Appendix

B

STATUS OF WATER QUALITY
PORTAGE RIVER WATERSHED

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In 2008 Ohio EPA conducted a water quality survey of the Portage River watershed. Aquatic communities were sampled to determine the presence or absence of various aquatic species, which indicates the quality of streams and determines whether water quality goals are being met. Fish were electroshocked and macroinvertebrates were collected from natural and artificial substrates and then identified. Water samples were collected multiple times at various sampling locations and analyzed for the concentrations of *E. coli* bacteria (to assess recreation use water quality goals) as well as chemical pollutants, which indicate the quality of streams and suggest causes of aquatic life use impairment and pollution sources. Fine sediment was collected within the wetted stream channel along the banks to determine whether certain persistent chemicals are present in the systems and in concentrations high enough to have a significant impact on the food web and human health. Fish tissue was also collected from areas likely to be recreationally fished to determine if human health standards were being met. And finally, during the biological sampling, stream habitat was assessed using a qualitative index which provides a relative measure of quality of the macrohabitat and its potential to support diverse, healthy aquatic communities.

The results of this survey are presented in a technical support document entitled *Biological and Water Quality Survey of the Portage River Basin, Select Maumee River Tributaries, and Select Lake Erie Tributaries, 2006 - 2008. Hancock, Lucas, Ottawa, Sandusky, Seneca, and Wood Counties, Ohio,* which can be downloaded at http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx.

B1 Aquatic Life Use Attainment

In terms of aquatic life uses, thirty-seven (54%) of the evaluated sites fully met the existing or recommended life use. Eighteen (26%) of the sites partially met and thirteen (19%) of the sites were not attaining their designated or recommended use. Only ten (12%) of the sites surveyed met the recreation use criteria while the remaining 76 sites did not meet standards.

The remainder of this section presents the results of the water quality assessment for aquatic life and recreation uses by the respective 10-digit assessment units. Figure B-1 is a group of pie charts showing the respective aquatic life use attainment statuses for each of the ten digit HUCs.

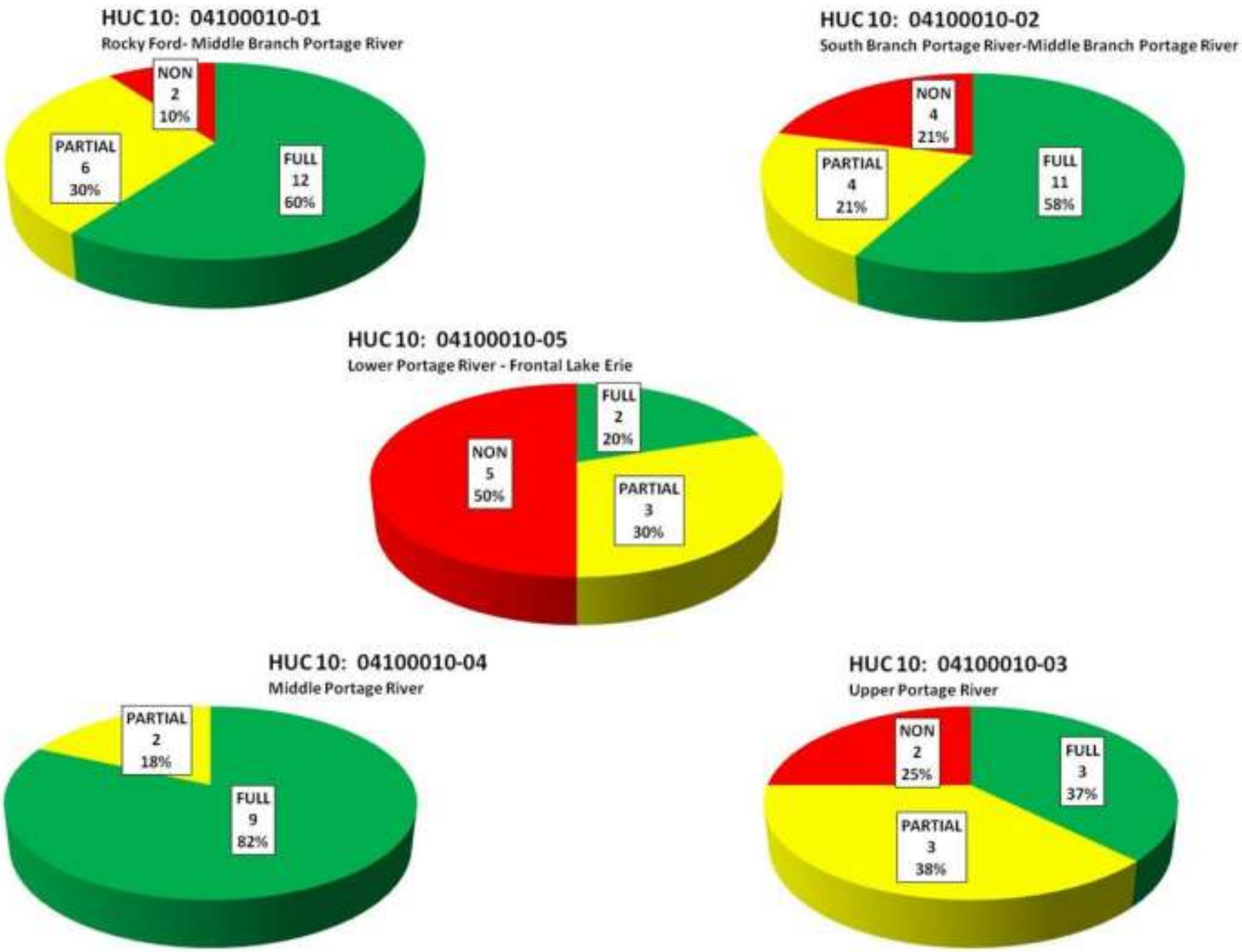

Figure B-1. Aquatic life use attainment for each of the four ten digit HUCs in the TMDL project area. Proportions are based on the number of sites assessed in that area.

B1.1 Causes and Sources of Impairment

The most significant cause of aquatic life use impairment is an excessive amount of fine sediment in the stream channel. In fact, 77 percent of just the impaired sites and 35 percent of all of the sites have sediment-related impairments. The effects of high nutrient loading and poor habitat quality each impact about half as many sites as those impaired by sediment amounting to 18 and 16 percent of all of the sites, respectively. Low flow conditions affected 12 percent of all sites which amounts to 26 percent of the impaired sites. Other causes of impairment include organic enrichment, low dissolved oxygen concentrations and high ammonia concentrations, PCBs in the channel sediment, high concentrations of dissolved solids and low pH. Each of these stressors impact less than six percent of the total number of sites surveyed. See Figure B-2 for a bar chart showing the distribution of these causes of aquatic life use impairment among the survey sites.

Sources associated with the causes of impairment described above include cropland run off and subsurface drainage in regard to sediment and nutrients. Channelization degrades habitat, diminishes assimilative capacity of the stream for sediment and nutrients and can exacerbate channel erosion. Other sources include inadequacies of central sewage collection and treatment systems, failing home septic systems, and manure run off from crop fields where it is land applied which contributes nutrients, organic materials (i.e., oxygen demanding substances) and ammonia. Industrial waste water is also causing impaired aquatic life due to degradation of water quality as well as accumulation of toxins in the channel sediment over years of operation. See Figure B-3 for a bar chart showing the distribution of these sources of aquatic life use impairment.

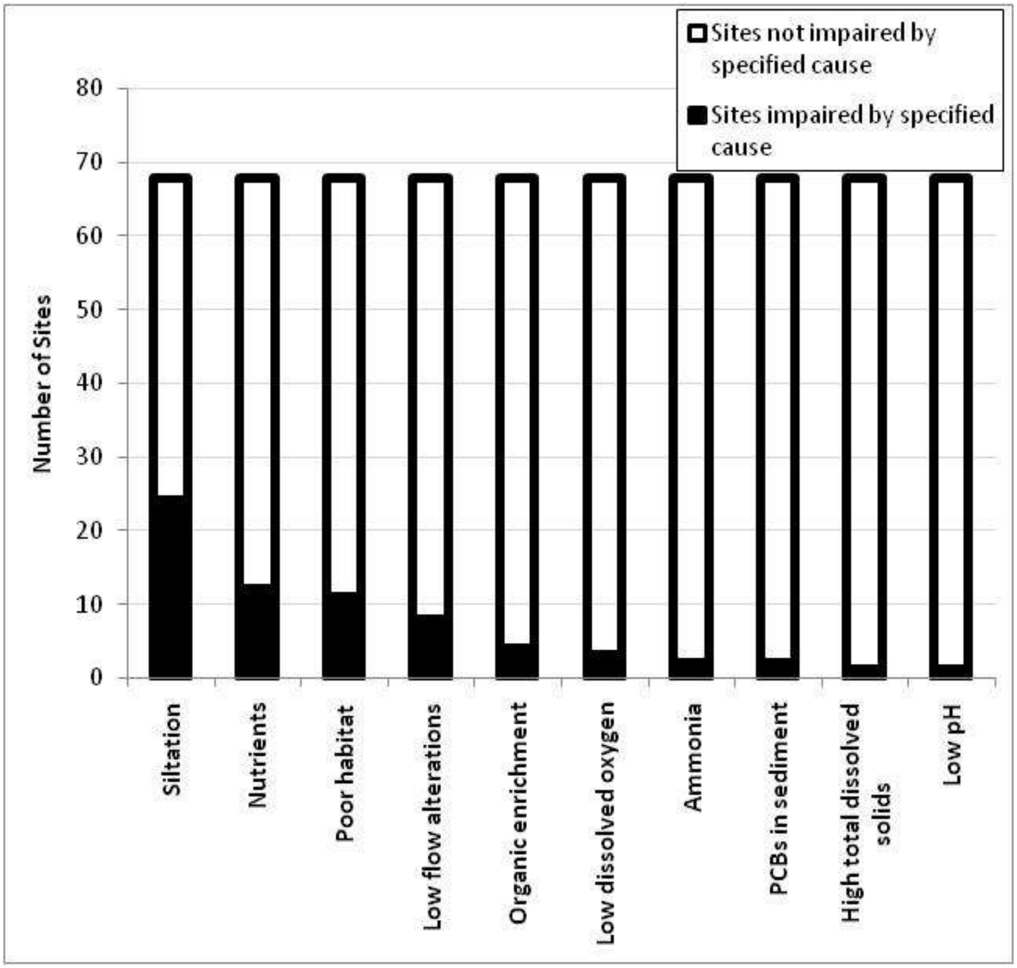

Figure B-2. Distribution of the causes of ALU impairment among sites surveyed throughout the entire TMDL project area.

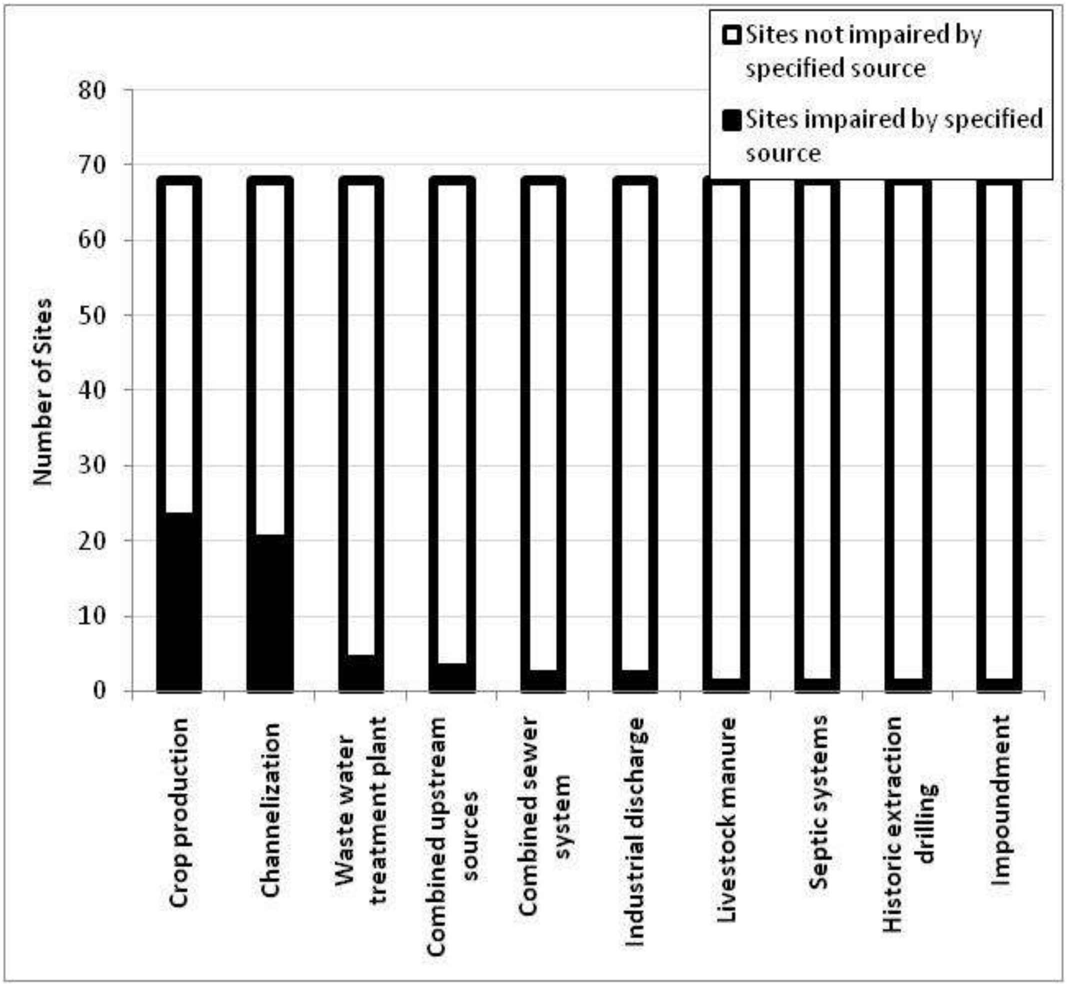

Figure B-3. Distribution of the sources of ALU impairment among sites surveyed throughout the entire TMDL project area.

B1.2 Water and Sediment Chemistry

Water Chemistry

Results from the survey showed nutrients and metals to be the most problematic. Of the two, the more severe and more widely distributed pollutants were nutrients, where total phosphorus, nitrate-nitrite, and ammonia each demonstrated elevated concentrations at a number of sites but, not necessarily in association with one another. Elevated concentrations of basic metals, such as aluminum, iron, copper, and strontium were observed at nearly 30 sites distributed throughout the watershed compared to the nearly 60 sites where all or some of the samples collected at each site showed elevated nutrient concentrations. Other pollutants that exceeded water quality target concentrations include pesticides, especially atrazine, but to a lesser degree simazine and alachlor.

Nutrients
Total phosphorus is the nutrient that is focused on in the development of nutrient TMDLs in the Portage River watershed because phosphorus is typically more limiting to primary production in freshwater systems. Likewise, total phosphorus is a more easily managed or controlled pollutant in terms of both point and nonpoint sources.

The following series of boxplots are based on sampling data that was collected during the field season of 2008, where most sites had five or six samples collected. A subset of sites had approximately ten samples collected to enhance the dataset at strategic locations in the basin (i.e., to facilitate loading analyses).

Figure B-4 shows boxplots which each represent the pooled water chemistry data within a 12-digit HUC based on sampling events that are not in immediate response to rainfall. This reflects normal to low flow conditions where point sources and internal loading have almost exclusive impact on the ambient nutrient concentrations. There are 384 observations or data points. These data indicate that the12-digit HUCs with waste water facilities that have a large discharge relative to normal stream flow have high ambient nutrient concentrations, namely the 01-01 (McComb WWTP), 02-02 (Fostoria WWTP), 03-01 (Bowling Green WWTP), and 04-01 (Gibsonburg WWTP). Most of the other 12-digit HUCs are near the water quality target in terms of the median and arithmetic average concentrations under lower flow conditions.

Figure B-5 shows the same information as Figure B-4 but instead only includes sampling events that follow rainfall (runoff influenced). In this case there are 38 observations. The median and arithmetic mean of the concentration is typically two to three times higher than the water quality target. These high flow concentration values that are observed are substantially higher than the observed concentrations under the lower flow conditions. The red dashed line in both figures is used as a frame of reference to help show the difference in concentration between these two groups of samples. Figures B-6 and B-7 further illustrate the differences between rain impacted events and events not impacted by rain by both pooled and paired comparisons, respectively. Figure B-8 presents the 12-digit HUC boxplots for the entire data set (419 observations from events both impacted and not impacted by rainfall).

A linear regression was performed to examine the influence of drainage area on ambient total phosphorus concentrations. There was a relatively small, but statistically significant correlation ($p < 0.05$; $R^2 = 0.02$) where concentration decreased with increasing drainage area. This relationship may be related to the disproportionate impact nonpoint sources have on ambient nutrient concentrations in smaller streams in this watershed where nonpoint sources are substantial. Also, there are several small point sources of phosphorus and some large sources that discharge to small tributary streams. This probably also has an impact on the relationship between total phosphorus concentrations and drainage area.

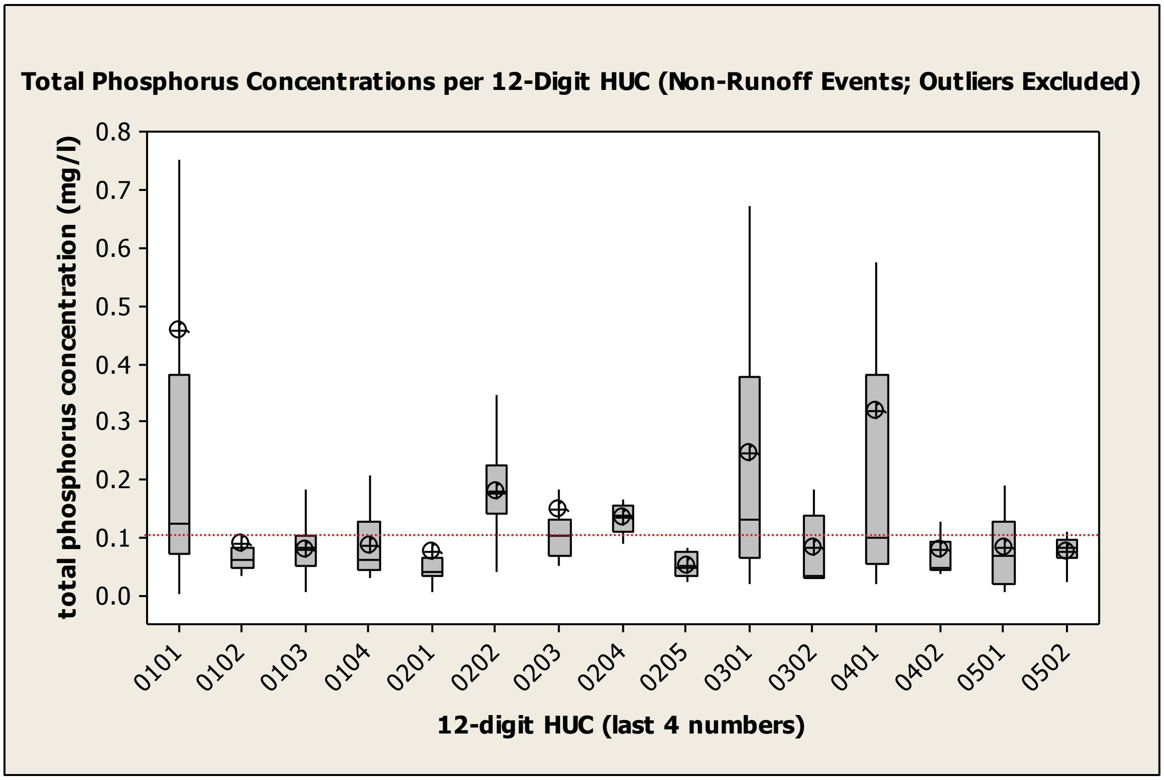

Figure B-4. Box and whisker plots for total phosphorus concentrations within the 12-digit HUCs for sampling events that do not immediately follow rainfall events.

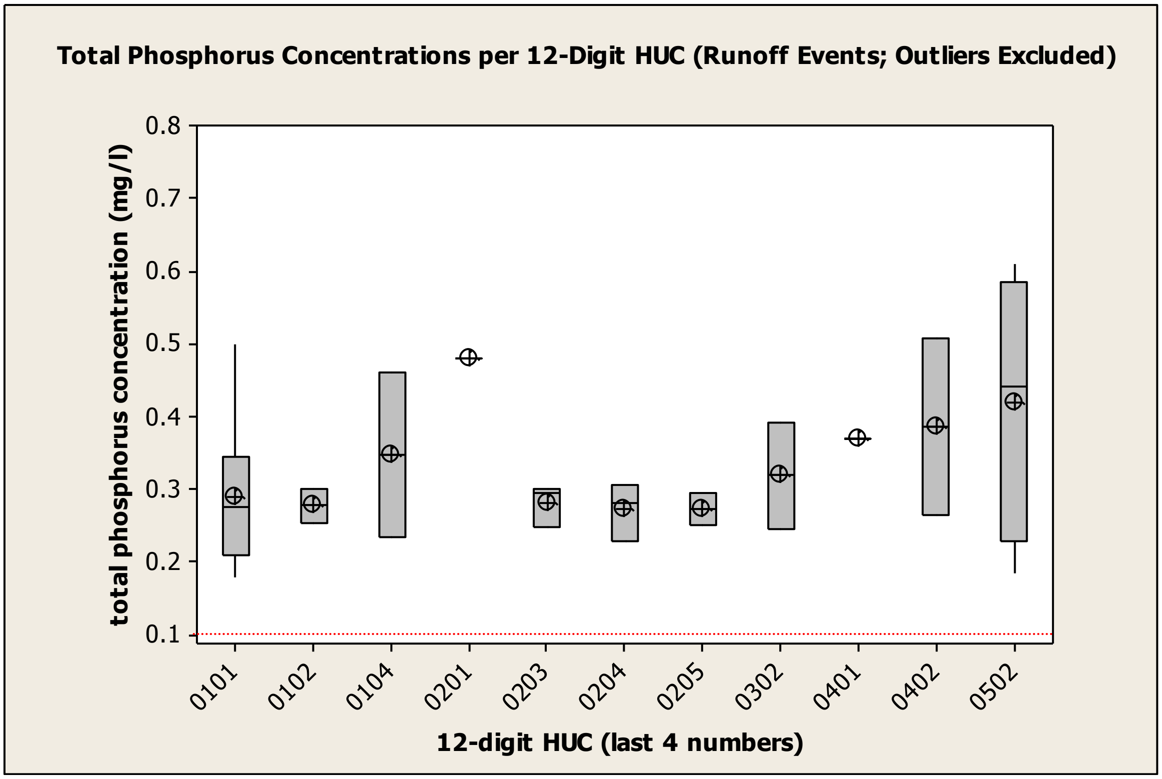

Figure B-5. Box and whisker plots for total phosphorus concentrations within the 12-digit HUCs for sampling events that immediately follow rainfall events.

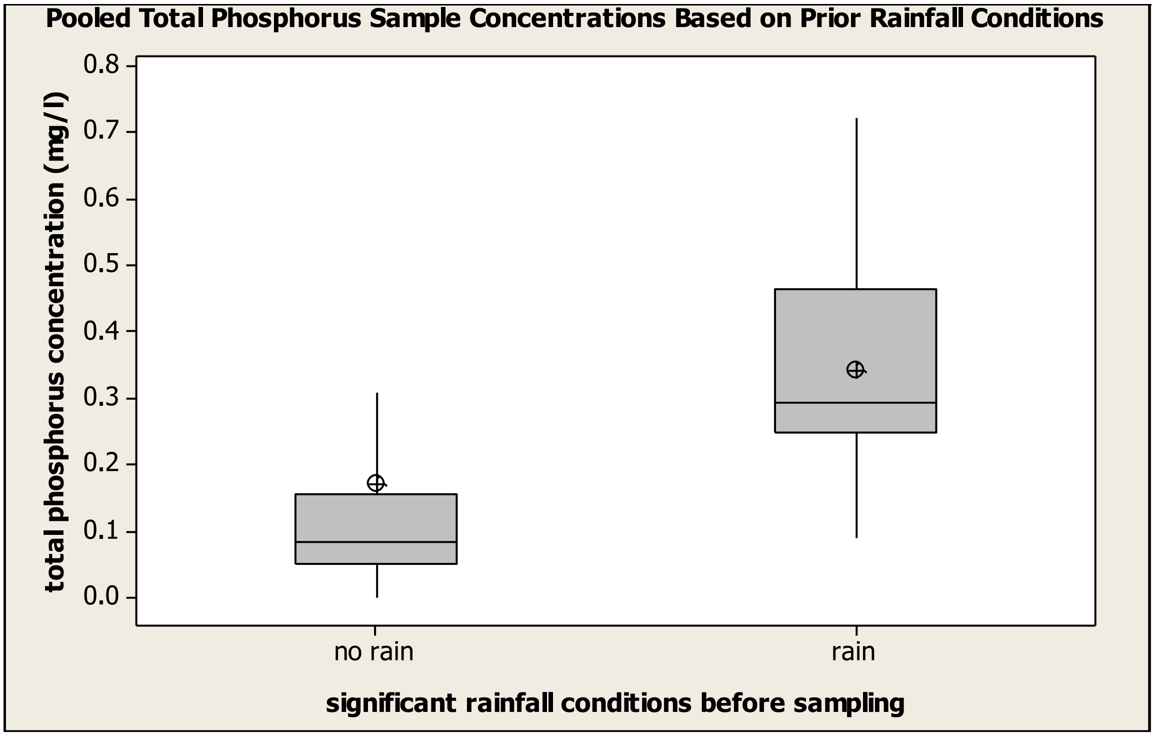

Figure B-6. Box and whisker plots for an analysis of variance for total phosphorus concentrations based on pooled samples discriminated on rainfall conditions prior to collecting the samples.

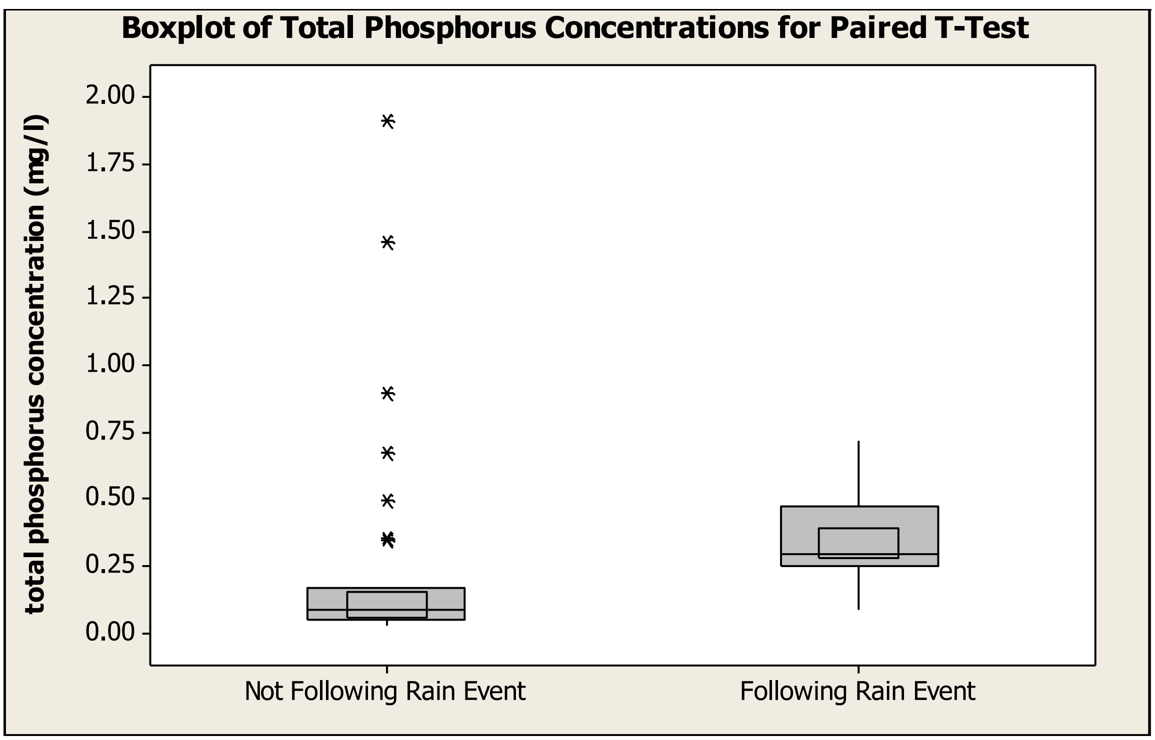

Figure B-7. Box and whisker plots for developed for a paired T-test for total phosphorus concentrations based on pooled samples discriminated on rainfall conditions prior to collecting the samples.

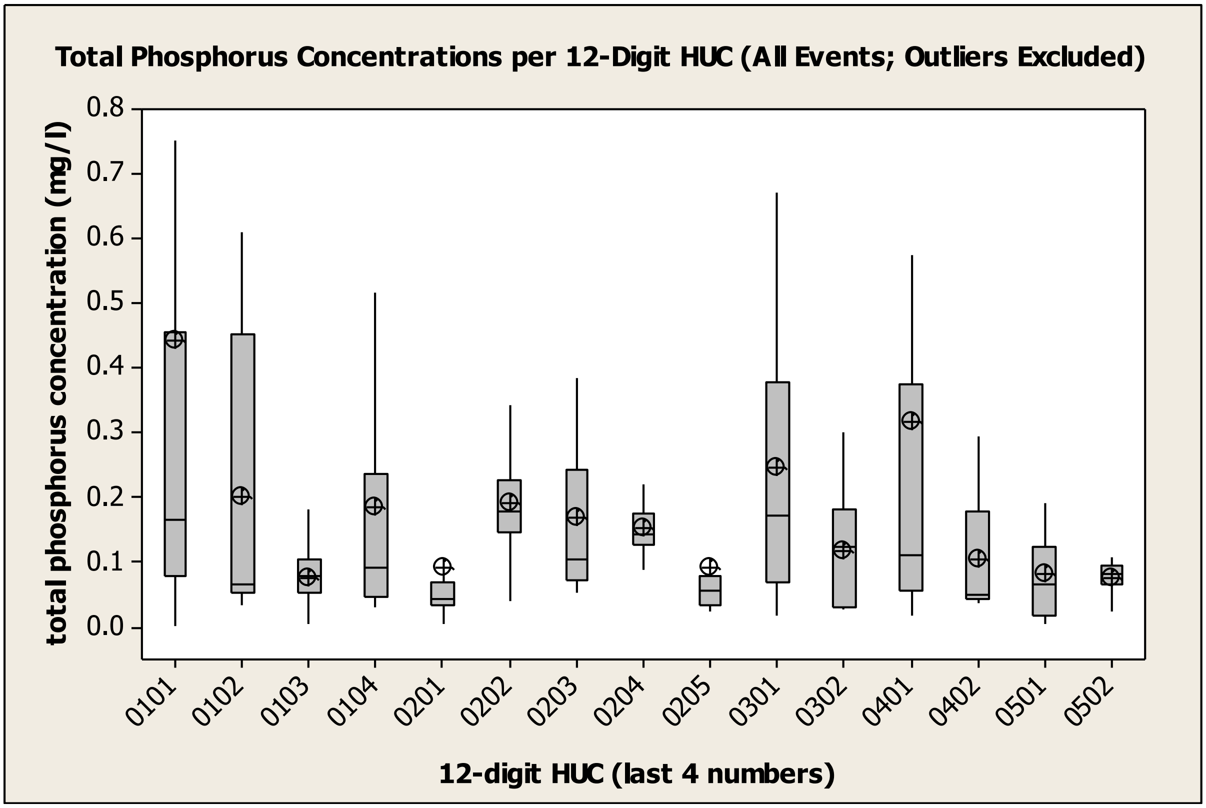

Figure B-8. Box and whisker plots for total phosphorus concentrations within the 12-digit HUCs for all sampling events.

Nitrate-nitrite concentrations were elevated above water quality targets for all flow conditions in nearly every 12-digit HUC. The concentrations observed were typically more than two times higher than the target, and often more than five times higher for samples collected in response to rainfall events. Figure B-9 presents a series of boxplots in which each represents the pooled data within a 12-digit HUC for events that are not in immediate response to rainfall. This reflects normal to low flow conditions where point sources and internal loading have almost exclusive impact on the ambient nutrient concentrations. There are 386 observations or data points. Like the concentrations observed for total phosphorus, the 02-02 and 03-01 12-digit HUCs showed the highest ambient concentrations, corresponding to receiving streams for Fostoria’s waste water treatment plant and Bowling Green’s waste water treatment plant, respectively.

Figures B-10 and B-11 provide a comparison of the pooled nitrate-nitrite concentration values for each HUC 12 based on prior rainfall conditions. Based on these two graphs nitrate-nitrite concentrations are generally a little more than twice as high under runoff response conditions and for the 01-04 and 01-01 HUCs as much as seven and four times as high, respectively. Figure B-12 is a boxplot representation of the pooled nitrate-nitrite concentrations throughout the entire project area discriminated on prior rainfall conditions. Despite what appear to be a substantial increase for both the mean and median for the rain impacted samples, there is no statistically significant difference between these groups. This is most likely attributable to the relatively small sample size (i.e., N=38) of the rain impacted sample group. Also, through linear regression analysis, it was shown that there is no appreciable relationship between ambient nitrate-nitrite concentrations and drainage area.

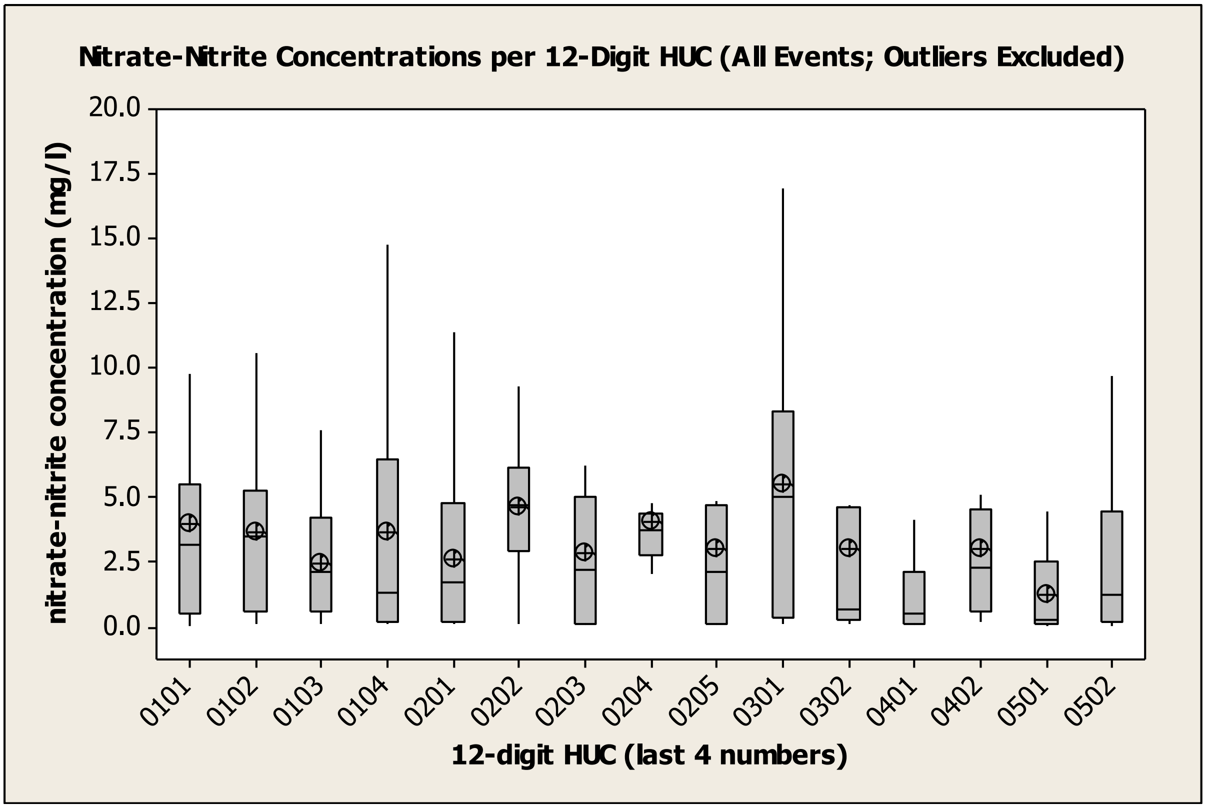

Figure B-9. Box and whisker plots for nitrate-nitrite concentrations within the 12-digit HUCs for all sampling events.

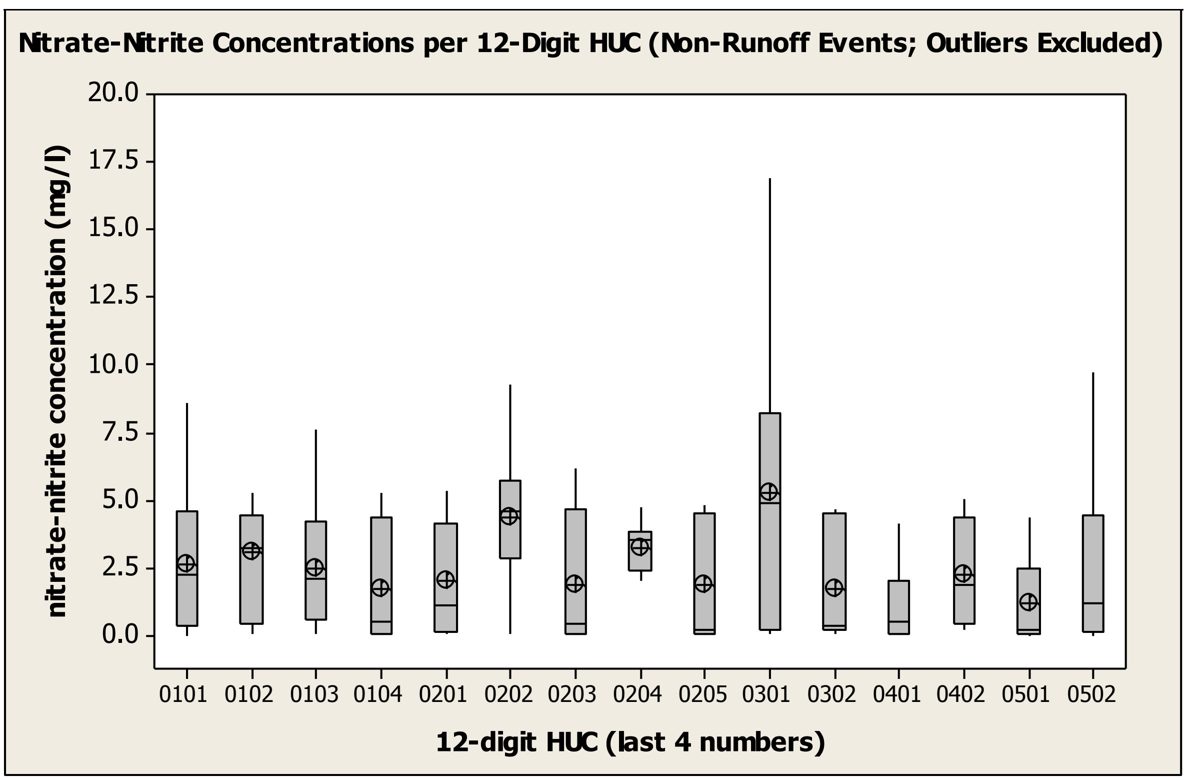

Figure B-10. Box and whisker plots for nitrate-nitrite concentrations within the 12-digit HUCs for sampling events that do not immediately follow rainfall events.

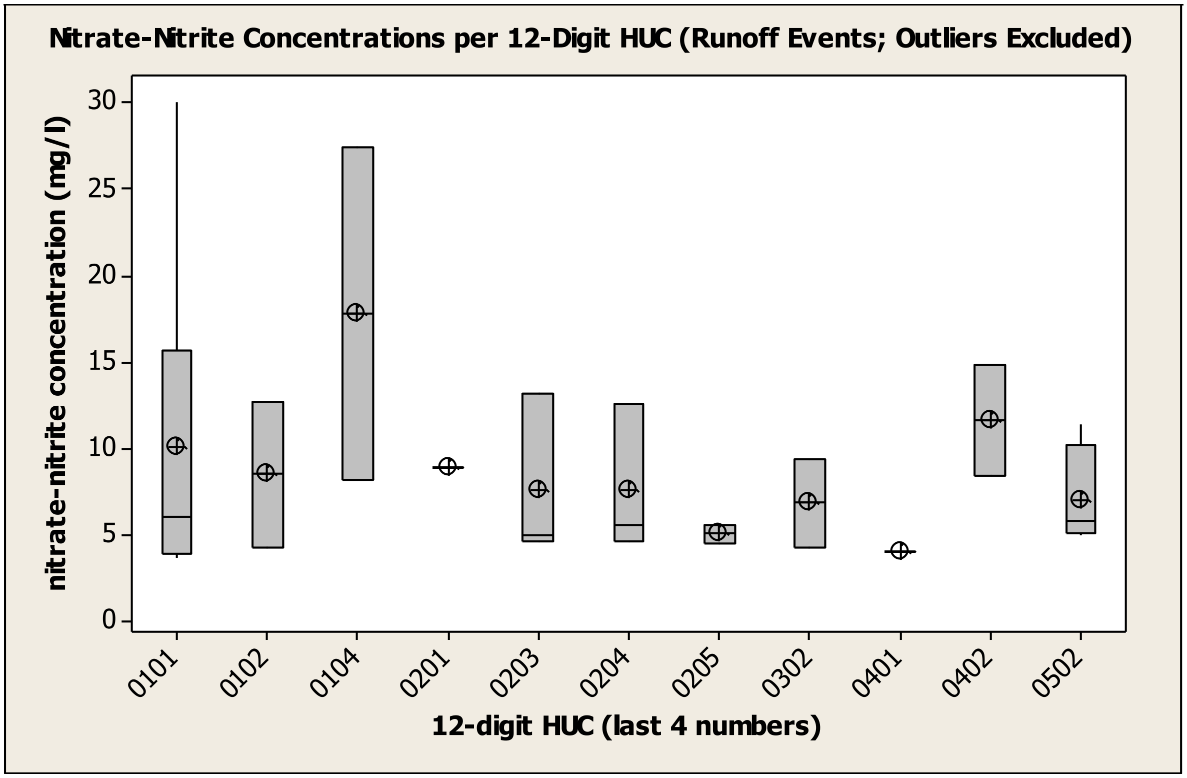

Figure B-11. Box and whisker plots for nitrate-nitrite concentrations within the 12-digit HUCs for sampling events that immediately follow rainfall events.

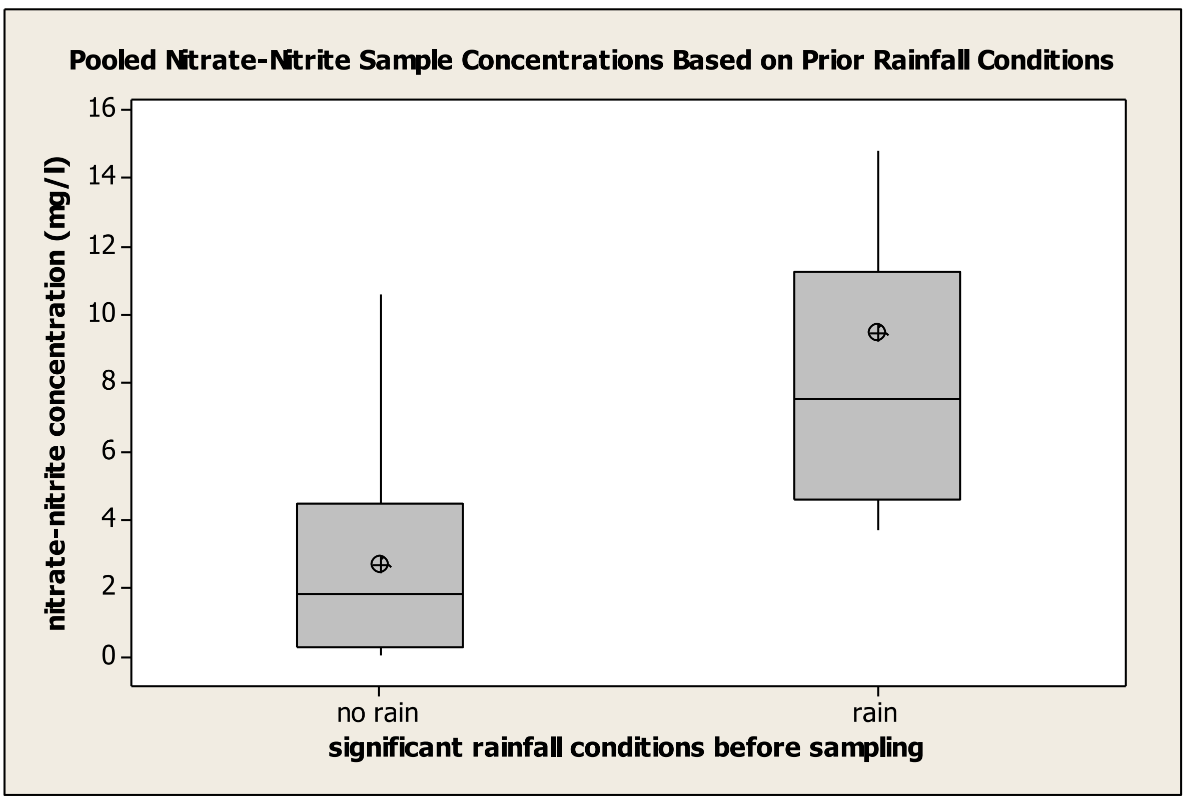

Figure B-12. Box and whisker plots for nitrate-nitrite concentrations pooled based on rainfall conditions just prior collecting the samples.

Sediment Chemistry

Sediment samples were collected at 19 sites in the Portage River basin. Samples were tested for select inorganics and metals, semi-volatile organics, and PCBs. Sediment quality was evaluated by comparing inorganics and metals results to the Ohio statewide or ecoregion specific Sediment Reference Values (SRV) (Ohio EPA, 2008). Additionally, the Consensus-Based Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) were also considered (MacDonald, et al., 2000). Organics and PCB results were compared to the TECs and PECs in the absence of specific sediment quality guidelines for these compounds in Ohio. Most of the organic compounds detected were polycyclic aromatic hydrocarbons (PAHs). PAH compounds are more common in urban areas and come from the incomplete combustion of fossil fuels.

B2 Recreation Use Attainment

Only ten (12%) of the sites surveyed met the recreation use criteria while the remaining 76 sites did not meet standards. Figure B-13 shows the distribution of sites that are attaining versus those that are not attaining criteria established for recreation uses. Figure B-14 shows recreation use attainment for sites along the larger streams in the project area which are more likely to be used for recreation. The following five figures are maps of the ten-digit HUCs and the attainment status of recreation and aquatic life uses at the respective survey sites. The five figures that follow the maps are bar charts of the geometric mean values of the *E. coli* concentration (as per colony forming units per 100 ml of sample) for each sample location in every ten-digit HUC. The standard deviation is also presented as a line graph in these figures.

Based on the bar charts, it is readily apparent that the water quality standards for *E. coli* concentrations are exceeded at the vast majority of the sites, often by an order of magnitude or more. However, the standards deviation is also very high (often several times larger than the geometric mean), which reflects the extreme variability in ambient concentrations of bacteria in streams and rivers.

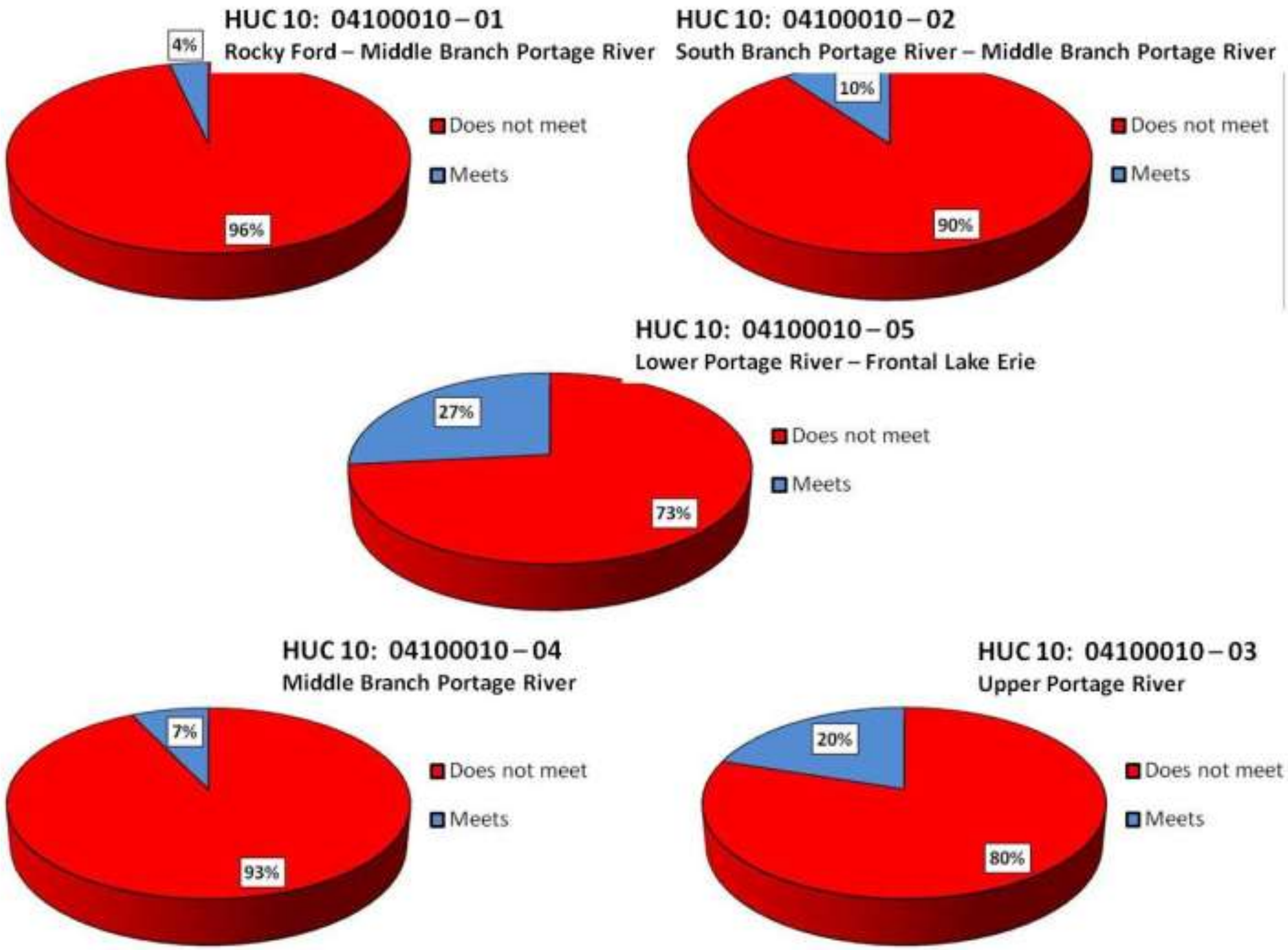

Figure B-13. Recreation use attainment for each of the five ten digit HUCs in the TMDL project area. Proportions are based on the number of sites assessed in that area.

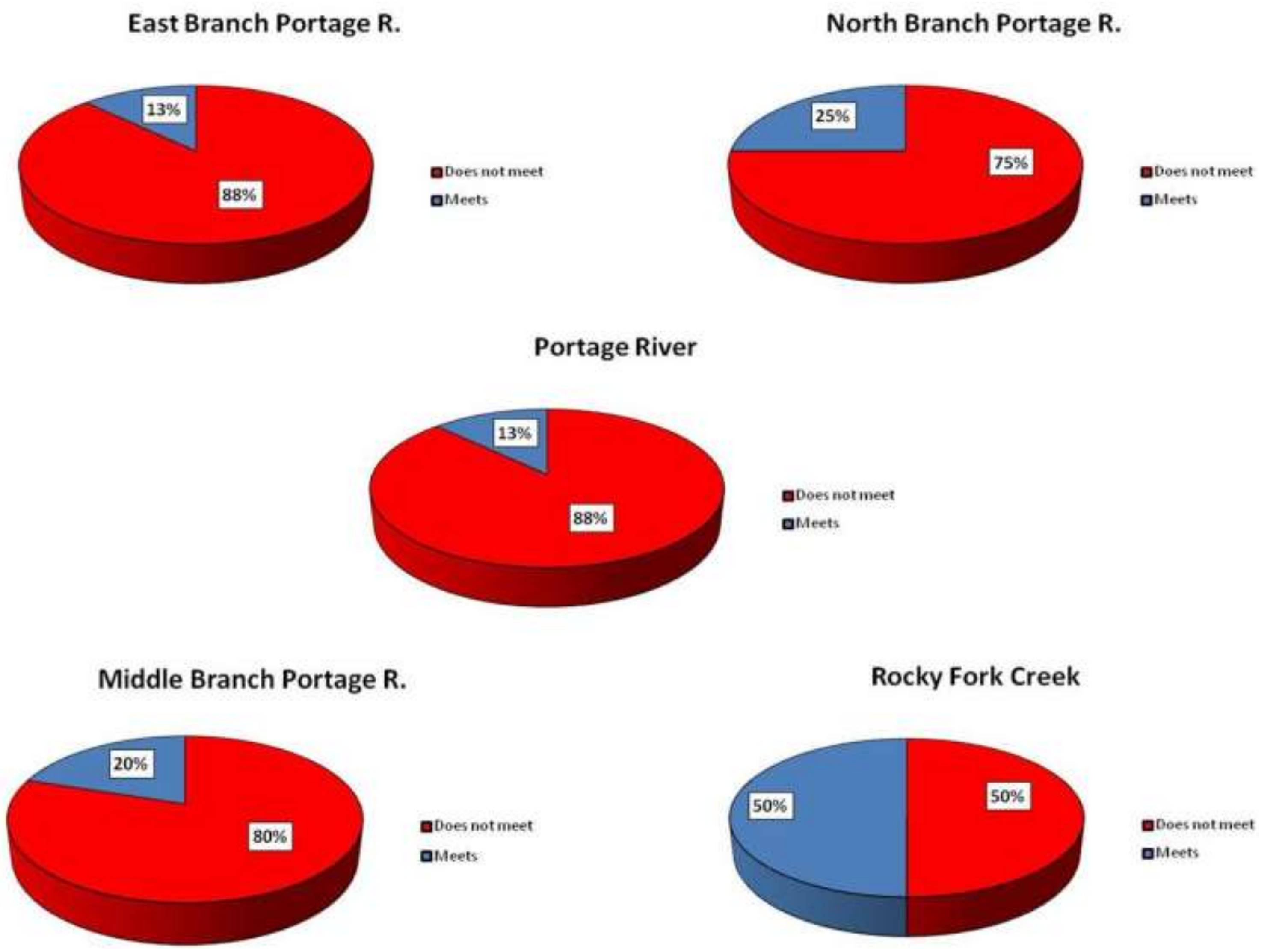

Figure B-14. Recreation use attainment for largest stream in the project area. Proportions are based on the number of sites assessed in that area.

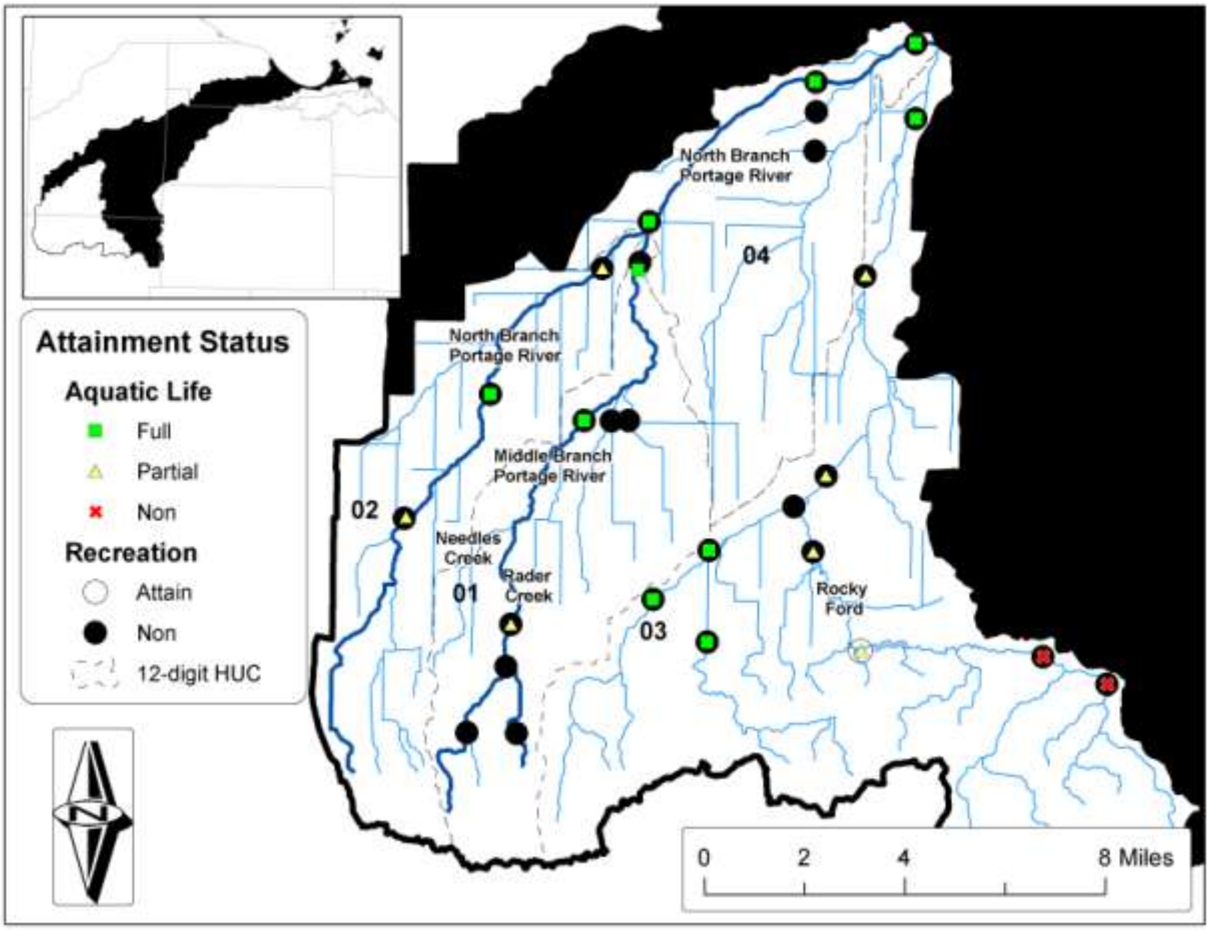

Figure B-15. HUC 04100010-01 aquatic life and recreation use attainment.

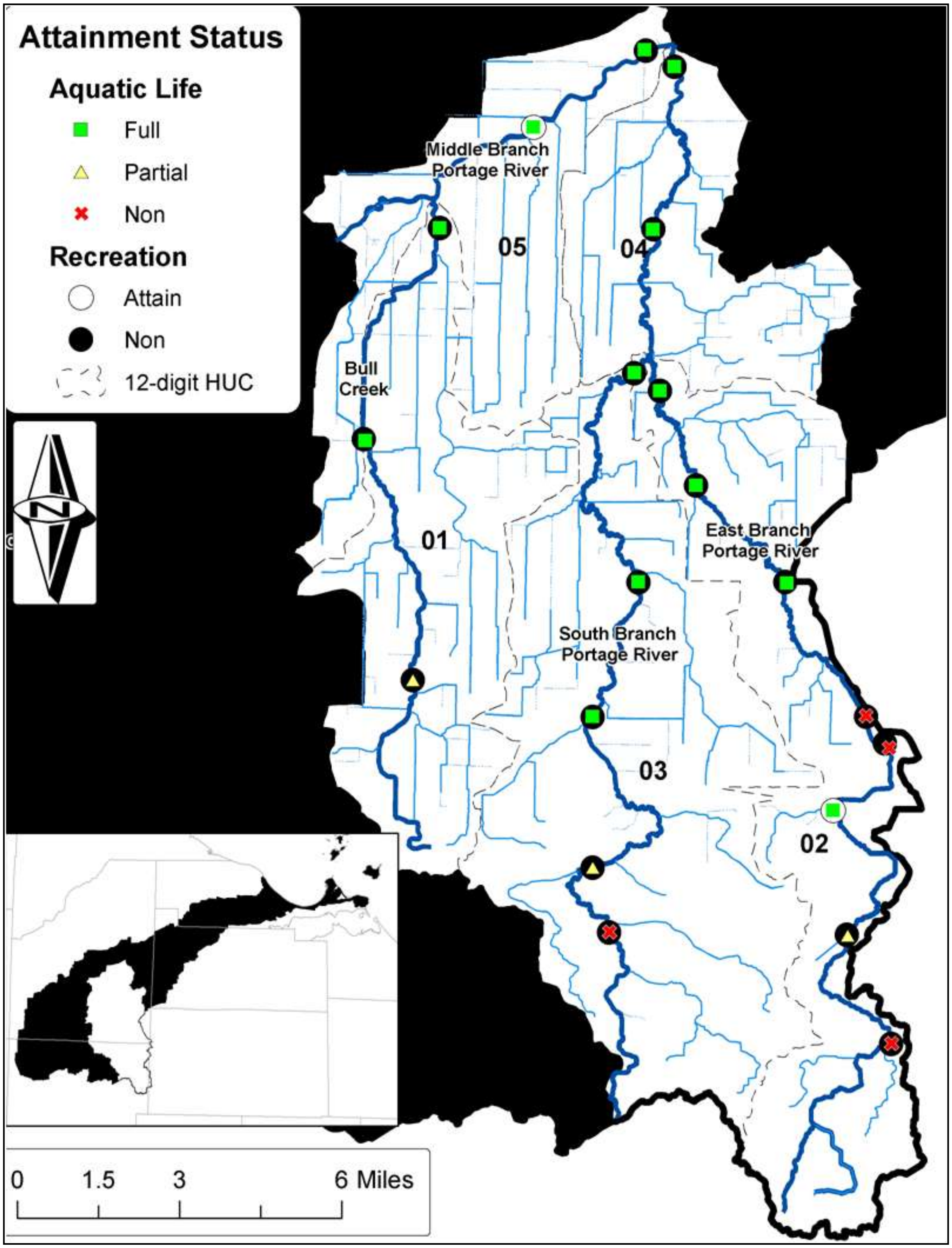

Figure B-16. HUC 04100010-02 aquatic life and recreation use attainment.

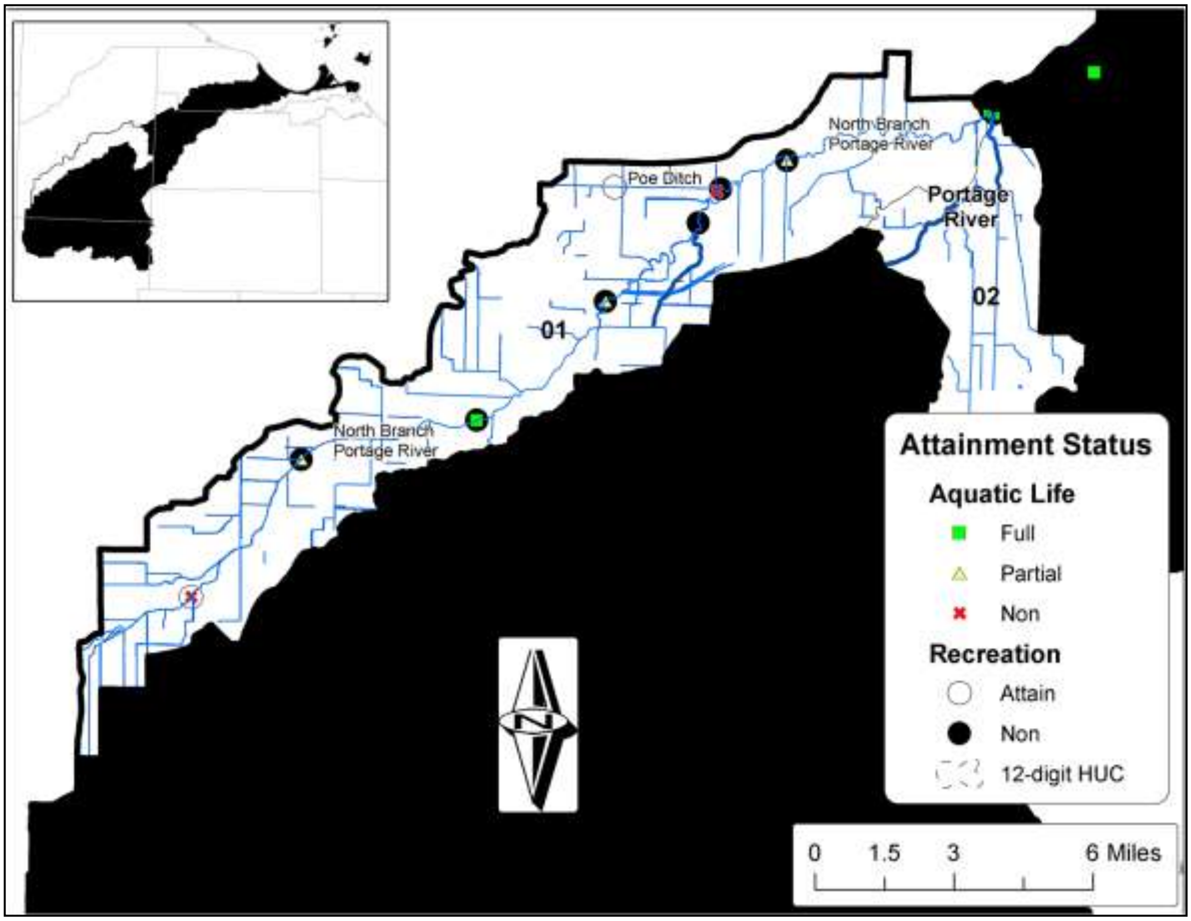

Figure B-17. HUC 04100010-03 aquatic life and recreation use attainment.

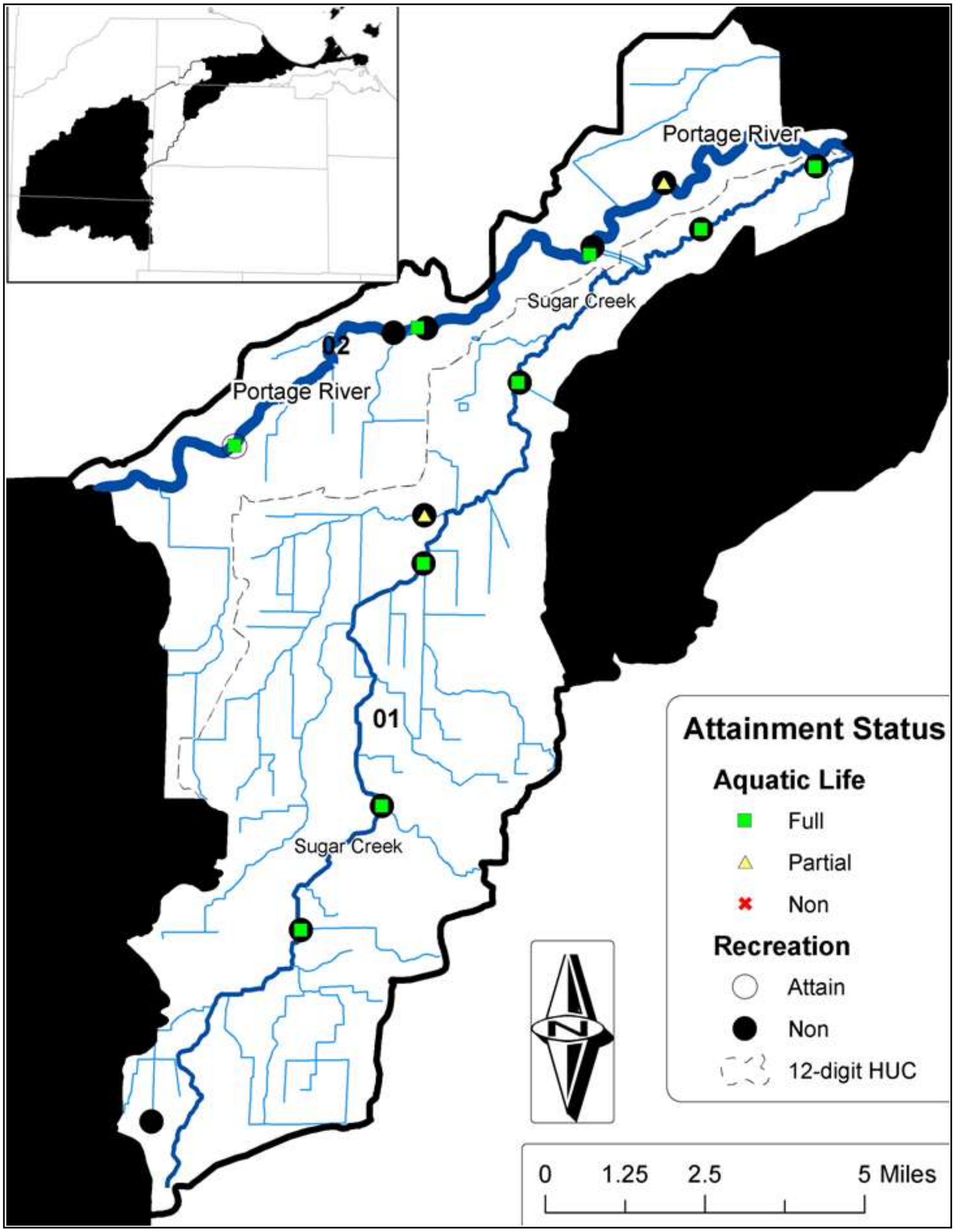

Figure B-18. HUC 04100010-04 aquatic life and recreation use attainment.

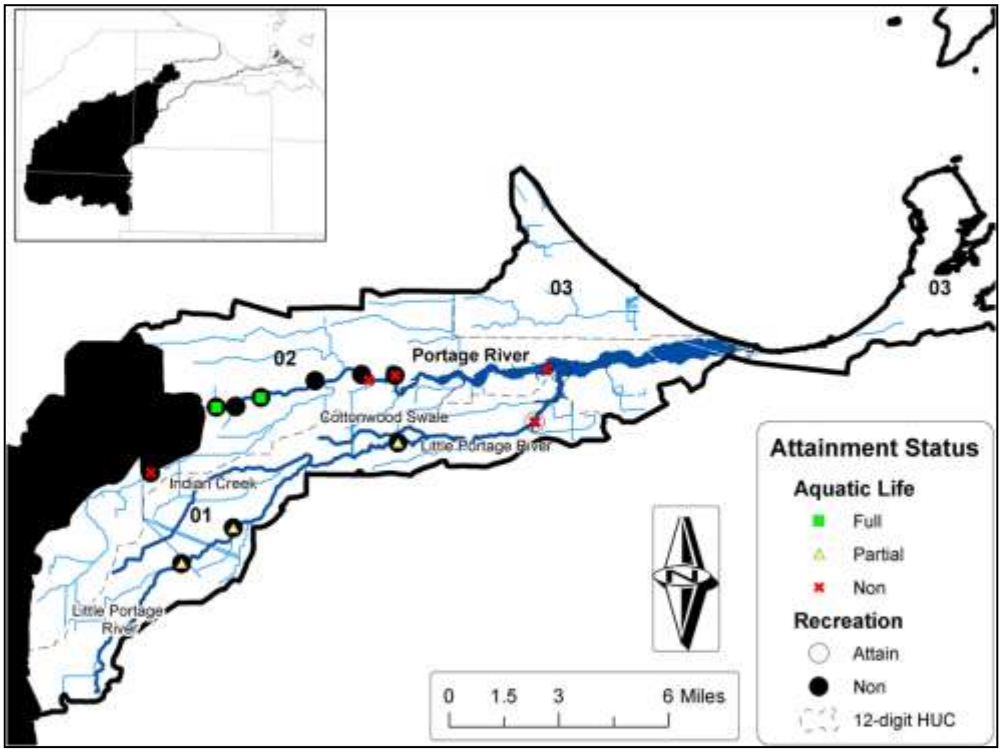

Figure B-19. HUC 04100010-05 aquatic life and recreation use attainment.

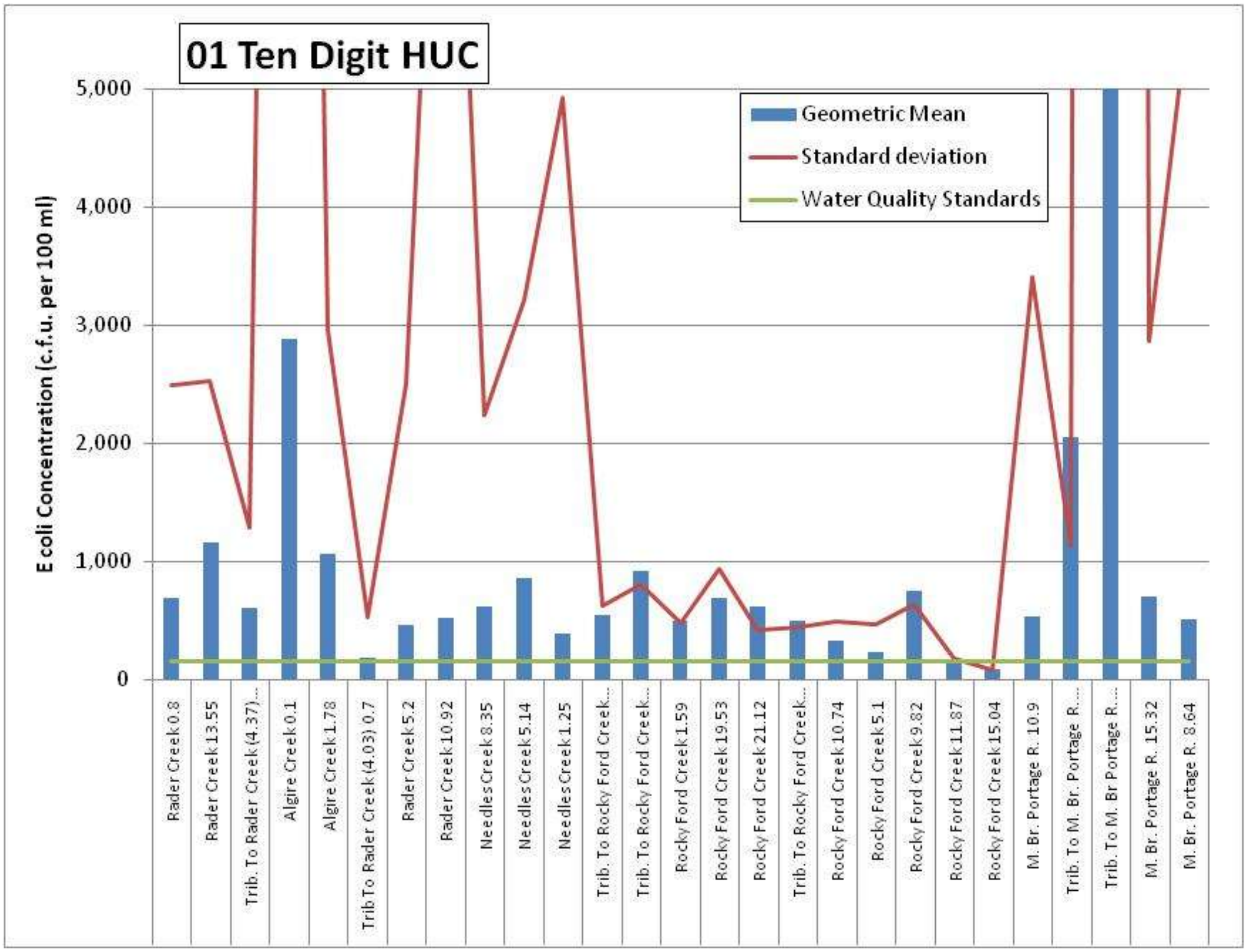

Figure B-20. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-01 watershed.

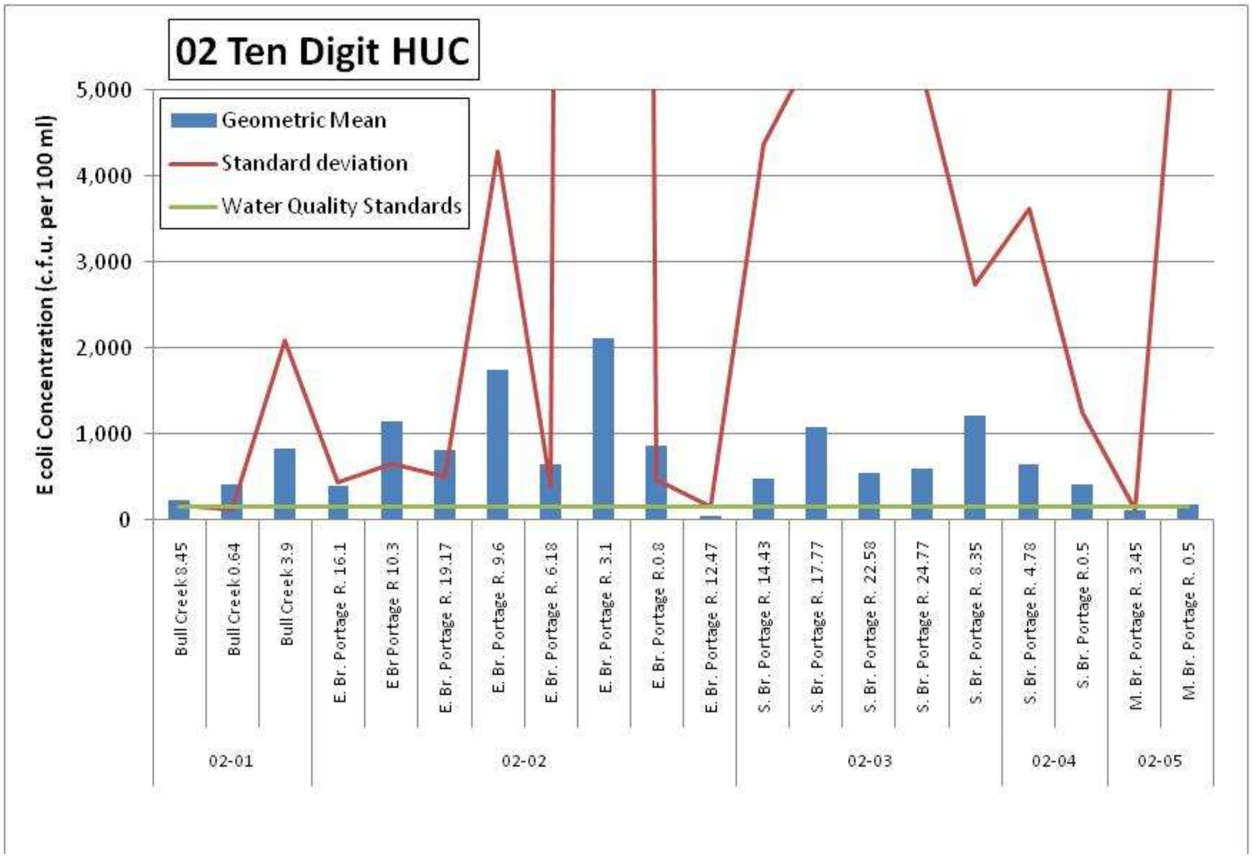

Figure B-21. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-02 watershed.

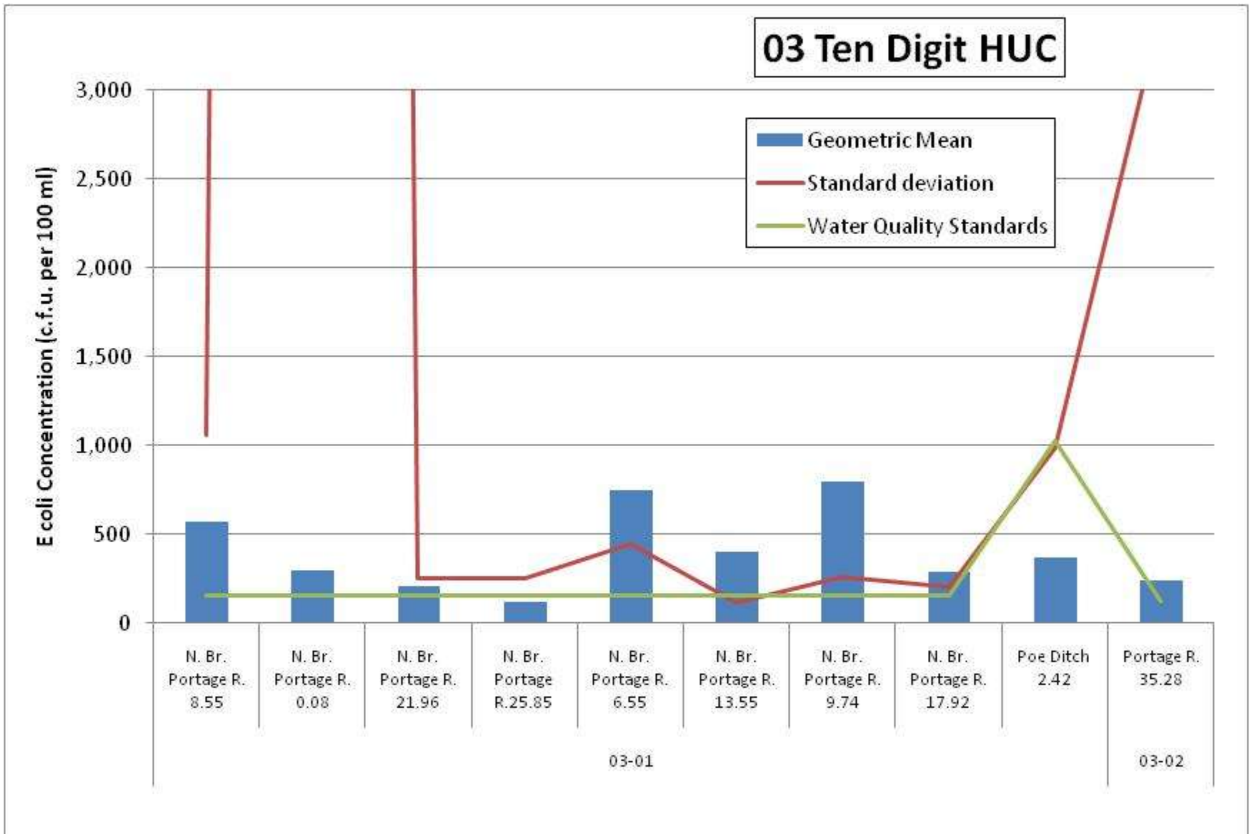

Figure B-22. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-03 watershed.

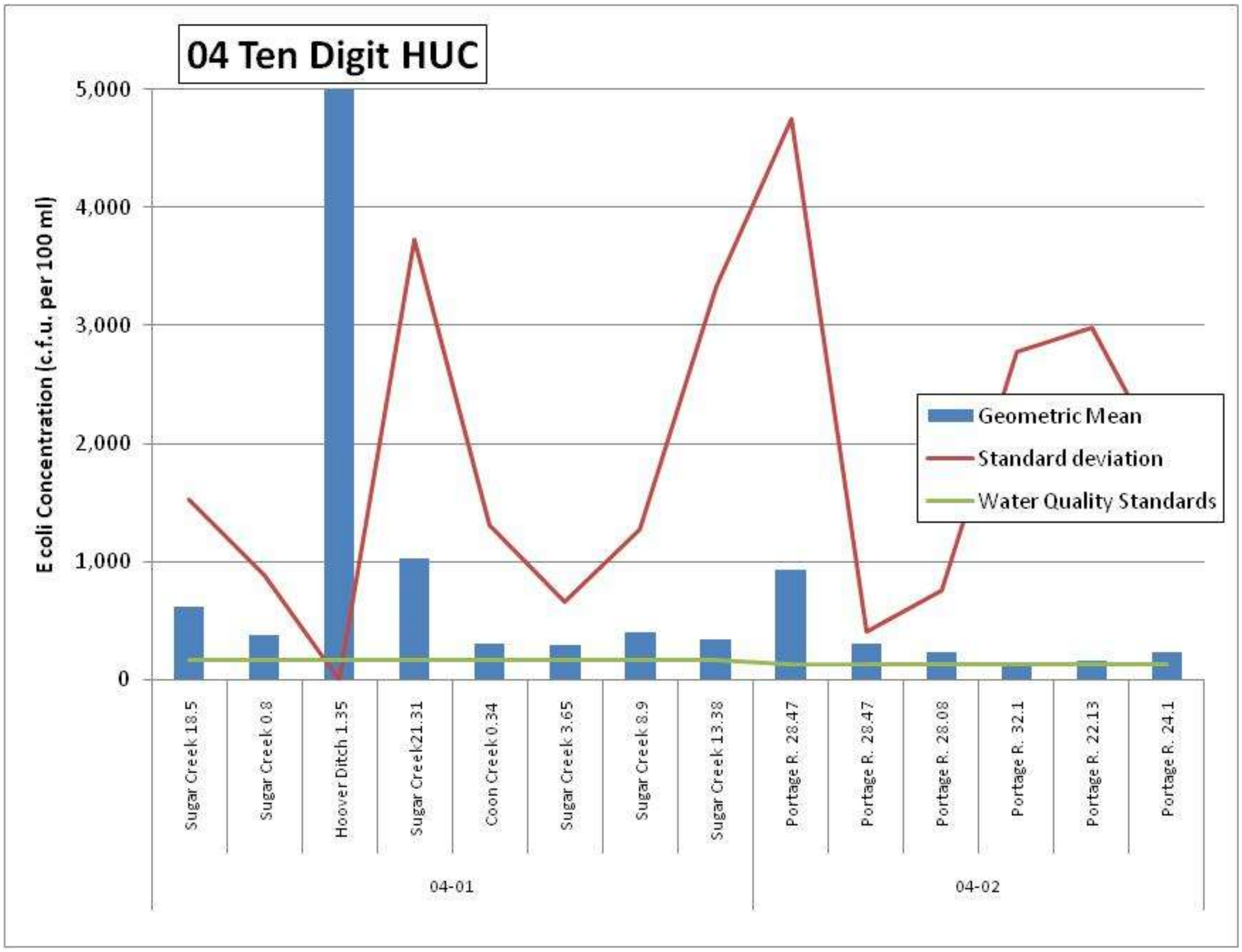

Figure B-23. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-04 watershed.

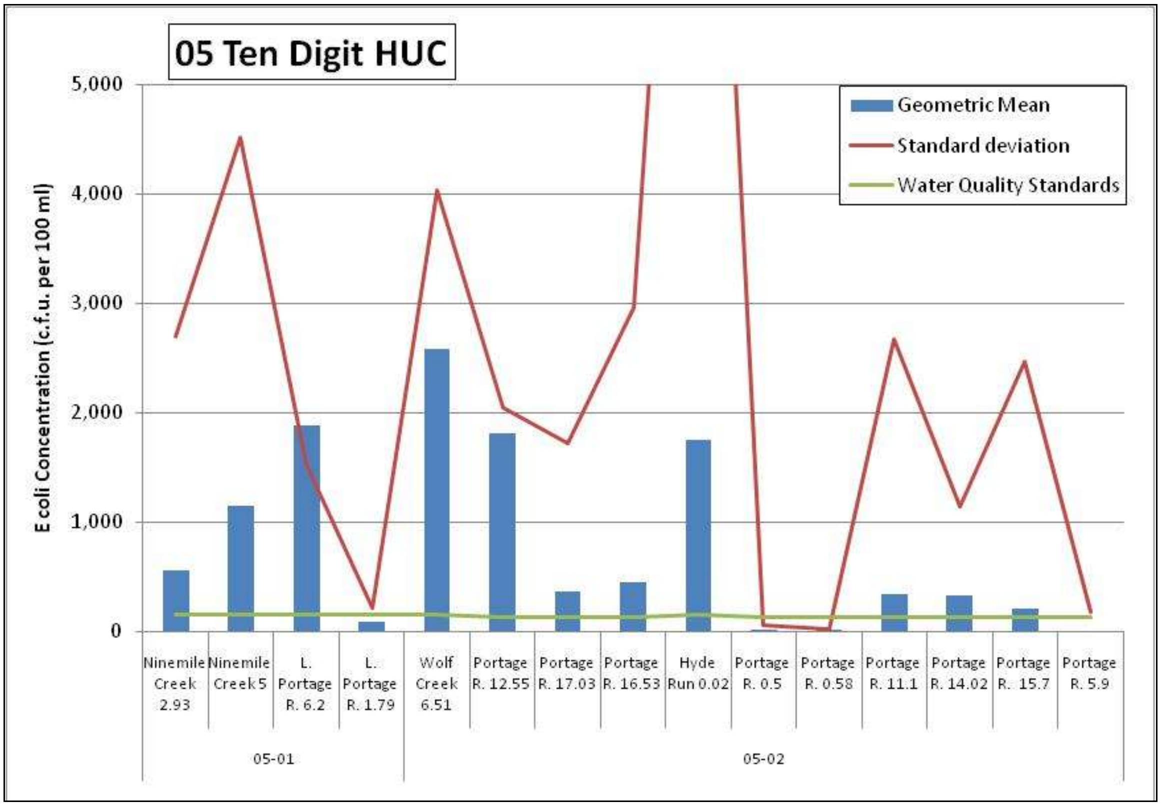

Figure B-24. Site by site geometric mean for *E. coli* concentrations for the 04100010-04 HUC.

The most substantial problem identified in the technical support document (Ohio EPA, 2010) is inadequately treated sewage from decentralized home sewage treatment systems. The majority of the recreation use impairments caused by high bacteria loading stem from this source; however, other sources include run off from cropland and urban areas, inadequately treated waste water, and overflows from combined sewer systems. Figure D-25 shows the distribution of sources of bacteria associated with recreation use impairments based on the technical support document (Ohio EPA, 2010).

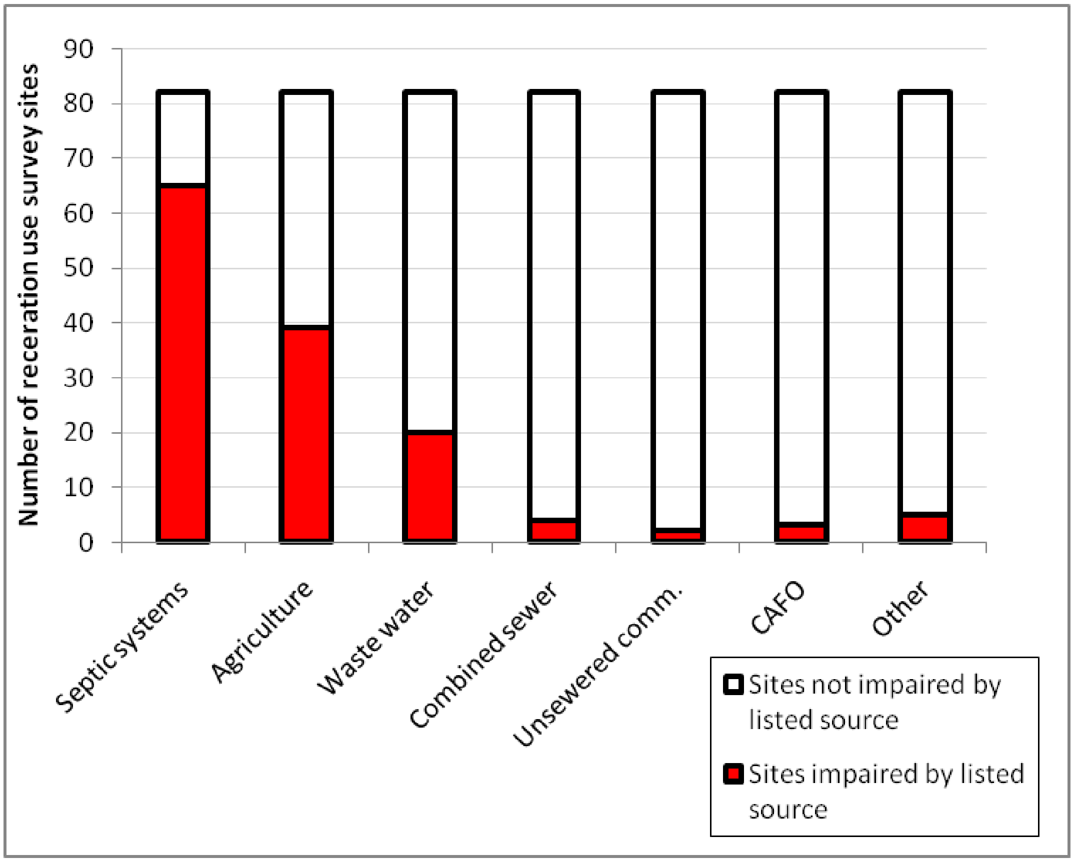

Figure B-25. Bar graph of the distribution of sources of impairment for RU impaired sites throughout the entire TMDL project area.

B3 Public Drinking Water Supply Use Attainment

There was not sufficient data available to evaluate attainment status of the three public drinking water suppliers in the Portage River watershed. For this reason no TMDLs are needed for Rader Creek (McComb Water Treatment Plant) in the 04100010- 01-01, 12-digit HUC; Rocky Fork Creek (North Baltimore Water Treatment Plant) in the 04100010- 01-03, 12-digit HUC; and East Branch Portage River (Fostoria Water Treatment Plant) in the 04100010- 02-02, 12-digit HUC.

Table B-1. Public drinking water supply use attainment.

Name/Community	Stream	Nitrate Status	Atrazine Status	Impairment (Y/N)
04100010 01 01 Rader Creek				
McComb	Rader Creek	Watch list	No listing	Insufficient data
04100010 01 03 Rocky Ford				
North Baltimore	Rocky Ford	Watch list	No listing	Insufficient data
04100010 02 02 East Branch Portage River				
Fostoria	East Branch Portage River	Watch list	No listing	Insufficient data

B4 Human Health Use Attainment

Three 12-digit HUC assessment units are impaired for human health uses based on concentrations of PCBs in the tissue of sport fish. These are the East Branch Portage River (04100010–02–02); North Branch Portage River (04100010–03–01); and Portage River (04100010–05–02). Six other 12-digit HUCs were not able to be evaluated due to insufficient data. Likewise, only one of four reservoirs in basin had sufficient data to make an attainment status determination. As such, the Veteran's Memorial Reservoir did not show impairment of human health uses. No TMDLs were developed to address the human health impairments in the Portage River watershed.

Table B-2. Human health (fish tissue) use attainment.

Waters Sampled	Impairment (Y/N)	Pollutants (Concentration)
04100010 02 02 East Branch Portage River		
East Branch Portage River	Y	PCBs (26 ppb)
04100010 03 01 North Branch Portage River		
North Branch Portage River	Y	PCBs (195 ppb)
04100010 05 02 Portage River		
Portage River	Y	PCBs (129 ppb)