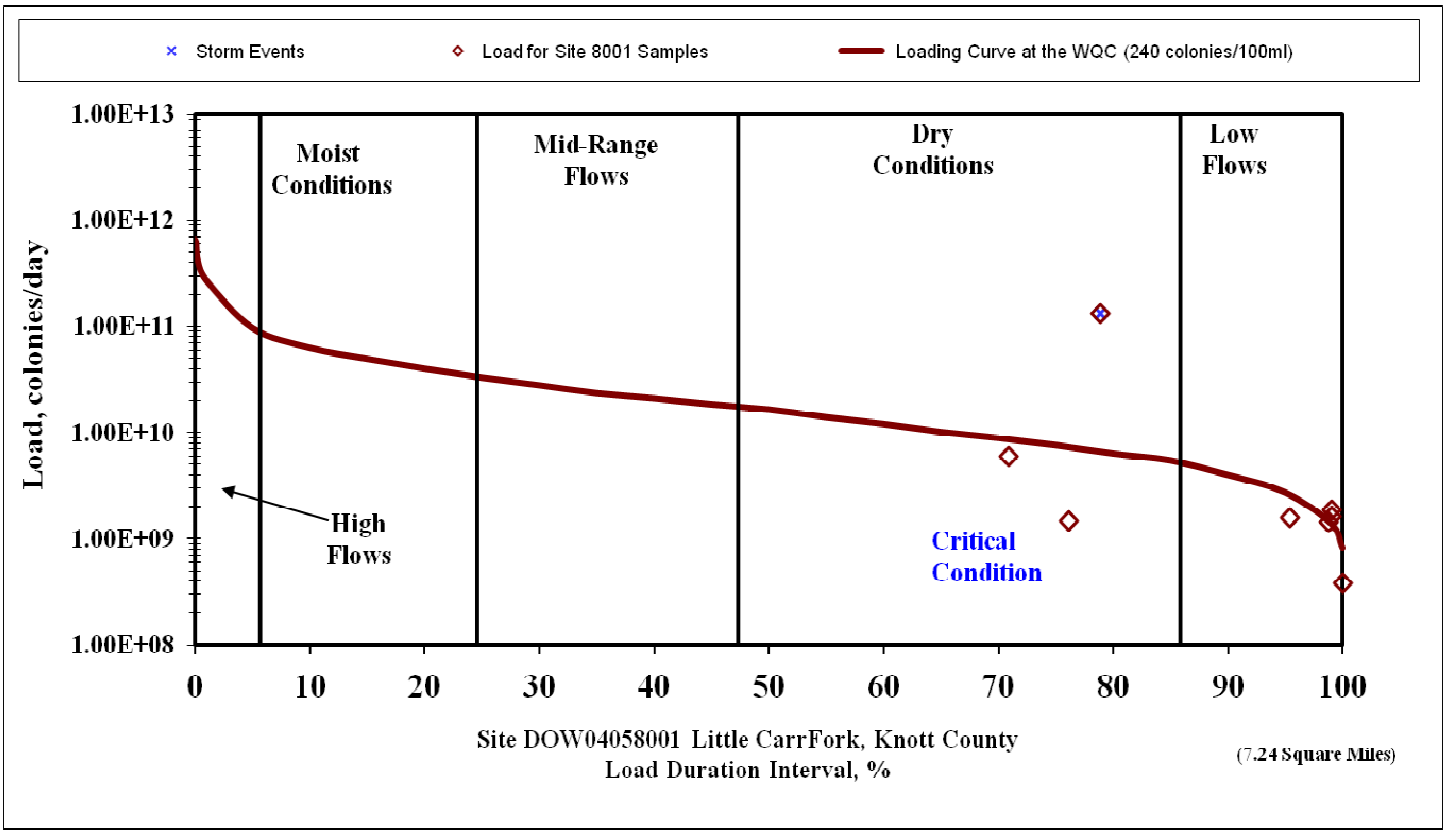

Figure 8.16 PCR *E. coli* LDC for Site DOW04058001

Table 8.38 PCR *E. coli* TMDLs by Flow Zone for Site DOW04058001

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	3.28E+11	3.28E+10	2.95E+11	*	0.00E+00	2.95E+11
Moist	*	7.93E+10	7.93E+09	7.14E+10	*	0.00E+00	7.14E+10
Mid	*	3.14E+10	3.14E+09	2.82E+10	*	0.00E+00	2.82E+10
Dry	1.33E+11	6.93E+09	6.93E+08	6.24E+09	95.3	0.00E+00	6.24E+09
Low	1.90E+09	1.47E+09	1.47E+08	1.32E+09	30.3	0.00E+00	1.32E+09

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Little Carr Fork at RM 0.0 has an upstream watershed area of 7.48 square miles while site DOW04058001 has an upstream watershed area of 7.24 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.03) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.39).

Table 8.39 *E. coli* PCR TMDL Allocations for Little Carr Fork 0.0 to 4.8

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	1.37E+11
TMDL (colonies/day)	7.16E+09
MOS (colonies/day)	7.16E+08
TMDL Target (colonies/day)	6.44E+09
Percent Reduction (%)	95.3
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	6.44E+09
Future Growth-WLA (colonies/day)	6.44E+07
LA (colonies/day)	6.38E+09

8.2.8 TMDL Summary for Little Smith Branch 0.3 to 1.4

Little Smith Branch at RM 0.3 is located in the eastern portion of the Carr Fork watershed (Figure 8.17). Little Smith Branch 0.3 to 1.4 does not support the PCR use due to *E. coli*. Information about Little Smith Branch 0.3 to 1.4, including its WBID is shown in Table 8.40. Little Smith Branch does not display at the 1:100K scale, therefore its stream order is listed as N/A. The subwatershed for the impaired segment has a total drainage area of approximately 0.5 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (74%) followed by natural grassland (17.8%) and developed (6.9%) as shown in Table 8.41.

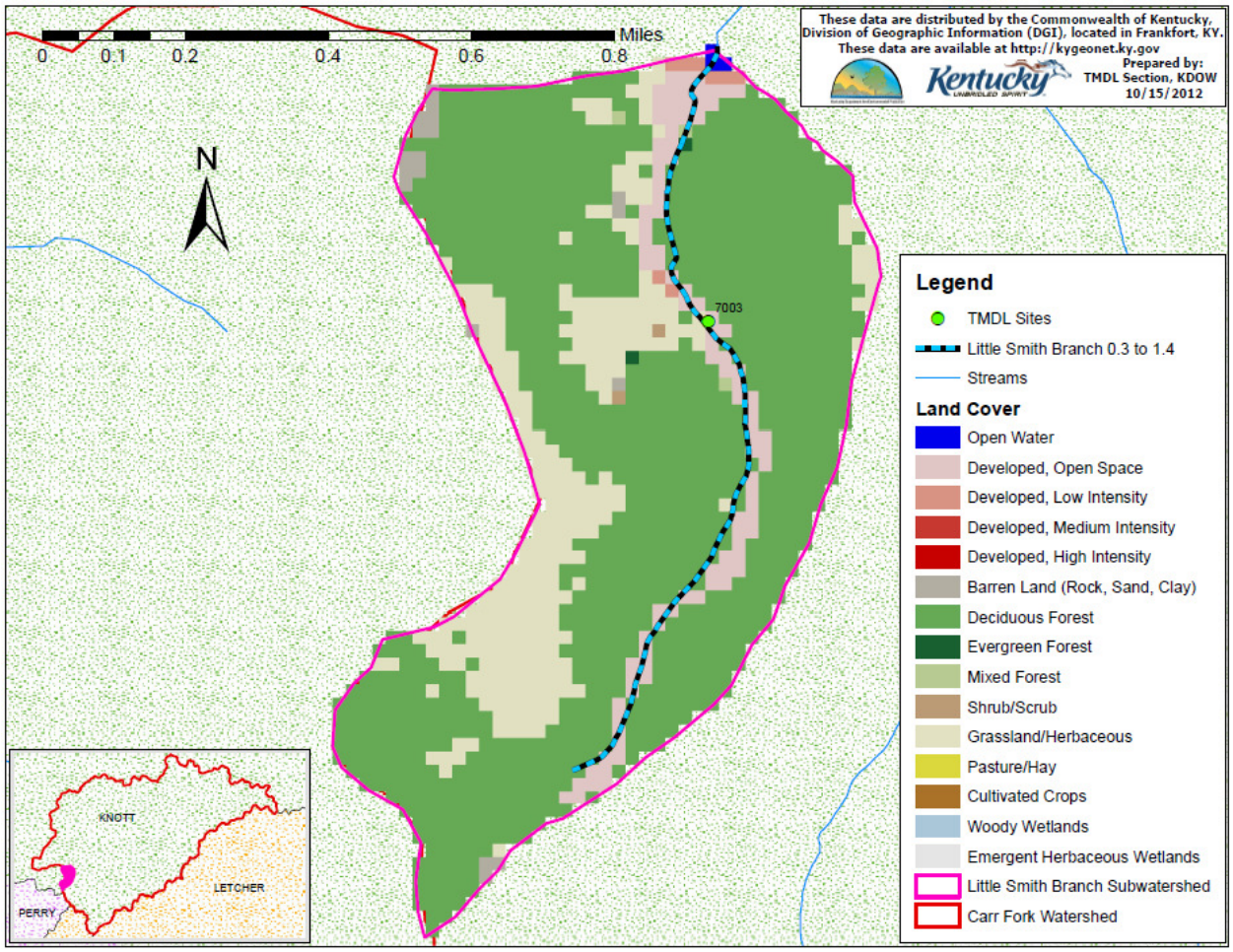

Figure 8.17 Land Cover and TMDL Site Location in the Little Smith Branch 0.3 to 1.4 Subwatershed

Table 8.40 Little Smith Branch 0.3 to 1.4 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Little Smith Branch 0.3 to 1.4	KY496864_01	339	0.5	N/A

Note: N/A indicates that the stream does not display at the 1:100K scale.

Table 8.41 Land Cover in the Little Smith Branch 0.3 to 1.4 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	6.86	23	0.0	1.0
Agriculture (total)	0.00	0	0.0	
Pasture	0.00	0	0.0	
Row Crop	0.00	0	0.0	
Forest	73.99	251	0.4	
Natural Grassland	17.78	60	0.1	
Water	0.20	1	0.0	
Wetland	0.00	0	0.0	
Barren	1.18	4	0.0	
Total	100.00	339	0.5	

Site information is shown in Table 8.42; site DOW04057003 was used to develop the *E. coli* LDC (Figure 8.18). The critical condition was the mid-range flow zone, although exceedances were found in other zones. Table 8.43 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04057003 (the yellow highlight indicates the critical condition TMDL).

Table 8.42 Information for Sample Site DOW04057003

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057003	37.22058	-82.99945	0.7	0.28	0.16

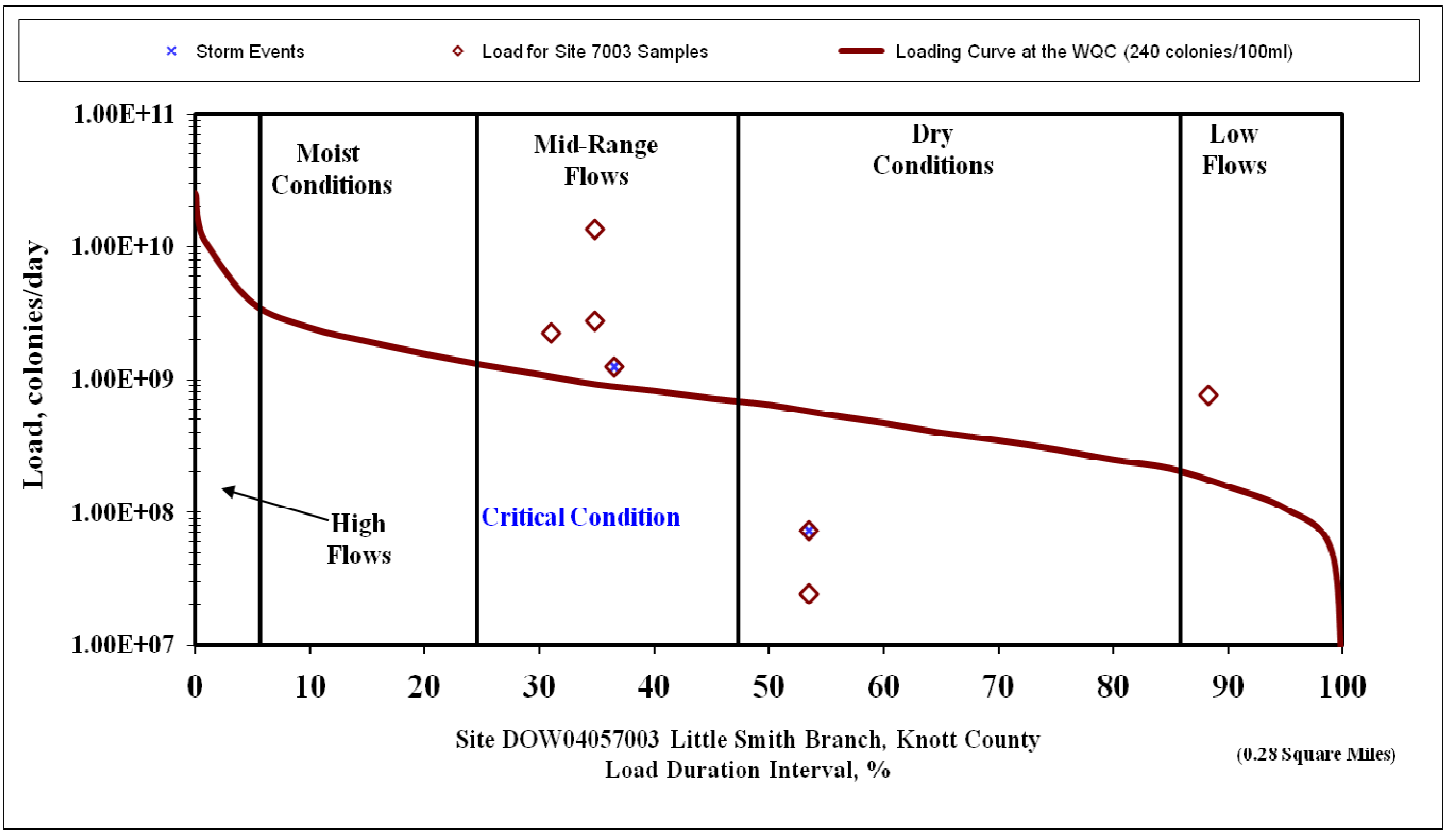

Figure 8.18 PCR *E. coli* LDC for Site DOW04057003

Table 8.43 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057003

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	1.27E+10	1.27E+09	1.14E+10	*	0.00E+00	1.14E+10
Moist	*	3.07E+09	3.07E+08	2.76E+09	*	0.00E+00	2.76E+09
Mid	1.37E+10	9.39E+08	9.39E+07	8.46E+08	93.8	0.00E+00	8.46E+08
Dry	*	6.19E+08	6.19E+07	5.57E+08	*	0.00E+00	5.57E+08
Low	7.63E+08	1.76E+08	1.76E+07	1.59E+08	79.2	0.00E+00	1.59E+08

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Little Smith Branch at RM 0.3 has an upstream watershed area of 0.53 square miles while site DOW04057003 has an upstream watershed area of 0.28 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.89) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.44).

Table 8.44 *E. coli* PCR TMDL Allocations for Little Smith Branch 0.3 to 1.4

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	2.59E+10
TMDL (colonies/day)	1.78E+09
MOS (colonies/day)	1.78E+08
TMDL Target (colonies/day)	1.60E+09
Percent Reduction (%)	93.8
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	1.60E+09
Future Growth-WLA (colonies/day)	1.60E+07
LA (colonies/day)	1.58E+09

8.2.9 TMDL Summary for Trace Fork 1.25 to 3.4

Trace Fork at RM 1.25 is indicated to be a 0 order stream (due to the stream submerging and re-emerging) located in the eastern portion of the Carr Fork watershed (Figure 8.19). Trace Fork 1.25 to 3.4 does not support the PCR use due to *E. coli* and the SCR use due to fecal coliform. Information about Trace Fork 1.25 to 3.4, including its WBID is shown in Table 8.45. The subwatershed for the impaired segment has a total drainage area of approximately 2.2 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a primarily forested (65.4%) followed by natural grassland (22.3%) and developed (9.1%) as shown in Table 8.46.

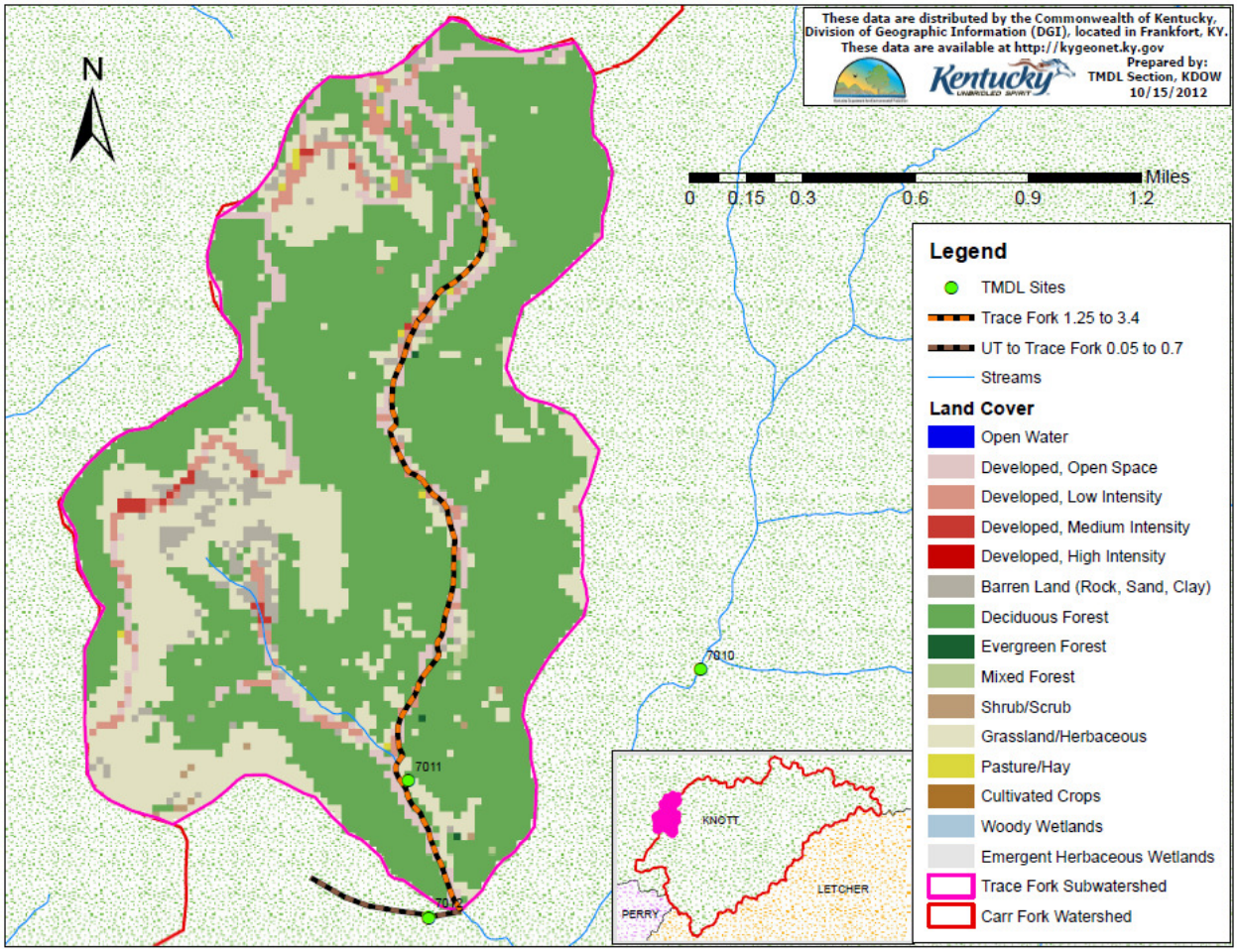

Figure 8.19 Land Cover and TMDL Site Location in the Trace Fork 1.25 to 3.4 Subwatershed

Table 8.45 Trace Fork 1.25 to 3.4 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
Trace Fork 1.25 to 3.4	KY505441_01	1424	2.2	0

Table 8.46 Land Cover in the Trace Fork 1.25 to 3.4 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	9.07	129	0.2	1.0
Agriculture (total)	0.22	3	0.0	
Pasture	0.22	0	0.0	
Row Crop	0.00	0	0.0	
Forest	65.42	932	1.5	
Natural Grassland	22.33	318	0.5	
Water	0.00	0	0.0	
Wetland	0.00	0	0.0	
Barren	2.97	42	0.1	
Total	100.00	1424	2.2	

Site information is shown in Table 8.47; site DOW04057011 was used to develop the *E. coli* LDC (Figure 8.20) while site 2CFK11203 was used to develop the fecal coliform LDC (figure 8.21). The critical conditions were the dry flow zone and high flow zone for *E. coli* and fecal coliform, respectively, although exceedances were found in other zones. Table 8.48 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04057011 and Table 8.49 does the same for fecal coliform at site 2CFK1120 (the yellow highlight indicates the critical condition TMDLs).

Table 8.47 Information for Sample Sites DOW04057011 and 2CFK11203

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057011	37.25514	-83.00108	1.6	2.07	0.5
2CFK11203	37.254444	-83.001389	1.6	2.07	6.2

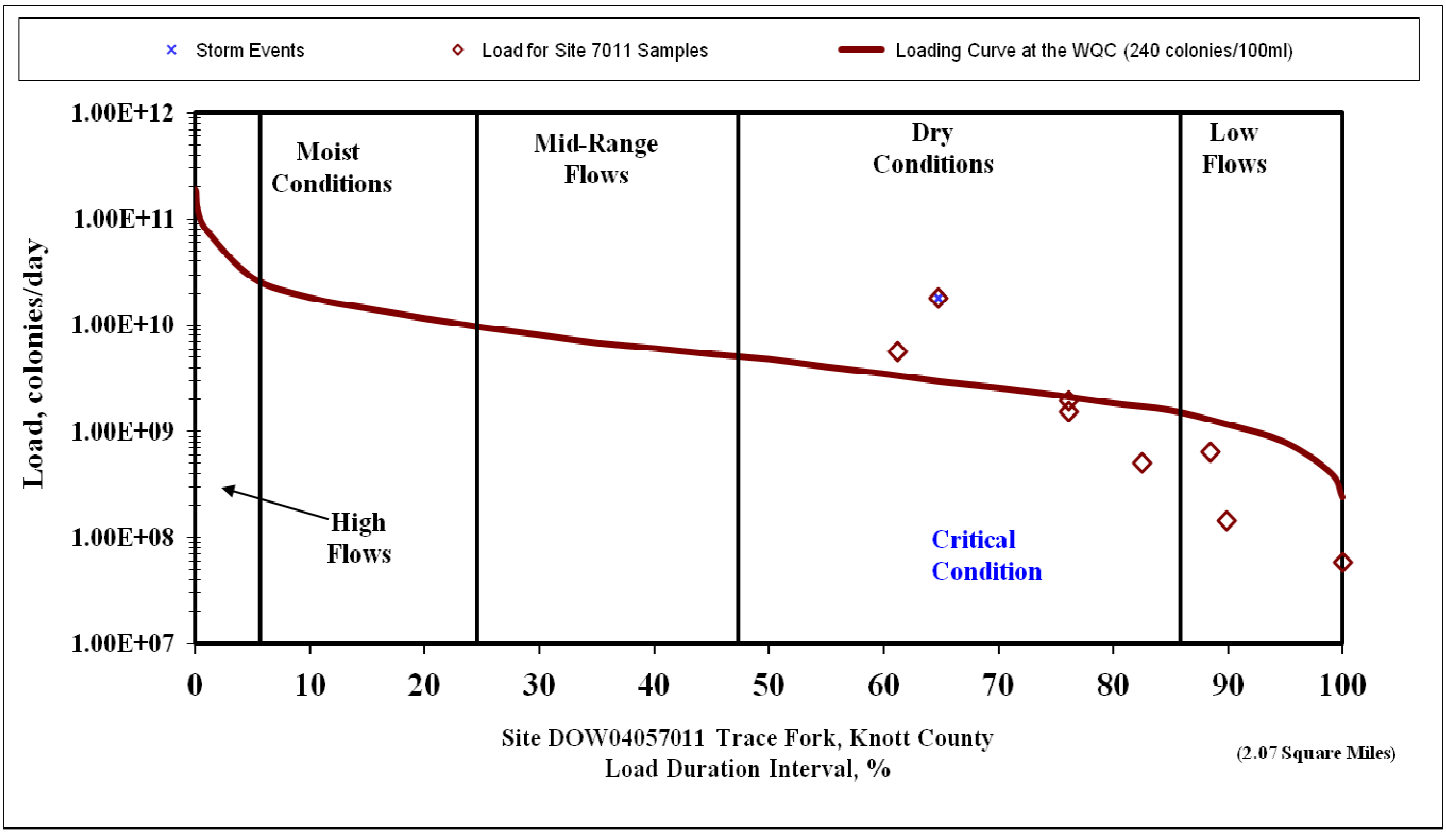

Figure 8.20 PCR *E. coli* LDC for Site DOW04057011

Table 8.48 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057011

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	9.36E+10	9.36E+09	8.43E+10	*	0.00E+00	8.43E+10
Moist	*	2.27E+10	2.27E+09	2.04E+10	*	0.00E+00	2.04E+10
Mid	*	8.97E+09	8.97E+08	8.07E+09	*	0.00E+00	8.07E+09
Dry	1.83E+10	2.94E+09	2.94E+08	2.64E+09	85.6	0.00E+00	2.64E+09
Low	*	1.43E+09	1.43E+08	1.29E+09	*	0.00E+00	1.29E+09

*No exceedances within a zone—See Section 8.0

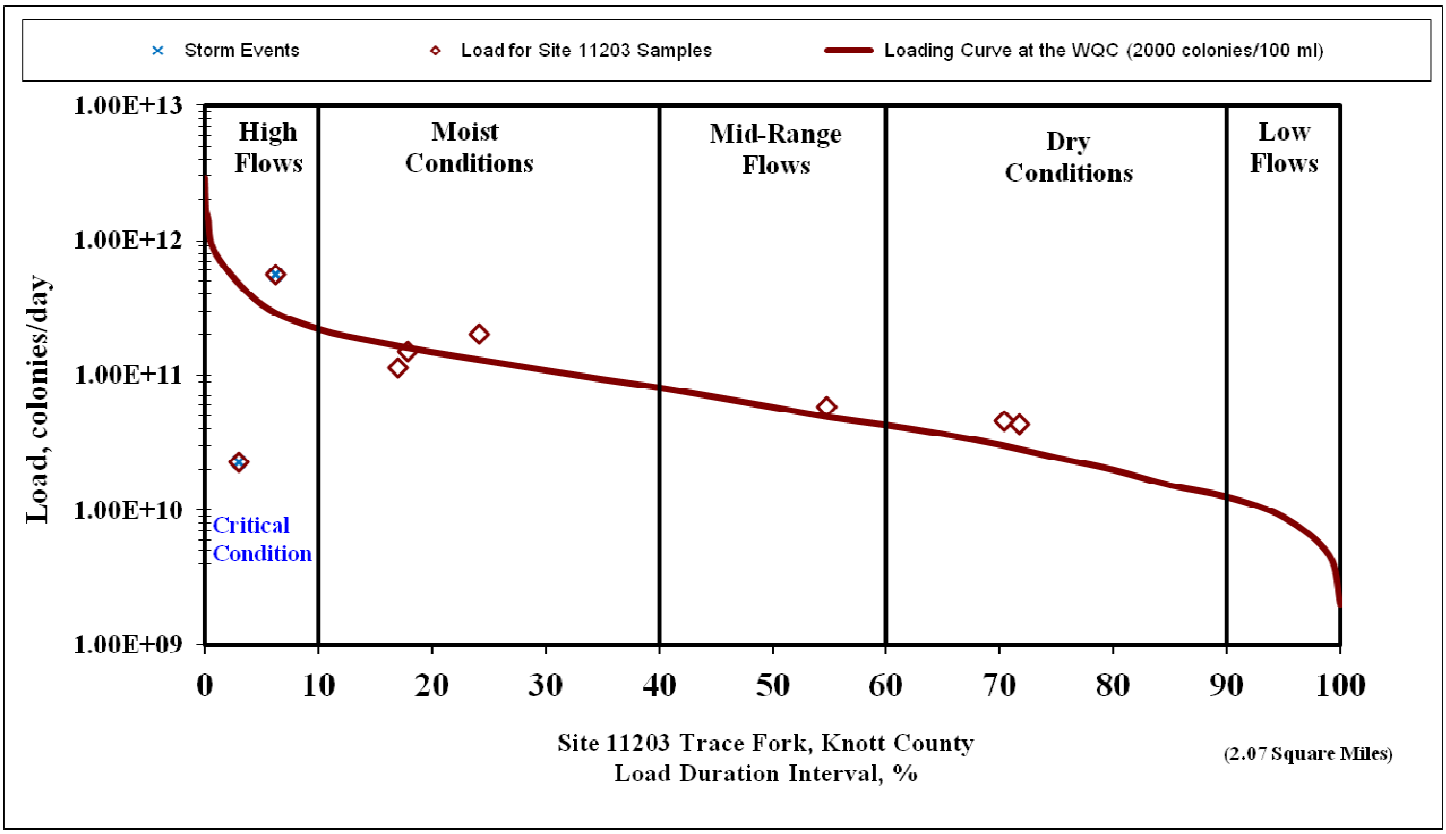

Figure 8.21 SCR Fecal Coliform LDC for Site 2CFK11203

Table 8.49 SCR Fecal Coliform TMDLs by Flow Zone for Site 2CFK11203

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	5.59E+11	2.94E+11	2.94E+10	2.65E+11	52.6	0.00E+00	2.65E+11
Moist	2.01E+11	1.30E+11	1.30E+10	1.17E+11	41.9	0.00E+00	1.17E+11
Mid	5.86E+10	4.88E+10	4.88E+09	4.39E+10	25.0	0.00E+00	4.39E+10
Dry	4.35E+10	2.90E+10	2.90E+09	2.61E+10	40.0	0.00E+00	2.61E+10
Low	*	1.19E+10	1.19E+09	1.07E+10	*	0.00E+00	1.07E+10

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. Trace Fork at RM 1.25 has an upstream watershed area of 2.23 square miles while both sites DOW04057011 and 2CFK11203 have an upstream watershed area of 2.07 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.08) to generate the final *E. coli* and fecal coliform TMDL allocations for the impaired segment (Table 8.50).

Table 8.50 *E. coli* PCR and Fecal Coliform SCR TMDL Allocations for Trace Fork 1.25 to 3.4

Pollutant (Use)	*E. coli* (PCR)	Fecal Coliform (SCR)
Existing Load (colonies/day)	1.98E+10	6.03E+11
TMDL (colonies/day)	3.16E+09	3.17E+11
MOS (colonies/day)	3.16E+08	3.17E+10
TMDL Target (colonies/day)	2.85E+09	2.85E+11
Percent Reduction (%)	85.60%	52.63%
SWS-WLA (colonies/day)	0.00E+00	0.00E+00
Remainder (colonies/day)	2.85E+09	2.85E+11
Future Growth-WLA (colonies/day)	2.85E+07	2.85E+09
LA (colonies/day)	2.82E+09	2.83E+11

8.2.10 TMDL Summary for UT to Trace Fork 0.05 to 0.7

UT to Trace Fork at RM 0.05 is located in the eastern portion of the Carr Fork watershed (Figure 8.22). UT to Trace Fork 0.05 to 0.7 does not support the PCR use due to *E. coli*. Information about UT to Trace Fork 0.05 to 0.7, including its WBID is shown in Table 8.51. This stream does not display at the 1:100K scale; therefore its stream order is listed as N/A. The subwatershed for the impaired segment has a total drainage area of approximately 0.3 square miles. There are no KPDES permitted SWS dischargers within the subwatershed boundary. The land cover in this subwatershed is a mixture of forested (51.9%) and natural grassland (42.9%) followed by developed (4.7%) as shown in Table 8.52.

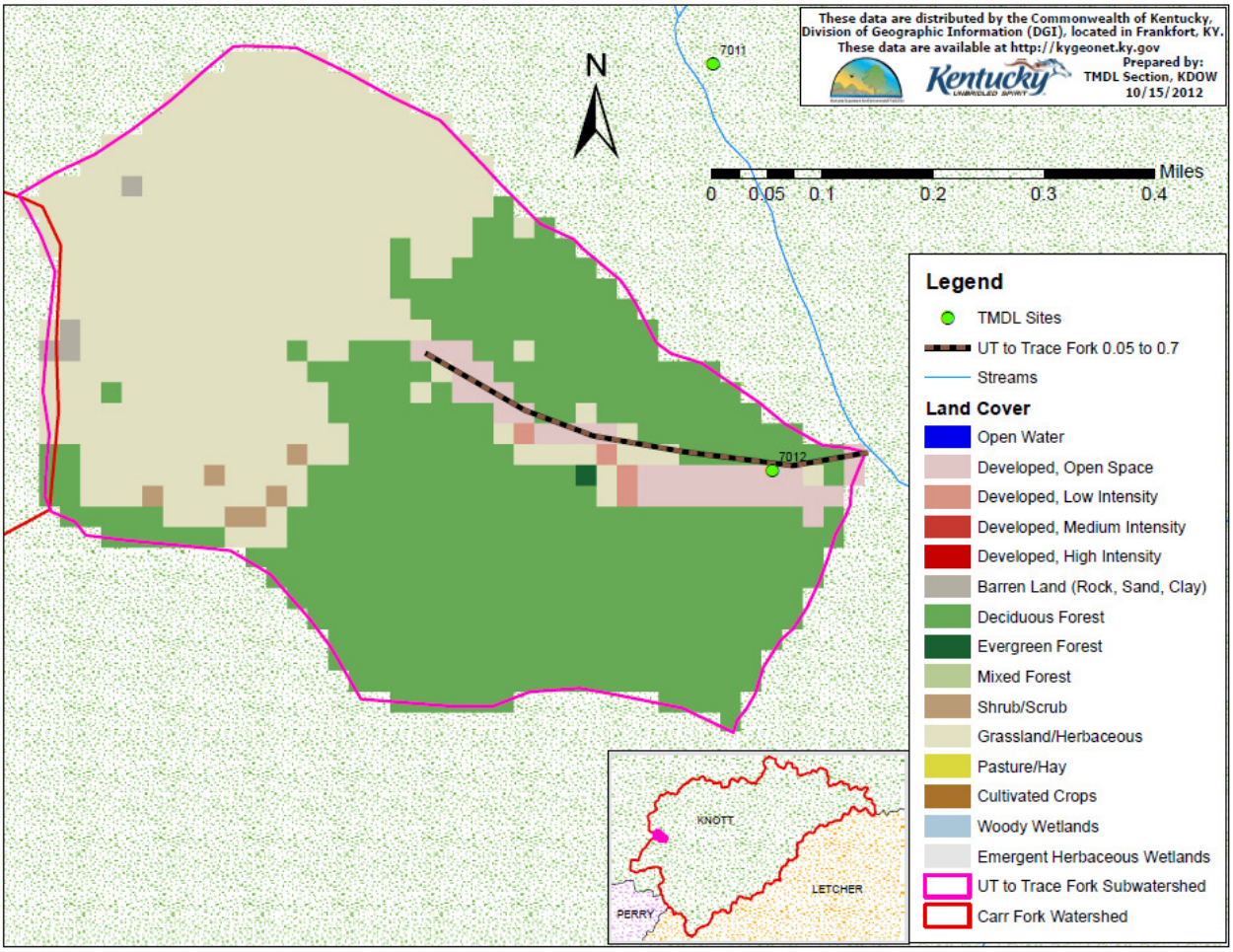

Figure 8.22 Land Cover and TMDL Site Location in the UT to Trace Fork 0.05 to 0.7 Subwatershed

Table 8.51 UT to Trace Fork 0.05 to 0.7 Segment Information

Stream Segment	WBID #	Acres	Square Miles	Stream Order
UT to Trace Fork 0.05 to 0.7	KY505441-1.25_01	183	0.3	N/A

Note: N/A indicates that the stream does not display at the 1:100K scale.

Table 8.52 Land Cover in the UT to Trace Fork 0.05 to 0.7 Subwatershed

Land Cover	% of Total Area	Acres	Watershed Square Miles	Future Growth WLA %
Developed	4.72	9	0.0	0.5
Agriculture (total)	0.00	0	0.0	
Pasture	0.00	0	0.0	
Row Crop	0.00	0	0.0	
Forest	51.87	95	0.1	
Natural Grassland	42.93	79	0.1	
Water	0.00	0	0.0	
Wetland	0.00	0	0.0	
Barren	0.48	1	0.0	
Total	100.00	183	0.3	

Site information is shown in Table 8.53; site DOW04057012 was used to develop the *E. coli* LDC (Figure 8.23). The critical condition was the dry flow zone, although exceedances were found in other zones. Table 8.54 shows the TMDLs for the flow zones associated with *E. coli* at site DOW04057012 (the yellow highlight indicates the critical condition TMDL).

Table 8.53 Information for Sample Site DOW04057012

Station Name	Latitude	Longitude	RM	Area above Site (square miles)	Critical Flow (cfs)
DOW04057012	37.2498	-83.00031	0.1	0.24	0.04

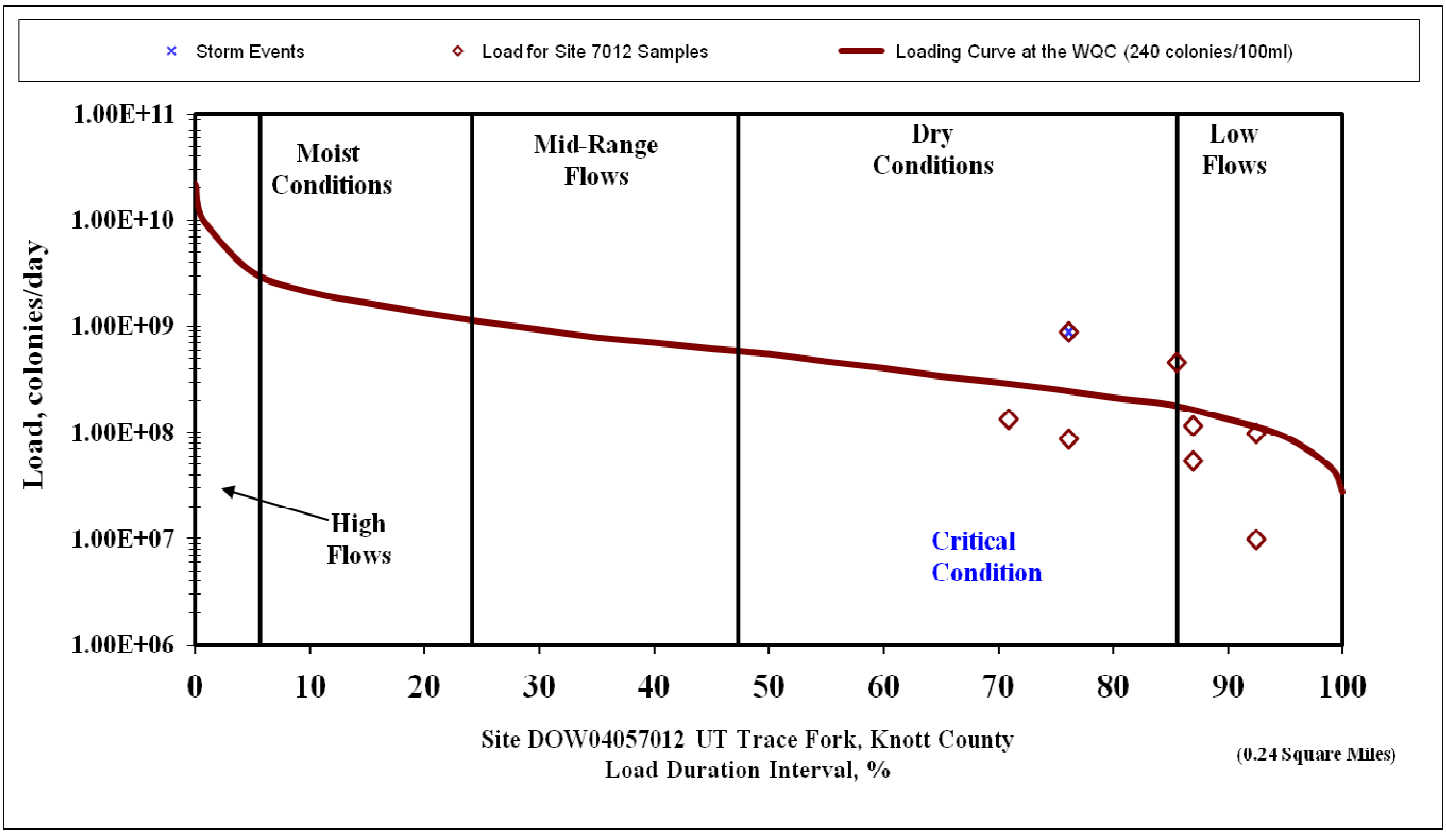

Figure 8.23 PCR *E. coli* LDC for Site DOW04057012

Table 8.54 PCR *E. coli* TMDLs by Flow Zone for Site DOW04057012

LDC Zone	Existing Load (colonies/ day)	TMDL (colonies/ day)	MOS (colonies/ day)	TMDL Target (colonies/ day)	Percent Reduction (%)	SWS-WLA (colonies/ day)	Remainder (colonies/ day)
High	*	1.09E+10	1.09E+09	9.77E+09	*	0.00E+00	9.77E+09
Moist	*	2.63E+09	2.63E+08	2.37E+09	*	0.00E+00	2.37E+09
Mid	*	1.04E+09	1.04E+08	9.36E+08	*	0.00E+00	9.36E+08
Dry	8.81E+08	2.35E+08	2.35E+07	2.11E+08	76.0	0.00E+00	2.11E+08
Low	*	1.66E+08	1.66E+07	1.49E+08	*	0.00E+00	1.49E+08

*No exceedances within a zone—See Section 8.0

The critical condition TMDL for a site must be extrapolated from the sampling station to the bottom of the impaired segment to account for any additional sources of the pollutant of concern and increases in discharge between the site and the bottom of the segment. UT to Trace Fork at RM 0.05 has an upstream watershed area of 0.29 square miles while site DOW04057012 has an upstream watershed area of 0.24 square miles. The Existing Load and TMDL allocations were multiplied by the ratio of these areas (1.21) to generate the final *E. coli* TMDL allocations for the impaired segment (Table 8.55).

Table 8.55 *E. coli* PCR TMDL Allocations for UT to Trace Fork 0.05 to 0.7

Pollutant (Use)	*E. coli* (PCR)
Existing Load (colonies/day)	1.06E+09
TMDL (colonies/day)	2.84E+08
MOS (colonies/day)	2.84E+07
TMDL Target (colonies/day)	2.55E+08
Percent Reduction (%)	76.0
SWS-WLA (colonies/day)	0.00E+00
Remainder (colonies/day)	2.55E+08
Future Growth-WLA (colonies/day)	1.28E+06
LA (colonies/day)	2.54E+08

8.3 Summary for all TMDLs and Allocations

TMDL summary tables for all bacteria impaired segments are presented in Tables 8.56-8.58.

Table 8.56 *E. coli* PCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Blair Branch 0.0 to 0.7	2.94E+08	2.94E+07	0.00E+00	1.32E+06	2.63E+08	93.8
Breeding Branch 0.9 to 4.2	3.43E+10	3.43E+09	0.00E+00	3.08E+08	3.05E+10	98.2
Carr Fork 15.6 to 26.4	3.58E+10	3.58E+09	2.73E+08	3.20E+08	3.16E+10	93.3
Flaxpatch Branch 0.1 to 2.6	5.65E+08	5.65E+07	0.00E+00	2.54E+06	5.06E+08	95.7
Irishman Creek 0.0 to 4.3	5.60E+09	5.60E+08	0.00E+00	5.04E+07	4.99E+09	88.6
Little Carr Fork 0.0 to 4.8	7.16E+09	7.16E+08	0.00E+00	6.44E+07	6.38E+09	95.3
Little Smith Branch 0.3 to 1.4	1.78E+09	1.78E+08	0.00E+00	1.60E+07	1.58E+09	93.8
Trace Fork 1.25 to 3.4	3.16E+09	3.16E+08	0.00E+00	2.85E+07	2.82E+09	85.6
UT to Trace Fork 0.05 to 0.7	2.84E+08	2.84E+07	0.00E+00	1.28E+06	2.54E+08	76.0

Table 8.57 Fecal Coliform PCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Defeated Creek 0.5 to 1.6	9.38E+09	9.38E+08	0.00E+00	4.22E+07	8.40E+09	72.3

Table 8.58 Fecal Coliform SCR TMDLs for Impaired Segments

Waterbody Name	TMDL (colonies/ day)	MOS (colonies/ day)	SWS-WLA (colonies/ day)	Future Growth-WLA (colonies/ day)	LA (colonies/ day)	Percent Reduction (%)
Carr Fork 15.6 to 26.4	4.39E+12	4.39E+11	4.54E+08	3.95E+10	3.91E+12	80.0
Trace Fork 1.25 to 3.4	3.17E+11	3.17E+10	0.00E+00	2.85E+09	2.83E+11	52.6

8.4 Translation of WLA Limits into Permit Limits

All KPDES-permitted point sources must meet permit limits based on the Water Quality Standards in 401 KAR 10:031. SWS-WLAs 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 or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average.

9.0 Implementation

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 Carr Fork 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 Carr Fork 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 Carr Fork watershed, a watershed plan should incorporate all available restoration and protection mechanisms, including any existing Groundwater Protection Plans, storm water or 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.

Kentucky Watershed Management Framework

A Watershed Management Framework approach to Water Quality Management 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. 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 river basins see: http://water.ky.gov/watershed/Pages/Basins.aspx (KDOW, 2012c).

Non-Governmental Organizations

There are several Non-Governmental Organizations (NGO) that may be operating in the Carr Fork watershed that may help to implement the TMDL, particularly with regard to nonpoint source issues. These organizations include Watershed Watch in Kentucky groups and Kentucky Waterways Alliance.

Watershed Watch in Kentucky

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 measurements are taken annually by Watershed Watch groups. Volunteers collect physical measurements, such as temperature, pH, dissolved oxygen, and conductivity. Stream monitoring may also include macroinvertebrate and habitat assessments. Data from annual monitoring is routinely used to help identify problems in the watershed, and assist with prioritizing streams for restoration and protection activities.

For more information about Watershed Watch see:
http://water.ky.gov/wsw/Pages/default.aspx (KDOW, 2012d).

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.

For more information about KWA see:
http://www.kwalliance.org.

10.0 Public Participation

This TMDL was published for a 30-day public comment period ending May 24, 2013. A notification was sent to all newspapers in the Commonwealth of Kentucky and advertisements were purchased in three local newspapers in the vicinity of the Carr Fork watershed: The Hazard Herald (Hazard, KY in Perry County, circulation 2475), The Mountain Eagle (Whitesburg, KY in Letcher County, circulation 5827), and the Troublesome Creek Times (Hindman, KY in Knott County, circulation 4661). No public comments were received on this TMDL document.

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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

Table B.1 shows the historical bacteria data collected by the USACE in the Carr Fork watershed. For samples collected May 1-Oct. 31, a red highlight indicates an exceedance of the maximum fecal coliform PCR WQS of 400 colonies/100 ml while for samples collected year round, an orange highlight indicates an exceedance of the fecal coliform SCR WQS of 2000 colonies/100 ml. Any sample collected May 1- Oct. 31 with an orange highlight also exceeds the PCR WQS of 400 colonies/100 ml.

Table B.1 Historical Data Collected by USACE in Carr Fork Watershed

Station Number	Date	Fecal Coliform (colonies/100 ml)
2CFK10000	7/25/1975	80
2CFK10000	8/28/1975	70
2CFK10000	9/29/1975	<90
2CFK10000	10/14/1975	60
2CFK10000	11/20/1975	<80
2CFK10000	6/19/1984	210
2CFK10000	8/14/1985	20
2CFK10000	5/29/1986	100
2CFK10000	7/29/1987	10
2CFK10007	4/13/1977	680
2CFK10007	5/10/1977	<20
2CFK10007	6/8/1977	19000
2CFK10007	7/5/1977	240
2CFK10007	9/13/1977	260
2CFK10007	6/22/1978	55
2CFK10007	7/20/1978	130
2CFK10007	8/10/1978	2700
2CFK10007	9/14/1978	600
2CFK10007	11/16/1978	12900
2CFK10007	3/8/1979	2000
2CFK10007	4/5/1979	<50
2CFK10007	5/4/1979	20000
2CFK10007	5/31/1979	12000
2CFK10007	7/3/1979	1300
2CFK10007	8/30/1979	1200
2CFK10007	9/25/1979	2400
2CFK10007	3/12/1980	650
2CFK10007	4/16/1980	100
2CFK10007	5/13/1980	30
2CFK10007	6/19/1980	<5

Station Number	Date	Fecal Coliform (colonies/100 ml)
2CFK10007	5/19/1981	8920
2CFK10007	7/1/1981	4100
2CFK10007	8/13/1981	400
2CFK10007	9/17/1981	3300
2CFK10007	5/27/1982	9800
2CFK10007	7/20/1982	900
2CFK10007	9/16/1982	1800
2CFK10007	5/3/1983	6200
2CFK10007	6/28/1983	100
2CFK10007	8/11/1983	1200
2CFK10007	8/31/1983	1200
2CFK10007	8/14/1985	240
2CFK11203	8/14/1985	220
2CFK11203	5/28/1986	200
2CFK11203	7/29/1987	<10
2CFK13002	8/14/1985	420
2CFK13002	5/28/1986	200
2CFK13002	7/29/1987	<10
2CFK14001	6/26/1975	160
2CFK20001	8/4/1976	<2
2CFK20001	8/4/1976	<2
2CFK20001	8/4/1976	<2
2CFK20001	4/14/1977	70
2CFK20001	4/14/1977	70
2CFK20001	4/14/1977	70
2CFK20001	5/11/1977	<1
2CFK20001	7/6/1977	1
2CFK20001	7/6/1977	<1
2CFK20001	7/6/1977	1
2CFK20001	9/12/1977	<1
2CFK20001	9/12/1977	<1
2CFK20001	9/12/1977	<1
2CFK20001	6/23/1978	2
2CFK20001	6/23/1978	2
2CFK20001	7/21/1978	75
2CFK20001	8/11/1978	<1
2CFK20001	8/11/1978	<1
2CFK20001	9/15/1978	<1

Station Number	Date	Fecal Coliform (colonies/100 ml)
2CFK20001	9/15/1978	1
2CFK20001	10/27/1978	<2
2CFK20001	10/27/1978	<2
2CFK20001	3/8/1979	56
2CFK20001	3/8/1979	56
2CFK20001	3/8/1979	94
2CFK20001	4/5/1979	2
2CFK20001	4/5/1979	2
2CFK20001	4/5/1979	24
2CFK20001	5/3/1979	<2
2CFK20001	5/3/1979	<2
2CFK20001	5/3/1979	<2
2CFK20001	6/1/1979	<2
2CFK20001	7/3/1979	2
2CFK20001	7/3/1979	6
2CFK20001	7/3/1979	6
2CFK20001	8/30/1979	<2
2CFK20001	8/30/1979	<2
2CFK20001	8/30/1979	<2
2CFK20001	9/26/1979	8
2CFK20001	9/26/1979	18
2CFK20001	9/26/1979	18
2CFK20001	10/18/1979	<2
2CFK20001	10/18/1979	<2
2CFK20001	10/18/1979	<2
2CFK20001	3/12/1980	<2
2CFK20001	3/12/1980	<2
2CFK20001	3/12/1980	<2
2CFK20001	4/17/1980	2
2CFK20001	4/17/1980	4
2CFK20001	4/17/1980	4
2CFK20001	5/14/1980	2
2CFK20001	5/14/1980	2
2CFK20001	5/14/1980	6
2CFK20001	6/19/1980	<2
2CFK20001	6/19/1980	<2
2CFK20001	6/19/1980	<2
2CFK20001	8/14/1980	<4

Station Number	Date	Fecal Coliform (colonies/100 ml)
2CFK20001	8/14/1980	<4
2CFK20001	8/14/1980	<4
2CFK20001	8/13/1981	<4
2CFK20001	8/13/1981	8
2CFK20001	8/13/1981	12
2CFK20001	8/13/1981	16
2CFK20001	8/13/1981	160
2CFK20001	9/16/1981	360
2CFK20001	9/16/1981	424
2CFK20001	9/16/1981	444
2CFK20001	9/16/1981	620
2CFK20001	5/25/1982	<4
2CFK20001	5/25/1982	<4
2CFK20001	5/25/1982	4
2CFK20001	5/25/1982	<4
2CFK20001	7/20/1982	<4
2CFK20001	7/20/1982	<4
2CFK20001	7/20/1982	<4
2CFK20001	7/20/1982	<4
2CFK20001	7/20/1982	<4
2CFK20001	9/16/1982	4
2CFK20001	9/16/1982	12
2CFK20001	9/16/1982	30
2CFK20001	9/16/1982	80
2CFK20001	9/16/1982	900
2CFK20001	5/3/1983	<10
2CFK20001	5/3/1983	<10
2CFK20001	5/3/1983	<10
2CFK20001	5/3/1983	<10
2CFK20001	5/3/1983	30
2CFK20005	6/23/1978	<2
2CFK20005	6/23/1978	<2
2CFK20005	9/15/1978	4
2CFK20005	9/15/1978	5
2CFK20005	3/8/1979	940
2CFK20005	3/8/1979	1200
2CFK20005	5/3/1979	10
2CFK20005	5/3/1979	15

Table B.2 shows the 2003 bacteria data collected by the USACE in the Carr Fork watershed. For samples collected May 1-Oct. 31, a red highlight indicates an exceedance of the maximum fecal coliform PCR WQS of 400 colonies/100 ml while for samples collected year round, an orange highlight indicates an exceedance of the fecal coliform SCR WQS of 2000 colonies/100 ml. Any sample collected May 1- Oct. 31 with an orange highlight also exceeds the PCR WQS of 400 colonies/100 ml.

Table B.2 2003 Data Collected by USACE in Carr Fork Watershed

Station Number	Date	Fecal Coliform (colonies/100 ml)
2CFK10000	4/24/2003	60
2CFK10000	5/16/2003	80
2CFK10000	6/19/2003	<10
2CFK10000	7/25/2003	110
2CFK10000	8/27/2003	600
2CFK10000	10/29/2003	190
2CFK10000	11/25/2003	10
2CFK10000	12/23/2003	50
2CFK10008	4/24/2003	1800
2CFK10008	5/16/2003	9000
2CFK10008	6/19/2003	10
2CFK10008	7/25/2003	1800
2CFK10008	8/27/2003	2000
2CFK10008	10/29/2003	1500
2CFK10008	11/25/2003	300
2CFK10008	12/23/2003	5200
2CFK11203	4/24/2003	1400
2CFK11203	5/16/2003	3800
2CFK11203	6/19/2003	100
2CFK11203	7/25/2003	2400
2CFK11203	8/27/2003	3000
2CFK11203	10/29/2003	3000
2CFK11203	11/25/2003	3100
2CFK11203	12/23/2003	1900
2CFK13002	4/24/2003	200
2CFK13002	5/16/2003	1100
2CFK13002	6/19/2003	<10
2CFK13002	7/25/2003	290
2CFK13002	8/27/2003	1300
2CFK13002	10/29/2003	40
2CFK13002	11/25/2003	410
2CFK13002	12/23/2003	250

Table B.3 shows the 2007-2008 bacteria data collected by the KDOW and the USACE in the Carr Fork watershed. For samples collected May 1-Oct. 31, a red highlight indicates an

exceedance of the maximum *E. coli* PCR WQS of 240 colonies/100 ml. A blank value in the discharge column indicates that discharge could not be measured.

Table B.3 2007-08 Data Collected by KDOW and USACE in Carr Fork Watershed

Station Number	Date	E coli (colonies/100 ml)	Discharge (cfs)
DOW04057002	5/30/2007	180	0.17
DOW04057002	6/27/2007	10	0.04
DOW04057002	8/15/2007	10	0.17
DOW04057002	9/12/2007	230	0.05
DOW04057002	6/25/2008	20	0.10
DOW04057002	7/29/2008	80	0.17
DOW04057002	8/26/2008	500	0.11
DOW04057003	5/30/2007	1040	0.03
DOW04057003	6/27/2007	710	0.16
DOW04057003	8/15/2007	510	0.18
DOW04057003	9/12/2007	340	0.15
DOW04057003	6/25/2008	10	0.10
DOW04057003	7/29/2008	3500	0.16
DOW04057003	8/26/2008	30	0.10
DOW04057004	5/30/2007	120	1.78
DOW04057004	6/27/2007	250	2.97
DOW04057004	8/15/2007	10	0.79
DOW04057004	9/12/2007	30	0.61
DOW04057004	6/25/2008	30	1.14
DOW04057004	7/29/2008	50	1.18
DOW04057004	8/26/2008	190	1.24
DOW04057005	5/30/2007	70	1.38
DOW04057005	6/27/2007	2300	2.96
DOW04057005	8/15/2007	40	0.49
DOW04057005	9/12/2007	10	0.50
DOW04057005	6/25/2008	50	1.04
DOW04057005	7/29/2008	110	0.72
DOW04057005	8/26/2008	90	
DOW04057006	5/30/2007	50	1.15
DOW04057006	6/27/2007	40	3.31
DOW04057006	8/15/2007	10	0.78
DOW04057006	9/12/2007	20	0.67
DOW04057006	6/25/2008	20	0.90
DOW04057006	7/29/2008	10	0.71
DOW04057006	8/26/2008	1500	0.51

Station Number	Date	E coli (colonies/100 ml)	Discharge (cfs)
DOW04057007	5/30/2007	360	0.1
DOW04057007	6/27/2007	140	0.02
DOW04057007	8/15/2007	180	0.02
DOW04057007	9/12/2007	200	0.03
DOW04057007	6/25/2008	740	0.03
DOW04057007	7/29/2008	1500	0.07
DOW04057007	8/26/2008	80	0.05
DOW04057008	5/31/2007	170	
DOW04057008	6/28/2007	10	
DOW04057008	8/16/2007	10	
DOW04057008	5/21/2008	10	
DOW04057008	6/26/2008	10	
DOW04057008	7/30/2008	10	
DOW04057009	5/31/2007	610	0.27
DOW04057009	6/28/2007	20	0.19
DOW04057009	8/16/2007	5000	0.08
DOW04057009	9/13/2007	70	0.08
DOW04057009	5/21/2008	1200	0.90
DOW04057009	6/26/2008	350	0.03
DOW04057009	7/30/2008	360	0.04
DOW04057009	8/27/2008	1500	0.32
DOW04057010	5/31/2007	220	1.19
DOW04057010	6/28/2007	60	0.45
DOW04057010	8/16/2007	90	0.37
DOW04057010	9/13/2007	10	0.28
DOW04057010	5/21/2008	140	
DOW04057010	6/26/2008	150	0.23
DOW04057010	7/30/2008	1000	0.29
DOW04057010	8/27/2008	1900	0.82
DOW04057011	5/31/2007	180	0.35
DOW04057011	6/28/2007	120	0.22
DOW04057011	8/16/2007	30	0.20
DOW04057011	9/13/2007	70	0.29
DOW04057011	5/21/2008	390	0.59
DOW04057011	6/26/2008	60	0.04
DOW04057011	7/30/2008	230	0.35
DOW04057011	8/27/2008	1500	0.50
DOW04057012	5/31/2007	80	0.03

Station Number	Date	E coli (colonies/100 ml)	Discharge (cfs)
DOW04057012	6/28/2007	630	0.03
DOW04057012	8/16/2007	90	0.04
DOW04057012	9/13/2007	170	0.03
DOW04057012	5/21/2008	200	0.02
DOW04057012	6/26/2008	20	0.02
DOW04057012	7/30/2008	110	0.05
DOW04057012	8/27/2008	900	0.04
DOW04058001	5/31/2007	160	1.52
DOW04058001	6/28/2007	220	0.27
DOW04058001	8/16/2007	270	0.25
DOW04058001	9/13/2007	190	0.08
DOW04058001	5/21/2008	50	1.20
DOW04058001	6/26/2008	140	0.46
DOW04058001	7/30/2008	310	0.25
DOW04058001	8/27/2008	4600	1.18
DOW04058002	5/31/2007	370	1.52
DOW04058002	6/28/2007	100	0.44
DOW04058002	8/16/2007	50	0.18
DOW04058002	9/13/2007	70	
DOW04058002	5/21/2008	540	5.07
DOW04058002	6/26/2008	20	0.14
DOW04058002	7/30/2008	40	
DOW04058002	8/27/2008	3200	3.62
DOW04058003	5/30/2007	10	0.92
DOW04058003	6/28/2007	690	0.43
DOW04058003	8/15/2007	320	0.06
DOW04058003	9/13/2007	260	0.12
DOW04058003	6/26/2008	880	
DOW04058003	7/30/2008	2200	
DOW04058003	8/27/2008	12000	5.13