Damon Creek Watershed Plan

for

E. coli Identification and Management

Prepared For

Kentucky Division of Water
Frankfort, KY

Prepared By

Jackson Purchase RC & D Foundation
With Calloway County Conservation Office

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Chapter I. Introduction

A. Background

Watershed Planning efforts have been ongoing in the greater Clarks River watershed for over 15 years. Damon Creek, which is a sub-watershed located within the Clarks River watershed, was identified as a focus watershed as part of the initial watershed planning process for the greater Clarks River watershed. The following section details grants and implementation work that has occurred since that time.

Through a 2002 EPA 319(h) grant, the Jackson Purchase Foundation (JPF) collaborated with Strand Associates, Inc. and developed a Watershed-based plan for Clarks River. This plan identified pollutants of concern throughout the Clarks River watershed, possible sources of these pollutants, and potential best management practices (BMPs) that could be implemented to address these pollutants of concern. Through this watershed-based plan, four critical areas in need of BMPs were identified: the Clayton Creek sub-watershed, the Bee Creek sub-watershed, the Chestnut Creek sub-watershed, and the Damon Creek sub-watershed.

In 2012, the JPF was awarded a second EPA 319(h) grant to implement BMPs that would address water quality issues for the critical areas that were identified in the Clarks River plan. Through this second grant, the JPF developed the 'Clarks River Watershed-based Plan - Best Management Practices Implementation Plan' (Jackson Purchase RC & D Foundation, 2009), and implemented 76 BMPs in the identified critical areas.

However, because of the large geographic area covered in the original Clarks River plan, further work was needed to better define the water quality issues, and to select solutions that could be implemented to address these issues on a local level. As such, the intention of this document is to develop a Watershed-based plan specifically for the Damon Creek Watershed to address bacterial pollution. This plan presents the collaborative culmination of a data collection and analysis effort to identify the sources of bacterial pollution, recruitment of partners, stakeholders, and community interest within the watershed, and the development of a BMP implementation strategy to address these sources.

A series of BMPs that addressed bacterial pollution were implemented in 2011 (Figure 1). These BMPs were implemented to address households with inadequate or failing septic systems, which were thought to be contributing factors to the water quality issues because of unsuitable soils for septic systems, small residential lot sizes that do not allow for appropriately sized septic systems, and the age of homes.

The Damon Creek Watershed and Sewer Association (DCWSA) was formed to lead efforts for the construction of a community wastewater lagoon. Several public meetings were held to measure the residents' receptiveness to a community wastewater lagoon. The majority of residents in the area agreed that the construction of a lagoon was necessary to address the pollution entering Damon Creek from failing septic systems.

Construction of the wastewater lagoon was completed in accordance with all regulations contained in 902 KAR 10:085 Kentucky On-Site Sewage Disposal Systems and approved by the Kentucky Cabinet for Health and Human Services. This wastewater lagoon is owned, operated, and maintained by the Damon Creek Watershed and Sewer Association. The lagoon was constructed just east of the of the Damon Creek Watershed border that accommodates the waste of 44 households from the Kirksey community. An additional six failing septic systems were also repaired through this BMP implementation project. For the repair of the other six failing septic systems within the Damon Creek Watershed, specifications for the repair or replacement of each septic system were determined by the Calloway County Health Department.

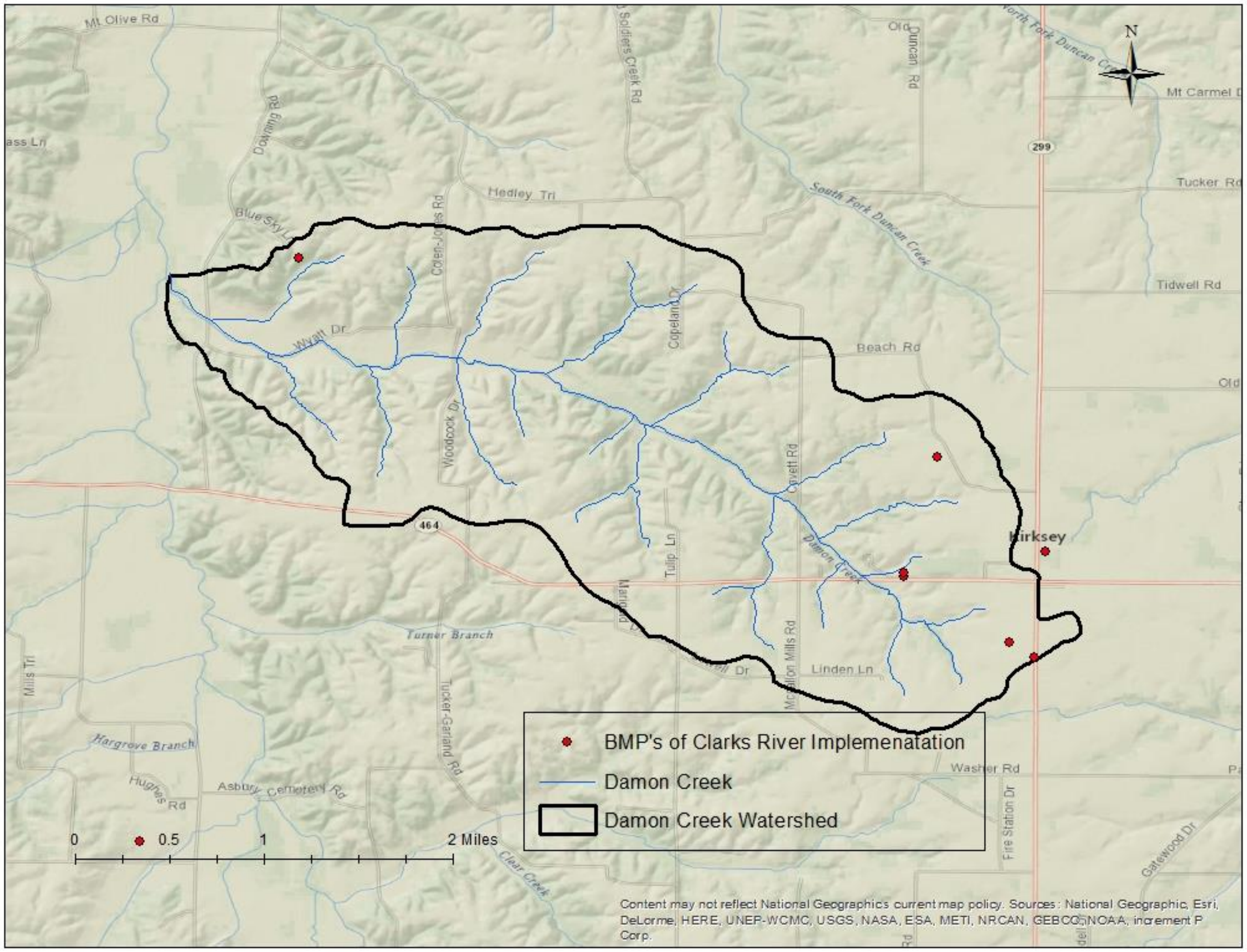

Figure 1. Location of BMPs in the Damon Creek Watershed

B. Partners and Stakeholders; Goals, Objectives and Strategies of the Damon Creek

Watershed Plan Project

To ensure the effectiveness in planning and implementing the watershed-based plan, the Jackson Purchase RC&D Foundation created a team of partners who represented the stakeholders in the Damon Creek watershed. Goals, objectives and strategies were also developed to address the watershed issues at a local level.

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C. Goals, Objectives and Strategies

1. GOAL	***OBJECTIVES***	***STRATEGIES***
Improve the water quality within the Damon Creek Watershed by developing a bacteria-only Watershed Plan that identifies the origination of the pollutants of concern, potential non-point sources of these pollutants and BMPs to be implemented in order to address these pollutants.	1. Compile and evaluate all available background information related to the Damon Creek Watershed.	1.1 Assemble a watershed planning team. Hold regular meetings to gather and evaluate information regarding the watershed. 1.2 Hold regular community meetings to gather historical information, and determine any areas of concern to the residents. 1.3 Gather and interpret existing water quality data collected by Murray State University (MSU) and Four Rivers Watershed Watch (FRWW), and the Kentucky Division of Water (DOW). 1.4 Collect and interpret available information about the natural features of the watershed and apply them to determining non-point sources of pollutants and BMPs to address these issues.
	2. Determine current condition of Damon Creek and its tributaries.	2.1 Conduct visual stream assessments to determine potential sources of *E.coli* contamination and areas of erosion in the watershed. 2.2 Determine pollutant loads from each sampling location. Identify the load reductions required to meet water quality standards.
	3. Produce a bacteria-only Watershed Plan for the Damon Creek Watershed.	3.1 Compare bacterial pollutant loads and their target load reduction to the background information from the watershed. 3.2 With assistance from the watershed team and local stakeholders, determine BMPs that could be implemented to address the sources of identified pollutants. 3.3 Prioritize areas for implementation of BMPs by considering local concerns, required load reductions, funding and landowner support. 3.4 Develop an implementation plan for the top priority BMPs. In the plan identify funding sources; locate practices that will be implemented, estimate load reduction of the BMPs and monitoring strategies. 3.5 Finalize a watershed-based plan according to the guidelines of the *Watershed Planning Guidebook for Kentucky Communities.*

2. GOAL	*OBJECTIVES*	*STRATEGIES*
Create a community that places a higher value on the importance of clean water, and therefore is more willing to implement BMPs that will improve water quality.	1. Bring the water quality issues to the attention of Damon Creek residents and those in the surrounding community.	1.1 Hold three public meetings in the Damon Creek Watershed to discuss water quality issues. A neutral facilitator will be utilized during these meetings to ensure that any information and concerns expressed by those attending are adequately noted. 1.1.1 The first meeting will be a kickoff meeting that will take place prior to the beginning of water quality sampling. Its purpose will be to introduce the project to the community and gather information from them. 1.1.2 The second meeting will be held to report the results of water quality monitoring efforts and potential BMPs. 1.1.3 The third meeting will be a discussion of additional implementation actions. 1.2 Advertise public meetings through posting flyers and printing an announcement in the Murray Ledger & Times.
	2. Educate the public on water quality issues and practices that can be implemented to improve those issues.	2.1 Produce and supply the public with brochures containing information on water quality. 2.2 Provide information on specific land use practices, and the impact they can have on water quality. 2.3 Recruit new volunteers in Four Rivers Watershed Watch. 2.4 Coordinate with Living Lands & Waters to bring the floating classroom to the region and conduct their Big River Education Program. 2.5 Host environmental workshops for teachers. 2.5.1 Project WET Workshop 2015 2.5.2 Project Learning Tree Workshop 2016 2.5.3 Project Wild Workshop 2017 2.6 Coordinate an annual steam cleanup in partnerships with other organizations. 2.7 Host a tree planting in conjunction with Earth Day. 2.8 Coordinate a nature walk during the Summer in the Park Program.
	3. Provide outreach to the community regarding non-point source pollution.	3.1 Discuss non-point source water quality issues within the watershed, and potential BMP implementations to address these issues with the landowners and community.

D. Local Concerns

The Damon Creek Watershed and Sewer Association is the operating body for the wastewater lagoon. Issues concerning this lagoon were expressed through personal communications with the president, Mr. Robert Tabers, and the vice president, Dr. Mike Kemp.

Concerns included that the wastewater lagoon is being underutilized, and therefore is not adequately funded. Funding for the operation and maintenance is supplied by the monthly charge each residence pays for the service. The lagoon was designed to accommodate 44 households, and currently only 17 households are connected.

The need to seek additional funding was identified in public meetings. Additional households need to connect in order to generate the necessary income to properly operate and maintain the wastewater treatment system. The current extent of the lagoon sewer system would allow five to six additional households to connect to the system. The sewer lines would have to be extended to accommodate additional residences.

Chapter II. Description of the Damon Creek Watershed

A. General Description

The Damon Creek Watershed (Figure 2) is located within the Upper West Fork Clarks River Watershed (HUC 0604000601), which combined with the Upper Clarks River (HUC 0604000601), the Lower West Fork Clarks River (HUC 0604000603), and the Lower Clarks River (HUC 0604000603) Watersheds, makes up the Clarks River Watershed (HUC 06040006). The area covers 343,500 acres, and contains a total of 1,580 miles of rivers and streams.

The Damon Creek Watershed covers an area of 5.641 square miles (3,610 acres), and is located approximately 7.3 miles northwest of Murray, Kentucky. The watershed includes approximately 4.5 river miles and 15 unnamed tributaries that feed into the main channel, totaling approximately 8.7 river miles. Damon Creek (HUC 06040006040160) is a small tributary to the West Fork Clarks River, and drains approximately 5.6 square miles.

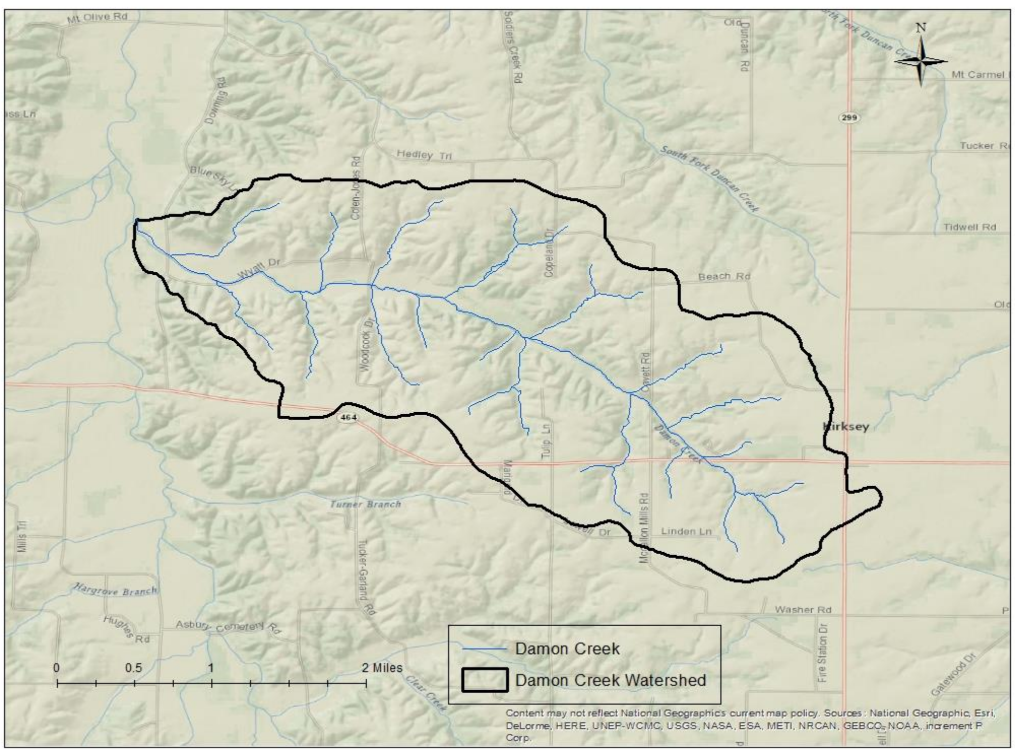

Figure 2. Map of the Damon Creek Watershed

Land Cover

According to the 2001 National Land Cover Database, land use within the Damon Creek watershed consists of 64% agriculture, 4% developed, 31% forest and 1% water/wetlands (Figure 3). The majority of land use within the Clarks River Watershed consists of pasture and cropland. Agricultural practices make up 177,781 acres which is 51.75% of the total area of the Clarks River Watershed.

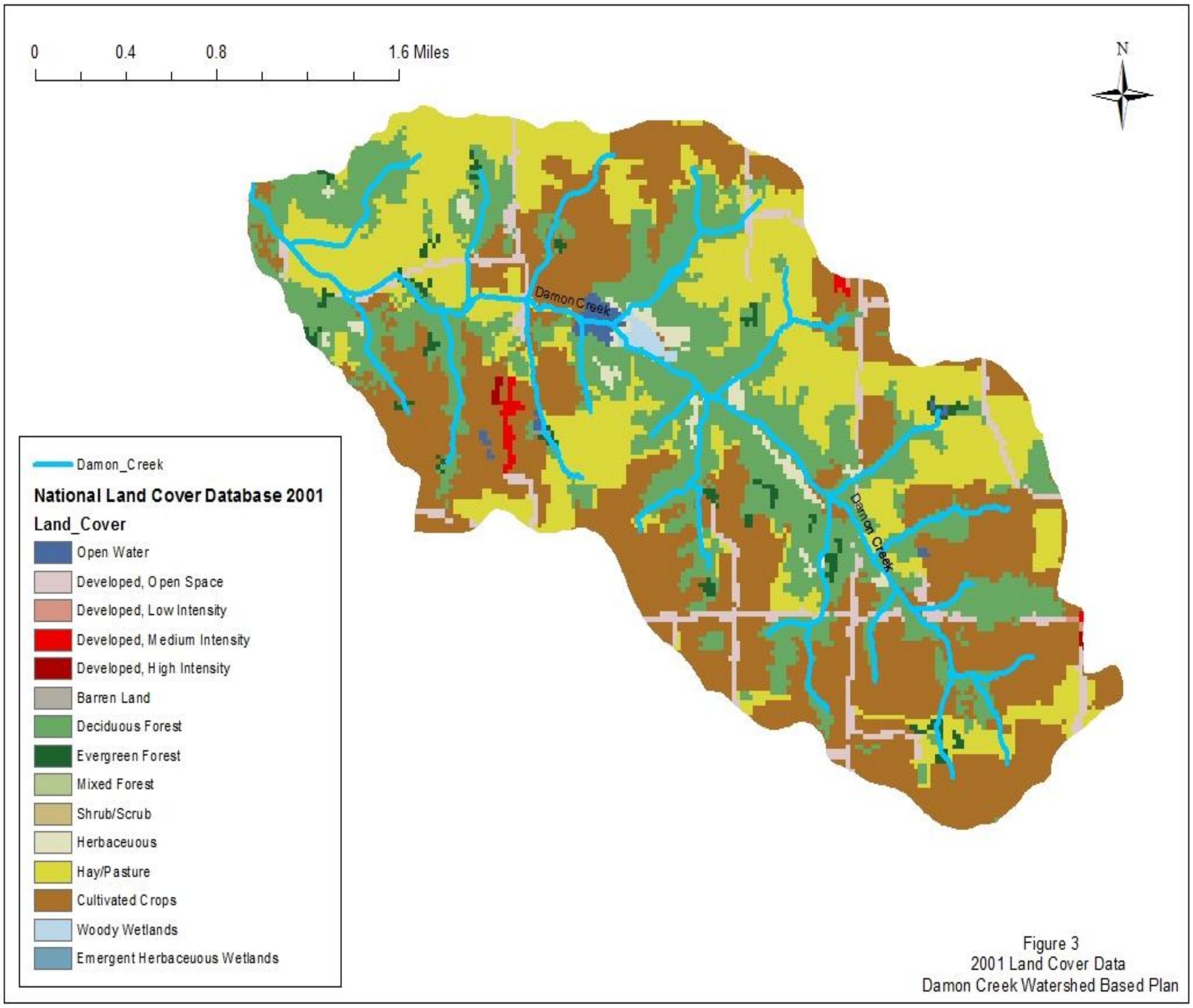

Figure 3. Land Cover Map of the Damon Creek Watershed

B. Water Quality Status of Damon Creek

The 2016 *Integrated Report (*IR*) to Congress on the Condition of Water Resources in Kentucky Volume II 303(d) List of Surface Waters* (KDOW, 2016) lists warm water aquatic habitat (WAH), primary contact recreation (PCR), secondary contact recreation (SCR), Domestic Water Supply (DWS), and Fish Consumption (FC) as the designated uses for Damon Creek. For the WAH designated use, the surface water and streambed substrate must be capable of supporting native warm water aquatic species. Streams suitable for PCR must be safe for recreational activities involving full body contact during the designated recreational season of May 1 through October 31. Water bodies designated for SCR must be safe for recreational activities involving partial body contact. DWS are bodies of water that when treated through conventional processes are suitable for human consumption through a public water system. For support of the designated use of FC, it must meet water quality standards that allow for consumption of fish harvested without having a negative impact on human health (401 KAR 10:001).

The IR reported that the 0.0 to 1.8 mile stream segment of Damon Creek is impaired for the PCR use and lists *E. coli* as the cause of the impairment. Damon Creek was listed as impaired for fecal coliform in the 2004 Integrated Report to Congress (KDOW, 2004). In addition, on the 2008 IR the 0.0 to 1.8 segment is listed as full support for WAH. The designated uses of SCR, FC and DWS currently have not been assessed due to insufficient data and/or no data being available.

River mile 0.0 to 1.8 of Damon Creek was assessed as non-supporting for PCR based on water quality data collected by MSU during the 2005 recreational season. PCR use support is based on *E. coli* concentrations. For a stream to support the designated use of PCR, the *E. coli* concentration must not exceed 130 colonies per 100 ml as a geometric mean based on no less than five samples taken during a thirty day period. Additionally, concentrations of *E. coli* shall not exceed 240 colonies per 100 ml in 20% or more of all samples taken in a thirty day period (401 KAR 10:031).

Since Damon Creek does not support its PCR designated use, and has an identified cause of impairment, a *Final Total Maximum Daily Load for* <u>*Escherichia coli*</u> *(in) 40 Stream Segments within the Clarks River Watershed Calloway Graves, Marshall, and McCracken Counties, Kentucky* was developed by the KDOW.

C. General Hydrology and Water Management

According to the 100K NHD Plus Stream Order GIS data from the Kentucky Geography Network, Damon Creek is a first order stream.

Damon Creek Watershed has one KDOW regulated dam as shown in Figure 4. This dam is designated as Floodwater Retarding Structure number 7 (FRS #7). FRS #7 is privately owned but maintained by the Calloway County Conservation District. Its purpose is for flood control.

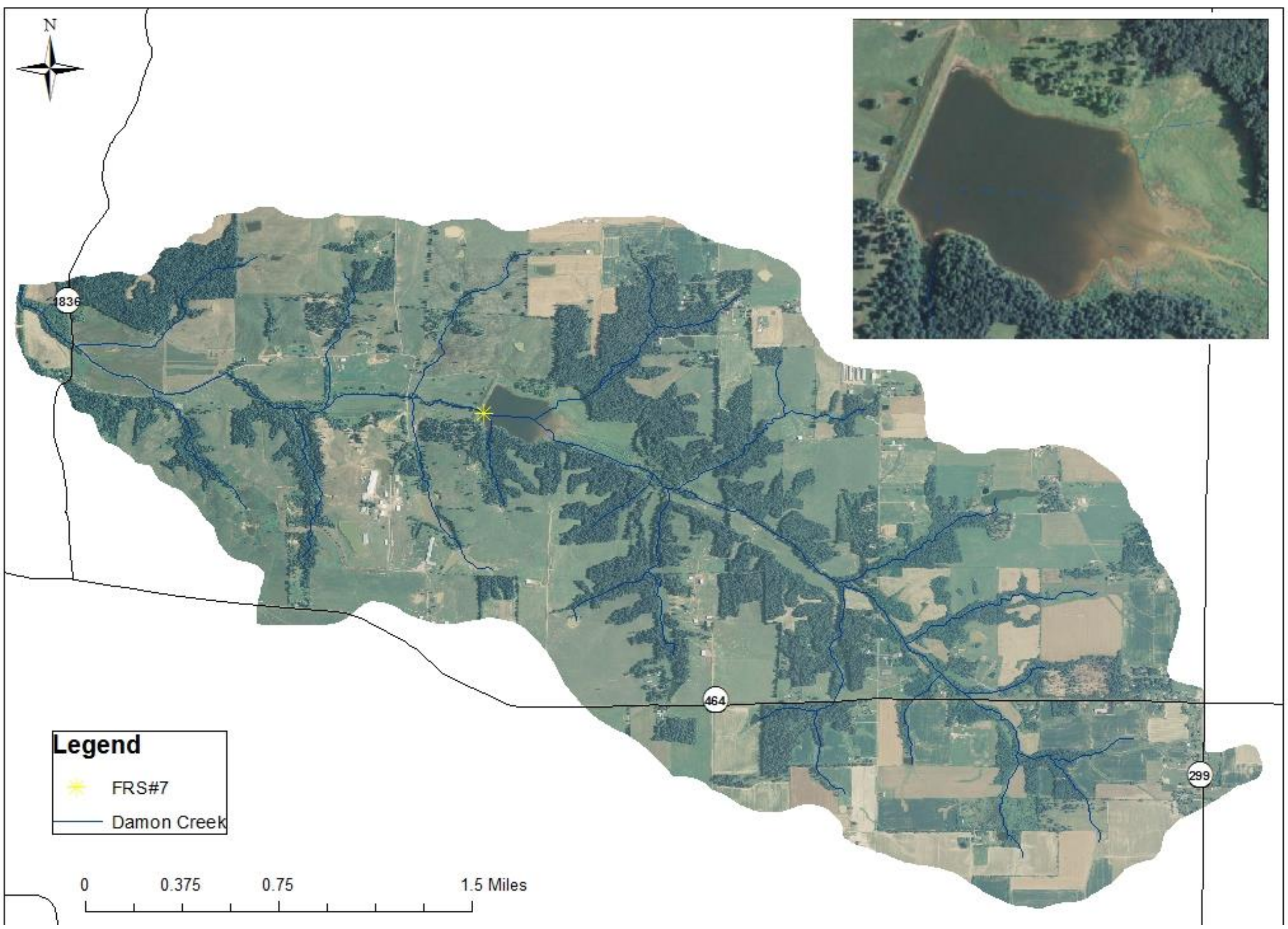

Figure 4. Regulated Flood Control Dam on Damon Creek

A hydrologic sensitivity index has been developed by the KDOW to evaluate the susceptibility of groundwater resources to contamination. Groundwater's sensitivity to contamination is primarily determined by three factors: recharge to the system, flow rate, and dispersion potential. The hydrologic sensitivity rating ranges from one (1) to five (5); with one (1) having the lowest sensitivity and five (5) the highest sensitivity.

Kentucky is divided into five physiographic regions. These regions are determined by geology, topography and hydrologic regime. Differences in these three areas give each region unique groundwater-surface interaction characteristics that are reflected in the sensitivity rating.

As a reflection of its geology, the hydrologic sensitivity rating for the Damon Creek Watershed ranges from two (2) (slightly sensitive) to three (3) (moderately sensitive as shown in Figure 5. No potentially karsts areas are identified within the boundaries of the Damon Creek watershed (Kentucky Geological Survey, 2015), which also can correlate with the hydrologic sensitivity rating of the area.

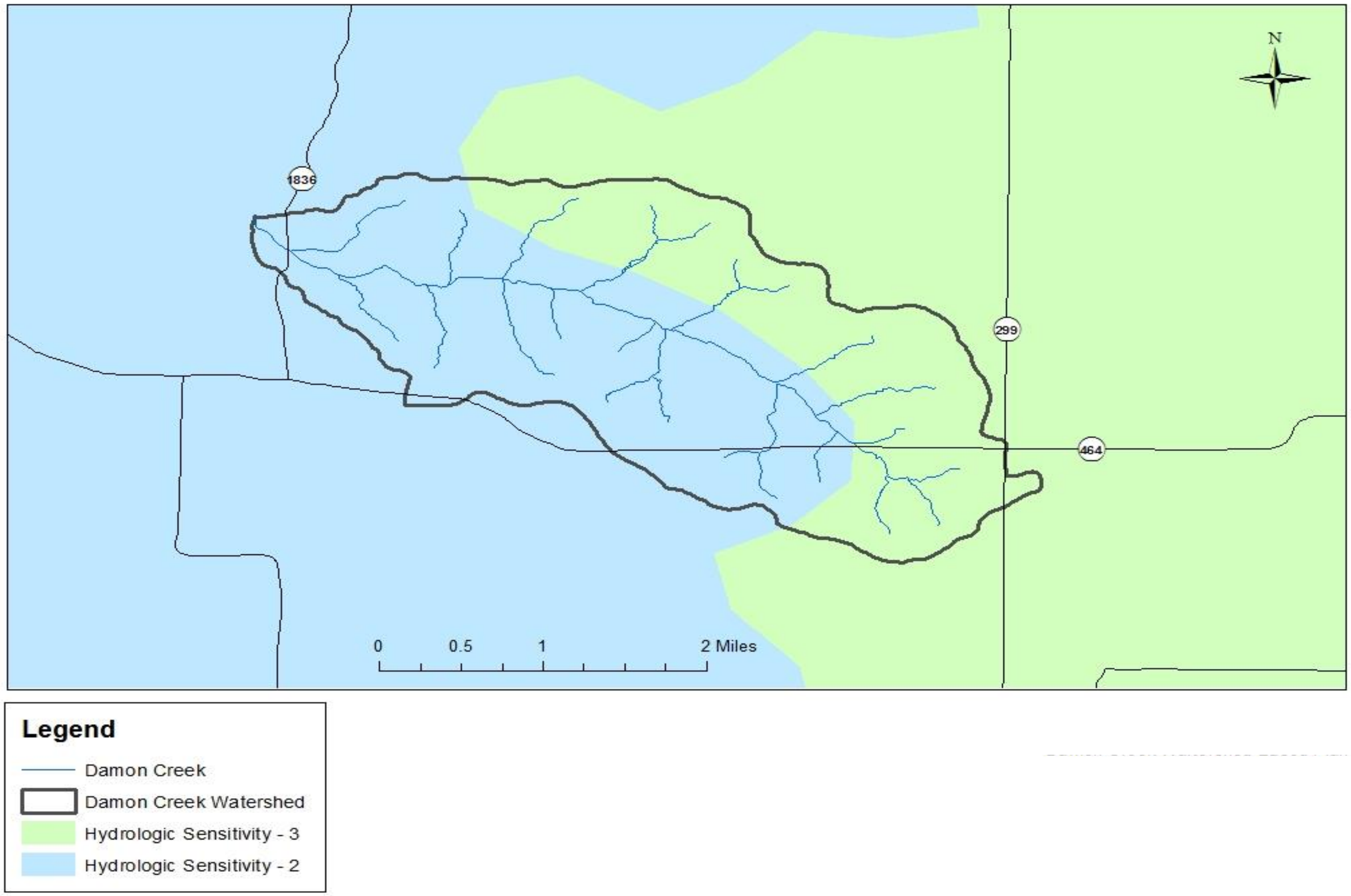

Figure 5. Groundwater Sensitivity Regions

D. Stream Channel General Description

In the headwaters of Damon Creek, the stream channel is narrow. Damon Creek is approximately ten feet wide with the stream bank heights approximately eight feet tall. The streambed has one to four inch rocks with little sediment. As Damon Creek flows westward, the stream bank width and base flow decrease. In some topographically restrictive areas, the stream width narrows within two to four feet.

The stream is braided going downstream, with up to four stream channels that flow together in an area within an altered stream channel. The stream channel has been altered for approximately 0.5 miles in this reach. Further down, the width of Damon Creek is approximately 50 to 70 feet wide. The embankment is approximately four feet high. From this site to the confluence with the Clarks River, more sediment, sand and rocks are visible. Near the confluence of Damon Creek with the West Fork Clarks River, the stream width remains the same, and the channel width decreases to approximately three feet.

Damon Creek has little to no vegetation along the bank. Erosion has begun in places leading to more sediment moving downstream. These eroded areas within the watershed could be addressed using BMPs to stabilize the soil, including restoration of the native vegetation.

E. Natural Features

Topography, and Flooding

Damon Creek is located within the Mississippi Embayment region of Western Kentucky. This area is characterized as a gently rolling plane where elevation differences rarely exceed 50 feet. Stream gradients are generally low, and low-lying valleys are prone to flooding (Carey & Stickney, 2005). Figure 6 is the Flood Insurance Rate Map (FIRM) that displays flood zone designations within the Damon Creek Watershed.

The highlighted portion of the map is designated Zone A - Special Flood Hazard Area (SFHA). SFHA is defined as an area in which flood management regulations must be enforced, and where the mandatory purchase of flood insurance applies. This area has a 1% annual chance of flooding and a 26% chance of flooding over 30 years. This is considered a high flood risk zone.

The remainder of the area as shown in Figure 6 is designated Zone X - Non-Special Flood Hazard Area (NSFHA). NSFHA is characterized as being at a low to moderate risk of flooding. Strand and Associates (2009) identified flooding as the most notable hydrologic hazard in the area.

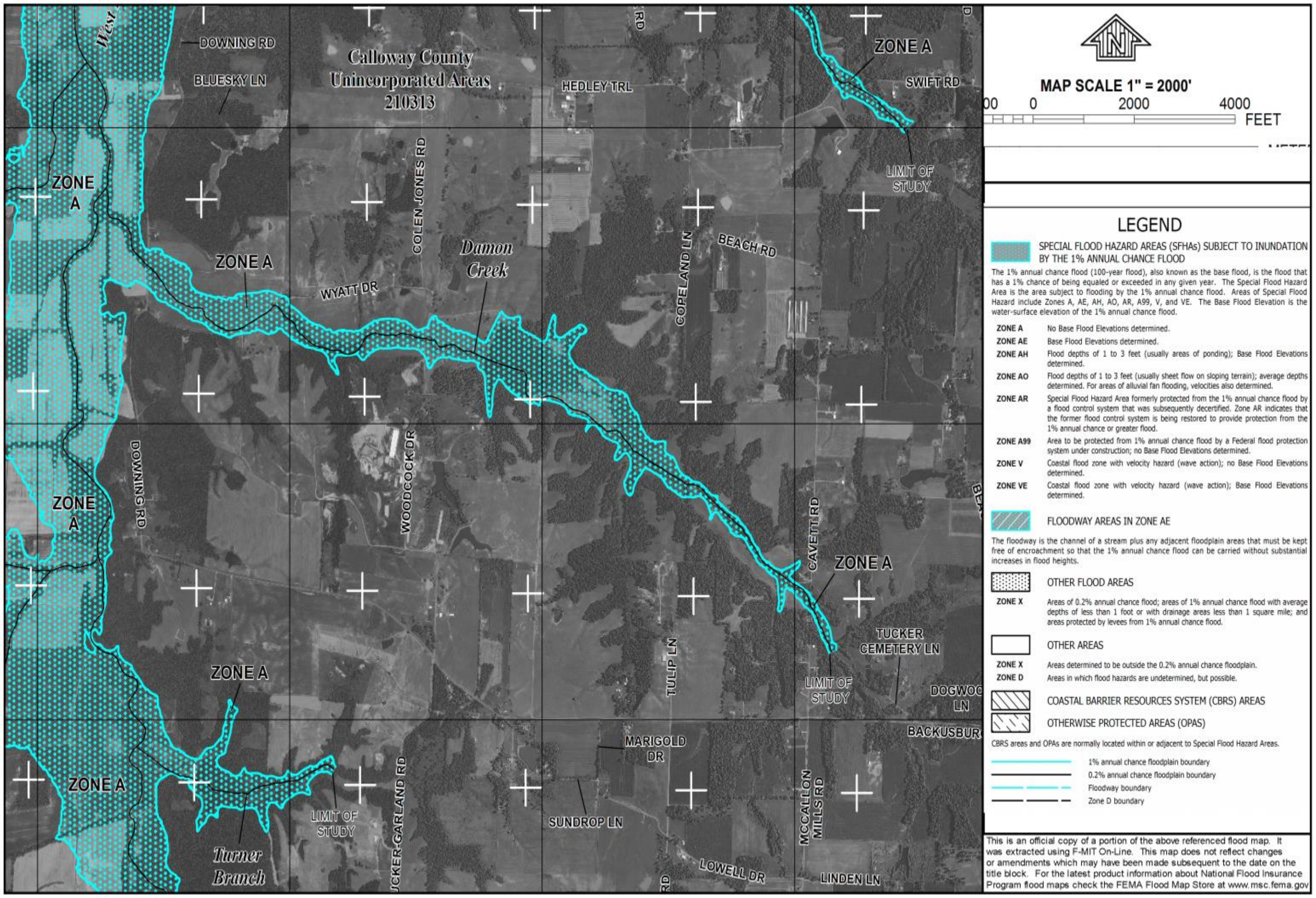

Figure 6. FEMA Flood Insurance Rate Map (FIRM)

F. Soils

Chapter 7 of the *National Engineering Handbook (NEH) Part 630- Hydrology* (NRCS, 2012) is the product of a multi-year collaboration between soil scientists at the National Soil Survey Center (NSSC) and engineers in the Conservation Engineering Division (CED). NEH 630.07 contains the official definitions of the hydrologic soil groups (HSG), and is identified by the National Soil Survey Handbook (NSSH) as the official HSG reference. Figure 7 shows the distribution of HSGs within the Damon Creek Watershed.

The majority of the watershed is composed of HSGs C, C/D and D. Group C is characterized as having a moderately high runoff potential when thoroughly wet with water transmission being somewhat restricted. Group D soils have a high runoff potential when thoroughly wet, and water transmission is restricted to very restricted. These groups make up the soil composition of the entire watershed excluding the Damon Creek flood plain and the valleys of its intermittent tributary streams.

The intermittent tributary valley soils are categorized into group B. Soils in this group have a moderately low runoff potential when thoroughly wet, and exhibit unimpeded water transmission. The underlying soils of Damon Creek and those found in its floodplain are made up primarily of HSGs B, C and B/D.

Areas of higher elevation within the watershed boundaries are all categorized into HSGs C/D, D, and C. These HSGs are characterized as having a moderately high to high runoff potential and somewhat restricted to very restricted water transmission capability. It has been well documented that enteric bacteria concentrations typically decline substantially when percolated through the soil (Gilbert, Gerba, Rice, Bouwer, Wallis, & Melnick, 1976) (Abu-Ashour, Joy, Lee, Whitely, & Zelin, 1994) (Howell, Coyne, & Cornelius, 1996) (Kunkel, 1970).

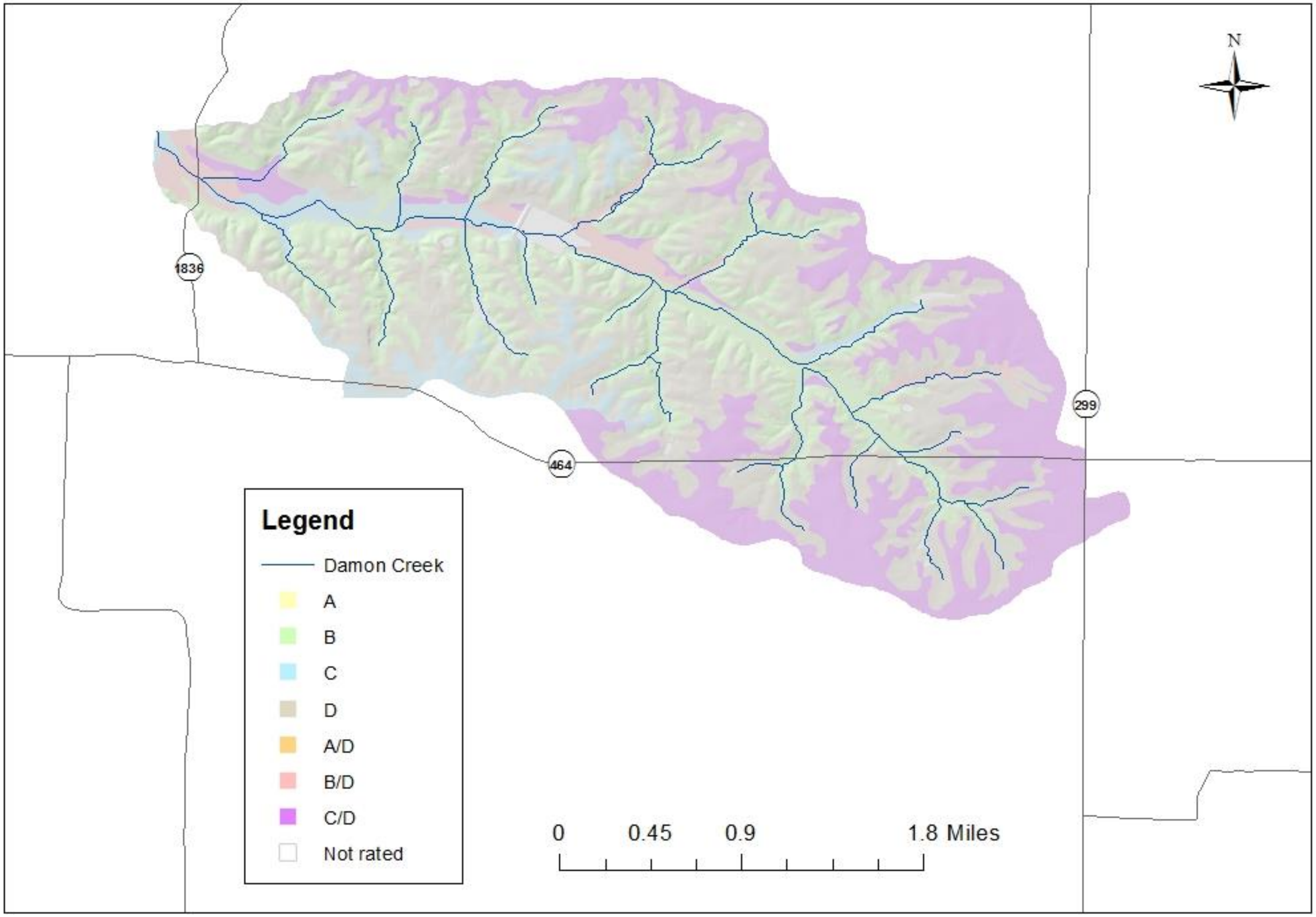

Figure 7. Hydrologic Soil Groups

The soil characteristics of the upland areas generally promote runoff rather than infiltration when saturated. This allows *E. coli* to be easily transported into Damon Creek and its tributaries by surface runoff. The generally high clay content of these soils is likely a contributing factor to the failing septic systems issues in the Kirksey area. Soils with a high percentage of clay do not allow proper percolation through the systems leaching field (Harlan & Dickey, 1999). The Damon Creek watershed is categorized into three categories of septic tank adsorption suitability. The majority of the Damon Creek watershed is in a very limited suitability area, which indicates that septic infiltration is not adequate for these soil types based on slope, flooding frequency and erosion characteristics (Figure 8).

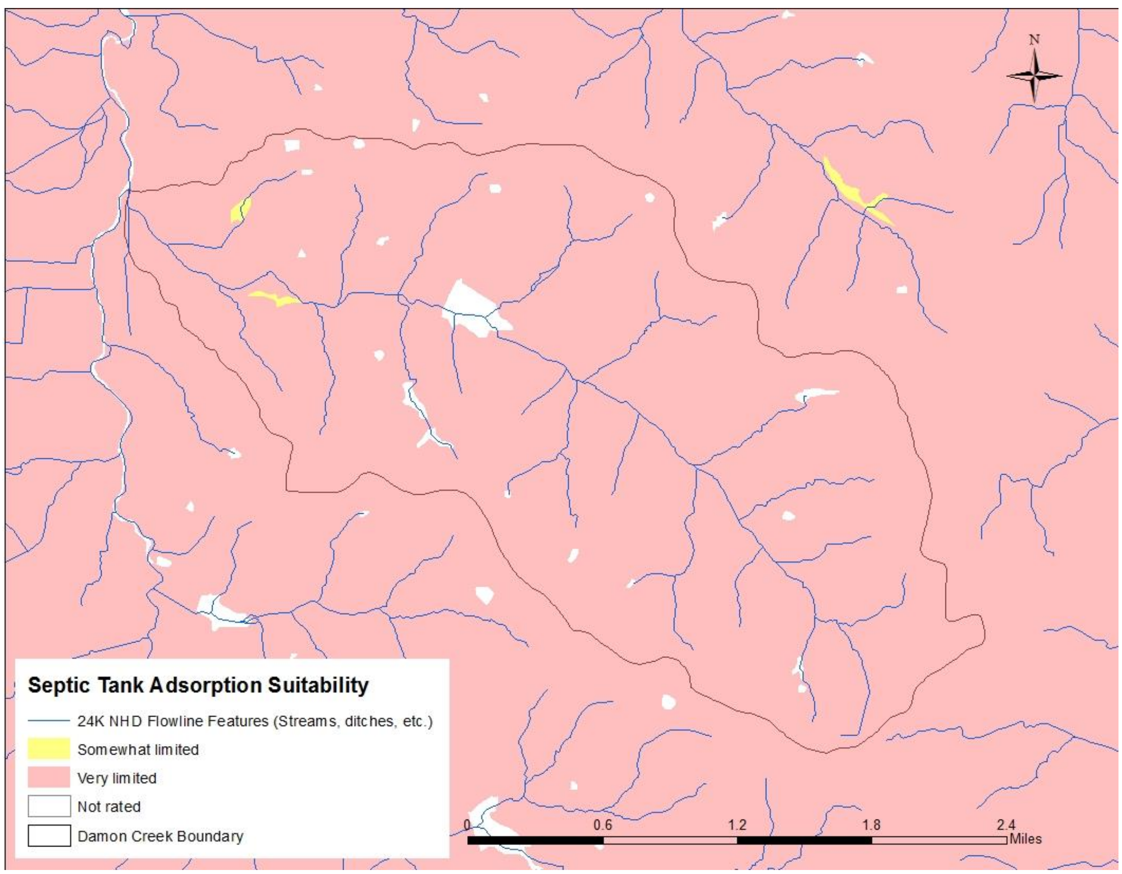

Figure 8. Damon Creek Septic Tank Suitability

G. Riparian Buffer Zone

The riparian buffer zone is a vital component to the long-term health of a watershed. Riparian buffers are effective means for reducing non-point source pollution from pastures and cropland (Hubbard, Newton, & Hill, 2004). These zones can also be effective in stabilizing stream banks, mitigating flooding, trapping nutrients and sediments, shading the stream to reduce excessive algae growth, as well as improving terrestrial and aquatic wildlife habitat (KDOW, 1997).

The primary function of the riparian buffer zone in the Damon Creek watershed is for water quality protection. The minimum recommended buffer width for this purpose is 35 feet (NRCS, July 2010). However, greater widths are necessary where non-point source pollution loads are elevated, such as with Damon Creek, particularly in the stream segment listed as impaired. This could help to prevent some of the erosion that was observed.

An analysis of the Damon Creek riparian buffer zone was carried out using National Agriculture Imagery Program (NAIP) 2014 aerial imagery and stream flow lines from the National Hydrography Dataset (NHD) 24k. Within a 45 feet buffer zone, areas with adequate vegetation were delineated from aerial imagery. These observations indicated that the majority of Damon Creek and its tributary streams have inadequate or non-existent riparian buffer zones. The highlighted stream segments in Figure 9 show the areas of Damon Creek that have an existing riparian buffer zone.

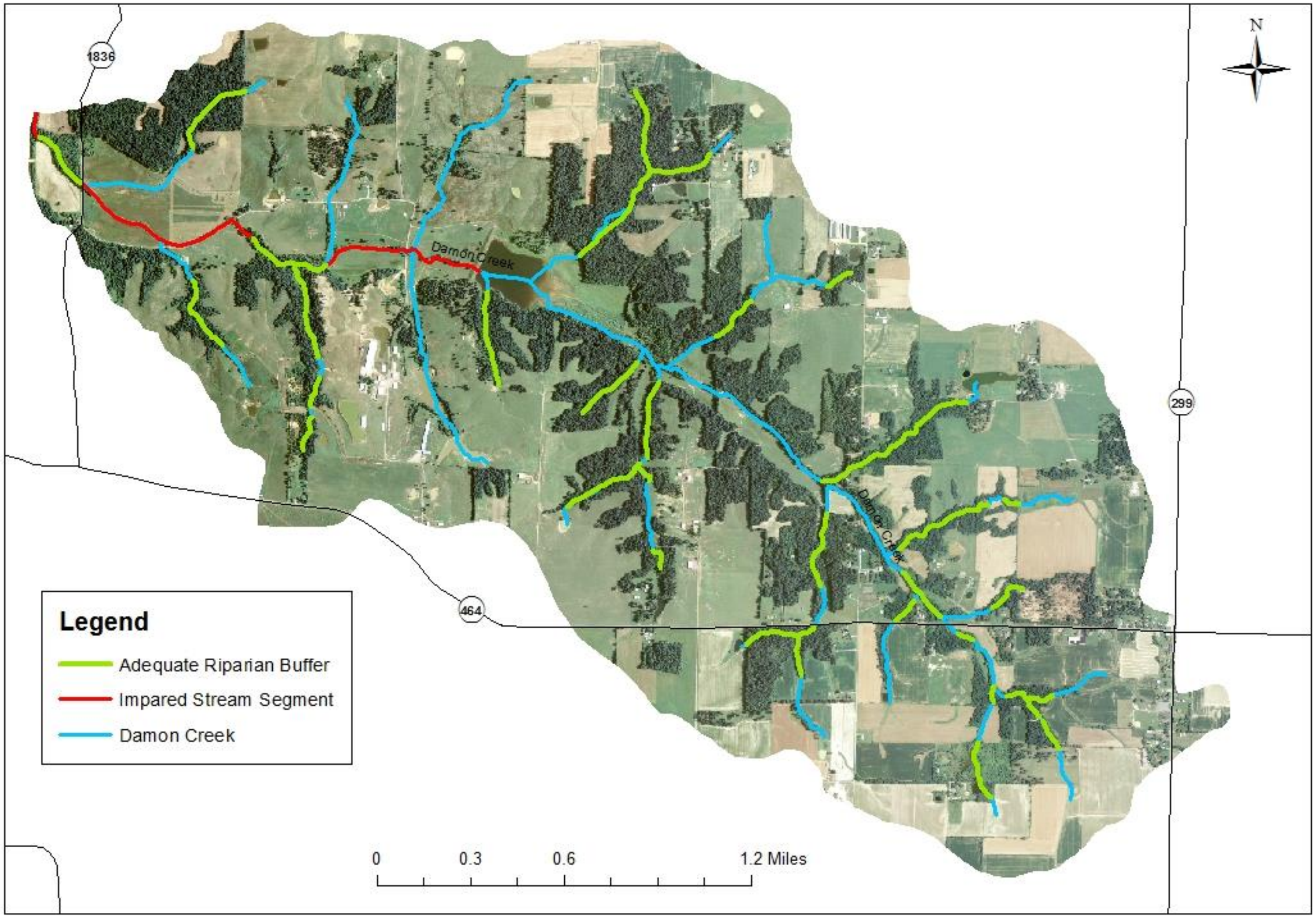

Figure 9. Riparian Buffers in the Damon Creek Watershed

H. Endangered/Threatened Species

The *2014 County Report of Endangered, Threatened, and Special Concern Plants, Animals, and Natural Communities of Kentucky* (Kentucky State Parks, 2014) is developed by the Kentucky State Nature Preserves Commission. This report lists all endangered, threatened, and special concern species known to be or to have been found naturally for each county in Kentucky.

The report identifies a total of 86 endangered, threatened, and special concern species in Calloway County. This includes 42 vascular plants, 2 crustaceans, 2 insects, 14 fish species, 3 amphibians, 9 reptiles, 9 breeding birds, 2 mammals, and 3 natural communities. Both fauna and flora species could benefit from management practices that improve water quality.

Establishing a continuous riparian buffer along Damon Creek would be particularly desirable, as it would not only improve water quality but also provide desirable habitat and travel corridors for these species.

I. Human Influences and Impacts

Water Use

There are 43 water wells within the Damon Creek Watershed according to the 2015 Kentucky Ground Water Data Repository (Kentucky Geological Survey, 2015). Figure 10 displays the location of these wells. The majority of the wells are located in the east end of the watershed. This portion is more densely populated when compared to the west end as it contains sections of the Kirksey community. Of the 43 wells identified, 39 of them are designated for domestic-single household, 1 for agricultural livestock watering, and 3 are unspecified.

Point Source Discharges

There are no permitted point source discharges located within the Damon Creek watershed.

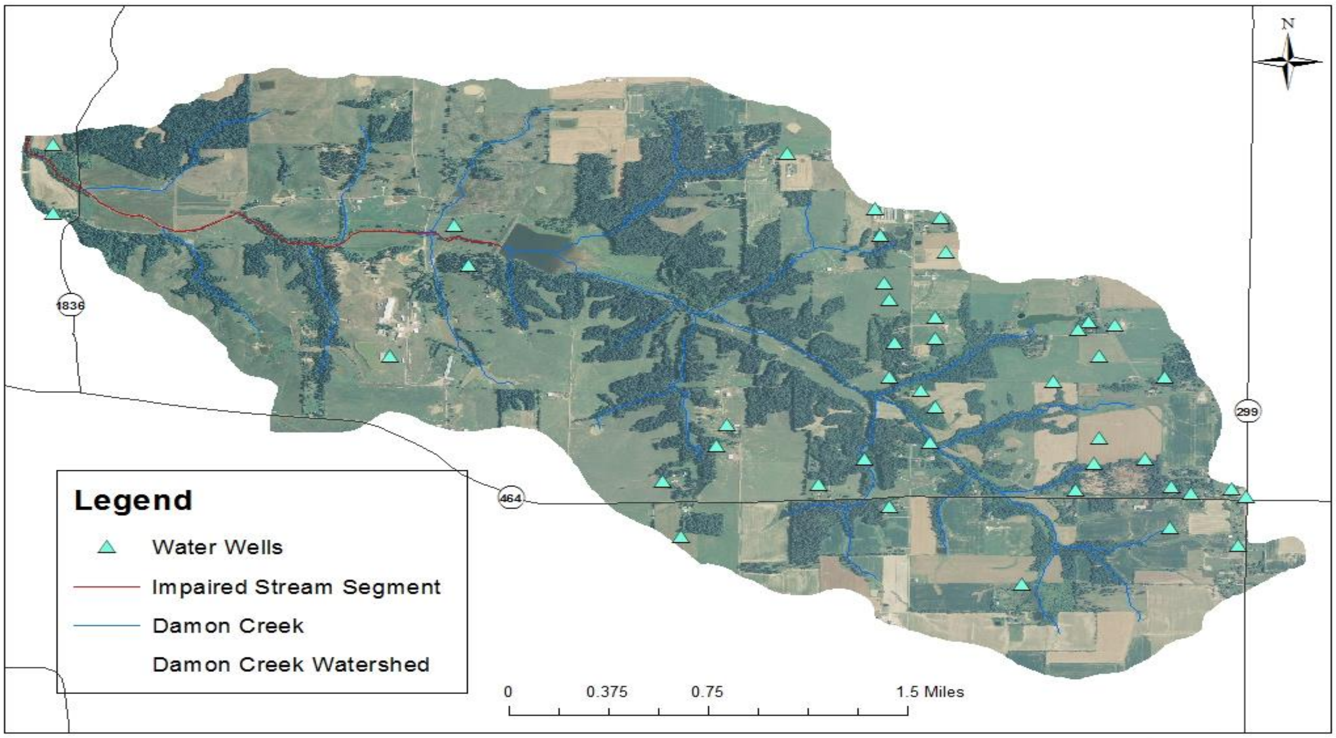

Figure 10. Water Wells

Land Use

The Damon Creek Watershed covers a total area of 3,610 acres. Approximately 1705 acres (47%) is currently being used for beef cattle production, by two farming operations. Approximately 2.87 miles (63.7%) of Damon Creek is within these livestock operations, including the majority of the impaired segment.

Throughout these two farms, cattle have been observed having direct access to Damon Creek, its tributaries, and the adjacent riparian areas. Cattle grazing patterns are determined primarily by their surroundings. Cattle prefer areas with gentle slopes, and generally do not graze more than 600 feet from a water source. Cattle will often congregate near water and shade sources (Higgins, Wightman, & Agouridis, 2011). Damon Creek generally flows throughout the year. The stream area provides partial shade in some areas and the majority of the adjacent land is characterized as having a gentle slope. This makes Damon Creek and its associated riparian zone an attractive location for cattle to graze and congregate. Livestock loafing in and near a stream have the potential to deposit a much higher amount of bacterial contamination than those who are excluded. Researchers have found that stream bacteria loads could be reduced by 95% if a minimum distance of 2.5 meters were maintained between the cattle access and the stream. (Larsen, Miner, Buckhouse, & Moore, 1994).

Feces that are deposited into a stream can be carried downstream and settle into the sediment which can then serve as a significant reservoir of bacteria. *E. coli* concentrations have been found to be 2 to 760 times greater in bottom sediment than in the overlying water (Stephenson & Rychert, 1982). These sediment bound bacteria have the potential to survive substantially longer than they typically can in water alone (Howell, Cyne, & Cornelius, 1996) (Sherer, Miner, Moore, & Buckhouse, 1992). In a stream, cattle have the ability to re-suspend this sediment-bound bacteria (Sherer, Miner, Moore, & Buckhouse, 1992), potentially causing an increase in the enteric bacteria concentration of the stream.

Grazing and trampling along stream banks and adjacent areas can also degrade riparian buffer zone vegetation, which will greatly reduce its ecological function and capacity. The removal of this vital vegetation will weaken the stream banks and allow erosion to take place at a faster rate. The pressure that a cow can apply through their hooves is much greater than the strength of the soil. This causes the upper layer of soil to be displaced while the underlying soil is compacted. The result is accelerated erosion and a reduced infiltration rate (Higgins, Wightman, & Agouridis, 2011). Not only can this have a negative effect on water quality, but it is also detrimental to livestock production. The decreased infiltration rate on pastureland will lower forage production during the dry summer months. During the winter when the soil remains saturated for extended periods it is especially susceptible to damage caused by trampling in high use areas. This can destroy pasture vegetation and cause a loss of nutrient rich top soil due to surface runoff.

Allowing livestock direct access to stream water and riparian buffer resources is a convenient practice operators employ to provide their herd with shade and drinking water. However, utilizing these sensitive areas will have negative consequences on surface and groundwater quality as described above. This practice can also be detrimental to the cattle, as they will be ingesting this poor quality water. Livestock require a supply of water that is both palatable and potable to remain healthy and productive. An elevated level of total suspended solids (TSS) can cause water to have an offensive taste, odor and color. Cattle may drink less of this unpalatable water than they require. Calves are more sensitive to pathogen contamination than adults.

The *NRCS Agricultural Waste Management Field Handbook* (NRCS, 2009) recommended *E. coli* concentrations for calves drinking from a water supply is <1cfu/100ml while the concentration for adults should not exceed 10cfu/100ml. Consuming contaminated water can reduce growth and limit production in livestock. Also, it will encourage them to drink less which leads to reduced feed intake and elevated vulnerability to heat stress. These are important issues to keep in mind when managing livestock, as the recommended pathogen concentration levels in their drinking water will be difficult to meet while they are allowed direct access to surface and groundwater resources (Higgins, Agouridis, & Gumbert, 2008).

J. Demographics

In 2010 The United States Census Bureau lists the population of Kirksey, Kentucky as 1,108. Of that population the median age was 37.4. 644 (58.1%) of the residents were male and 464 (41.9%) were female. The total number of households in the area was 430. Also located in the Damon Creek Watershed are 3 churches, a post office, a general store, and a recreational ball park. The area has several active and/or closed cemeteries. Damon Creek Watershed is located in the First Congressional District, (James Comer) Kentucky Senate District 1, (Sen. Stan Humphries), and Kentucky House District 5 (Rep. Kenny Imes).

K. Interim Conclusions

The Damon Creek Watershed is in a highly rural area with the majority of the population being concentrated in the eastern headwaters portion, while the western two-thirds of the drainage area is dominated by cattle production operations and owned predominately by two stakeholders. These two cattle production operations make up nearly half of the entire watershed area and encompass the entire impaired segment of stream as well as the associated flood plain. The land intensive nature of beef cattle production, and the lack of a functional riparian buffer throughout much of the watershed makes these operations a likely source of *E. coli* contamination. Maintaining the support and cooperation of these stakeholders will be crucial to the success of this project.

Several BMPs were previously implemented within the watershed during 2008-2011. This included the construction of a wastewater lagoon in the Kirksey area which is designed to accommodate 44 residential households. Currently there are 16 households utilizing this system. The current extent of the lagoon sewer system will allow for another 5 households to utilize it. Any connections beyond that will require an extension of the sewer system. During this period, six septic systems were either replaced or repaired.

Funds from this project will be utilized to conduct water quality monitoring throughout May 2015. The *Clarks River Watershed Plan-Best Management Practices Implementation Project Final Report 2012* (Jackson Purchases RC & D Foundation, 2012) states agriculture is the suspected source of *E. coli* contamination. However, future monitoring should take place after all BMPs are completed. This monitoring effort should include a bacterial source tracking component to indicate sources of bacteria. This monitoring effort will serve as a means to evaluate the success between previous BMPs and the recently installed practices.

Chapter III. Water Quality Monitoring

A. Historical Results

Figure 11 shows the locations of the sampling sites from the Murray State University (MSU) and Four Rivers Watershed Watch (FRWW) efforts. Site FRWW 282 was monitored from 2001 to 2007. Since 2007, sites FRWW 415 and FRWW 414 have been monitored. Prior to 2005, samples collected were tested for fecal coliform content; while data collected from 2005 to the present has been collected for *E. coli*. Since sampling through the FRWW program was conducted once a month for two to three months of the recreational season of each year, there are not sufficient data to calculate a geometric mean for *E. coli*

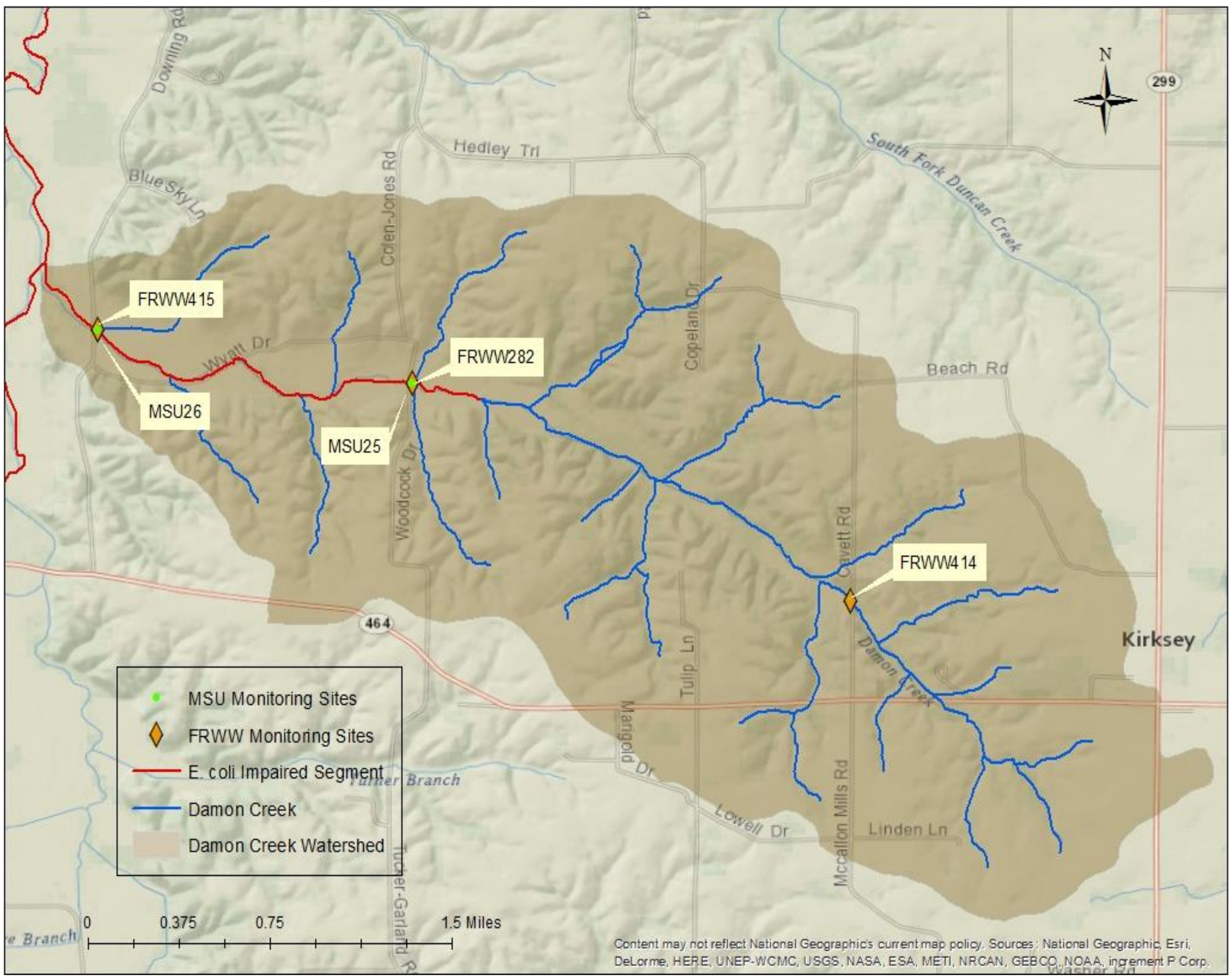

Figure 11. FRWW and MSU Monitoring sites

B. Previous Data

Stream flow data was recorded by MSU during 2005 at sampling sites 25 and 26. Site 25 produced a mean flow rate of 2.1 cfs (cubic feet per second) while the mean flow rate at site 26 was 1.7 cfs (cubic feet per second). Table 1 shows the flow rate recorded during each sampling event for sites 25 and 26.

Table 1. Flow Rate during Sampling Events for MSU Sites 25 & 26

Flow (cfs) at MSU Sites 25 and 26		
Sampling Date	MSU 25	MSU 26
5/12/2005	1.8	1.4
5/16/2005	1.4	0.4
5/23/2005	1.3	0.7
6/6/2005	0.9	0.3
6/13/2005	17.4	14.2
6/20/2005	0.7	0.8
6/27/2005	0.6	0.5
7/7/2005	0.7	0.7
7/11/2005	0.9	0.6
7/18/2005	1.7	0.8
7/25/2005	1	0.6
8/8/2005	0.8	0.5
8/15/2005	1	0.5
8/22/2005	0.8	1
8/29/2005	0.6	2.8
9/12/2005	1.3	0.8
9/19/2005	2.2	0.8
9/26/2005	2.8	3.6
Mean	2.1	1.7

Data was collected on Damon Creek during the 2000 recreational season by Murray State University. The university was awarded a 319(h) grant to assess fecal coliform concentrations in the Lower Cumberland, Tennessee, and Mississippi River Basins. MSU sampling site 26 on Damon Creek was monitored as part of this project. The results from this monitoring effort are summarized in Table 2.

Table 2. Summary of 2000 MSU Water Quality Monitoring

Date	Site ID	Number of Observations	% Exceeding WQC (400 colonies/ 100ml)	Minimum (colonies/100ml)	Maximum (colonies/100ml)	Average (colonies/100ml)
2000	26	6	100	750	228000	72475

Water quality sampling was conducted by Murray State University in 2005 as a part of a TMDL study in partnership with the Kentucky Division of Water. Two sites along Damon Creek were included in this study; MSU sampling site 25 and MSU sampling site 26 (Figure 11). A summary of the data collected at these sites is shown in Table 3.

Table 3. Summary of Water Quality Data used in TMDL Development

Site ID	**Number of Observations**	**% Exceeding WQC (240 colonies/ 100ml)**	**Minimum (Colonies/ 100ml)**	**Maximum (Colonies/ 100ml)**	**Average (Colonies/ 100ml)**	**Geometric Mean (colonies/ 100ml)**
MSU 25	18	72.2	40	3340	1247	652
MSU 26	18	100	398	12262	1846	1275

MSU26 had a geometric mean *E. coli* concentration of 1,275 colonies/100 ml and MSU25 had a geometric mean *E. coli* concentration of 652 colonies/100 ml. Both sites produced a geometric mean *E. coli* concentration above the 130 colonies/100 ml water quality standard for Damon Creek. Additional data has been collected at three sites, FRWW 282, FRWW 415, and FRWW414 through the Four Rivers Watershed Watch (FRWW) volunteer stream monitoring program.

Table 4 shows the total fecal coliform (shaded blue) and *E. coli* concentrations (shaded green) for each sampling event.

Table 4. Fecal Coliform and *E.coli* Results from FRWW Monitoring Sites; FRWW 282, 414 & 415

MSU 25/FRWW 282/KDOW18		MSU 26/FRWW 415/KDOW 4		FRWW 414/KDOW 19	
Date	cfu/100ml	Date	cfu/100ml	Date	cfu/100ml
5/5/2001	8500	9/21/2007	172	9/21/2007	52
7/20/2001	22500	5/25/2012	2909	5/25/2012	364
9/13/2001	2250	7/21/2012	626	7/21/2012	134
5/1/2002	12500	5/16/2013	86	5/16/2013	1725
6/29/2002	16300000	7/19/2013	594	7/19/2013	41
9/20/2002	8200	5/16/2014	3700	5/16/2014	158
5/2/2003	150	7/19/2014	17329	7/19/2014	75
7/24/2003	16	5/15/2015	10772	5/15/2015	41
9/27/2003	60	7/18/2015	801	7/18/2015	624
5/22/2004	210	5/19/2016	7701	5/19/2016	161
7/8/2004	715	7/16/2016	520	7/16/2016	259
9/18/2004	610	9/10/2016	529	9/10/2016	75
5/14/2005	14430				
7/28/2005	860				
9/16/2005	1860				
5/12/2006	768				
7/22/2006	366				
9/22/2006	14540				
5/10/2007	48392				
7/12/2007	3684				
9/21/2007	346				

C. Additional Data Needs

Although numerous historical data exists for the Damon Creek watershed, it was determined that additional and more up-to-date data was needed for this watershed planning effort. Specifically, additional E. coli data was needed to create an approved bacteria focused watershed plan specifically for the Damon Creek Watershed. Therefore, *E. coli* monitoring efforts were focused in the Damon Creek watershed during the 2015 Primary Contact Recreation use season. These monitoring efforts were completed by the Kentucky Division of Water TMDL Section staff with assistance from the Damon Creek watershed coordinator.

Water quality monitoring was conducted at four locations along Damon Creek during May 2015; these sites are shown in Figure 12. During a 30-day period, five sampling events were conducted, which met the requirements to calculate the geometric mean *E. coli* concentration. Parameters that were monitored included: *E.coli*, stream discharge, dissolved oxygen, dissolved oxygen saturation, pH, specific conductivity, temperature, and field observations.

Furthermore, bacterial source tracking was completed for all *E. coli* samples collected during the monitoring effort. Source tracking analysis was done at the ERTL facility at the University of Kentucky. *E. co*li was compared to or against host specific biomarkers to determine the source of the enteric bacteria. The markers chosen for this analysis were general, human, ruminant, and chicken.

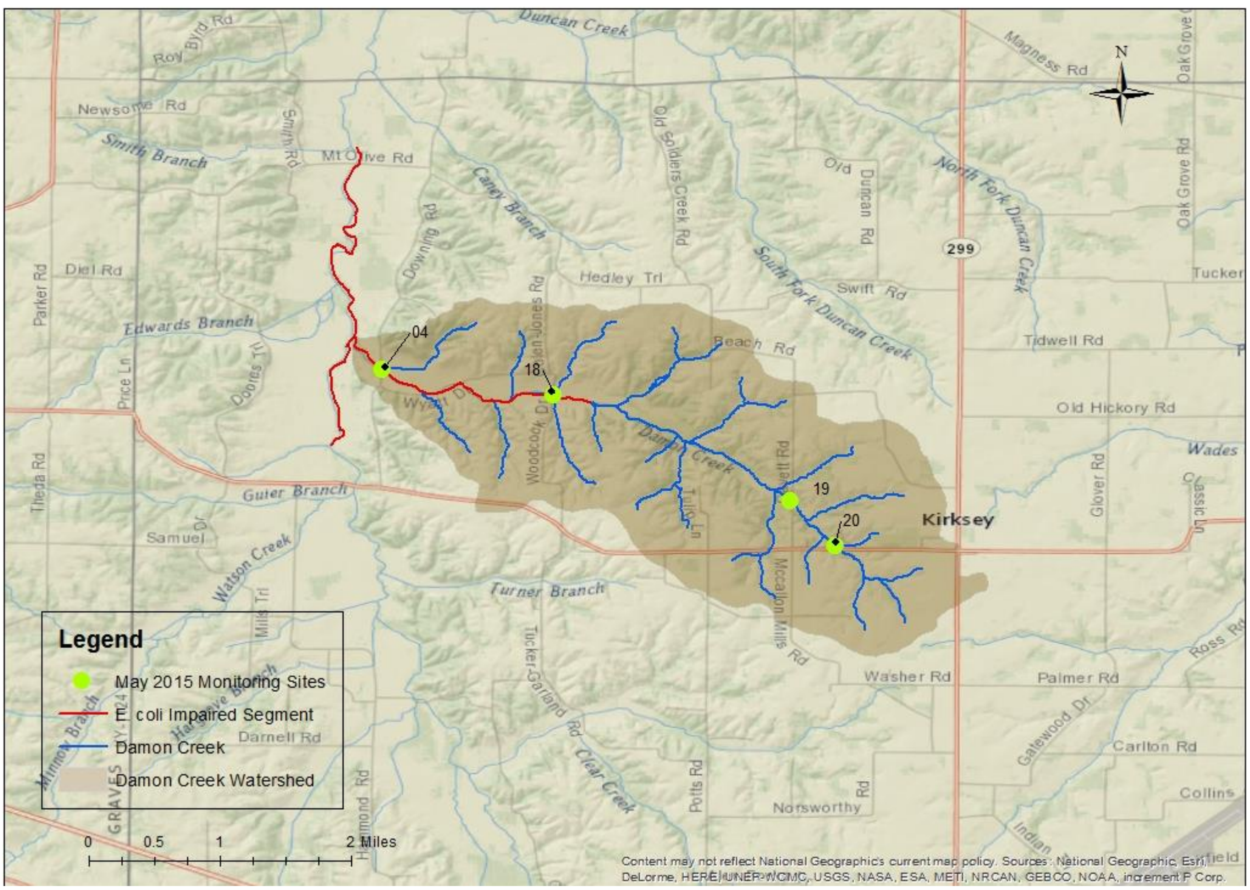

Figure 12. KDOW Monitoring Sites

D. Monitoring Strategy

The full monitoring strategy for this project can be found in the *TMDL Study Plan, E. coli Monitoring in Damon Creek (USGS HUC06040006050160), Calloway County* developed by the Kentucky Division of Water in 2015 (KDOW, 2015) (Appendix B). A total of four locations were monitored for the parameters listed in Table 5. Sample locations were selected based upon the location of the impaired segments listed on the 2014 303(d) list, watershed evaluation using ArcGIS, and historical Four Rivers Watershed Watch sampling sites. Watershed accessibility, the location of potential non-point sources, land use cover, and TMDL monitoring staff resources were also taken into consideration for site selection.

Table 5. KDOW Sampling Sites with Locations & Parameters

Site No.	Station ID	Stream Name	Location	River Mile	Catchment Area (mi^2)	Latitude	Longitude	Parameters
04	CRR090004	Damon Creek	At KY 1836	0.3	5.6	36.71854	-88.45921	*E. coli,* Discharge, Multiparameter Probe, Field Observations
18	DOW09010018	Damon Creek	At Woodcoc k Dr.	1.55	4.34	36.71575	-88.44036	*E. coli,* Discharge, Multiparameter Probe, Field Observations
19	DOW09010019	Damon Creek	At Cavett Rd.	3.35	1.2	36.70392	-88.41391	*E. coli,* Discharge, Multiparameter Probe, Field Observations
20	DOW09010020	Damon Creek	At KY 464	3.8	0.58	36.69867	-88.40867	*E. coli,* Discharge, Multiparameter Probe, Field Observations

E. coli

Five *E. coli* samples were collected in a 30-day period in late May and early June of 2015. *E. coli* samples were analyzed at Kentucky Division of Water's Microbiology Lab in Paducah, KY, following the procedures in *Enzyme Substrate Test for the Detection of Total Coli forms and Escherichia coli* (KDOW, 2011b).

Bacterial Source Tracking

Samples were collected on the same schedule and with the same protocol as the *E. coli* samples. Filtered samples were transferred on dry ice to the ERTL facility at the University of Kentucky where DNA extractions and PCR assays were completed. Positive control samples, including human, bovine, and chicken were also submitted.

Stream Discharge

Stream discharge measurements were taken at every site during every visit, as long as flow conditions were deemed safe for wading. The procedures used followed those found in *Measuring Stream Discharge* (KDOW, 2010).

Multi-parameter Probe

A multi-parameter water quality probe was used to measure *in situ* water quality parameters following the procedures in *In situ Water Quality Measurements and Meter Calibration* (KDOW, 2009). The following parameters were collected using the probe at every site during every visit: dissolved oxygen (mg/L), dissolved oxygen saturation (%), pH (SU), specific conductivity (µs/cm), and temperature (°C).

Field Observations

A field observation sheet was completed at each site during each sampling event. The following sample event information was recorded: site location information, water chemistry sampling details, *in situ* measurements and discharge measurements. The following observations were recorded: general observations (weather, stream mixing, etc.), in-stream observations, biological observations and any other relative observations.

CHAPTER IV. Water Chemistry and Physical Properties - Results

A. Bacteria

The Kentucky Water Quality Standard for Primary Contact Recreation Use states that *Escherichia coli* content shall not exceed 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. Additionally, twenty percent or more of al samples shall not have concentrations that exceed 240 colonies per 100 ml for *Escherichia coli*.

Based on the results of the *E. coli* sampling in May 2015, two sites exceeded both the geometric mean standard of 130 colonies per 100 ml, and had more than 20% of all samples exceed the standard of 240 colonies per 100 ml.

Table 6 - *E. coli* Concentrations by Site and Date (CFU/100 mL)					
KDOW Monitoring Site	5-May	12-May	19-May	26-May	2-Jun
CRR090004 (KDOW4)	>2420	3466	>9680	839	518
DOW09010018 (KDOW18)	613	1553	1120	1986	56
DOW09010019 (KDOW19)	39	22	115	228	51
DOW09010020 (KDOW 20)	80	108	172	178	107

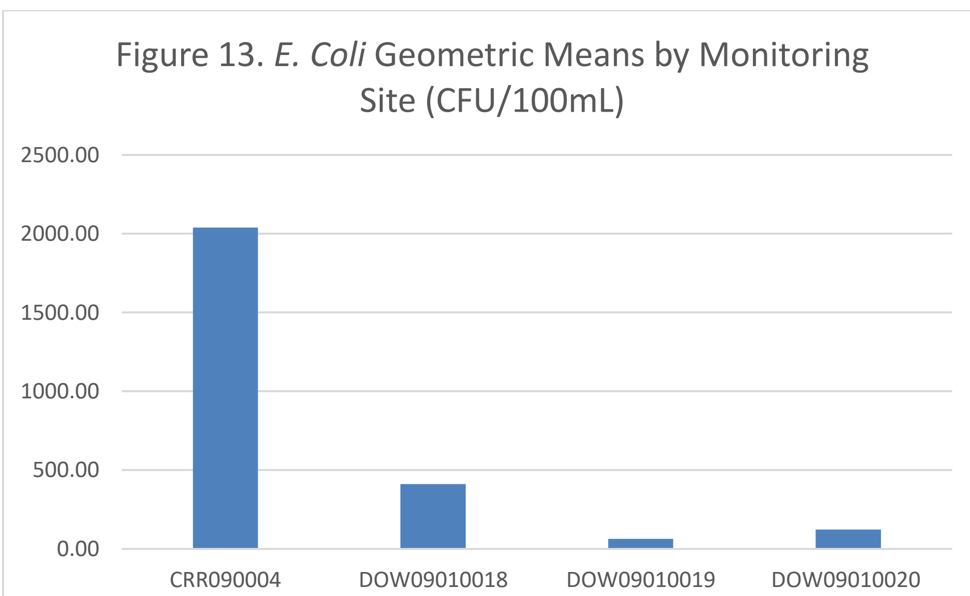

Figure 13. *E. coli* Geometric Means by Monitoring Site

The two sites that did not meet the standard for Primary Contract Recreation Use were in the downstream reaches, with the highest concentrations observed at KDOW4, located on Damon Creek at KY 1836 near the mouth. The other site, KDOW18, is located on Damon Creek at Woodcock Drive.

Precipitation

Precipitation and flow can greatly affect *E. coli* concentrations. If the source of *E. coli* tends to be located on the surrounding landscape, concentrations will increase after a precipitation event, as the bacteria transferred by water running off the land and are washed into the stream. Thus, one would expect to see a relationship between precipitation amounts or flow and the observed *E. coli* concentrations, with *E. coli* concentrations increasing after rain events. Sample time following a rainfall event can also affect pollution concentrations. If samples are collected shortly after the rainfall event they are likely to be higher than if they are collected later, as much of the pollution from the surrounding landscape has been “flushed” through the stream system.

At site KDOW4, *E. coli* concentrations are consistently high, but increased greatly after the May 15, 16, 17 precipitation events as shown in Figure 14. This could indicate that there are several sources of *E. coli* at this site including, constant sources such as cattle in stream, and surrounding landscape sources, such as pasture/grazing land and failing septic systems.

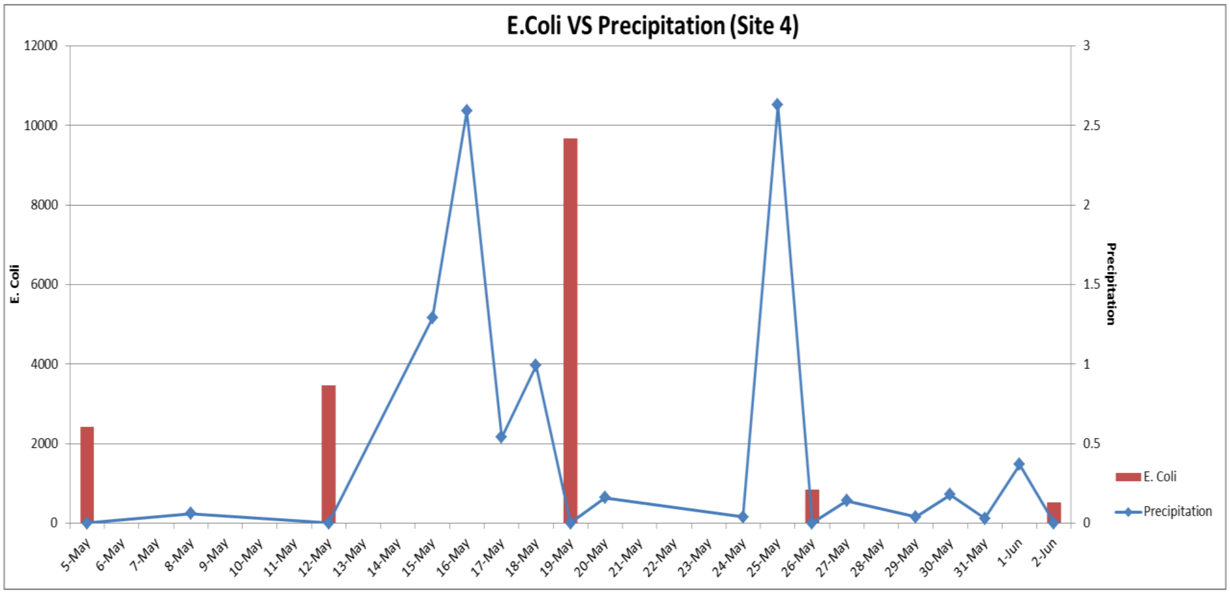

Figure 14. Monitoring Site KDOW4 – *E. coli* Verses Precipitation

At site KDOW18, *E. coli* concentrations are again consistently high, with the highest concentration observed following the May 24 precipitation event as shown in Figure 15. This could indicate that there are several sources of *E. coli* at this site including, constant sources such as cattle in stream, and surrounding landscape sources, such as pasture/grazing land and failing septic systems.

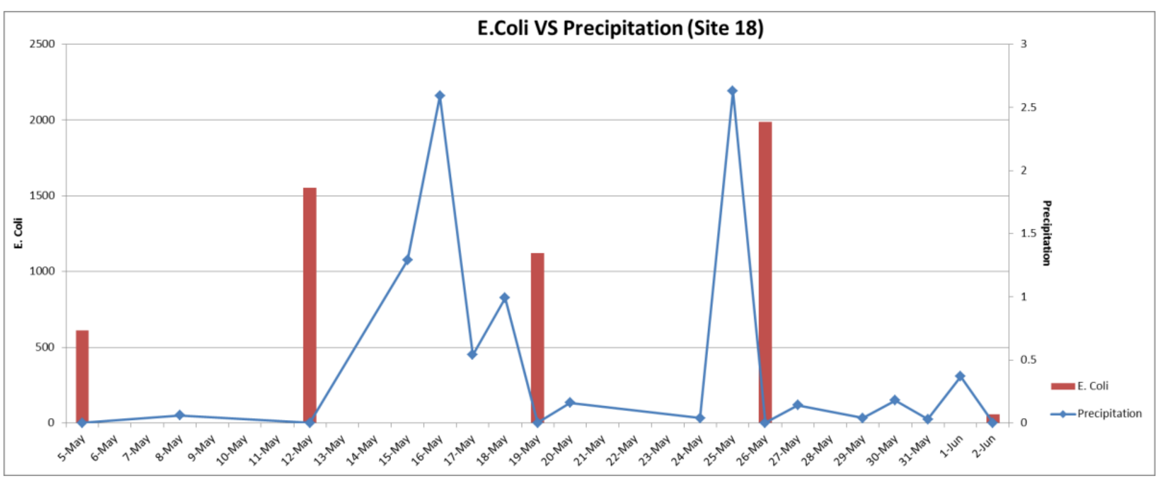

Figure 15. Monitoring Site KDOW 18 – *E. coli* verses Precipitation

At site KDOW19, *E. coli* concentrations were lower than sites KDOW4 and KDOW18, often below the water quality standard as shown in Figure 16.

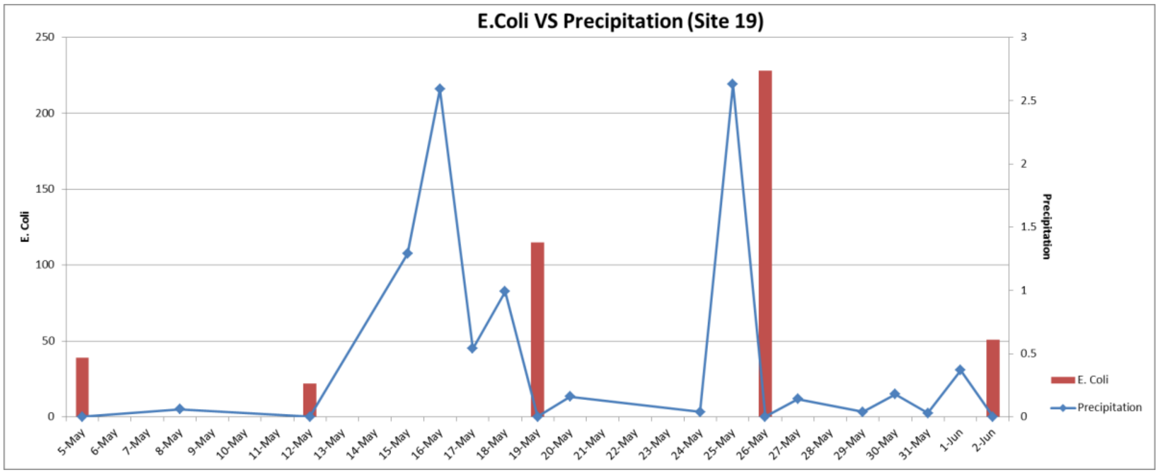

Figure 16. Monitoring Site KDOW 19 - *E. coli* Verses Precipitation

At site KDOW20, *E. coli* concentrations are generally much lower, increasing after rainfall events, indicating a runoff component to *E. coli* sources, as shown in Figure 17.

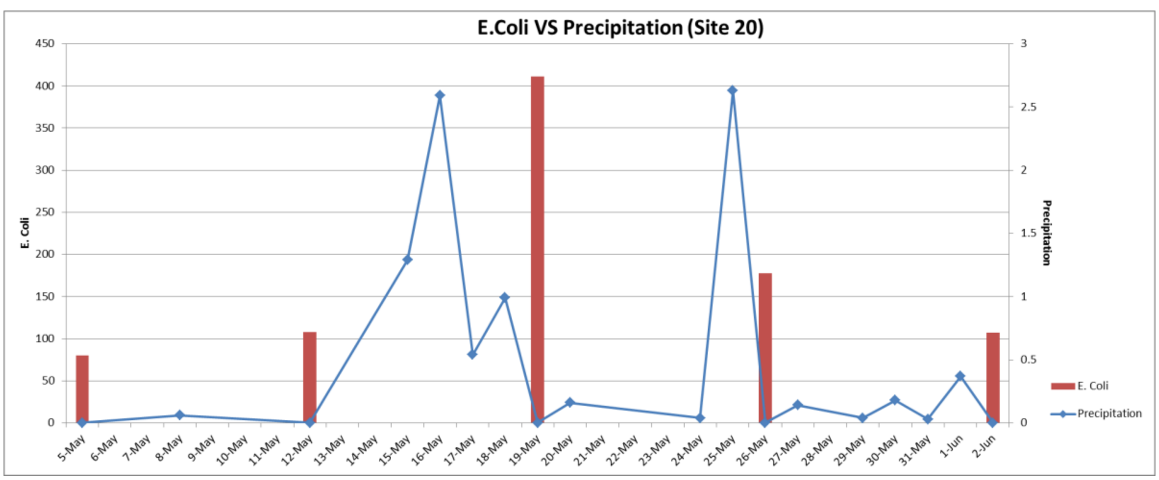

Figure 17. Monitoring Site KDOW 20 - *E. coli* Verses Precipitation

C. Flow

At site KDOW4, in general, as flow increases, *E. coli* concentrations increase, except on the May 26 sampling event as shown in Figure 18. This is likely due to the timing of sample collection, with it being long enough after the rainfall event that *E. coli* has been flushed through the stream system. Because *E. coli* concentrations are higher than the water quality standard even at base flow conditions, this indicates a constant source of *E. coli* to the stream. Concentrations then rise as flow increase, indicating there is also a runoff contribution of *E. coli*.

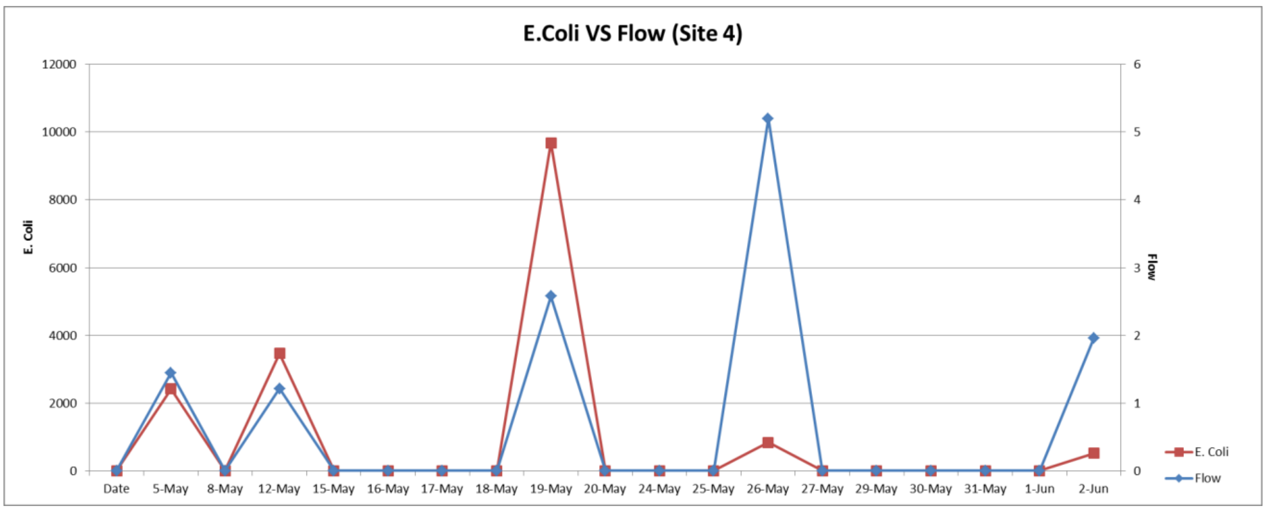

Figure 18. Monitoring Site KDOW4 – *E. coli* Verses Flow

At sampling site KDOW18, *E. coli* concentrations are lower than site 4, but still tend to follow the same pattern, increasing as flow increased as shown in Figure 19. This could indicate that there is both a constant source and a runoff contribution of *E. coli* in the stream.

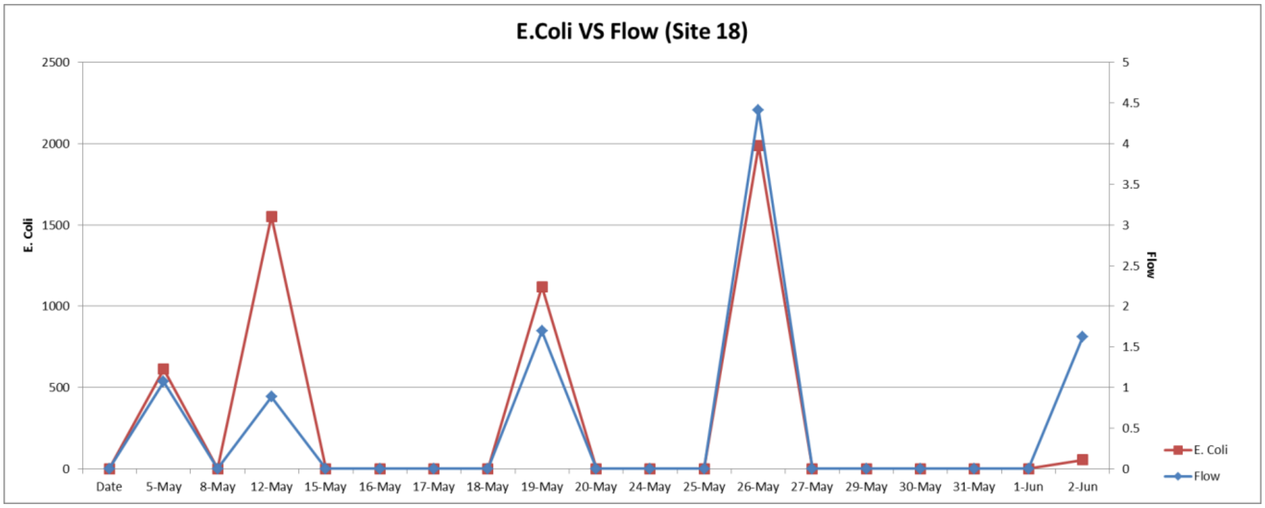

Figure 19. Monitoring Site KDOW18 – *E. coli* Verses Flow

At sampling site KDOW19, *E. coli* concentrations are lower (Figure 20.) The highest observations can be seen when flow is greatest, indicating a runoff contribution of *E. coli* to the stream.

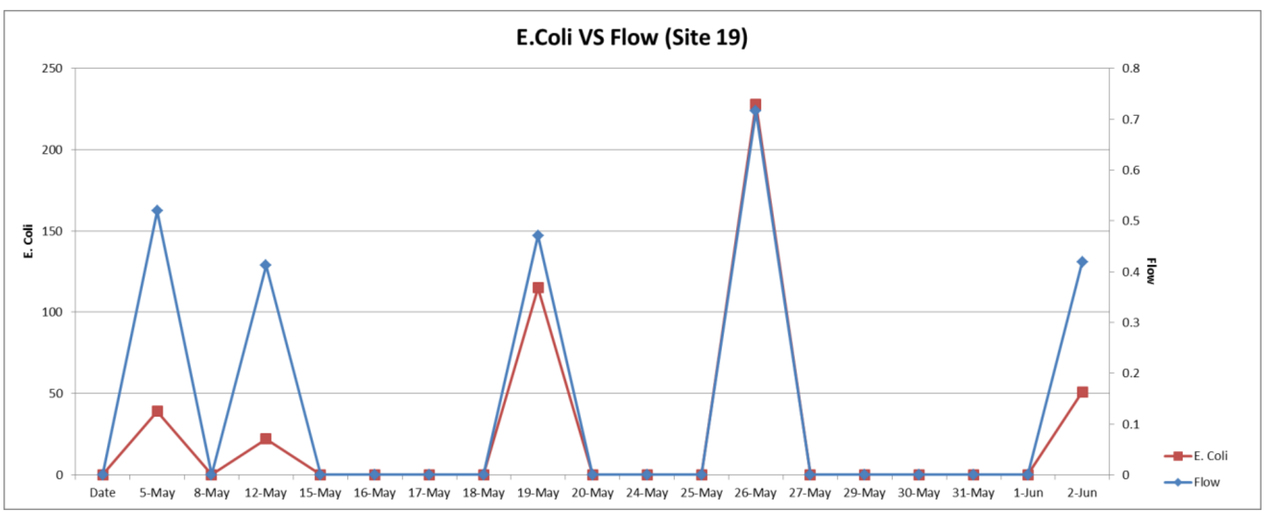

Figure 20. Monitoring Site KDOW19 – *E. coli* Verses Flow

At sampling site KDOW20, in general, *E. coli* concentrations are greater with increased flow, indicating a runoff contribution to *E. coli* in the stream (Figure 21).

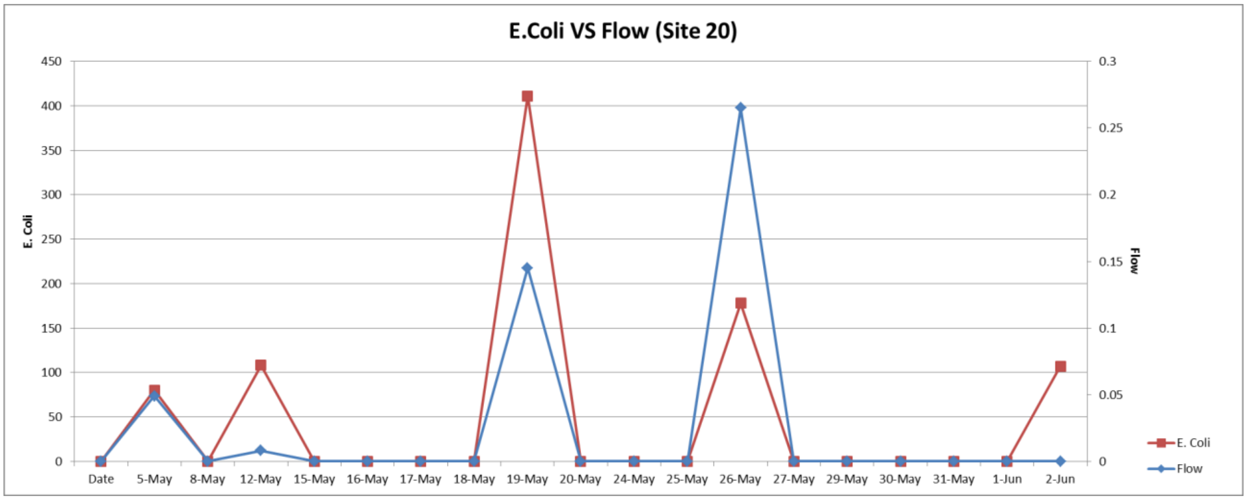

Figure 21. Monitoring Site KDOW20– *E. coli* Verses Flow

Whether the stream was on the rise or fall at the time of sampling does affect the results. However, the above figures demonstrate the trend that *E. coli* concentrations increase with an increase in precipitation, and therefore flow, due to the *E. coli* being washed into Damon Creek with runoff from the surrounding landscape.

The average annual load for E. coli was calculated for each monitoring site. Additionally, the target load, reduction needed, and percent reduction needed to meet water quality standards for Primary Contact Recreation use were calculated. As Tables 7 and 8 show the majority of the *E. coli* loads, and consequentially reductions needed, are located at the two most downstream sites.

Annual *E. coli* Loads and Reductions Needed - 240 CFU/100ml				
KDOW Monitoring Site	Average Annual Load (CFU/100mL)	Target Load (CFU/100mL)	Reduction Needed (CFU/100mL)	Percent Reduction Needed
CRR090004 (KDOW4)	6.77179E+13	5.29732E+12	6.24206E+13	92.18
DOW09010018 (KDOW18)	2.27795E+13	4.14413E+12	1.86354E+13	81.81
DOW09010019 (KDOW19)	4.75383E+11	1.08478E+12	-6.09394E+11	-128.19
DOW09010020 (KDOW20)	1.98754E+11	1.98754E+11	-969722040.9	-0.49

Table 7. Annual *E. coli* Loads and Reductions Needed - 240 CFU/100ml

Annual *E. coli* Loads and Reductions Needed - 130 CFU/100ml				
KDOW Monitoring Site	Average Annual Load (CFU/100mL)	Target Load	Reduction Needed	Percent Reduction Needed
CRR090004 (KDOW4)	6.77179E+13	2.86938E+12	6.48485E+13	95.76
DOW09010018 (KDOW18)	2.27795E+13	2.24474E+12	2.05348E+13	90.15
DOW09010019 (KDOW19)	4.75383E+11	5.87588E+11	-1.12205E+11	-23.60
DOW09010020 (KDOW20)	1.98754E+11	1.08184E+11	90570399556	45.57

Table 8. Annual *E. coli* Loads and Reductions Needed - 130 CFU/100ml

To better determine the specific sources of the *E. coli* contamination at each site, bacterial source tracking was conducted. Through this type of analysis, different host species potentially contributing *E. coli* to the stream were evaluated. For this project, potential sources evaluated included human, ruminant, and chicken sources. Samples collected from Damon Creek indicated that neither human nor chicken sources were detectable in any of the samples collected. Ruminant sources were found in samples collected at all four sampling sites, with the ruminant contributions increasing at the downstream sites of KDOW4 and KDOW18, indicating BMPs selected for implementation should target ruminant sources should be prioritized.

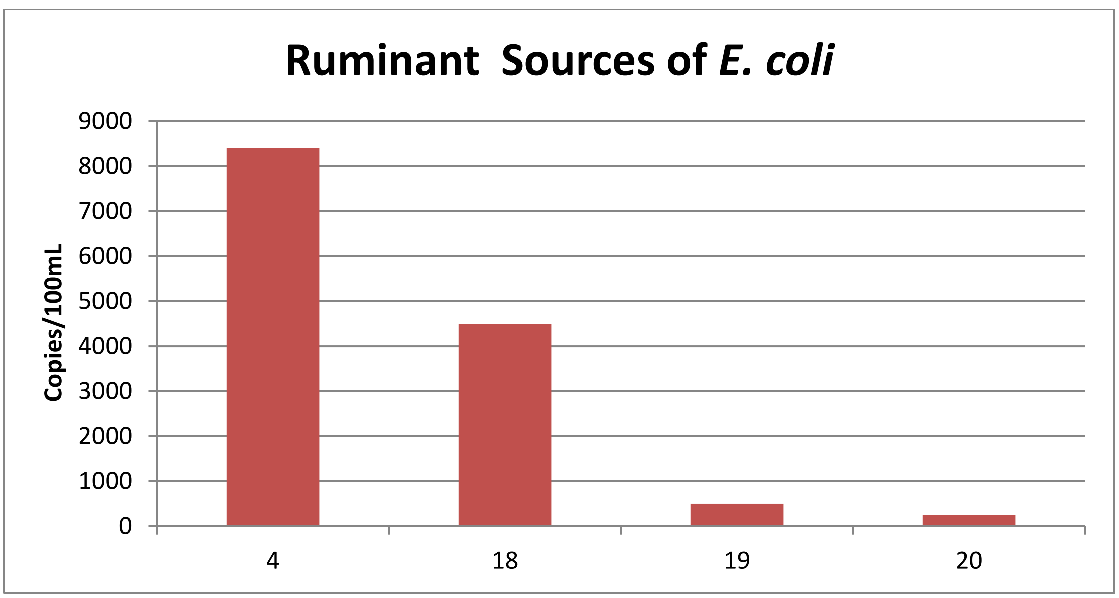

Figure 22. Bacterial Source Tracking Results for Ruminant

B. Conductivity

A high conductivity reading is a sign that there are solids dissolved in the water. The temperature of the water can also affect conductivity. The warmer the water the higher the conductivity. The geology of the ground through which the water flows can also affect conductivity. Granite bedrock streams tend to have lower conductivity, while clay and limestone have higher conductivities. Conductivity concentrations can affect aquatic life in streams. There are no numeric water quality criteria set by the Kentucky Division of Water for conductivity, instead the narrative standard reads that "Total dissolved solids or specific conductance shall not be changed to the extent that the indigenous aquatic community is adversely affected" (401KAR10:031). Conductivity values measured at sampling sites along Damon Creek were lower than 200 uS/cm indicating water quality that should sustain aquatic life species based on this parameter.

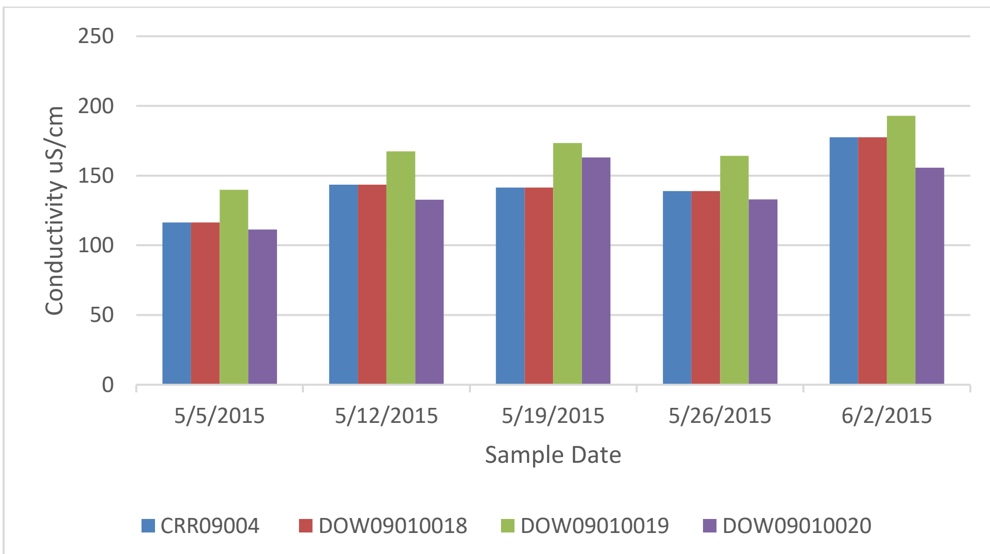

Figure 23. Specific Conductivity for Monitoring Sites 2015

C. Dissolved Oxygen

Oxygen from the atmosphere enters the water and allows aquatic creatures to inhabit the stream. The more movement there is in a body of water, the higher the oxygen content. The temperature can also influence dissolved oxygen. The cooler the water the more oxygen it is able to hold. If the colonies of bacteria are too numerous, they can consume the dissolved oxygen too quickly and deprive other organisms of the oxygen needed. The water quality standard for dissolved oxygen is an instantaneous minimum of 4 milligrams per liter (401 KAR10:031). The dissolved oxygen concentration did not meet this standard on May 5 at KDOW18, but did meet the standard in all other instances.

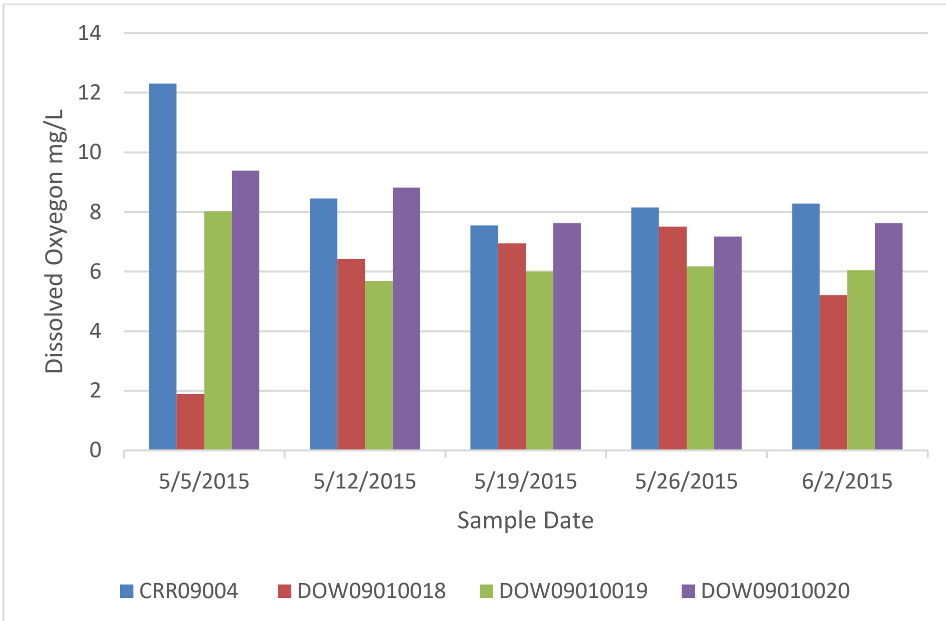

Figure 24. Dissolved Oxygen for Monitoring Sites May 2015

D. pH

The pH of a stream or river is a measurement of the amount of hydrogen ions present. pH is identified using a scale of 1 through 14. If a water source is too acidic or too basic the aquatic wildlife cannot survive, as this stresses the organisms. Extreme pH levels can also aid in the leaching of metals and toxins into the stream. The Kentucky Water Quality Standard requires pH to be between 6.0 and 9.0 to be protective of aquatic life (401 KAR 10:031). All samples from all monitoring sites met this standard.

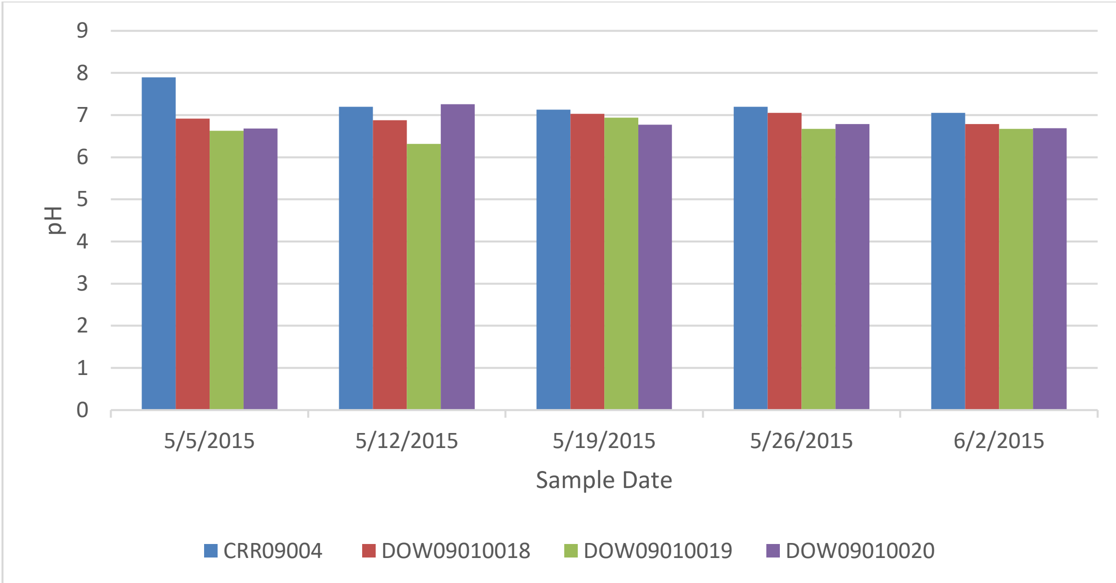

Figure 25. pH at Monitoring Sites May 2015

E. Temperature

Discharges into a stream or river can affect the temperature depending on source. The amount of shade along a stream can also directly affect the temperature. Warm water aquatic habitats must not exceed 31.7 degrees Celsius, according to the Kentucky Water Quality Standards (401 KAR 10:031). All samples from all monitoring sites met this standard.

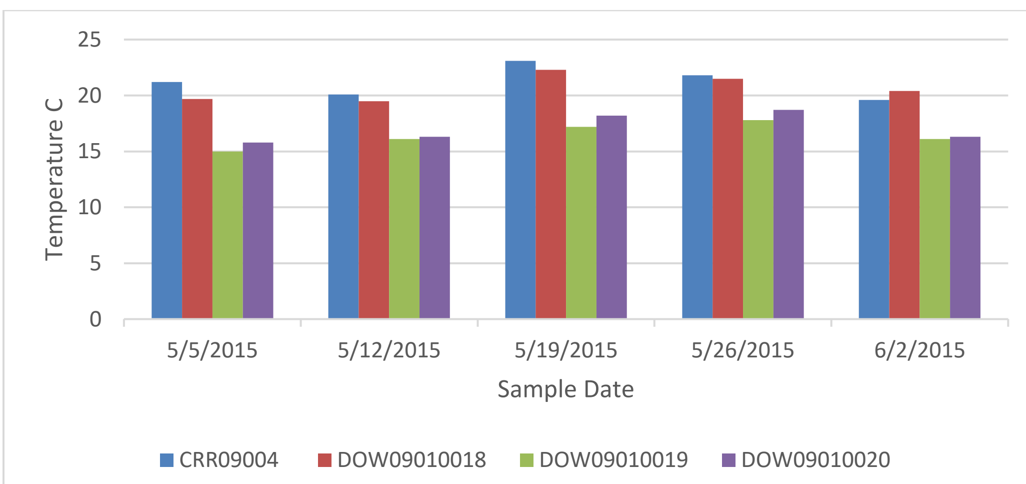

Figure 26. Temperatures for Monitoring Sites May 2015

Chapter V. Best Management Practices

A. General Observations and Concerns

Based upon the data presented in Chapter IV, the primary focus of implementation efforts should be to address cattle access to Damon Creek downstream of FRS #7. The amount of *E. coli* significantly increases at sites KDOW4 and KDOW18. In addition, the ruminant contributions of fecal pollution increase at sites KDOW4 and KDOW18. Observances of cattle directly accessing the stream throughout the downstream section reinforce the data.

The deposit of cattle feces straight into the stream is an obvious source of *E. coli*, especially considering that in many places, cattle have unrestricted access to Damon Creek. Additionally, the trampling of the creek bed and vegetation from these cattle also leads to erosion and other water quality issues. Cattle accessing the creek can remove natural filters and barriers that would otherwise slow the flow of polluted runoff entering Damon Creek. Livestock exclusion fences should be installed to keep cattle a minimum of 35 feet away from the stream according to NRSC Conservation Practice Standard, Riparian Forest Buffer, Code 391 (NRCS, July 2010). This will allow vegetation to return, minimize erosion, and provide a buffer to prevent feces from being directly deposited or washed into the creek during rainfall events. For areas where no riparian buffer exists, the creation of a buffer zone of at least 50 feet would create a filtration system for bacteria and other non-point source pollution, and stabilize stream banks, preventing erosion and sediment from entering the stream.

Assisting in the connection of more homes, businesses, or churches to the wastewater lagoon located in Kirksey will aid in the reduction of human contributions of *E. coli* from the headwaters of the watershed (above sites KDOW19 and KDOW20), and as such should be prioritized. Additionally, repairing any inappropriate or failing onsite wastewater systems, primarily in the headwaters region of the watershed, should also be pursued. Efforts need to be made to repair or remove the gate of FRS #7 to allow for a steady flow of Damon Creek. Additionally, green infrastructure BMPs should be implemented in the Kirksey area as educational demonstration sites and to reduce stormwater runoff.

B. Pollutant Load Reductions Expected

The Kentucky Water Quality Standard for Primary Contact Recreation Use states that *Escherichia coli* content shall not exceed 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. Additionally, twenty percent or more of al samples shall not have concentrations that exceed 240 colonies per 100 ml for *Escherichia coli*.

Based on the data presented in Chapter IV, a reduction in *E. coli* concentrations is needed to meet water quality standards. At site KDOW4, the most downstream site, a 96% reduction in E. coli (a reduction of 6.48485E+13 cfu/100 mL) is needed to meet water quality standards. At site KDOW18, an 81% reduction in E. coli (a reduction of 2.05348E+13 cfu/100 mL) is needed to meet water quality standards. At site KDOW19, no reduction in E. coli loads is needed to meet water quality standards. At site KDOW20, a 45% reduction in E. coli (a reduction of 90570399556 cfu/100 mL) is needed to meet water quality standards.

The Watershed Coordinator estimates that there are approximately 500 to 550 cattle within the Damon Creek watershed. This estimation is based off visual observations and the Watershed Coordinator's knowledge of the watershed and the two cattle operations within the watershed. Based on the average *E. coli* loading rate for cattle (Table 9), approximately 327 cattle need to be excluded from the stream in order to meet water quality standards.

Additionally, it is estimated that there are approximately 47 septic systems within the Damon Creek watershed, and that approximately 34% of them are failing (STEPL Input Data Server Reference). Based on the E. coli loading rates for failing septic systems and the number of systems expected to be failing, approximately 16 septic systems need to be repaired, replaced, or decommissioned and connected to the wastewater lagoon.

Table 10 represents the *E. coli* load reductions expected from implementing these management measures.

Table 9. *E. coli* Loading Rates by Pollutant Source			
Pollutant Source	***E. coli* Loading Rate**	**Units**	**Source**
Cattle	2.25E+09	CFU/animal/day	KDOW 2013
Failing Septic Systems	1.72E+09	CFU/person/day	Horsely & Whitten 1996

Table 10 *E. coli* Water Quality Standard (WQS) - 130 cfu/100 mL					
Reduction Needed to Meet WQS (cfu/100 mL)	**Number of Cattle to be Excluded from Stream**	**Reductions Possible from Cattle Exclusion (cfu/100 mL)**	**Number of Failing Septic Systems to Address**	**Reductions Possible from Septic System BMPs (cfu/100 mL)**	**Total Load Reductions Expected (cfu/100 mL)**
6.48485E+13	327.271	6.16382E+13	15.98	3.21032E+12	6.48485E+13

C. BMP Prioritization

As the data shows, the majority of the *E. coli* pollutant loads are found at sites KDOW4 and KDOW18. Additionally, Bacterial Source Tracking has indicated that cattle are the primary source of *E. coli*. This data is further reinforced by the fact both of the cattle operations are located at sites KDOW4 and KDOW18, and that cattle have been observed with direct access to the creek at these sites. As such, this Watershed Plan recommends that the BMPs that promote cattle exclusion be the first implementation priority for this plan with a focus in the downstream half of the watershed where these two cattle operations are located. Examples of BMPs may include, but are not limited to, education, livestock exclusion fencing, rotational grazing, riparian buffer establishment, alternative water sources, alternative shade, low-water crossings, pasture renovation, fence-line feeders, heavy use areas, and winter feeding areas. Other BMPs that are determined to facilitate the goal of excluding livestock from the creek will be considered for implementation on an individual basis. Furthermore, educational materials and opportunities should be provided and targeted directly for producers in the watershed to explain the water quality and herd health benefits of these practices.

In the upstream half of the watershed (above sites KDOW19 and KDOW20) near the community of Kirksey, KY, BMPs that address failing septic systems should be prioritized. Site KDOW20, which drains the land around Kirksey, KY, needs a 45% reduction in E. coli to meet water quality standards. Based upon visual observation, the majority of the homes in the watershed are concentrated in this portion of the watershed, and there are none to minimal cattle present in this area. As such, BMPs such as septic system, repairs, replacements, and installation should be pursued.

Furthermore, when the opportunity is present, failing septic systems with access to the wastewater lagoon should be decommissioned and connected to that wastewater treatment system. Homeowner education with regards to proper septic system maintenance should also be provided.

While the focus of implementation for this plan should be on the installation of BMPs that promote cattle exclusion and address failing septic systems, other BMPs that target riparian buffers, Flood Retarding Structure #7 (FRS #7), and the installation of Green Infrastructure should also be implemented.

As evidenced in Chapter II, there are significant portions of the watershed that lack an effective riparian buffer (Pages 25 and 26). Where needed, riparian buffers should be established. Additionally, existing riparian buffers should be restored or enhanced where needed. Implementing these BMPs will help to filter out pollutants from entering the streams and help to restore and protect the streambank.

Needed repairs for FRS #7 should be pursued to remedy known flow and debris issues caused from a failing gate. Performing these repairs will help stabilize and protect the streambank downstream from the structure. Furthermore, the repairs should promote improved aquatic life habitat establishment downstream from the structure.

Implementing Green Infrastructure BMPs should also be considered, especially around the residentially dense area of Kirksey, KY. BMPs should include the installation of rain gardens, rain barrels, permeable pavers or pavement, and educational signage. Not only will these BMPs help to treat and/or reduce stormwater runoff, but they will also serve as educational pieces for the community.

Education and outreach efforts will be paramount to the overall community success of the implementation of this watershed plan. As such, education and outreach efforts should be included as a vital component for every BMP type implemented and/or target audience reached. A detailed Education and Outreach Plan will be produced by the Watershed Coordinator to direct and guide educational efforts throughout the watershed. Additionally, participation in the Four Rivers Watershed Watch volunteer sampling program will be encouraged and facilitated.

D. Potential Best Management Practices (BMP)

Additional information about BMPs practices and cost and monitoring are listed in Appendices. The following tables show the priority BMPs, target audience/area, responsible parties, funding sources, timeframes, cost, expectant load reductions and goals.

Table 11. Agricultural Practices – Cattle

Target Audience or Area:	Cattle Operations within the watershed, particularly the two operations located near sites KDOW4 and KDOW18.					
Responsible Parties:	Jackson Purchase Foundation with assistance from Basin Coordinator, USFWS, KFWR, USDA-NRCS, Calloway County Conservation District,					
Funding Source:	USFWS Partners for Fish & Wildlife programs, USDA, Kentucky State Cost Share, Kentucky Ag Development Funds (CAIP)					
Cost Estimate:	Dependent on BMPS installed, estimated $ 2,208,000	***Goals Addressed***				
Estimated Load Reductions	*E. coli* - 6.16382E+13 cfu/ 100 mL					
Description of BMP/Action Items Best Management Practices (BMPs) for Livestock to reduce fecal pollution in Damon Creek, protect habitat, promote riparian buffer establishment, and to facilitate the restoration and stabilization of stream banks and aquatic habitat.		**1. Bacteria**	**2. Habitat**	**3. Trash/Debris**	**4. Restore & stabilize Stream banks**	**5. Education & Outreach**
1. Livestock exclusion fences		✓	✓		✓	✓
2. Alternative water sources		✓	✓		✓	✓
3. Alternative shade structures (permanent or portable)		✓	✓		✓	✓
4. Heavy Use Areas, winter feeding areas, and/or fence-line feeders		✓	✓		✓	✓
5. Riparian Buffer Establishment		✓	✓		✓	✓
6. Rotational grazing		✓	✓		✓	✓
7. Low-water crossings			✓		✓	✓
8. Pasture renovation		✓	✓		✓	✓
9. Agricultural Water Quality Plans and/or Nutrient Management Plans – create new plans or update existing		✓	✓		✓	✓
10. Provide educational materials and opportunities for producers to learn about the water quality and herd health benefits of implementing the above practices.		✓	✓		✓	✓

Table 12. Onsite Wastewater Treatment Systems

Target Audience or Area:	General/Watershed Wide: focus in and around Kirksey (upstream of sites KDOW19 and KDOW20).					
Responsible Parties:	Jackson Purchase Foundation with assistance from Basin Coordinator, Calloway County Conservation District, Calloway County Health Department and Calloway County Fiscal Court					
Funding Source:	319(h) grant					
Cost Estimate:	Dependent on BMPS installed, estimated $ 244,000	***Goals Addressed***				
Estimated Load Reductions	*E. coli* - 3.21032E+12 cfu/ 100 mL	**1. Bacteria**	**2. Habitat**	**3. Trash/Debris**	**4. Restore & stabilize Stream banks**	**5. Education & Outreach**
Description of BMP/Action Items Best Management Practices (BMPs) that facilitate proper septic system function and maintenance.						
11. Repair or replace failing septic systems.		✓				✓
12. Install new systems if straight-pipes are discovered.		✓				✓
13. Decommission existing septic systems and connect to the wastewater lagoon where access is available		✓				✓
14. Provide homeowner education regarding proper septic system maintenance.		✓				✓

Table 13. Riparian Buffer Practices

Target Audience or Area:	General/Watershed Wide: focus on areas with known inadequate riparian buffers.
Responsible Parties:	Jackson Purchase Foundation with assistance from Basin Coordinator, USFWS, KFWR, USDA-NRCS, Calloway County Conservation District
Funding Source:	USFWS Partners for Fish & Wildlife Program, USDA programs, Kentucky State Cost Share, Kentucky Ag Development Funds (CAIP)
Cost Estimate:	TBD
Estimated Load Reductions	TBD

Description of BMP/Action Items Best Management Practices (BMPs) for the entire watershed to promote riparian buffer establishment and streambank stability of at least 50’ in areas identified as lacking a suitable riparian buffer.	***Goals Addressed*** **1. Bacteria**	**2. Habitat**	**3. Trash/Debris**	**4. Restore & stabilize Stream banks**	**5. Education & Outreach**
15. Establish new riparian buffers where needed	✓	✓	✓	✓	✓
16. Restore or enhance existing riparian buffers	✓	✓	✓	✓	✓
17. Implement grassed swales and filter strips where applicable	✓	✓	✓	✓	✓
18. Repair severe erosion areas as needed		✓		✓	✓
19. Provide educational materials and opportunities to enhance residents understanding of the benefits of healthy riparian buffer areas.	✓	✓	✓	✓	✓

Table 14. Flood Retarding Structure #7

Target Audience or Area:	Flood Retarding Structure #7 (FRS #7)					
Responsible Parties:	USDA-NRCS, Calloway County Conservation District with assistant with Basin Coordinator, and Calloway County Fiscal Court					
Funding Source:	Calloway County Conservation District & 319 grant					
Cost Estimate:	Dependent on BMPS installed, estimated $ 2,000	***Goals Addressed***				
Estimated Load Reductions	NA	**1. Bacteria**	**2. Habitat**	**3. Trash/Debris**	**4. Restore & stabilize Stream**	**5. Education & Outreach**
Description of BMP/Action Items Best Management Practices (BMP) to remediate flow and debris issues associated with a failing gate for FRS #7						
20. Repair and/or replace structure gate.			✓	✓	✓	
21. Remove debris from gate area and spillway.			✓	✓	✓	

Table 15. Green Infrastructure

Target Audience or Area:	General/Watershed Wide: Churches, Businesses and Residents					
Responsible Parties:	Calloway County Fiscal Court and Road Department with assistance from Jackson Purchase Foundation and Calloway County Conservation District					
Funding Source:	Fiscal Court, Road Department & 319 Grant					
Cost Estimate:	Dependent on BMPS installed	***Goals Addressed***				
Estimated Load Reductions	TBD	**1. Bacteria**	**2. Habitat**	**3. Trash/Debris**	**4. Restore & stabilize Stream banks**	**5. Education & Outreach**
Description of BMP/Action Items Best Management Practices (BMP) that help to reduce stormwater runoff around Kirksey, KY and help to facilitate and enhance water quality education in the community.						
22. Install rain gardens and rain barrels			✓		✓	✓
23. Install permeable pavers in public places for demonstration			✓		✓	✓
24. Install educational signage where appropriate						✓
25. Provide educational resources and opportunities for residents and county officials regarding general water quality issues and green infrastructure benefits.			✓	✓	✓	✓

Chapter VI. Implementation Schedule and Success Monitoring

A. Watershed Coordinator

A Watershed Coordinator for the Damon Creek watershed will be hired to oversee and coordinate BMP implementation efforts. The Watershed Coordinator will work closely with landowners and homeowners in the watershed to recruit, design, and install BMP where needed. Additionally, the Watershed Coordinator will be the lead on providing education and outreach materials and opportunities to the Damon Creek watershed community. The Watershed Coordinator will be responsible for tracking and documenting all BMP implementation, education and outreach contracts, and behavioral changes that occur as a result of outreach efforts. The Watershed Coordinator will be lead person responsible for tracking and evaluating progress towards plan implementation, and will work closely with stakeholders and DOW for any plan changes or updates needed.

B. Milestones and Plan Implementation Schedule

For this plan, an implementation schedule with specific milestones has been developed to guide BMP implementation efforts (Table 16). Additionally, this schedule can be used as a resource for evaluating progress towards complete plan implementation, and specifically calls for a biennial review of progress made. This implementation timeline has been broken down into Phase I, Phase II, and Phase III goals to be accomplished over the next ten years. Furthermore, each milestone attempts to define a numeric goal for the number of BMPs to be implemented or the number of sources to be addressed.

Table 16. Watershed Plan Implementation Schedule: Phase I , II, and III Goals

Milestone	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Implement BMPs 11, 12, 13, and 14. Phase I goal of addressing 8 septic systems.	X	X	X	X						
Implement BMPs 11, 12, 13, and 14. Phase II goal of addressing 8 septic systems.					X	X	X			

Implement BMP 14. Phase III goal of continuing to support proper septic system maintenance.								**X**		**X**
Implement BMPs 1 thru 10 as appropriate. Phase I goal of excluding 109 cattle from the stream.	**X**	**X**	**X**	**X**						
Implement BMPs 1 thru 10 as appropriate. Phase III goal of excluding 109 cattle from the stream.					**X**	**X**	**X**			
Implement BMPs 1 thru 10 as appropriate. Phase III goal of excluding 109 cattle from the stream.								**X**	**X**	**X**
Implement BMPs 15, 16, 17, 18, and 19 as opportunities arise.	**X**	**X**	**X**	**X**						
Implement BMPs 15, 16, 17, 18, and 19 as opportunities arise.					**X**	**X**	**X**			
Implement BMPs 15, 16, 17, 18, and 19 as opportunities arise.								**X**	**X**	**X**
Implement BMPs 20 and 21. Phase I goal of restoring proper function of the gate to FRS #7	**X**									
Implement BMPs 22, 23, 24, and 25. Phase I goal of implementing 5 practices.	**X**	**X**	**X**	**X**						
Implement BMPs 22, 23, 24, and 25. Phase II goal of implementing 5 practices.					**X**	**X**	**X**			
Implement BMPs 22, 23, 24, and 25. Phase III goal of implementing 5 practices.								**X**	**X**	**X**

Develop an Education and Outreach Plan. Phase I goal of having a finalized plan.	**X**	**X**								
Biennially re-evaluate and update the Education and Outreach plan as needed. Phase II and Phase III goal.				**X**		**X**		**X**		**X**
Water quality monitoring to evaluate effectiveness.					**X**					**X**
Biennial review of Watershed Plan Implementation effectiveness.		**X**		**X**		**X**		**X**		**X**

C. Education and Outreach

Education and outreach for this watershed plan to the public is a key part of goals identified in the watershed plan, and will be critical to the success of implementing the plan. A comprehensive Education and Outreach Plan will be developed by the Watershed Coordinator within the first two years of implementing the watershed plan. The Education and Outreach Plan will be evaluated for effectiveness every two years and updated as needed. Furthermore, to increase success of BMP implementation, education and outreach materials and opportunities will be incorporated into each BMP type, such as offering materials and events specific to septic system BMPs and maintenance.

The watershed plan will be made available to the public by distributing hard copies to the Calloway County Public Library, the Calloway County Fiscal Court, the Calloway County Conservation District Office and the Watershed Coordinator. Additionally, electronic copies of the plan shall be provided upon request to interested parties. On a similar note, a fact sheet will be developed which condenses the findings of the plan for local leaders and communities.

D. Success Monitoring

The success of the Damon Creek Watershed Plan will be monitored in many ways. The implementation progress, education and behavior changes, as well as water quality monitoring are all forms of monitoring.

BMP Implementation Tracking

The implementation of BMPs will be documented so that progress towards completing milestones can be evaluated. Documentation will include photographs, extensive notes from daily visits to work site, responses from responsible parties, funding updates and design and construction updates. The latitudes and longitudes of the installed BMPs will be documented to aid in monitoring the success of the practices.

Education and Outreach Tracking

The watershed coordinator will be available for individual and/or group meetings with landowners. The number of educational materials developed and distributed will be tracked, as will the number and type of community meetings, educational workshops, and farm field days offered. When applicable, surveys should be developed and conducted to evaluate changes in behavior and knowledge of BMPs with water quality benefits.

Water Quality Monitoring

Water quality monitoring should be conducted to evaluate effectiveness of BMPs implemented and progress made towards meeting water quality standards. Presently, the goal is to conduct an initial round of success monitoring in Year 5 after the completion of Phase I implementation goals, and then a subsequent monitoring effort in Year 10 after the completion of Phase II and Phase III goals. The purpose of the initial Phase I monitoring is to evaluate progress made so far, and to identify any new issues that need to be addressed. Hopefully, the monitoring conducted at the end of Phase III will show that Damon Creek has been restored to meet water quality standards.

Specific parameters, frequency, and site locations for success monitoring will be determined at a later date. It is anticipated that the Watershed Coordinator will work closely with DOW to develop an approved QAPP and study plan for this monitoring effort. It is also possible that DOW's Success Monitoring Program will personally conduct the sampling.

It should be noted that success monitoring screening can be conducted through the Four Rivers Watershed Watch (FRWW) volunteer monitoring network. As such, it should be ensured that a FRWW volunteer is able to conduct monitoring in the Damon Creek watershed at least once every two years. Performing this type of screening will aid in evaluating success between more substantial monitoring efforts, and may provide crucial information for updating the plan and/or timetable.

E. Evaluating and Updating the Plan

The overall plan goals, recommended BMPs, and milestones were based upon the best available information and projected needs of the watershed at the time of this plan development. With time, the watershed changes as well as the people within it and their desires. The impacts to the watershed can also change with time, and as new monitoring data is collected, changes in implementation direction may be necessary.

Therefore, the Watershed Plan must have the flexibility to change with time. As such, the progress towards the plans implementation will be evaluated every two years, and changes and updates will be made as determined necessary by the Watershed Coordinator in collaboration with stakeholders and DOW.

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Appendix A

TMDL Study of

E. coli Monitoring
in
Damon Creek, 2015

TMDL Study Plan

E. coli **Monitoring in Damon Creek (USGS HUC06040006050160), Calloway County**

Effective Date: 05/01/2015

Revision Date:

Revision: 0

Prepared By:
TMDL Section
Division of Water
Kentucky Department for Environmental Protection

This document is approved for release

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Alicia Jacobs, Supervisor   Date
TMDL Section
Kentucky Division of Water

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Overview

Damon Creek, a small 5.6 mi^2 tributary of West Fork Clarks River in Calloway County, was monitored extensively over the past ten years as a result of several projects within the Clarks River watershed, a US EPA Region 4 and Kentucky Division of Water (KDOW) priority water. Data collection activities focused on TMDL development for *E. coli*, 319(h) Watershed Plan development and 319(h) Best Management Practices (BMP) implementation. The various activities within Damon Creek included:

- 2000: Fecal coliform data indicate the stream segment's designated swimming (primary contact)
- use assessed as impaired
- 2002: 319(h) funded Watershed Plan developed
- 2005: *E. coli* monitoring for TMDL development
- 2008-2011: Several watershed BMPs implemented
- 2011: *E. coli* TMDL approved by EPA

Numerous data exist for the watershed prior to 2011, however, the need for new data exists in order to measure the success of 319(h) funded BMP implementation and TMDL development. Therefore, *E. coli* monitoring efforts will be focused in the Damon Creek watershed during the 2015 Primary Contact Recreation season.

Sampling Strategy

A total of four locations (Figure 1) will be monitored for the parameters listed in Table 1. Sample site locations are based upon the location of the impaired segments listed on the 2012 303(d) list (KDOW 2013), watershed evaluation using ArcGIS and historical Watershed Watch sampling sites. Watershed accessibility, the location of potential non-point sources, landuse cover and TMDL monitoring staff resources are also taken into consideration for site selection.

E. coli

Five E. *coli* samples will be collected within a 30-day period in May or June of 2015 following the procedures found in *Sampling Surface Water Quality in Lotic Systems* (KDOW 2011a). *E. coli* samples will be analyzed at Kentucky Division of Water's Microbiology Lab in Paducah, KY following the procedures in *Enzyme Substrate Test for the Detection of Total Coliforms and Escherichia coli* (KDOW2011b).

Stream Discharge

Stream discharge measurements will be taken at every site during every visit, as long as flow conditions are deemed safe for wading. The procedures used will follow those found in *Measuring Stream Discharge* (KDOW 2010).

Multiparameter Probe

A multiparameter water quality probe will be used to measure in situ water quality parameters following the procedures in *In situ Water Quality Measurements and Meter Calibration* (KDOW 2009). The following parameters will be collected using the probe at every site during every visit: dissolved oxygen (mg/L), dissolved oxygen saturation (%), pH (SU), specific conductivity (µs/cm) and temperature (°C).

Field Observations

A field observation sheet will be completed at each site during each sampling event (Appendix A). The following sample event information should be recorded: site location information, water chemistry sampling details, in situ measurement details and discharge measurement details. The following observations will be recorded: general observations (weather, stream mixing, etc.), instream observations, biological observations and any other relative observations.

Data Management

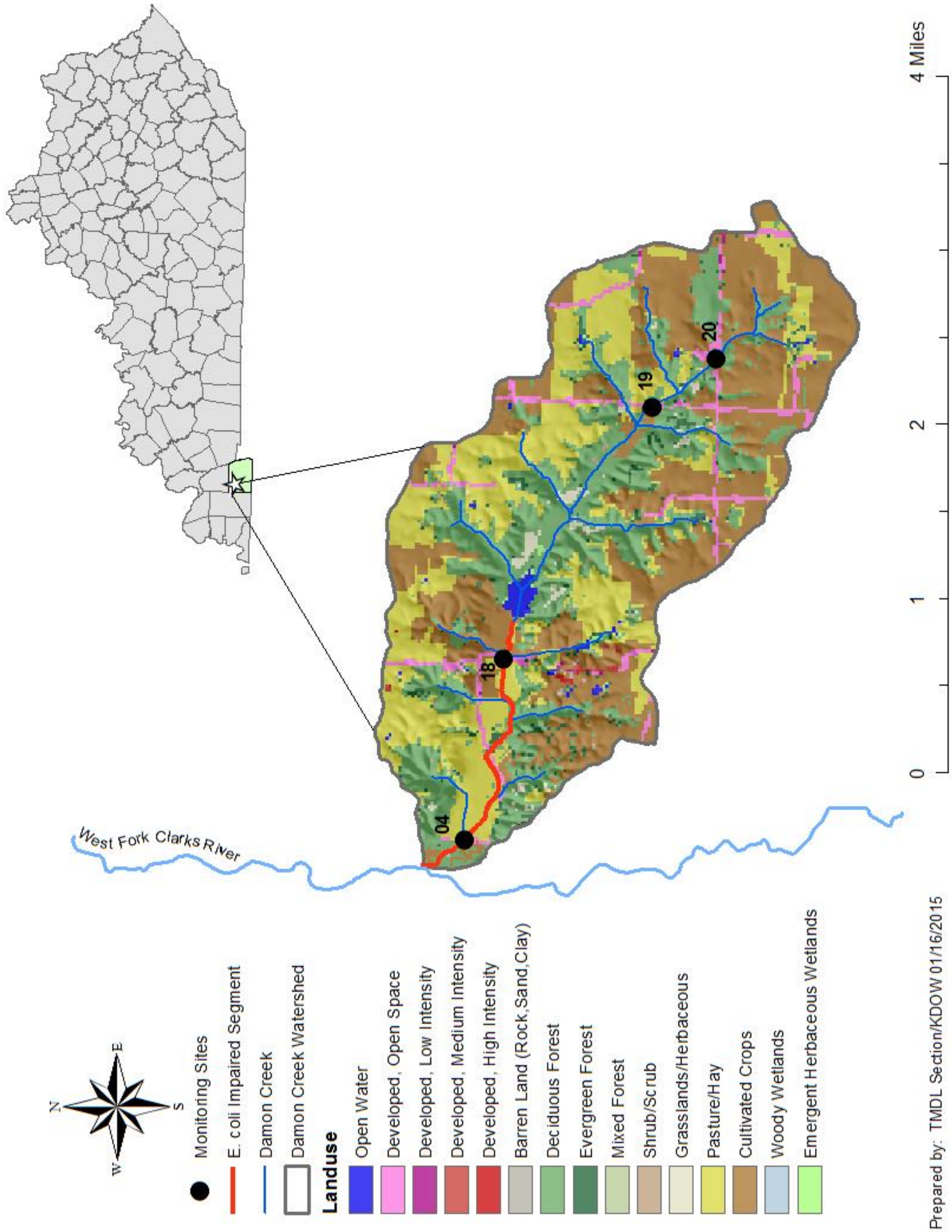
The data acquired from this project will be housed within KDOW's Kentucky Water Assessment Data for Environmental Monitoring (KWADE) database. Refer to Section B10.1 in the FFY2015 Water Quality Monitoring for TMDL Development Quality Assurance Project Plan (QAPP) for the procedures that will be followed when performing data entry, data management and data quality assurance.

Quality Control/Quality Assurance

QA/QC will be implemented for this project as described in the FFY 2015 QAPP, and all data collection, field activities, and sample analyses will follow methodologies set forth in the applicable Standard Operating Procedures, which are outlined in the FFY 2015 QAPP.

Table 1. Monitoring Location Details and Parameters

Site #	Station ID	Stream Name	Location	River Mile	Catchment Area (mi^2)	Latitude	Longitude	
04	CRR090004	Damon Creek	At KY 1836	0.3	5.6	36.71854	-88.45921	*E. co*
18	DOW09010018	Damon Creek	At Woodcock Dr.	1.55	4.34	36.71575	-88.44036	*E. c*
19	DOW09010019	Damon Creek	At Cavett Rd.	3.35	1.2	36.70392	-88.41391	*E. co*
20	DOW09010020	Damon Creek	At KY 464	3.8	0.58	36.69867	-88.40867	*E. co*


N
E
S
W
Monitoring Sites
E. coli Impaired Segment
Damon Creek
Damon Creek Watershed
Landuse
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land (Rock,Sand,Clay)
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Grasslands/Herbaceous
Pasture/Hay
Cultivated Crops
Woody Wetlands
Emergent Herbaceous Wetlands
West Fork Clarks River
04
18
19
20
0
1
2
4 Miles
Prepared by: TMDL Section/KDOW 01/16/2015

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Field Observation Sheet

FIELD MEASUREMENTS AND OBSERVATIONS

STREAM NAME:	**LOCATION:**	
STATION #:	**COUNTY:**	**DATE:**
INVESTIGATORS:	**START TIME:** **END TIME:**	

WATER CHEMISTRY

☐Acid/Alk ☐Bulk ☐Nutrients ☐Metals ☐Low Hg ☐Herbicides ☐Pesticides ☐ Ortho P ☐ *E. coli* ☐ Other:	Collector:
Sampling Location:	

***In situ* WATER QUALITY METER READINGS**

Temp (°C)	Specific Conductivity (μS/cm)	pH (S.U.)	Dissolved Oxygen (mg/L)	%Saturation, DO (%)	Turbidity (NTU)

Multi-Parameter Probe ID:	Calibration Date:	Probe Location:	Probe Depth:

DISCHARGE MEASUREMENTS

Discharge (cfs):	☐ Measured ☐ Estimated	Measured by:	X-section Location:
FlowTracker Serial #:		Beam Check Date:	

GENERAL OBSERVATIONS

WEATHER	Now	Past 24 hours	Past 48 hours
Heavy rain	☐	☐	☐
Steady rain	☐	☐	☐
Intermittent showers	☐	☐	☐
Clear/sunny	☐	☐	☐
Cloudy	☐	☐	☐
Total Precip (in)	_____	_____	_____

days since 0.1” rainfall

STREAM FLOW
- ☐ Dry
- ☐ Pooled
- ☐ Low
- ☐ High
- ☐ Normal

STREAM MIXING
- ☐ Excellent
- ☐ Good
- ☐ Fair
- ☐ Poor

If poor, explain why:

CANOPY COVER
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☐ Partially Shaded (50-75%)
- ☐ Fully Shaded (75-100%)

HYDROLOGIC CONDITION
- ☐ Stable
- ☐ Rising
- ☐ Falling
- ☐ Peak

INSTREAM OBSERVATIONS

Floating Woody Debris	Floating Garbage	Algal Mats	Fish Kill	Suds	Turbidity	Odor	Oil/Grease	Stream Color
☐ None	☐ None	☐ None	☐ None	☐ None	☐ None	☐ None	☐ None	☐ Brown
☐ Mild	☐ Mild	☐ Mild	☐ Mild	☐ Mild	☐ Mild	☐ Mild	☐ Mild	☐ Green
☐ Moderate	☐ Moderate	☐ Moderate	☐ Moderate	☐ Moderate	☐ Moderate	☐ Moderate	☐ Moderate	☐ Blue
☐ Severe	☐ Severe	☐ Severe	☐ Severe	☐ Severe	☐ Severe	☐ Severe	☐ Severe	☐ Clear
☐ Extreme	☐ Extreme	☐ Extreme	☐ Extreme	☐ Extreme	☐ Extreme	☐ Extreme	☐ Extreme	☐ Other

Other Observations:

Biological Observations

Appendix B

Health Report

Each measurement made or sample collected is considered an indicator of **Water Quality**. These indicators demonstrate how pollution entering the stream impacts the overall health of the **Damon Creek Watershed.** Below, indicators of watershed health that DOW biologists will measure or collect are defined.

Indicators of Water Quality

E. coli: A type of bacteria that lives in the intestinal tract of humans and other warm-blooded animals. The higher the amount of bacteria in the water, the higher the chance of getting sick when recreating in that water.

Dissolved Oxygen: The concentration of oxygen dissolved in water that is readily available to fish and other aquatic organisms.

Specific Conductivity: A measure of the ability of water to conduct an electrical current, which is used for approximating the amount of dissolved substances in water. When specific conductivity is elevated above natural levels, it may negatively impact fish and aquatic bugs.

What can you expect?

- Once monitoring is complete in 2015, DOW will distribute an informal "health report" of the Damon Creek watershed to share results of the study.
- For the next four years (2015—2018), the watershed coordinator will partner with the Four Rivers Basin Coordinator and the Kentucky Division of Water to develop a watershed plan for Damon Creek. This watershed plan will identify water quality issues with bacteria contamination, i.e. where the worst areas of bacterial contamination are and what potential sources of bacteria could be. This plan will also identify strategies that could be taken to reduce bacteria concentrations in Damon Creek.
- Implementation of these strategies will likely start to occur in 2019, and may extend for several years. Implementation of these strategies will be voluntary, and the watershed coordinator will be actively looking for volunteers starting in 2017-2018 so grant funds for implementation can be identified and requested. Public participation and input is requested throughout the project, and can be accomplished by participating in the watershed team, or contacting the watershed coordinator directly at 270-753-5151.
- Our goal with this project is to collect enough water quality data to accurately identify the sources of bacteria in Damon Creek, and then implement strategies that will reduce bacterial contamination from those sources. By conducting this project, we hope to implement enough strategies to protect Damon Creek so that it fully supports primary contact recreation and is a safe, healthy stream for generations to come.
- To stay informed, **LIKE** 'Kentucky Watershed Health Reports' on Facebook.

Kentucky Division of Water
200 Fair Oaks Lane
Frankfort, KY 40601
Phone: 502-564-3410
Website: http://water.ky.gov/waterquality/Pages/TMDLHealthReports.aspx

Damon Creek Watershed

Department for Environmental Protection - Division of Water

Published by the Kentucky Division of Water on April 13, 2015

In the 1960s government officials started to realize how polluted streams, rivers and lakes of the U.S. had become. In 1972, Congress passed laws, known as **The Clean Water Act** (CWA), to protect surface water. The goal of the CWA is for all waters in the U.S. to be safe for swimming, fishing and drinking (called **designated uses**).

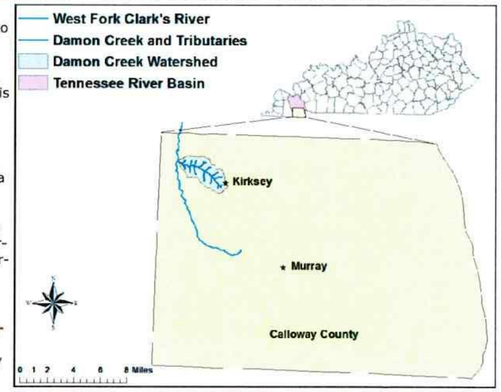
We rely on local water sources for water to drink. We pay water treatment plants to withdraw and treat water with chemicals or other processes to make it safe for drinking. The dirtier the water, the more expensive it is to clean the water, which makes drinking water more expensive. The cleanliness of water is also referred to as **water quality**.

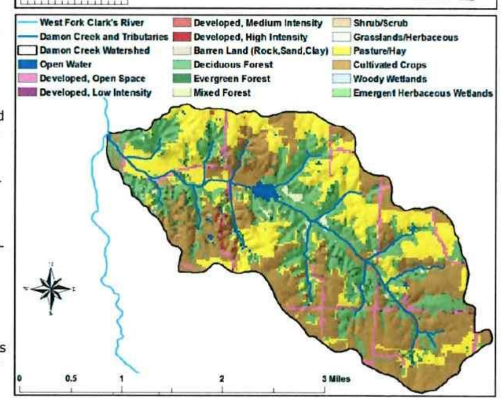
We all affect water quality because we all live in a watershed. A **watershed** is an area of land where runoff flows to a common stream. When streams come together, the two streams' watersheds combine to make a larger watershed. The **Damon Creek** Watershed (see map on right, top) is a small watershed within a much larger watershed called the Tennessee River Basin.

There are two types of pollution that can affect a watershed: **point sources** and **nonpoint sources.** Point sources are any distinct points from which pollutants are or may be discharged. Examples include any pipe, ditch, channel, tunnel, well or concentrated animal feeding operation. Nonpoint sources are pollutants originating from the land surface that have no well-defined source. The pollutants are generally carried off the land by storm water.

Land cover is the best way to understand how humans may potentially pollute the watershed in which they live. Cities and towns tend to have more point sources due to the number of facilities required to clean the water used in households and businesses, and may also have an increase in nonpoint sources due to impervious surfaces such as roads, parking lots and sidewalks. Rural areas tend to have more nonpoint source pollution associated with agriculture. Animal waste, fertilizers, pesticides and loose soil, which is exposed when trees are cut down, may enter the stream during rain events.

The map on the bottom of this page shows the land cover for the **Damon Creek** Watershed. Much of the watershed is brown, demonstrating that the major land cover is cultivated crops. However, green and yellow also dominate the land cover map, demonstrating that deciduous forest and pasture/hay are also major features of the landscape.





The Clean Water Act, Impaired Waters and TMDLs

The Clean Water Act (CWA) requires states to submit a report to congress, called the **305 (b) list**, which reports the water quality of streams, rivers and lakes within the state that have been assessed. To prepare this report, the Kentucky Division of Water (DOW) identifies the **designated uses** of a waterbody and then assesses the waterbody to see if the water is clean enough to meet these uses. If the stream is not clean enough to meet its uses, the stream is found to be impaired.

Examples of designated uses include:

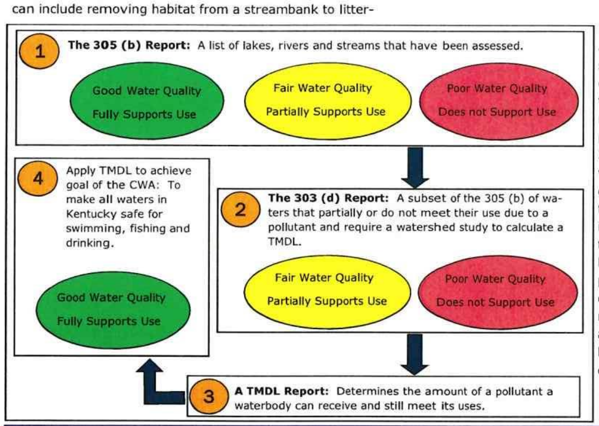
- **Aquatic Habitat -** water quality promotes a healthy population of plants and animals that live in the water
- **Primary Contact Recreation -** water is safe for human swimming.

Another requirement of the CWA is the **303 (d) list of impaired waters**. This report lists all of the assessed waters from the 305 (b) list that partially support or do not support their uses and identifies the impairment as being caused by a **pollutant**, even though impairments can result from pollution or pollutants. **Pollution** is a general term that refers to something that causes instability, disorder, harm or discomfort to an ecosystem and can include removing habitat from a streambank to littering. **Pollutants** are measureable substances that contribute to pollution that makes the water harmful or unsuitable for a specific purpose; examples include chemicals or waste products.

Only impairments caused by a pollutant can be placed on the 303 (d) list since waters on the 303 (d) list require a pollutant load reduction plan, usually in the form of a **Total Maximum Daily Load** (TMDL). A TMDL calculation is the total amount of pollutant(s) a waterbody can receive and still meet its designated use(s). A TMDL can be thought of as a watershed diet; the watershed's intake of a pollutant must be reduced by a certain percentage in order for the watershed to be healthy once again.

Upon assessment, it was determined that river miles 0 to 1.8 of Damon Creek do **not support** the Primary Contact Recreation Use and are therefore highlighted **red** (see map on the next page).

For a stream to be listed as impaired for Primary Contact Recreation, *E. coli* concentrations exceeded the level considered safe for swimming at least 20 percent of the time when the assessment was completed. Elevated *E. coli* concentrations indicate an increased risk of gastrointestinal illness if the water is swallowed or infection if contact is made with an open sore or wound.



Since **Damon Creek** and its tributaries do not support some of their designated uses, and the cause of the impairment was identified as a pollutant, it is on the 303(d) list of impaired waters. A TMDL for *E. coli* has been developed for this segment. Since its development, five failing septic systems have been repaired/replaced and a community waste treatment lagoon that can accept water from 40 households has been constructed.

Damon Creek Watershed Study

In addition, a large scale animal feeding operation that was suspected of contributing to the pathogen impairment has been shut down. These types of improvements to the landscape and infrastructure that aim to improve water quality are referred to as **Best Management Practices (BMPs).** More work is needed to better define the main contributors of nonpoint source pollution so that additional BMPs can be implemented to improve water quality. Therefore, Damon Creek will be studied during May and June of 2015 by the Kentucky DOW, TMDL Section.

DOW biologists will sample four sites throughout the Damon Creek watershed five times during May/June at the locations shown in the map below. At each site the following will be measured or collected:

- Dissolved Oxygen
- Specific Conductivity
- *E. coli*

These terms are defined on the next page.

Beginning in March of 2015, the Calloway County Conservation District will be employing a watershed coordinator that will be working on this project. This employee will be assisting with sample collection and watershed plan development, and coordinating the outreach activities associated with this project. This will include the formation of a local watershed team to provide local advice on the project. This watershed team will likely meet every other month and will be kept up to date with the project. This watershed team will be responsible for helping to select strategies to improve water quality in Damon Creek. If you are interested in becoming a member of this team, please contact the Calloway County Conservation District at 270-767-0491. The watershed coordinator will also be directing all educational activities associated with this project. If there is a particular group you would like the watershed coordinator to speak with, please contact the Calloway County Conservation District at 270-767-0491.