Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) for the Beanblossom Creek Watershed, Brown and Monroe Counties

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Indiana Department of Environmental Management
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Total Maximum Daily Load (TMDL) for *Escherichia coli* (*E. coli*) in Beanblossom Creek watershed, Brown and Monroe Counties, Indiana

Introduction

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) requires states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). TMDLs provide states a basis for determining the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the sources and determine the allowable levels of *E. coli* bacteria that will result in the attainment of the applicable WQS in the Beanblossom Creek watershed in Brown and Monroe Counties in Indiana.

Background

In 1998, 2002, and 2004, Indiana's section 303(d) list cited the Beanblossom Creek as being impaired for *E. coli* in Brown and Monroe Counties. In 2004, Indiana's section 303(d) list cites, in addition to the Beanblossom Creek, Lick Creek, North Bear Fork, Honey Creek, Indian Creek, Jacks Defeat Creek for *E. coli*. With the addition of the above streams in 2004, the majority of the Beanblossom Creek watershed is impaired for *E. coli*.

The segment for Lick Creek on the 2004 303(d) list has been named incorrectly. For the 2006 303(d) list, Lick Creek will be split into Bell Creek and Bear Creek with new segment ID numbers. The change is reflected in the table below. This splitting of segments also effects segment ID number INW0213_T1002 of Beanblossom Creek as labeled in the 2004 303(d) list. On the 2006 303(d) list, this segment of Beanblossom Creek will have a new segment ID number as reflected in the table below.

This TMDL will address approximately 91.17 miles of the Beanblossom Creek watershed in Brown and Monroe Counties where recreational uses are impaired by elevated levels of *E. coli* during the recreational season. Brown and Monroe Counties are located in south-central Indiana (Figure 1). All of the sixteen (16) segments of the listed streams for this TMDL are located in the West Fork White River Basin in hydrologic unit codes 05120202. The description of the study area, its topography, and other particulars are as follows:

Waterbody Name	303(d) List ID	Segment ID Number(s)	Length (miles)	Impairment
Beanblossom Creek-Headwaters	100	INW0221_00	7.31	*E. coli*
Beanblossom Creek	100	INW0211_T1001, INW0213_00, INW0214_T1053, INW0215_T1004, INW0216_T1005, INW0218_T1006, INW0219_T1007, INW021A_T1008	43.17	*E. coli*
North Bear Fork	100	INW0212_00	9.29	*E. coli*

Waterbody Name	303(d) List ID	Segment ID Number(s)	Length (miles)	Impairment
Lick Creek	100	INW0213_T1001	4.87	*E. coli*
Bell Creek	100	INW0213_T1002	2.89	*E. coli*
Bear Creek	100	INW0213_T1003	4.42	*E. coli*
Honey Creek	100	INW0215_00	5.12	*E. coli*
Indian Creek	100	INW0219_00	4.31	*E. coli*
Jacks Defeat Creek	122	INW021A_T1017	9.79	*E. coli*, IBC

All impairments for each segment are listed in the above table, however this TMDL only addresses impairments caused by *E. coli*.

Historical data collected by IDEM documented elevated levels of *E. coli* in Beanblossom Creek in 1996. Three sites were sampled during the recreational season, once a month, in April, June, July, and October of 1996. Each of these three sampling sites violated the single sample maximum standard at a minimum of two times. The *E.coli* values exceeded the single sample maximum standard from 270 cfu/100mL to 2800 cfu/100mL. In 1996, IDEM also sampled an additional site on Beanblossom Creek once in August. This site did not violate the single sample maximum standard. This data was the basis for the listing of the Beanblossom Creek on the 1998 and 2002 303(d) list.

IDEM completed an intensive survey of the watershed for Beanblossom Creek in 2001. In the intensive survey, IDEM sampled twenty three sites, five times, with the samples evenly spaced over a 30-day period from September 10, 2001, to October 9, 2001. Only two sites, WWL010-0035 and WWL010-0026 did not violate the single sample maximum standard. These two sites were representative of the outfall from the Helmsburg WWTP and the outfall from the Bloomington WWTP. Of the sampling sites where a geometric mean could be calculated, two sites, WWL010-0034 and WWL010-0026, did not violate the geometric mean standard during this sampling event. (Figure 2, Attachment A).

In addition to the intensive survey of Beanblossom Creek in 2001, Beanblossom Creek and Jacks Defeat Creek were sampled as part of two other studies conducted by IDEM in 2001. Jacks Defeat Creek was sampled at one site, five times, with samples evenly spaced over a 30-day period from August 2, 2001 to August 29, 2001. This site violated the single sample maximum standard on each sampling event and violated the geometric mean standard. Beanblossom Creek was sampled at one site, five times, with samples evenly spaced over a 30-day period from September 11, 2001 to October 10, 2001. This site violated the single sample maximum standard four times and violated the geometric mean standard. (Figure 2, Attachment A)

The Brown County Health Department sampled several sites around the county from May of 2004 to July of 2004 for *E. coli*. Many of these sites were in public access areas. For these sites, the single sample maximum standard was violated 50% of the time with the *E. coli* values ranging from 7 cfu/100mL to greater than 2400 cfu/100mL (Attachment A).

The Lake Lemon Conservancy works with Indiana University's School of Public & Environmental Affairs to sample Lake Lemon including a site on Beanblossom Creek upstream of Lake Lemon. Indiana University's School of Public & Environmental Affairs has conducted water testing of Lake Lemon and Beanblossom Creek since 1996. This water testing has included collecting fecal coliform data in addition to other water quality parameters. Research indicates that *E. coli* is approximately 80% of fecal coliform. Using this estimation, the samples collected on Beanblossom Creek from 1996 to 2003 would not violate the single day maximum standard

(Jones, W., 1996; Jones, W., Lake Lemon Monitoring 1997 Results; Jones, W., Lake Lemon Monitoring 1998 Results; Clark, M. & Jones, B., 2000; Jones, B. & Peel, S., 2000; Clark, M. & Jones, B., 2000; Clark, M. & Jones, B., 2002; Clark, M. & Jones, B., 2003; Clark, M. & Jones, B., 2004; Attachment B).

The TMDL development schedule corresponds with IDEM's basin-rotation water quality monitoring schedule. To take advantage of all available resources for TMDL development, impaired waters are scheduled according to the basin-rotation schedule unless there is a significant reason to deviate from this schedule. Waterbodies could be scheduled based on the following:

1) Waterbodies may be given a high or low priority for TMDL development depending on the specific designated uses that are not being met, or in relation to the magnitude of the impairment.

2) TMDL development of waterbodies where other interested parties, such as local watershed groups, are working on alleviating the water quality problem may be delayed to give these other actions time to have a positive impact on the waterbody. If water quality standards still are not met, then the TMDL process will be initiated.

3) TMDLs that are required due to water quality violations relating to pollutant parameters where no EPA guidance is available, may be delayed to give EPA time to develop guidance.

This TMDL was scheduled based on the data available from the basin-rotation schedule, which represents the most accurate and current information available on water quality within waterbodies covered by this TMDL.

Water quality *E. coli* load duration curves were created using IDEM's data. A flow duration interval is described as a percentage. Zero (0) percent corresponds to the highest stream discharge (flood condition) and 100 percent corresponds to the lowest discharge (drought condition). The *E. coli* values at three of the sampling sites, WWL010-0004, WWL010-0001, and WWL010-0002, were plotted with the corresponding flow duration interval to show the *E. coli* violations of the single-sample maximum standard and geometric mean standard during the recreational season. These sampling sites have *E.coli* data from 1996 and 2001. These sampling sites are representative of the hydrodynamics of the Beanblossom Creek watershed (Attachment C).

Numeric Targets

The designated use for the waterbodies in the Beanblossom Creek watershed is for total body contact recreational use during the recreational season, April 1st through October 31st.

327 IAC 2-1-6(d) establishes the total body contact recreational use *E. coli* Water Quality Standard (WQS[1]) for all waters in the non-Great Lakes system as follows:

[1] *E. coli* WQS = 125 cfu/100ml or 235 cfu/100ml; 1 cfu (colony forming units)= 1 mpn (most probable number)

> *E. coli* bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period.

The sanitary wastewater *E. coli* effluent limits from point sources in the non-Great Lakes system during the recreational season, April 1st through October 31st, are also covered under 327 IAC 2-1-6(d).

For the Beanblossom Creek watershed during the recreational season (April 1st through October 31st) the target level is set at the *E. coli* WQS of 125 per one hundred milliliters as a 30-day geometric mean based on not less than five samples equally spaced over a thirty day period.

Source Assessment

Watershed Characterization

Beanblossom Creek starts in north central Brown County. Beanblossom Creek than flows west until it discharges into Lake Lemon. Prior to discharging into Lake Lemon, the tributaries of North Bear Fork and Lick Creek join Beanblossom Creek. Lake Lemon is located along the Brown-Monroe County Line. Beanblossom Creek is recreated as an outlet of Lake Lemon in Monroe County. Beanblossom Creek continues to flow southwest through Monroe County until it is joined by an unnamed tributary that is fed by Griffy Lake. Beanblossom Creek then flows northwest until it discharges into the West Fork White River near the Monroe-Owen County Line. In Monroe County, the tributaries of Honey Creek, Stouts Creek, Indian Creek, and Jacks Defeat Creek join Beanblossom Creek (Figure 1).

Landuse information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 67% of the landuse in the Beanblossom Creek watershed was forested. The remaining landuse for the Beanblossom Creek watershed consisted of approximately 26% agriculture, 3% developed, and 2% palustrine wetlands (Figure 3). Sampling completed in 2001 confirmed that there are no substantial changes to the landuse in the Beanblossom Creek watershed.

Wildlife is a known source of *E. coli* impairments in waterbodies. Many animals spend time in or around waterbodies. Deer, geese, ducks, raccoons, turkeys, and other animals all create potential sources of *E. coli*. Wildlife contributes to the potential impact of contaminated runoff from animal habitats, such as urban park areas, forest, and cropland.

Homes within the Beanblossom Creek watershed are almost entirely on septics. Failing septic tanks are known sources of *E. coli* impairment in waterbodies (Brown and Monroe County Health Department communication 2004).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are eight NPDES permitted facilities in the Beanblossom Creek watershed (Figure 4, Table 1). Four of the eight permitted discharges have *E. coli* limits in their permits. Bloomington N, Blucher Poole (IN0035726) has had sporadic violations of their *E. coli* limits in 2001 as well as in 2000, 2003, 2004. No enforcement actions have resulted from these violations, so this facility is considered to be in compliance. The remaining three facilities have no reported *E.coli* violations.

Therefore, the four permitted dischargers that have *E. coli* limits are considered to be in compliance and are not considered a significant source of the *E. coli* impairment in the Beanblossom Creek watershed.

Three of the eight NPDES permitted facilities have total residual chlorine limits in their permits. These dischargers do have possible sanitary components in their discharge. Previously, facilities with design flows under 1 MGD (typically minor municipals and semipublics) were not required to have *E. coli* effluent limits or conduct monitoring for *E. coli* bacteria, provided they maintained specific total residual chlorine levels in the chlorine contact tank. The assumption was that as long as chlorine levels were adequate in the chlorine contact tank, the *E. coli* bacteria would be deactivated and compliance with the *E. coli* WQS would be met by default. The original basis for allowing chlorine contact tank requirements to replace bacteria limits was based on fecal coliform, not *E. coli*. No direct correlation between the total residual chlorine levels and *E. coli* bacteria can be conclusively drawn. Further, it has been shown that exceedances of *E. coli* bacteria limits may still occur when the chlorine contact tank requirements are met. There have been no violations of total residual chlorine limits reported for these three facilities. Due to the complications of comparing total residual chlorine to *E. coli*, it is difficult to determine to what extent, if any, these three dischargers could be a source of *E. coli* in the Beanblossom Creek watershed.

The remaining permitted facility (Speedway Station #6013, ING080181) does not have *E. coli* or total residual chlorine limits in its permit. Since this permitted facility does not have a sanitary component to its discharge, *E. coli* limits do not apply. This permitted facility is not contributing to the sources of *E. coli* in the Beanblossom Creek watershed.

Storm Water General Permit Rule 13

There are two municipal separate storm sewer systems (MS4) communities, the City of Bloomington and Monroe County in the Beanblossom Creek watershed. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). It is difficult to determine if these MS4 communities are a significant source of *E. coli* in the Beanblossom Creek watershed.

Confined Feeding Operations and Confined Animal Feeding Operations

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations falls under the regulations for confined feeding operations (CFOs) and confined animal feeding operations (CAFOs). There is one CFO in the Beanblossom Creek watershed (Figure 5). This CFO is not considered a CAFO due to the number of animals housed at the facility (Table 2). The CFOs and CAFO regulations (327 IAC 16, 327 IAC 15) require operations "not cause or contribute to an impairment of surface waters of the state." The currently active animal operation in Beanblossom Creek watershed has no open enforcement actions at this time. Therefore, this operation is not considered a significant source of *E. coli* for the Beanblossom Creek watershed.

There are many smaller livestock operations in the watershed. These operations, due to their small size, are not regulated under the CFO or CAFO regulations. These operations may still have an impact on the water quality and the *E. coli* impairment. No specific information on these small livestock operations is currently available for the Beanblossom Creek watershed however; it is believed that these small livestock operations are a source of the *E. coli* impairment. (Ormiston, 2004).

Linkage Analysis and *E. coli* Load Duration Curves

The linkage between the *E. coli* concentrations in the Beanblossom Creek watershed and the potential sources provides the basis for the development of this TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. Analysis of this relationship allows for estimating the total assimilative capacity of the stream and any needed load reductions. Analysis of the data for the Beanblossom Creek watershed indicates that a significant amount of the *E. coli* load enters the Beanblossom Creek watershed through both wet (nonpoint) and dry (point) weather sources.

There are two USGS gages that could be representative of the Beanblossom Creek watershed. One USGS gage (03354000) is located in Centerton, Indiana, which is upstream of Beanblossom Creek, and the other USGS gage (03360500) is located in Newberry, Indiana, which is downstream of Beanblossom Creek. The Centerton gage is the closest gage to the Beanblossom Creek watershed, which would be more representative than the Newberry gage which is located in a different county. To determine that the upstream gage was acceptable, IDEM compared the USGS gage in Centerton, Indiana with the USGS gage (03360500) in Newberry, Indiana. This comparison uses a coefficient of determination value, R^2, to indicate the "fit" of the data. The comparison found the coefficient of determination, R^2, to be 0.7. Values near 1 for R^2 indicate a good fit of the data, whereas values near 0 indicate a poor fit of the data. Therefore the USGS gage (03354000) in Centerton was used for the load duration curves for the Beanblossom Creek watershed. The flow from this gage and the *E. coli* data from the Beanblossom Creek watershed were then used to create the load duration curves for the Beanblossom Creek watershed.

To investigate further the potential sources mentioned above, an *E. coli* load duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for each sampling site in the Beanblossom Creek watershed. The load duration curve analysis is a relatively new method utilized in TMDL development. The method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and non-point).

In order to develop a load duration curve, continuous flow data is required. The USGS gage for the West Fork White River (03354000) located in Centerton, Indiana was used for the development of the *E. coli* load duration curve analysis for the Beanblossom Creek watershed TMDL. USGS gage 03354000 is located upstream from the mouth of Beanblossom Creek on the West Fork of the White River; therefore, the drainage area for the Beanblossom Creek watershed is not accounted for in the drainage area for this gage. In order to obtain an estimated flow for the Beanblossom Creek watershed, the drainage area was calculated at the mouth of the Beanblossom Creek watershed (193 square miles) and compared to the West Fork White River (WFWR) drainage area downstream of the Beanblossom Creek watershed (2521 square miles). The flow for USGS gage 03354000 was then multiplied by the percent of drainage area that is accounted for in the total drainage area at the WFWR location. The calculated flow number and the drainage area for Beanblossom Creek watershed were then used to create the load duration curves for the Beanblossom Creek watershed.

The flow data is used to create flow duration curves, which display the cumulative frequency of distribution of the daily flow for the period of record. The flow duration curve relates flow values measured at the monitoring station to the percent of time that those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly 100 percent of the time, to extremely high flows, which are rarely exceeded. Flow duration curves are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for *E. coli* and appropriate conversion factors. The load duration curves are

conceptually similar to the flow duration curves in that the x-axis represents the flow recurrence interval and the y-axis represents the allowable load of the water quality parameter. The curve representing the allowable load of *E. coli* was calculated using the daily and geometric mean standards of 235 *E. coli* per 100 ml and 125 *E. coli* per 100 ml, respectively. The final step in the development of a load duration curve is to add the water quality pollutant data to the curves. Pollutant loads are estimated from the data as the product of the pollutant concentrations, instantaneous flows measured at the time of sample collection, and appropriate conversion factors. In order to identify the plotting position of each calculated load, the recurrence interval of each instantaneous flow measurement was defined. Water quality pollutant monitoring data are plotted on the same graph as the load duration curve that provides a graphical display of the water quality conditions in the waterbody. The pollutant monitoring data points that are above the target line exceed the water quality standards (WQS); those that fall below the target line meet the WQS (Mississippi DEQ, 2002).

Load duration curves were created for all the sampling sites in the Beanblossom Creek watershed. However, sampling sites, WWL010-0004, WWL010-0001, and WWL010-0002, on Beanblossom Creek provide the best description of the sources of *E. coli* to the Beanblossom Creek watershed (Figure 2, Attachment D). These are IDEM sampling sites that have *E. coli* sampling from 1996 and 2001. The data indicate that the largest exceedances of the *E. coli* WQS are prevalent during wet weather events (noted by diamonds above the curve on the far left side of the figure in Attachment D). Dry weather contributions are also a source of *E. coli* to the Beanblossom Creek watershed (noted by the diamonds above the curve on far right side of the figure in Attachment D).

While there are point source contributions, compliance with the numeric *E. coli* WQS in the Beanblossom Creek watershed most critically depends on controlling of nonpoint sources using best management plans (BMPs). If the *E. coli* inputs can be controlled, then total body contact recreation use in Beanblossom Creek watershed will be protected.

TMDL Development

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving the Waters Quality Standard (WQS). As indicated in the Numeric Targets section of this document, the target for this *E. coli* TMDL is 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the critical conditions that will be used when defining allowable levels. Many TMDLs are designed as the set of environmental conditions that, when addressed by appropriate controls, will ensure attainment of WQS for the pollutant. For example, the critical conditions for the control of point sources in Indiana are given in 327 IAC 5-2-11.1(b). In general, the 7-day average low flow in 10 years (Q7, 10) for a stream is used as the design condition for point source dischargers. However, *E. coli* sources to Beanblossom Creek watershed arise from a mixture of dry and wet weather-driven conditions, and there is no single critical condition that would achieve the *E. coli* WQS. For the Beanblossom Creek watershed and the contributing sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g. pounds per day). For *E. coli* indicators, however, mass is not an appropriate measure because *E. coli* is expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). The geometric mean *E. coli* WQS allows for the best characterization of the watershed. Therefore, this *E. coli* TMDL is

concentration-based consistent with 327 IAC 5-2-11.1(b) and 40 CFR, Section 130.2 (i) and the TMDL is equal to the geometric mean *E. coli* WQS for each month of the recreational season (April 1 through October 31).

Allocations

TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a Margin of Safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. This *E. coli* TMDL is concentration-based consistent with USEPA regulations at 40 CFR, Section 130.2(i).

Wasteload Allocations

As previously mentioned, there are eight permitted dischargers in the Beanblossom Creek watershed. Seven of the eight permitted dischargers have a sanitary component to their discharge. Four of these seven permitted dischargers already have *E. coli* limits in their permits. The remaining three of these seven permitted dischargers have total residual chlorine limits in their permits. IDEM's TMDL program recommends the addition of *E. coli* limits to these three permits during the next permit renewal.

There are two MS4 communities, City of Bloomington and Monroe County, in the Beanblossom Creek watershed. To date, stormwater permits have not been finalized for any of these MS4 communities. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11).

The WLA is set at the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1st through October 31st.

Load Allocations

The LA is equal to the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1st through October 31st. The assumption used in this load allocation strategy is that there are equal bacterial loads per unit area for all lands within the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions is determined by the amount of land under the jurisdiction of the various local units of government within the watershed. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated uses to the Beanblossom Creek watershed.

The government entity with the largest portion of the land area in the Beanblossom Creek watershed is Jackson Township (24%). Government entities utilizing fourteen to thirteen percent of the overall land area use the second largest portion of land area. Government entities utilizing nine to four percent of the overall land area use the third largest portion of the land area. The remaining users, with less than one percent of the land area, consist of only portions of townships that are included in the watershed (Table 3, Figure 6).

Load allocations may be affected by subsequent work in the watershed. Hoosier Riverwatch has received a 319 grant to complete a watershed management plan for Beanblossom Creek. Part of this watershed management plan will be to address the sources of *E.coli* in the Beanblossom Creek watershed. It is anticipated that this watershed management plan, once completed, will assist in defining the non-point sources of the *E. coli* in the Beanblossom Creek watershed.

Margin of Safety

A Margin of Safety (MOS) was incorporated into this TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into TMDL analysis thorough conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS by applying a couple of conservative assumptions. First, no rate of decay for *E. coli* was applied. *E. coli* bacteria have a limited capability of surviving outside of their hosts and therefore, a rate of decay normally would be applied. However, applying a rate of decay could result in a discharge limit that would be greater than the *E. coli* WQS, thus no rate of decay was applied. Second, the *E. coli* WQS was applied to all flow conditions. These assumptions add to the MOS for this TMDL. IDEM determined that applying the *E. coli* WQS of 125 per one hundred milliliters to all flow conditions and with no rate of decay for *E. coli* is a more conservative approach that provides for greater protection of the water quality.

Seasonality

Seasonality in the TMDL is addressed by expressing the TMDL in terms of the *E. coli* WQS for total body contact during the recreational season (April 1st through October 31st) as defined by 327 IAC 2-1-6(d). There is no applicable total body contact *E. coli* WQS during the remainder of the year in Indiana. Because this is a concentration-based TMDL, *E. coli* WQS will be met regardless of flow conditions in the applicable season.

Monitoring

Future monitoring of the Beanblossom Creek watershed will take place during IDEM's five-year rotating basin schedule and/or once TMDL implementation methods are in place. During the five-year rotating basin schedule, IDEM will monitor the Beanblossom Creek watershed for *E. coli*. Monitoring will be adjusted as needed to assist in continued source identification and elimination. When these results indicate that the waterbody is meeting the *E. coli* WQS, IDEM will monitor at an appropriate frequency to determine if Indiana's 30-day geometric mean value of 125 *E. coli* per one hundred milliliters is being met.

Reasonable Assurance Activities

Reasonable assurance activities are programs that are in place or will be in place to assist in meeting the Beanblossom Creek watershed TMDL allocations and the *E. coli* Water Quality Standard (WQS).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

For the permitted dischargers that have only total residual chlorine limits in their current permits, IDEM's TMDL program proposes the *E. coli* limits and monitoring be added when the next permit renewals are issued..

The Helmsburg WWTP, which does not discharge to the Beanblossom Creek watershed, and the Friends of Beanblossom are in negotiation to extend sewer service to approximately 163 homes and businesses in the Beanblossom Creek Watershed (Drum 2005).

Storm Water General Permit Rule 13

MS4 permits are being issued in the state of Indiana. The two MS4 communities in the Beanblossom Creek watershed are the City of Bloomington and Monroe County. Once these permits have been issued and implemented, they will improve the water quality in the Beanblossom Creek watershed. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). These permits will be used to address storm water impacts in the Beanblossom Creek watershed.

Confined Feeding Operations and Confined Animal Feeding Operations

CFO and CAFO are required to manage manure and litter and process wastewater pollutants in a manner that does not cause or contribute to the impairment of the *E. coli* WQS.

Watershed Projects

A 319 grant was awarded to the Hoosier Environmental Council to complete a watershed management plan for Beanblossom Creek. This watershed management plan will contain information on the *E. coli* impairment. This 319 grant started in 2005.

Smaller animal operations have been identified during the collection of data in the Beanblossom Creek watershed as potential sources of *E.coli*. As part of the watershed planning process more information should be collected on these activities. This information will assist in targeting activities in the watershed.

IDEM has recently hired a Watershed Specialist for this area of the state. The Watershed Specialist will be available to assist stakeholders with starting a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Beanblossom Creek watershed.

Potential Future Activities

Non-point source pollution, which is the primary cause of *E. coli* impairment in this watershed, can be reduced by the implementation of "best management practices" (BMPs). BMPs are

practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities. A BMP may be structural, that is, something that is built or involves changes in landforms or equipment, or it may be managerial, that is, a specific way of using or handling infrastructure or resources. BMPs should be selected based on the goals of a watershed management plan. Livestock owners, farmers, and urban planners, can implement BMPs outside of a watershed management plan, but the success of BMPs would be enhanced if coordinated as part of a watershed management plan. Following are examples of BMPs that may be used to reduce *E. coli* runoff:

Riparian Area Management - Management of riparian areas protects streambanks and river banks with a buffer zone of vegetation, either grasses, legumes, or trees.

Manure Collection and Storage - Collecting, storing, and handling manure in such a way that nutrients or bacteria do not run off into surface waters or leach down into ground water.

Contour Row Crops - Farming with row patterns and field operations aligned at or nearly perpendicular to the slope of the land.

Manure Nutrient-Testing - If manure application is desired, sampling and chemical analysis of manure should be performed to determine nutrient content for establishing the proper manure application rate in order to avoid overapplication and run-off.

Drift Fences - Drift fences (short fences or barriers) can be installed to direct livestock movement. A drift fence parallel to a stream keep animals out and prevents direct input of *E. coli* to the stream.

Pet Clean-up / Education - Education programs for pet owners can improve water quality of runoff from urban areas.

Septic Management/Public Education - Programs for management of septic systems can provide a systematic approach to reducing septic system pollution. Education on proper maintenance of septic systems as well as the need to remove illicit discharges could alleviate some anthropogenic sources of *E. coli*.

Conclusion

The sources of *E. coli* to the Beanblossom Creek watershed include both point and non-point sources. In order for the Beanblossom Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Beanblossom Creek watershed in Indiana have been set to the *E. coli* WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty day from April 1st through October 31st. Achieving the wasteload and load allocations for the Beanblossom Creek watershed depends on:

1) *E. coli* limits being added to sanitary dischargers who currently only monitor for total residual chlorine
2) CFOs not violating their permits
3) Non-point sources of *E. coli* being controlled by implementing best management practices in the watershed.
4) The issuance of the MS4 permits for the City of Indianapolis, City of Martinsville, and Monroe County.

5) Completion and implementation of the approved Beanblossom Creek Watershed Management Plan. The Beanblossom Creek Watershed Management Plan will include BMPs that will result in practices that will help implement the Beanblossom Creek TMDL for *E.coli*.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Beanblossom Creek watershed in compliance with the *E. coli* WQS. IDEM will continue to work with its existing programs on implementation. In the event that designated uses and associated water quality criteria applicable to the Beanblossom Creek watershed are revised in accordance with applicable requirements of state and federal law, the TMDL implementation activities may be revised to be consistent with such revisions. Additionally, IDEM will work with local stakeholder groups to pursue best management practices that will result in improvement of the water quality and attainment of WQS for *E.coli* in the Beanblossom Creek watershed.

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Table 1: NPDES Permits in the Beanblossom Creek Watershed

Facilities with *E. coli* Limits

Permit No.	Expiration Date	Facility Name	Receiving Waters
IN0053899	3/31/2009	Camp Gallahue	Jack Creek Tributary
IN0035726	8/31/2009	Bloomington N (Blucher Poole)	Beanblossom Creek
IN0021083	12/31/2010	Ellettsville Municipal STP	Jacks Defeat Creek
IN0060321	9/30/2007	Camp Hunt's WWTP	Lazy Creek

Facilities with Total Residual Chlorine Limits

Permit No.	Expiration Date	Facility Name	Receiving Waters
IN0058416	10/31/2010	Helmsburg Regional Sewer District	Beanblossom Creek
IN0037605	11/30/2010	Star of Indiana	Unnamed Tributary to Beanblossom Creek
IN0039110	6/30/2010	Lutheran Hills Camp	Bear Creek

Facilities with no Total Residual Chlorine or *E. coli* Limits

Permit No.	Expiration Date	Facility Name	Receiving Waters
ING080181	6/30/2008	Speedway Station #6013	Unnamed Creek to Jacks Defeat Creek

Table 2: Permitted Confined Feeding Operations in the Beanblossom Creek Watershed

			Approved Animals	
Log Number	**Name**	**NPDES Permit Number**	**Dairy**	**Dairy Calves**
6191	Wagler Farms		870	250

Table 3: Land Area Distribution for the Beanblossom Creek Watershed

Municipality	**Square Mile**	**Percent**
Jackson Township	46.81	24
Benton Township	27.57	14
Washington Township	27.15	14
Beanblossom Township	25.76	13
Bloomington Township	24.01	13
City of Bloomington	16.6	9
Hamblen Township	16.54	9
Richland Township	8.00	4
Hensley Township	0.15	0.08
Baker Township	0.003	0.001
Total	**192.6**	**100.00**

Figure 1: Beanblossom Creek Watershed TMDL

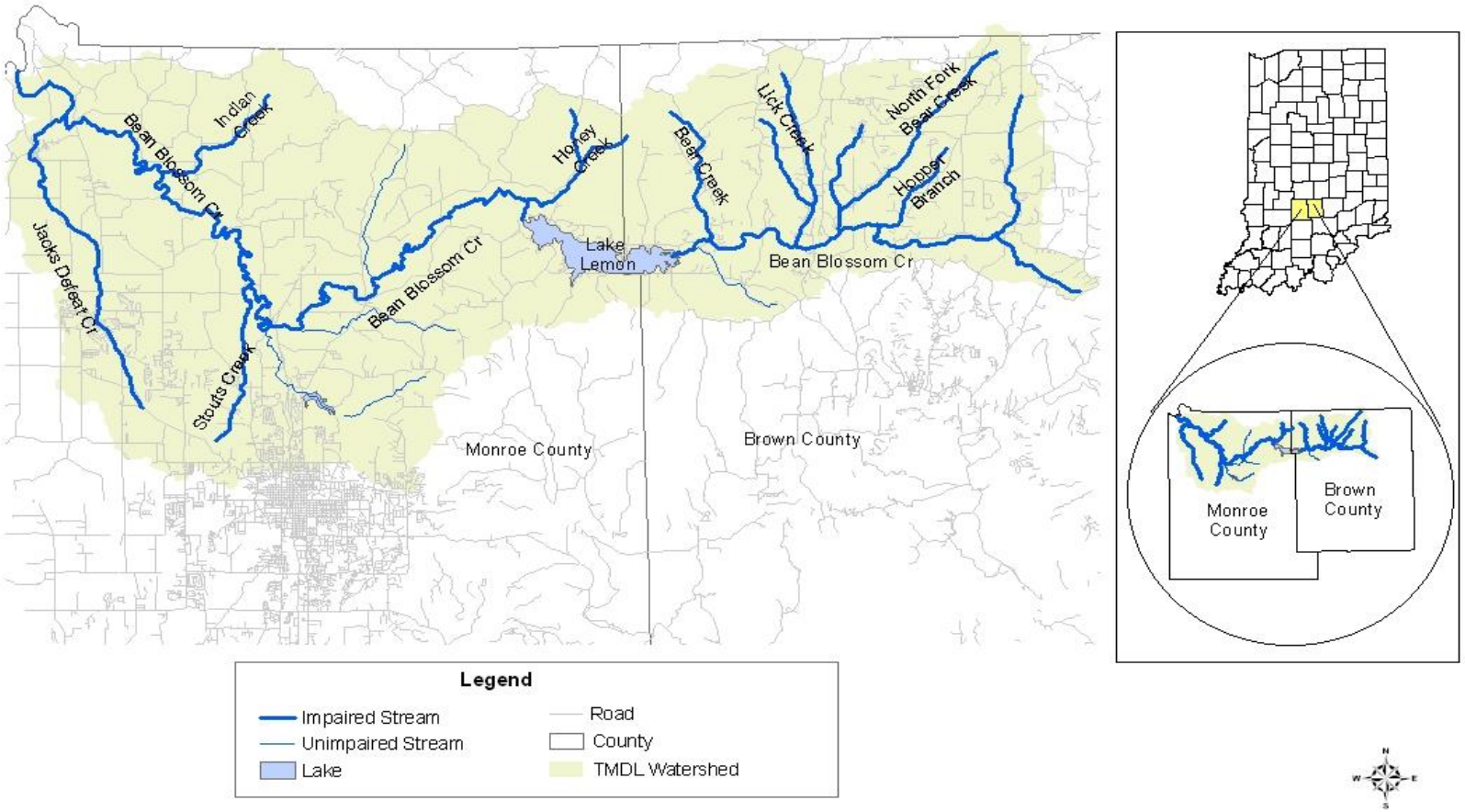


Figure 2: Sampling Sites in Beanblossom Creek Watershed

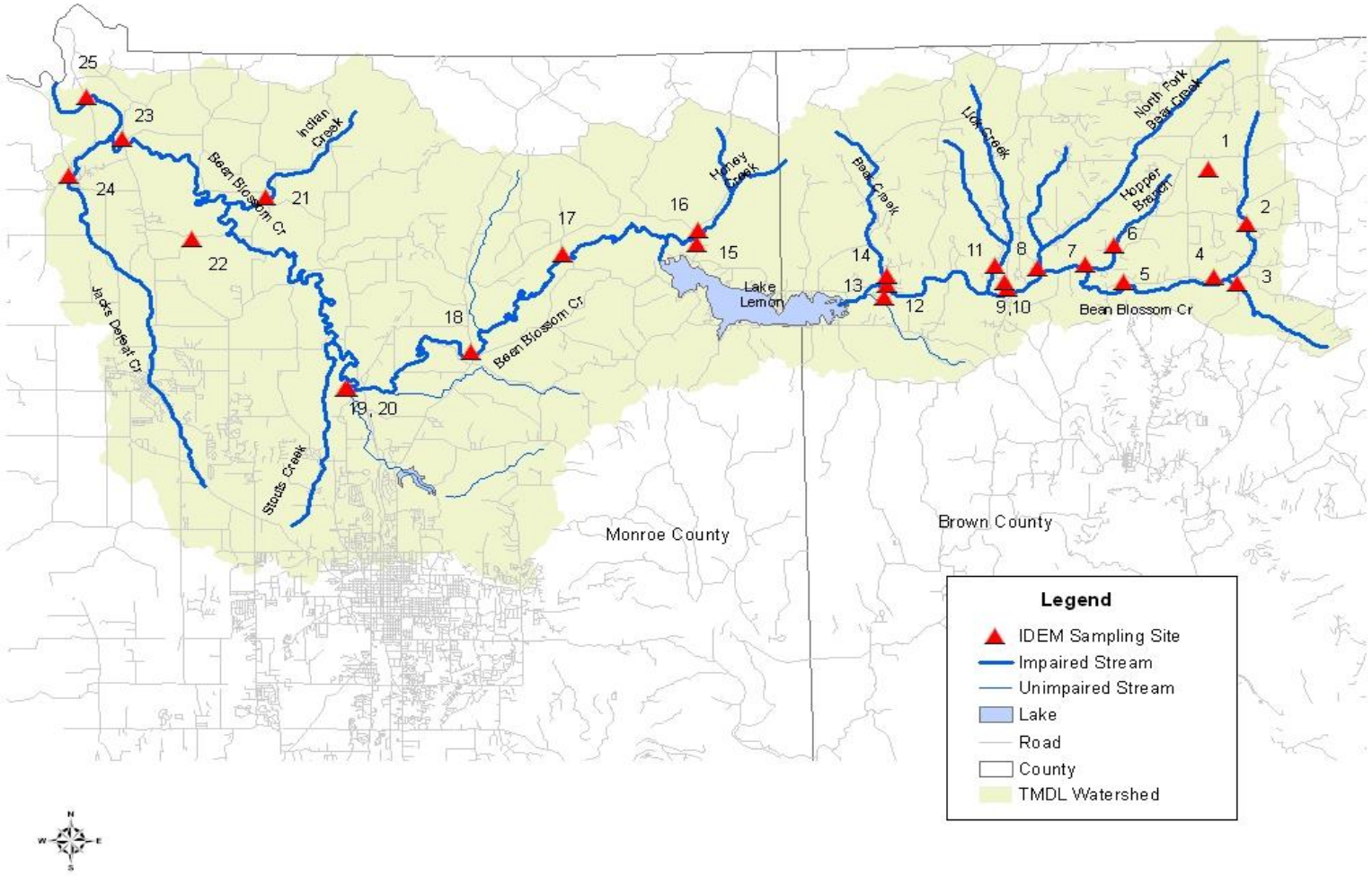


Figure 3: Landuse in Beanblossom Creek Watershed

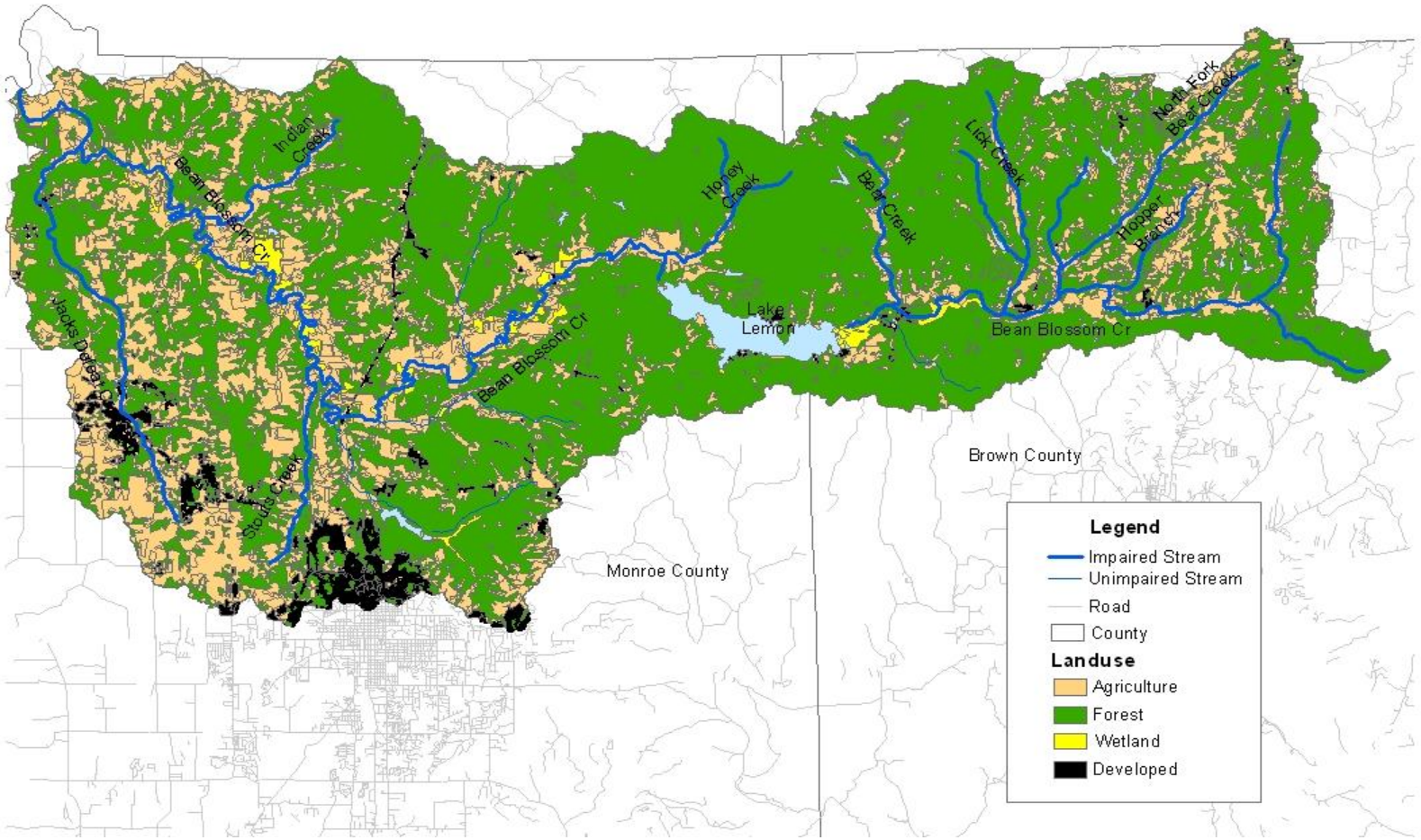


Figure 4: NPDES Permits in the Beanblossom Creek Watershed

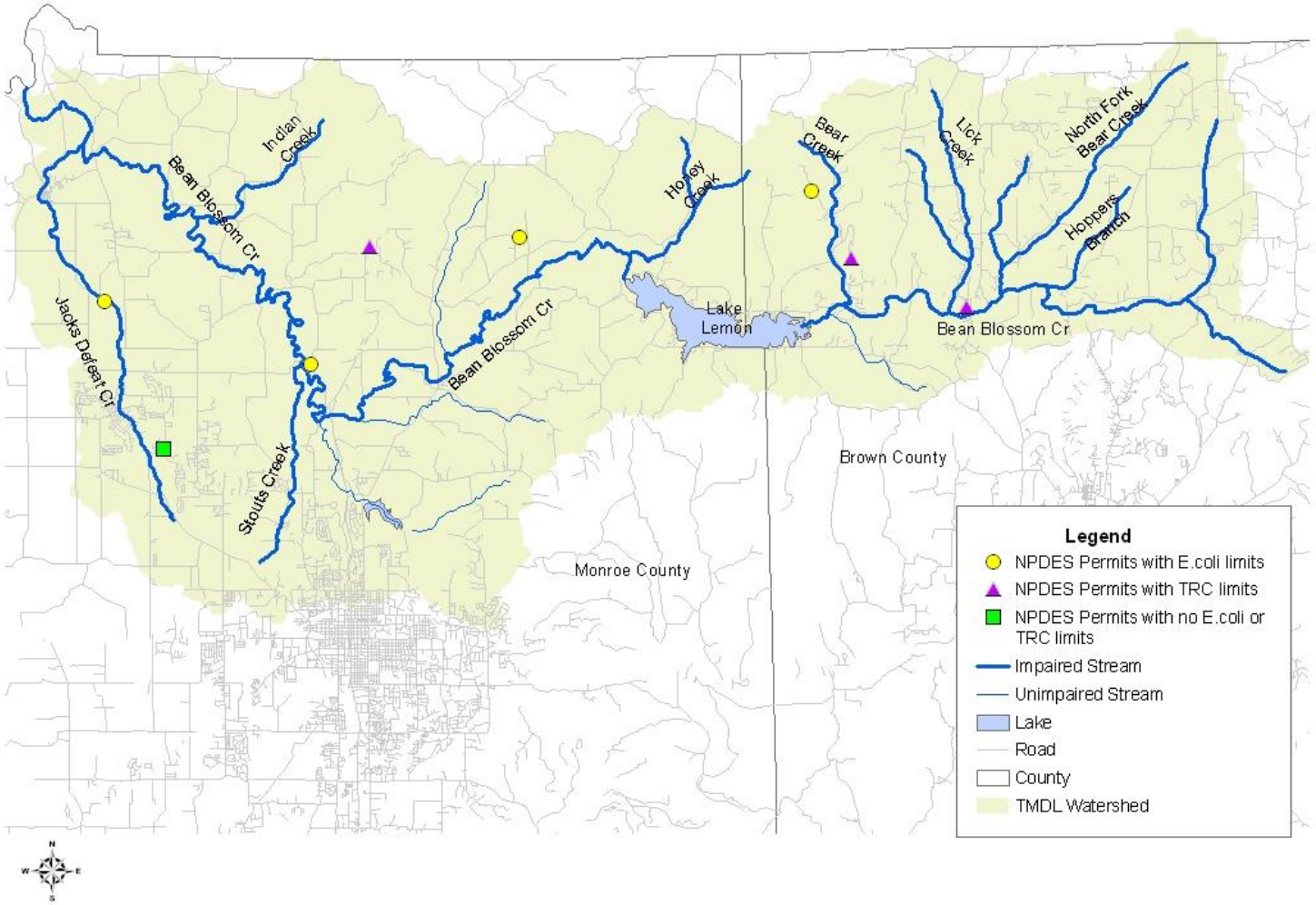


Figure 5: CFO in the Beanblossom Creek

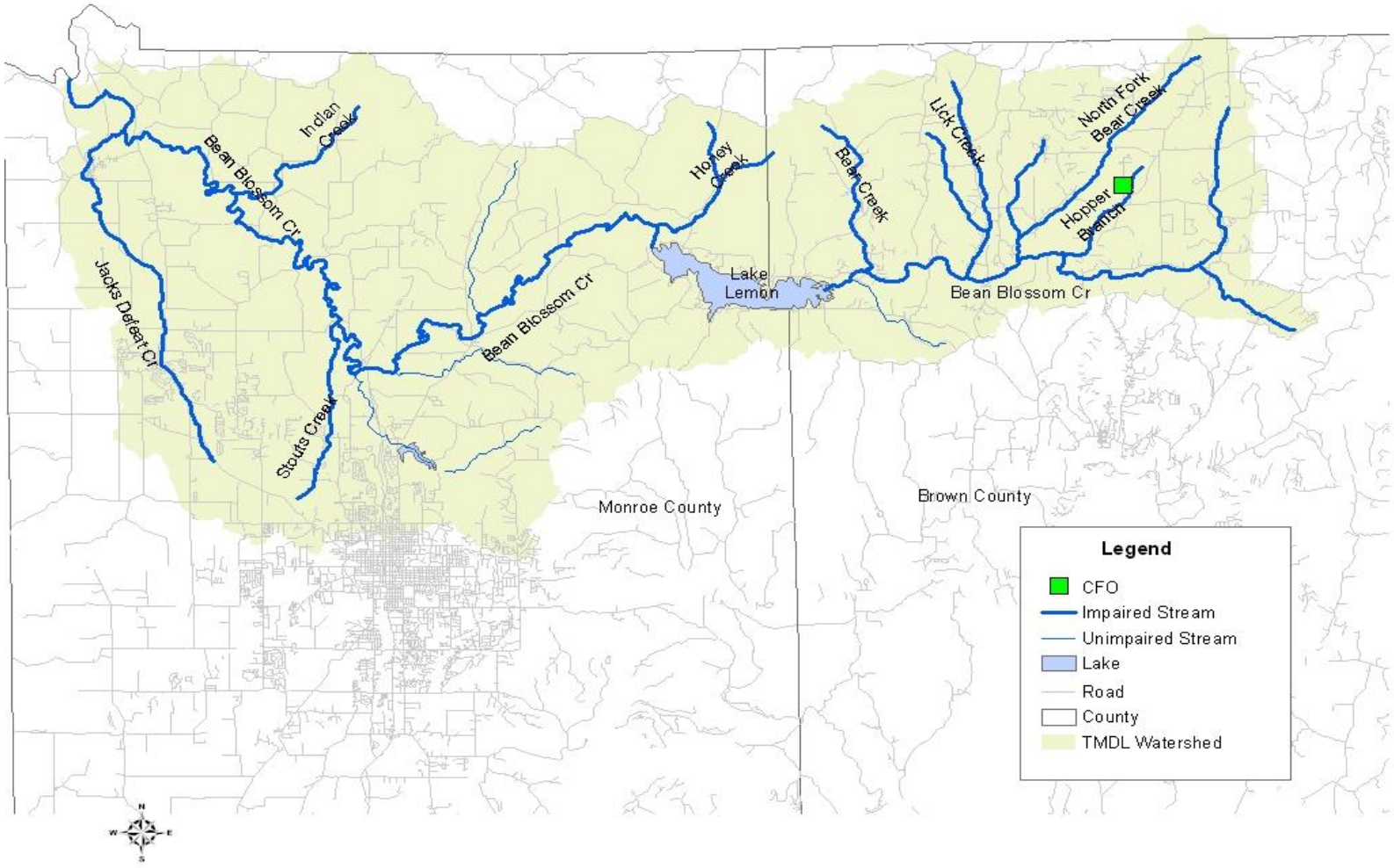
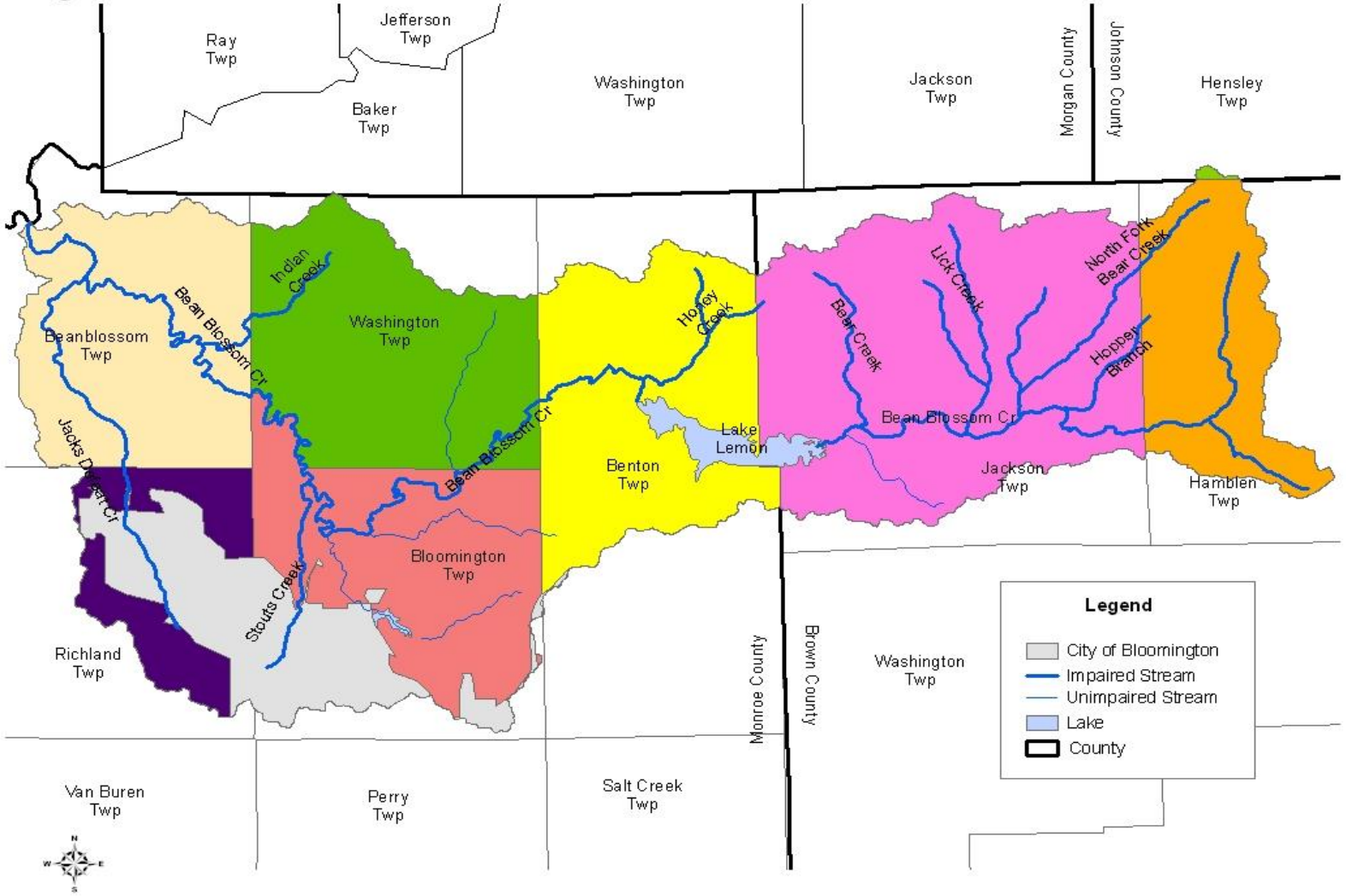


Figure 6: Land Area Distribution in Beanblossom Creek Watershed



Attachment A

E. coli Data for Beanblossom Creek watershed TMDL

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Attachment B

Fecal coliform data for Beanblossom Creek watershed TMDL

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Attachment C

Water Quality Duration Curves for Beanblossom Creek watershed TMDL

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Attachment D

Load Duration Curves for Beanblossom Creek watershed TMDL