Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) For the Lambs Creek Watershed, Morgan County

Prepared by:

Office of Water Quality – TMDL Program
Indiana Department of Environmental Management
100 N. Senate Avenue
Indianapolis, IN 46204

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Indiana Department of Environmental Management
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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) require 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 nonpoint 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 Lambs Creek watershed in Morgan County in Indiana.

Background

In 1998, 2002, and 2004, Indiana's section 303(d) list cited Lambs Creek as being impaired for *E. coli* in Morgan County. In 2004, Indiana's section 303(d) list cites, in addition to Lambs Creek, Goose Creek for *E. coli*. With the addition of the above stream in 2004, the majority of the Lambs Creek watershed is impaired for *E. coli*.

This TMDL will address approximately 17.73 miles of the Lambs Creek watershed in Morgan County where recreational uses are impaired by elevated levels of *E. coli* during the recreational season. Morgan County is located in south-central Indiana (Figure 1). All of the three (3) segments of the listed streams for this TMDL are located in the West Fork White River Basin in hydrologic unit codes 05120201160. 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
Lambs Creek	127	INW01G5_T1096, INW01G4_T1095	13.79	*E. coli*
Goose Creek	152	INW01G5_00	3.94	*E. coli*

Historical data collected by IDEM documented elevated levels of *E. coli* in Lambs Creek from 1996. This data was the basis for the listing of Lambs Creek on the 1998 and 2002 303(d) list. IDEM completed an intensive survey of the watershed for Lambs Creek in 2001. In 2001, IDEM sampled twelve sites, five times, with the samples evenly spaced over a 30-day period from June 1, 2001, to July 2, 2001 (Figure 2). Only two sites, WWU160-0017 and WWU160-0022, did not violate the single sample maximum standard and geometric mean standard during this sampling event. Both of these sampling sites were located downstream of two of the lakes in the Lambs Creek watershed. For the remaining ten sites, the E.coli values ranged from 42 cfu/100mL to greater than 2000 cfu/100mL. The single sample maximum standard violated approximately 77% of the time and the geometric mean standard violated 100% of the time for these ten sites. Based on these intensive surveys in 2001, IDEM determined that an *E. coli* TMDL would need to be completed on the Lambs Creek watershed (Attachment A).

The Morgan County Watershed Initiative (MCWI) completed a watershed management plan for the White River Watershed in North Central Morgan County. The watershed management plan included the Lambs Creek watershed. The MCWI contracted with Goode and Associates to collect *E. coli* samples at three sites on Lambs Creek monthly from January of 2002 through January of 2003. The samples were collected during both wet and dry conditions. During the recreational season, the sites on Lambs Creek violated the single sample maximum standard 44%. The *E. coli* values collected at Site 7, which is located at the mouth, showed higher values than Site 5 and Site 6, which are located upstream. Site 6, which is located downstream of Patton Lake, had the lowest *E. coli* values.(Figure 2, Attachment A). (Morgan County Watershed Initiative, 2003)

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 for sampling site WWU160-0005 was 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. This sampling site was sampled by IDEM in 1996 and in 2001, as well as, by the Morgan County Watershed Initiative in 2002. This sampling site is representative of the hydrodynamics of the Lambs Creek watershed (Attachment B).

Numeric Targets

The impaired designated use for the waterbodies in the Lambs 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:

> *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 Lambs 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

The Lambs Creek watershed is located on the west side of Morgan County. Lambs Creek flows west until it is joined by an unnamed tributary. Lambs Creek then flows southwest until it feeds into Patton Lake. Lambs Creek then leaves Patton Lake and continues flowing slightly southeast until its confluence with the West Fork White River. There is one major tributary that flows into Lambs Creek and several smaller tributaries whose headwaters are small lakes (Figure 1).

The tributary of Goose Creek is listed on the 2004 303(d) list for *E. coli*. In addition to Goose Creek, Sally Bradley Branch, and two unnamed tributaries were sampled in 2001. Based on *E. coli* sampling completed in 2001, each of these tributaries is also contributing to the *E. coli* impairment in Lambs Creek.

Landuse information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 71% of the landuse in the Lambs Creek watershed was forested. The remaining landuse for the Lambs Creek watershed consisted of approximately 0.21% developed, 1% palustrine wetlands, 27% agriculture (Figure 3). Aerial photos taken in 2003, confirm the landuse found using the 1992 GAP landuse data.

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 Lambs Creek watershed are almost entirely on septics. Failing septic tanks are known sources of *E. coli* impairment in waterbodies. Conversations with Morgan County Health Department staff indicate that septic system failure does occur, but no tangible septic failure rate has been established by the local Health Department at this time (Morgan County Health Department, 2004). Based on questions and concern about from Morgan County citizens, the

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

Morgan County Health Department had identified Patton Lake/Patton Park, Lambs Creek upstream and downstream of Patton Lake as problem areas for septic systems (MCWI, 2003).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are no NPDES permitted dischargers in the Lambs Creek watershed.

Storm Water General Permit Rule 13

There is one municipal separate storm sewer systems (MS4) community, Morgan County, in the Lambs 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 Lambs Creek watershed.

Confined Feeding Operations and Concentrated Animal Feeding Operations

There are no confined feeding operations (CFO) or concentrated animal feeding operations (CAFO) in the Lambs 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. Through windshield surveys, the MCWI found a concentration of livestock operations in the upper and lower Lambs Creek watersheds. The MCWI found approximately seventeen small livestock operations in the upper Lambs Creek watershed and approximately six smaller livestock operations in the lower Lambs Creek-Goose Creek watershed. It is believed that these small livestock operations are a source of the *E. coli* impairment to Lambs Creek watershed (Morgan County Watershed Initiative, 2003).

Linkage Analysis and *E. coli* Load Duration Curves

The linkage between the *E. coli* concentrations in the Lambs 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 Lambs Creek watershed indicates that a significant amount of the *E. coli* load enters the Lambs Creek watershed through both wet (nonpoint) and dry (point) weather sources.

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 Lambs 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 Lambs Creek watershed TMDL. USGS gage 03354000 is located upstream from the mouth of Lambs Creek on the West Fork of the White River, therefore the drainage area for the Lambs Creek watershed is not accounted for in the drainage area for this gage. In order to obtain an estimated flow for the Lambs Creek

watershed, the drainage area was calculated at the mouth of the Lambs Creek watershed (32.6 square miles) and compared to the West Fork White River (WFWR) drainage area downstream of the Indian 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 Lambs Creek watershed were then used to create the load duration curves for the Lambs Creek watershed.

There are two USGS gages that could be representative of the Lambs Creek watershed. One USGS gage (03354000) is located in Centerton, Indiana, which is upstream of Lambs Creek, and the other USGS gage (03360500) is located in Newberry, Indiana, which is downstream of Lambs Creek. The Centerton gage is the closest gage to the Lambs Creek watershed, which would be more representative than the Newberry gage which is 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 Lambs Creek watershed. The flow from this gage and the *E. coli* data from the Lambs Creek watershed were then used to create the load duration curves for the Lambs 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 Lambs Creek watershed. However, sampling site WWU160-0005 on Lambs Creek provides the best description of the sources of *E. coli* to the Lambs Creek watershed (Figure 2, Attachment C). This sampling site is an IDEM sampling site that contains *E. coli* data 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 C). Dry weather contributions are also a source of *E. coli* to the Lambs Creek watershed (noted by the diamonds above the curve on far right side of the figure in Attachment C).

While there is a point source contribution, compliance with the numeric *E. coli* WQS in the Lambs 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 Lambs 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 Lambs 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 Lambs 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).

<u>Wasteload Allocations</u>

There is one MS4 community, Morgan County, in the Lambs 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 Lambs Creek watershed.

The government entities with the largest portion of the land area in the Lambs Creek watershed are Jefferson Township (55%) and Gregg Township (43%). The remaining governmental entities in the Lambs Creek watershed are Ashland Township (3%) and Monroe Township (0.27%). (Table 1 and Figure 6)

Load allocations may be affected by subsequent work in the watershed. The MCWI watershed management plan for North Central Morgan County outlines nonpoint sources of *E. coli* and implementation activities that would help reduce the *E. coli* in Lambs Creek watershed. In addition, the MCWI is in the second year of a 319 for implementation activities in the Lambs 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. This adds 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 Lambs 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 Lambs 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 Lambs Creek watershed TMDL allocations and the *E. coli* Water Quality Standard (WQS).

Storm Water General Permit Rule 13

MS4 permits are being issued in the state of Indiana. The one MS4 community in the Lambs Creek watershed is Morgan County. Once this permit has been issued and implemented, they will improve the water quality in the Lambs 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). This permit will be used to address storm water impacts in the Lambs Creek watershed.

Watershed Projects

The MCWI completed a watershed management plan that includes the Lambs Creek watershed includes management plans for forested land, row crops, buffer strip projects, livestock management, commercial and industrial issues, and planning and zoning. The goal of the watershed management plan is to bring the north and south sections of Lambs Creek within compliance of the *E. coli* water quality standards with the next six years. The watershed management plans has strategies for dealing with the septic systems issues, identified area for potential buffer strip projects, and livestock management issues (Morgan County Watershed Initiative, 2003). In addition, the MCWI is in the second year of a 319 grant for implementation activities in the Lambs Creek 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 Lambs 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 Lambs Creek watershed include both point and nonpoint sources. In order for the Lambs Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Lambs 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 Lambs Creek watershed depends on:

1) nonpoint sources of *E. coli* being controlled by implementing best management practices in the watershed.
2) The issuance of the MS4 permits for the City of Indianapolis, City of Martinsville, and Morgan County.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Lambs 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 Lambs 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 in the Lambs Creek watershed.

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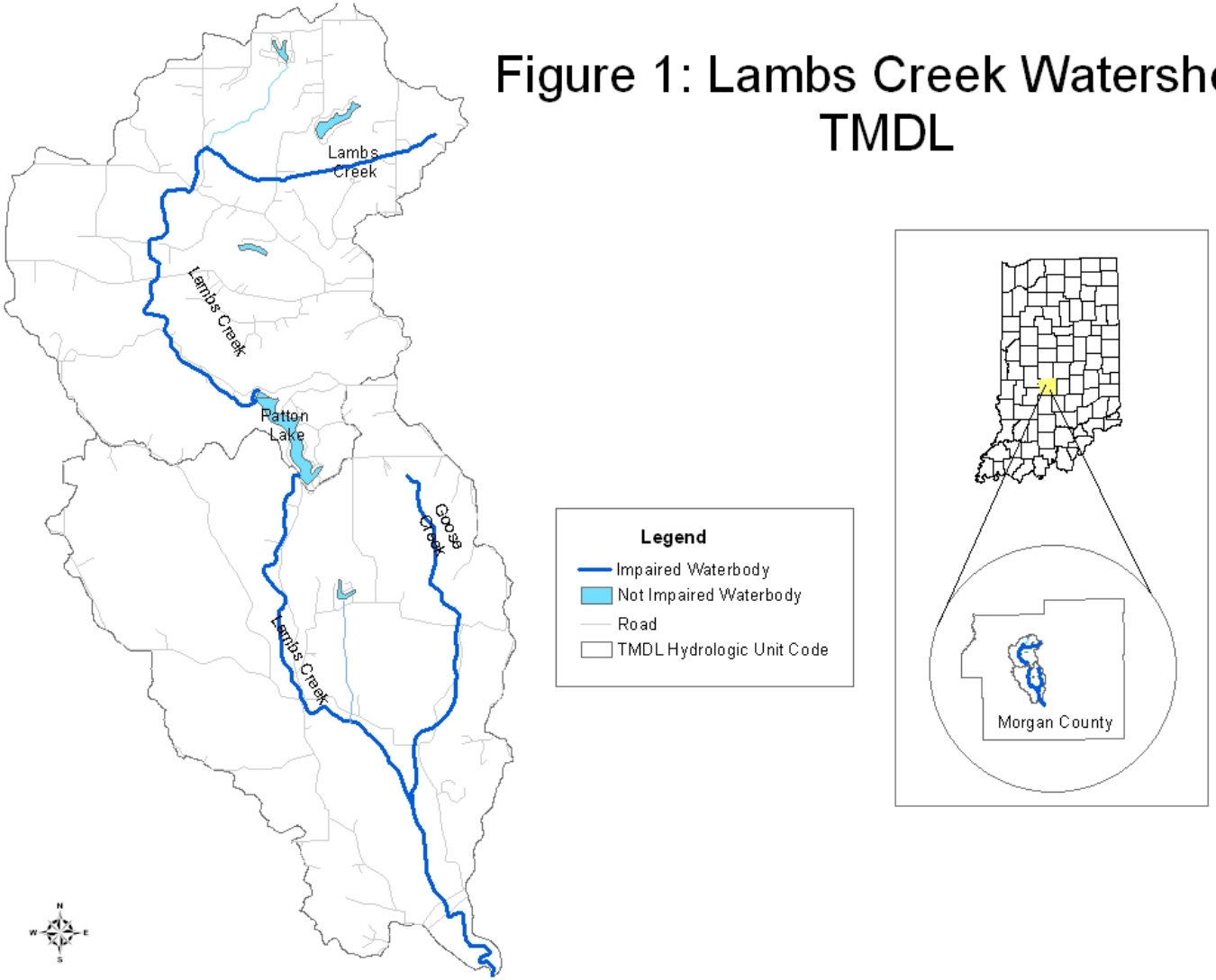
USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

Table 1: Land Area Distribution for the Lambs Creek Watershed

Municipality	**Mile**	**Percent**
Jefferson Township		55
Gregg Township		43
Ashland Township		3
Monroe Township		0.27
Total		**100.00**

Figure 1: Lambs Creek Watershed TMDL



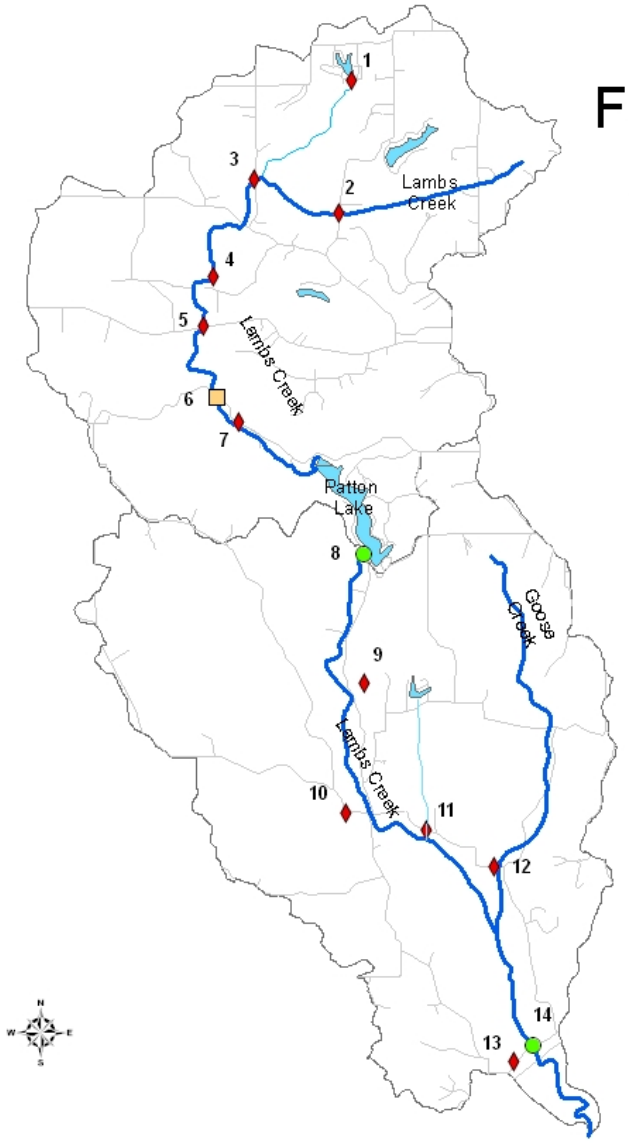


Figure 2: Sampling Sites in Lambs Creek Watershed

Legend

- IDEM Sampling Site
- IDEM & MCWI Sampling Site
- MCWI Sampling Site
- Impaired Waterbody
- Not Impaired Waterbody
- Road
- TMDL Hydrologic Unit Code

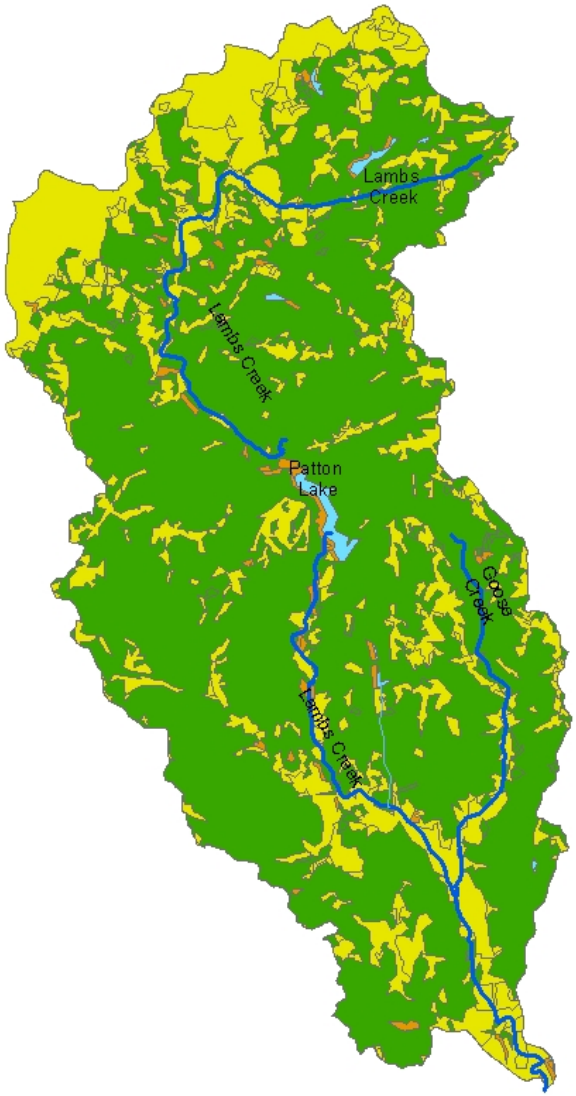
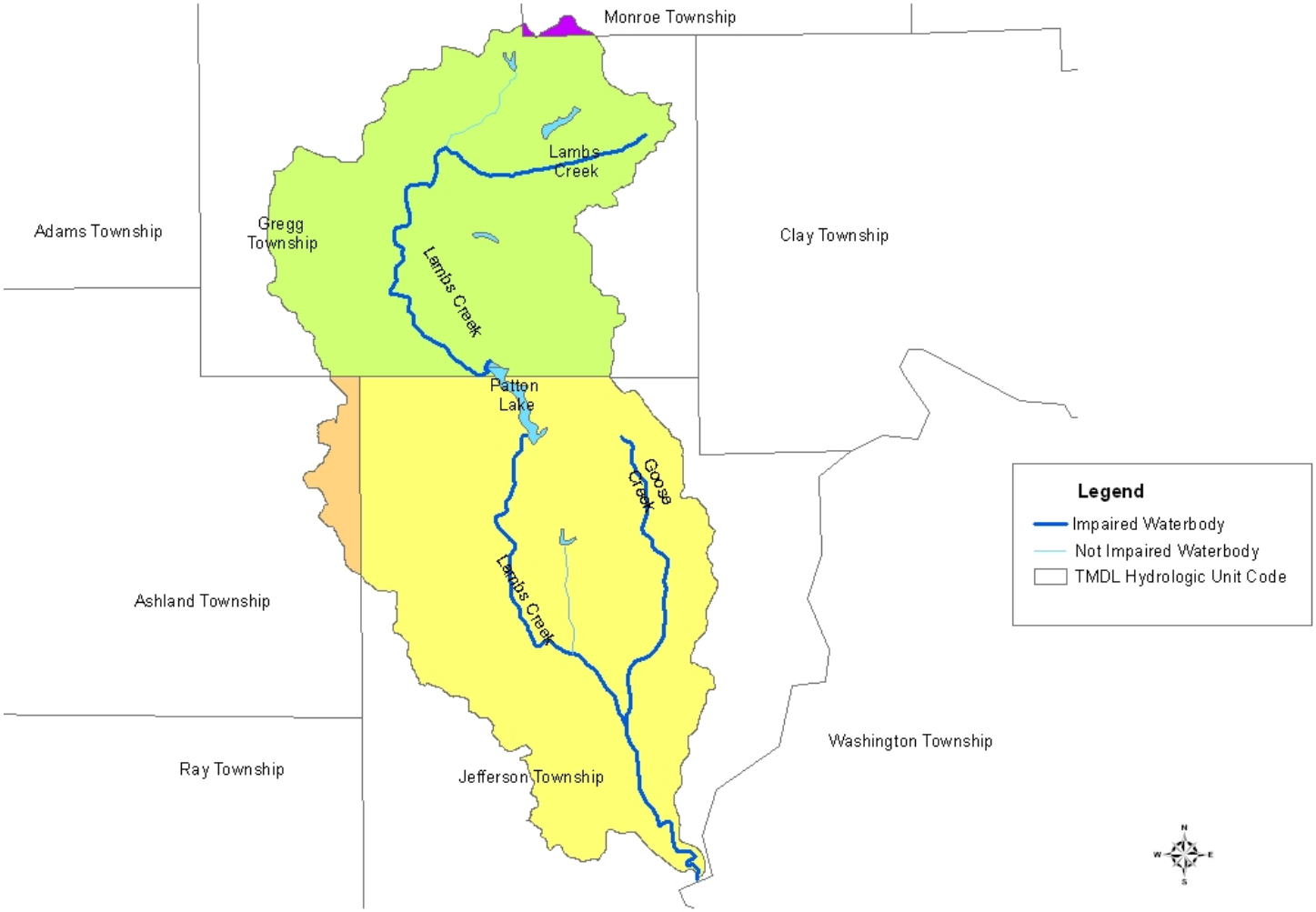


Figure 3: Landuse in Lambs Creek Watershed

Legend

- Agriculture
- Forest
- Palustrian Wetland
- Impaired Waterbody
- Not Impaired Waterbody
- TMDL Hydrologic Unit Code

Figure 4: Land Area Distribution in Lambs Creek Watershed



Attachment A

E. coli Data for Lambs Creek Watershed TMDL

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Attachment B
Water Quality Duration Curves for
Lambs Creek Watershed TMDL

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Attachment C
Load Duration Curves for
Lambs Creek Watershed TMDL

Attachment A: Lambs Lake E.coli Data

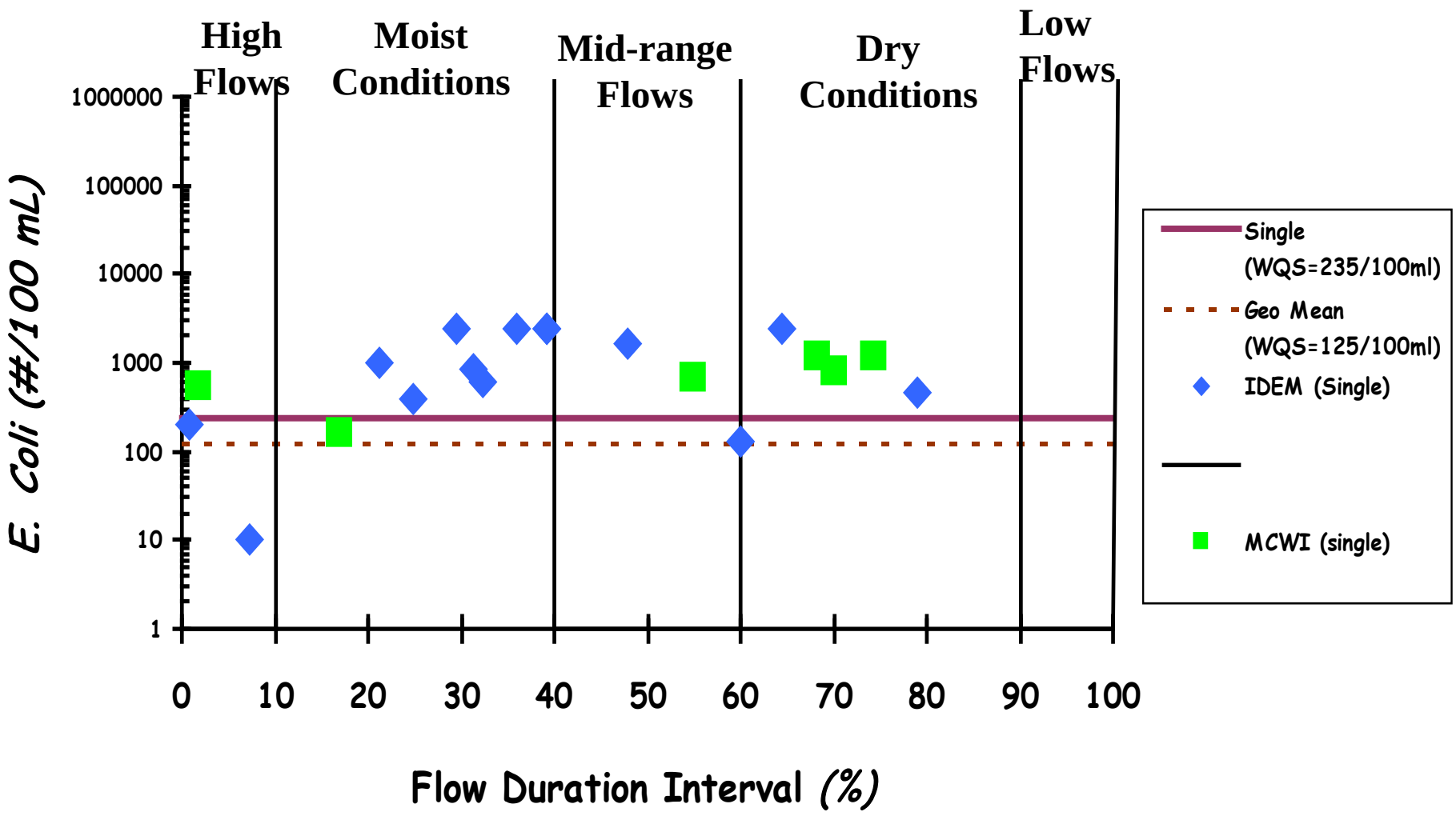
Site #	Description	Sampling Date	Fecal Coliform
1	Main Dam	7/28/2004	2
1	Main Dam	7/30/2004	>1
1	Main Dam	7/22/2002	3
1	Main Dam	7/27/2000	2
2	Highland & Meadow	7/28/2004	3
2	Highland & Meadow	7/30/2004	>1
2	Highland & Meadow	7/22/2002	1
3	Forest Court	7/28/2004	>1
3	Forest Court	7/30/2004	>1
3	Forest Court	7/22/2002	3
4	Earlham Dam	7/28/2004	>1
4	Earlham Dam	7/30/2004	2
4	Earlham Dam	7/22/2002	4
4	Earlham Dam	7/27/2000	15
5	Tomahawk & Woodpecker	7/28/2004	2
5	Tomahawk & Woodpecker	7/30/2004	1
5	Tomahawk & Woodpecker	7/22/2002	2
6	Fox Trail & Spring	7/28/2004	1
6	Fox Trail & Spring	7/30/2004	>1
6	Fox Trail & Spring	7/22/2002	1
6	Fox Trail & Spring	7/27/2000	1

Site #	Description	Sampling Date	Fecal Coliform
7	Pine Tree Lane & Gartner	7/30/2004	1
7	Pine Tree Lane & Gartner	7/22/2002	>1
7	Pine Tree Lane & Gartner	7/27/2000	2
8	Indiana Creek Hollow	7/28/2004	3
8	Indiana Creek Hollow	7/30/2004	3
8	Indiana Creek Hollow	7/22/2002	>1
8	Indiana Creek Hollow	7/27/2000	6
9	Bathing Beach	7/28/2004	>1
9	Bathing Beach	7/30/2004	4
9	Bathing Beach	7/22/2002	1
9	Bathing Beach	7/27/2000	3

Lambs Creek at SR 67

WQ Duration Curve *(1996, 2001, 2002 Monitoring Data)*

Site: WWU160-0005



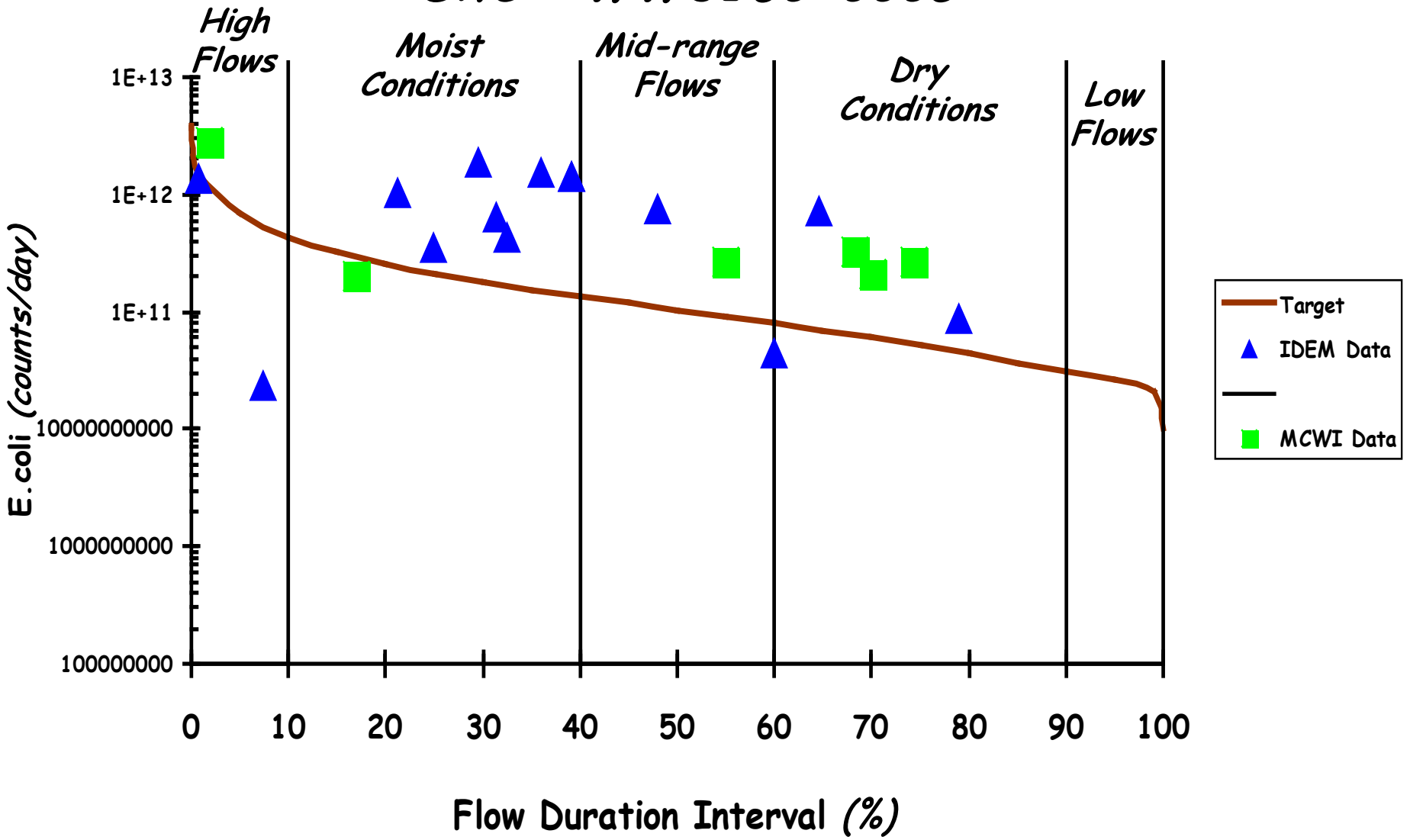
IDEM & MCWI Data & USGS Gage Duration Interval

32.6 square miles

Lambs Creek at SR 67

Load Duration Curve *(1996, 2001, 2002 Monitoring Data)*

Site: WWU160-0005



IDEM & MCWI Data & USGS Gage Duration Interval

32.6 square miles