State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Toussaint River Watershed

Final Report
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Acknowledgments

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1.0 INTRODUCTION

The Clean Water Act (CWA) Section 303(d) requires states, territories, and authorized tribes to list and prioritize waters for which technology based limits alone do not ensure attainment of water quality standards. The Section 303(d) list of impaired waters is made available to the public and submitted to the U.S. Environmental Protection Agency (USEPA) in even numbered years. The Ohio Environmental Protection Agency (Ohio EPA) identified the Toussaint Watershed as impaired in the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004).

The CWA also requires that Total Maximum Daily Loads (TMDLs) be calculated for all waters on the Section 303(d) lists. A TMDL calculates the maximum amount of pollution that a water body can receive and still meet water quality standards and an allocation of that amount to the various pollutant sources. The process of formulating TMDLs for specific pollutants is, therefore, a method by which impaired water body segments are identified and restoration solutions are developed. The ultimate goal of Ohio’s TMDL process is full attainment of biological and chemical Water Quality Standards (WQS) and subsequent removal of water body segments from the 303(d) list.

The Ohio EPA conducted a detailed assessment of the chemical, physical, biological, and bacterial quality of streams in the Toussaint Watershed in 2003. Results of this study are reported in the Biological and Water Quality Study of the Toussaint River and Rusha Creek Basins (Ohio EPA, 2005). Cause and source information was developed from the 2003 data after the 2004 Integrated Report was complete. The beneficial uses assessed for this report are aquatic life, recreation, and fish consumption. The main causes of impairment identified for TMDL development are organic enrichment/low dissolved oxygen, phosphorus, sedimentation, habitat alteration, flow alteration, and bacteria. Habitat alteration and low dissolved oxygen depletion are not load based quantities, but allocations for other impairing causes were calculated for these.

This report documents the Toussaint Watershed TMDL process and provides for tangible actions to restore and maintain this water body. The main objectives of the report are to describe the water quality and habitat condition of the Generic Watershed and to quantitatively assess the factors affecting non attainment or partial attainment of WQS. The Ohio EPA believes that developing TMDLs on a watershed basis is an effective approach towards meeting the goal of full attainment of WQS. As a result, water body conditions are summarized based on Watershed Assessment Units (WAUs) aligned with the 11-digit Hydrologic Unit Code (HUC) system and by Large River Assessment Units (LRAUs) for river segments that drain an area >500 mi^2. A summary of the 303(d) listed assessment units in this report is presented in Table 1.1 and maps of the watershed are displayed in Figure 1.1 and Figure 1.2. A flow schematic of point source discharges in the watershed is presented in Figure 1.3

Table 1.1 Summary of the 303(d) listed assessment units in this TMDL report.

HUC 11 Assessment Unit	Causes of Impairment	Included in this Report?	Comments
04100010 020	Enrichment/DO	Yes	Not a load based impairment, but allocations for other causes included
	Nutrients	Yes	
	Sedimentation	Yes	
	Habitat Alteration	Yes	

Figure 1.1 TMDL Study Area Map

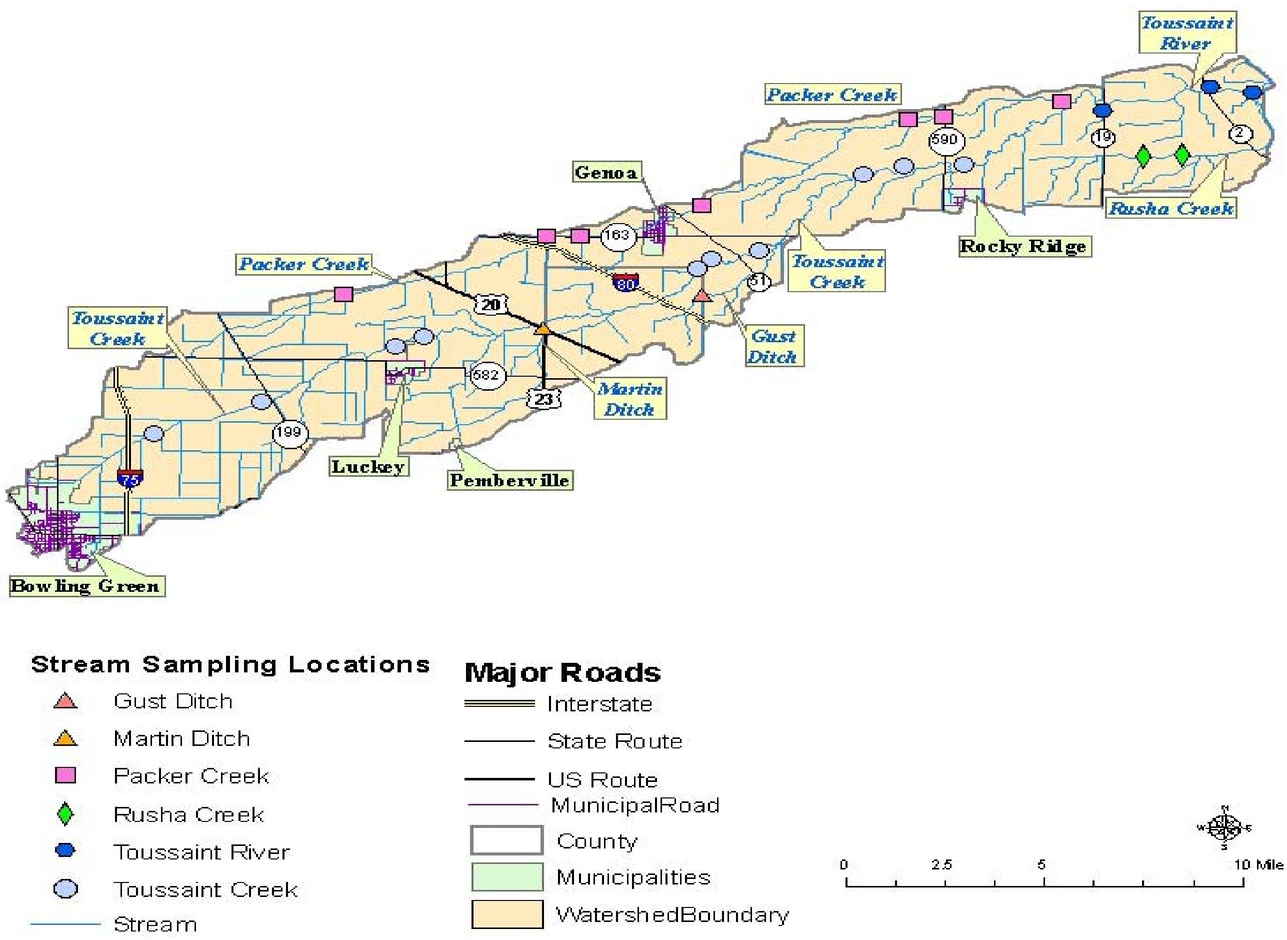


Figure 1.2 General Watershed map

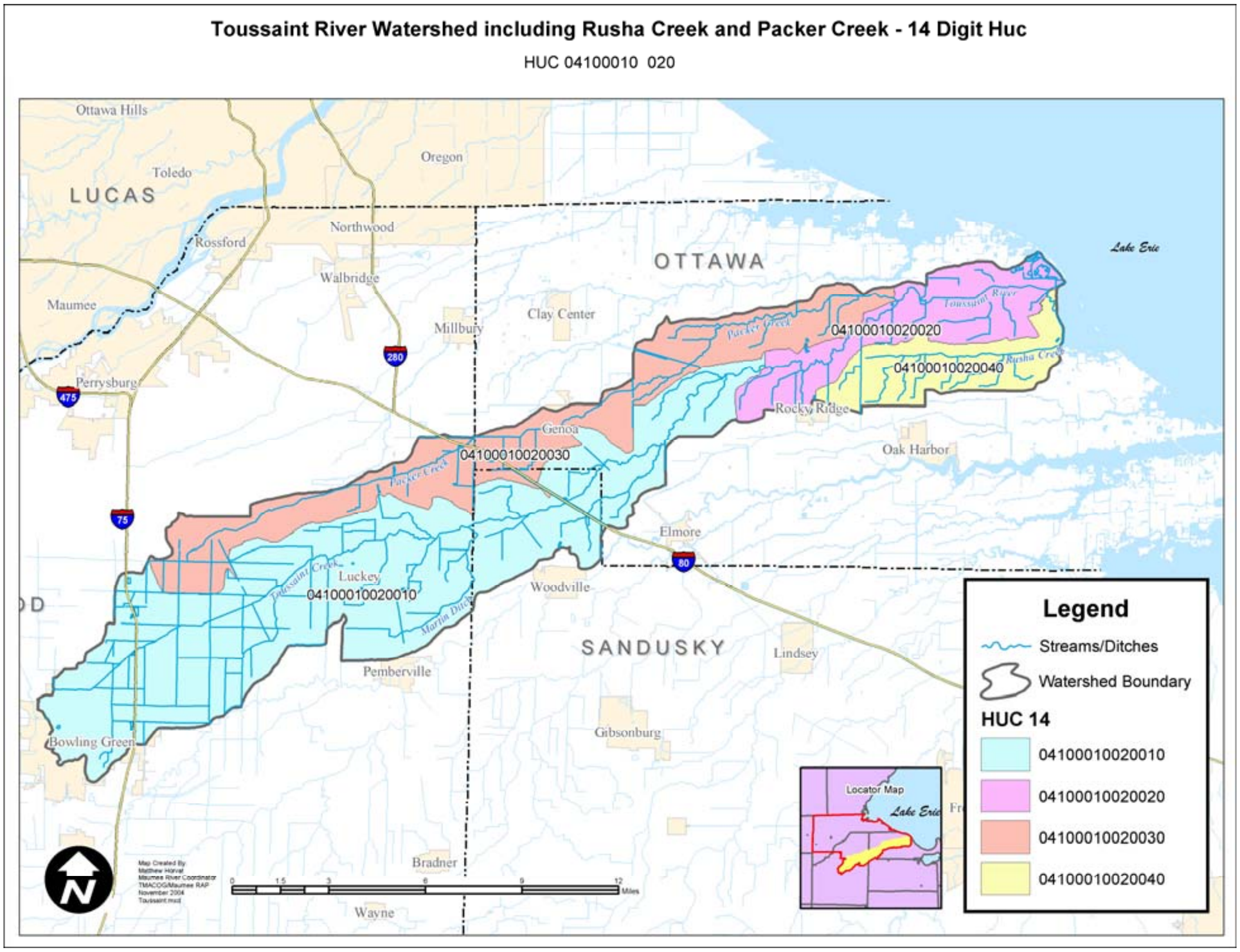
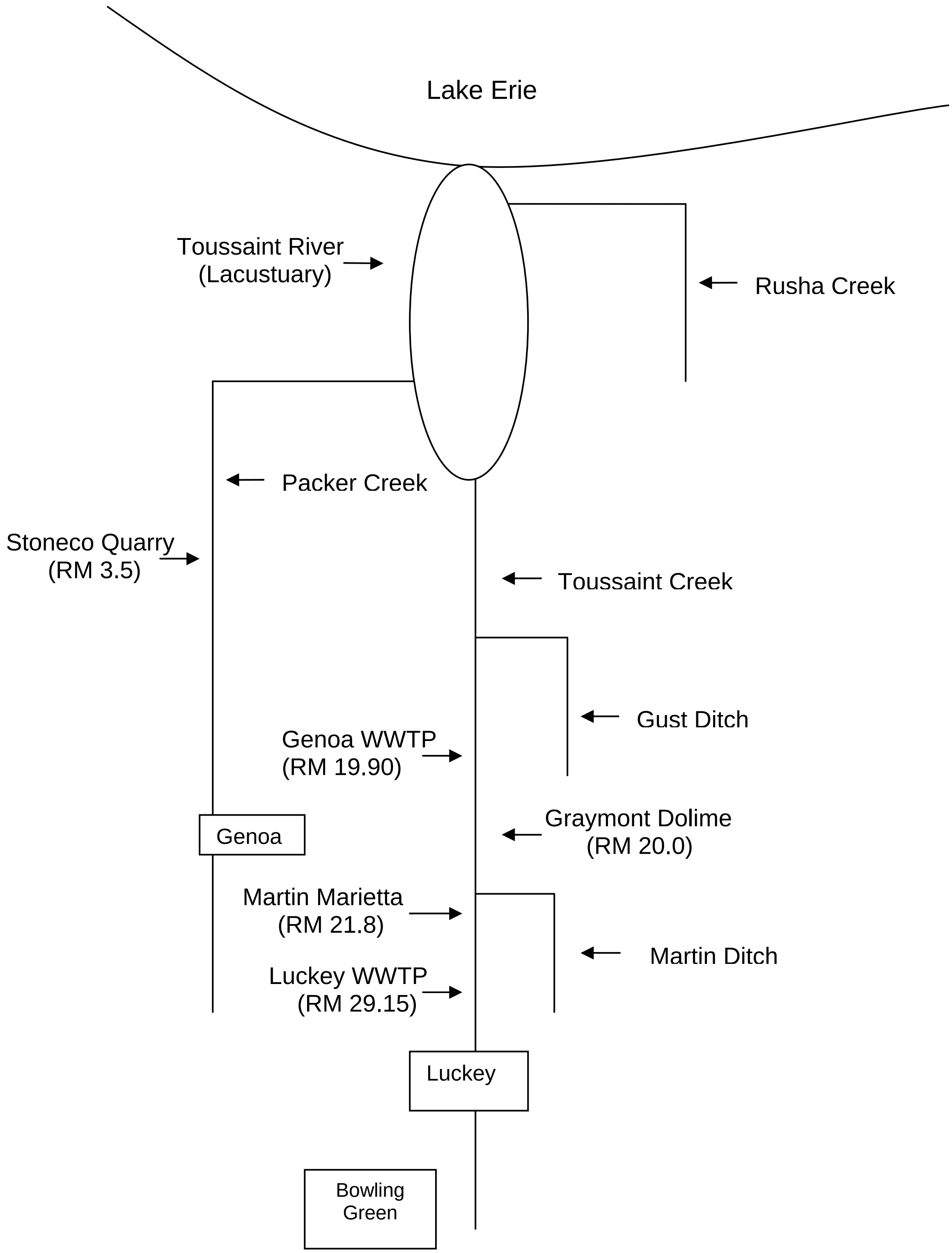


Figure 1.3 Flow Schematic of the Toussaint River Watershed



2.0 WATERBODY OVERVIEW

2.1 Description of the Study Area

The Toussaint River, Packer Creek and Rusha Creek watersheds are located in northwest Ohio in portions of Wood, Sandusky, and Ottawa counties that were formerly covered by the Black Swamp. The study area is designated as hydrologic unit code (HUC) 04100010-020 and includes the Toussaint River, Toussaint Creek, Packer Creek, Martin Ditch, Gust Ditch and Rusha Creek. The mainstem of the river is 37 miles long and flows from the north side of Bowling Green in Wood County, northeasterly through Luckey, Genoa, Rocky Ridge and on to Lake Erie through Carroll Township in Ottawa County. In the 2003 biological and water quality survey, 24 sites were assessed in the 143.1 square mile drainage area.

Upstream from its confluence with Packer Creek, the Toussaint has historically been considered a creek. The Toussaint widens as it reaches lake elevation downstream from Toussaint-Portage Road (river mile (RM) 4.7) in Ottawa County, where locally it becomes referred to as a river. For the purpose of biological assessment, Ohio EPA uses the term “lacustuary” to describe a riverine habitat that is affected by the intrusion of water levels from Lake Erie into tributary rivers and streams. In the 2003 sampling year, the Toussaint lacustuary zone comprised approximately the lower ten (10) miles of the watershed.

Several natural areas exist in the lower reach of the study area. One of these areas is the Toussaint Creek Wildlife Area which is managed by the Ohio Department of Natural Resources, Division of Wildlife http://www.dnr.state.oh.us/wildlife/pdf/pub56.pdf. In addition, the Ottawa National Wildlife Refuge, managed by the US Fish and Wildlife Service, encompasses several federal and state managed marshes and wildlife or recreation areas. These coastal wetlands extend along the Lake Erie shoreline from the eastern boundary of Lucas County to the mouth of the Toussaint River and serve as an important migration route for waterfowl, especially the American Black Duck. http://www.fws.gov/midwest/ottawa/ .

Additional coastal marsh areas are located on private property owned by Toledo Edison at the Davis Besse Nuclear Power Station. The 900 acre station has over 700 acres dedicated as a wildlife preserve.

Audubon Ohio and the Black Swamp Bird Observatory has conducted long-term monitoring of migratory bird populations in the Western Lake Erie Important Bird Area. The southwest shoreline of Lake Erie contains only four remaining segments of beach ridge west of Port Clinton, which is critical habitat for migratory passerine (perching and songbird) populations in the region. This important habitat is threatened by land use changes including development of marina and condominiums. For a map and more information on Important Bird Areas, please visit the Audubon Ohio web site at: http://www.audubonohio.org/bsc/ibas.html

2.1.1 Ecoregion and Geologic Characteristics

The study area is located entirely in the Huron-Erie Lake Plains (HELP) ecoregion, and more specifically the Maumee Lake Plains. The HELP ecoregion is a broad, fertile, nearly flat plain. When the Great Black Swamp was drained in the late 1800s, northwest Ohio settlers discovered very fertile soils under the deciduous swamp forests. Today most of the area has been cleared and artificially drained for agricultural crop production. Stream habitat and water quality have been degraded by channelization and agricultural activities. In the sub-ecoregion of the Maumee Lake plains, the soils originated from clayey lake deposits and water-worked glacial till. Because of the geologic history of this area and the current land use, Lake Erie water quality experiences high suspended sediment and nutrient loads from northern Ohio agricultural runoff. In the headwaters of Toussaint and Packer creeks, soils formed on water-worked glacial till and are predominantly of the Hoytville, Nappanee, and Blount series. In the lower portion of the study area, Toledo and Latty soils formed in the clayey lake deposits near Lake Erie.

2.1.2 Land Use Change

Until the early 1990’s, land use within the Toussaint River watershed was predominantly agricultural with 77% of the land in row crop production. Forest and pasture/hay land accounted for 5% and 11%, respectively, and only about 3% of the watershed had been developed in urban or residential land use. Additionally there was approximately 2% open water, and another 2% of land covered by marshes and reconstructed wetlands in the Ottawa National Wildlife Refuge and near the mouths of the Toussaint River and Rusha Creek (USGS-NLCD, 1992).

Figure 2.1 2003 Land Use Map

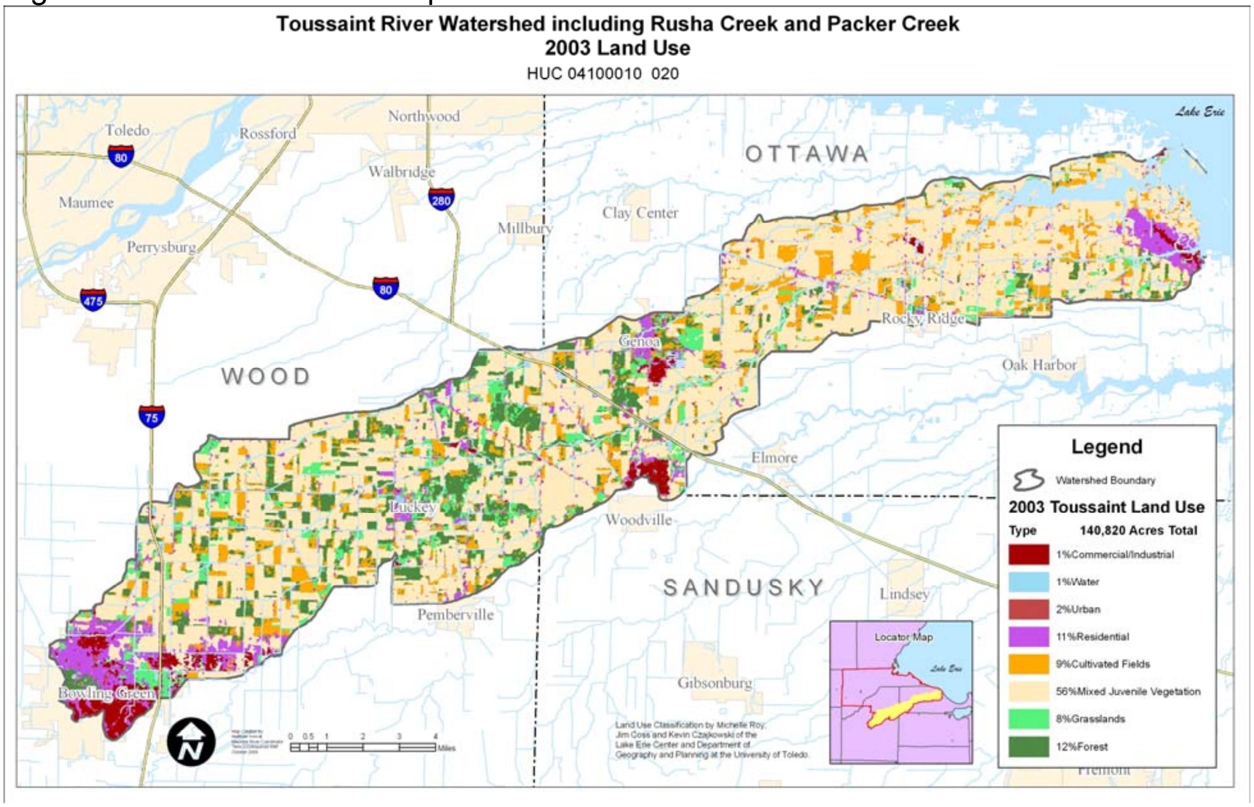


Figure 2.1 displays the 2003 land use classifications in a map produced by the University of Toledo for the Toussaint River watershed. Approximately 56 percent of the land is covered by mixed juvenile vegetation, and 9% cultivated crop land. The “mixed juvenile vegetation” type can be row crops in an early stage of growth, tracts of open space or yards. Forest and grassland account for 12 percent and 8 percent respectively. Nearly 11 percent of the watershed has now been developed for residential use, 2 percent for urban uses, and 1 percent for commercial/industrial uses. Marshes and reconstructed wetlands account for approximately 2% of land use.

According to the Census of Agriculture in 2002, land in agricultural use for either row crop or livestock production has been slowly declining since 1980. The number of farms has decreased, as has the number of livestock per operation. This watershed does not currently have any concentrated animal feeding operations over 1000 animal units. The decrease of land in crop production is due to rural development, and may also be reflected in land that has been taken out of production for conservation practices, such as riparian buffer strips, wetland and flood plain restorations (USDA, 1997; OSU Extension, 2002)

2.1.3 Regulated Point Source Discharges

Any entity that discharges to a surface water of the state must obtain a National Pollutant Discharge Elimination System (NPDES) permit from the Ohio EPA Division of

Surface Water. These permits limit the quantity of pollutants discharged and impose monitoring requirements and other conditions. The permits are designed to protect public health and the aquatic environment by helping to ensure compliance with state and federal regulations. Permits are classified as Individual and General.

2.1.4 Individual Permits

Individual permits are unique to each facility. The discharge limits imposed in the permit are based on the type of operation, volume of discharge, receiving stream characteristics, and other factors. Those entities regulated by an individual NPDES permit in the Toussaint River watershed are listed below in Table 2.1, which includes the location and type of discharge.

Table 2.1 Individual NPDES Permits

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Type of Treatment
Ernesto's Inc.	2PR00153	Genoa Storm Sewer	--------	extended aeration
Village of Genoa	2PB00008	Toussaint Creek	19.9	lagoon system/rock filter, polishing, aeration
Otterbein-Portage Valley Retirement Village	2PS00005	Toussaint Creek		extended aeration
Paradise Acres Camp & Pool	2PR00192	Toussaint Lacustuary		
Rocky Ridge Elementary	2PT00029	Kremke Ditch	1.05	extended aeration
Eastwood School WWTP	2PT00026	Trib. To Martin Ditch		extended aeration
Village of Luckey	2PA00080	Toussaint Creek	29.15	two controlled discharge lagoons
Alto US, Inc.	2II00033	Trib. To Toussaint Creek		storm water
Troy Energy, LLC	2IB00018	Trib. To Toussaint Creek		storm water, oil/water separator, sedimentation ponds
Uretech International	2IR00008	Trib. To Toussaint Creek	2.2	package plant, non-contact cool, storm water
Graymont Dolime, Inc.	2IJ00063	Trib. To Toussaint Creek	20.0	quarry water, process settling
Stoneco, Inc.-Rocky Ridge	2IJ00036	Trib. to Packer Creek		quarry water, process settling, storm water
USCO Distribution Services, Inc.	2IF00006	Rusha Creek	1.14	primary settling, aerated lagoon, stabilization
Martin Marietta Materials, Inc.	2IJ00040	Gust Sandwich Ditch	1.02	quarry dewatering, non-contact cooling, (two package plants /no discharge)

2.1.5 General Permits

General permits cover entities that have similar operations and types of discharges and that have a minimal affect on the environment. Types of discharges include;

- Industrial Stormwater- associated with an industrial activity and discharged from a point source, including through a municipal separate storm sewer system
- Construction Site Stormwater- associated with activities that disturb > 1 acre
- Non Contact Cooling- waters that remove heat from a process, but do not come in contact with raw materials, products, or other wastes
- Petroleum Corrective Action- associated with clean up of surface and groundwater exposed to gasoline or related products
- Small Sanitary Sources- systems that discharge < 25,000 gallons per day
- Coal Mines- associated with active coal strip mining
- Municipal Separate Storm Sewer System (MS4) - any public entity that owns or operates a separate storm sewer system

In December 1999, USEPA promulgated Phase II stormwater rules that required designated MS4 entities to submit permit applications. Phase II also required Ohio EPA to develop criteria to determine if MS4 entities with a population of 10,000 or more or a population density of 1,000/mi^2 must obtain permit coverage. Table 2.2 list those entities regulated by a general NPDES permit in the Toussaint River watershed.

2.1.6 Unsewered Areas

Home sewage treatment systems are found mainly in rural areas and small villages. One common system employs a septic tank followed by a leaching tile field. The septic tank is a concrete box that provides primary treatment. It allows solids to settle and also promotes some decomposition. Solids will eventually fill the tank and routine cleaning is necessary. Water that overflows from the septic tank is distributed to a leaching tile field. This consists of pipe laid in trenches of gravel and sand that the wastewater slowly seeps into. Tile fields require a sufficient land area with well drained soils for them to operate effectively and they have a short life span.

Home sewage treatment systems have minimal surface water impact if they are properly designed, installed, and maintained. Sometimes failed tile fields are bypassed into a storm sewer system or the nearest stream to prevent backing-up in yards and basements. The result of this is the presence of raw and poorly treated sewage in the stream, which can be a major source of impairment, especially if it occurs widely in larger communities and subdivisions. Communities lacking centralized wastewater treatment facilities have the potential to be substantial sources of untreated human sewage. Locust Point-Long Beach area, J & T Mobile Home Park, the villages of Rocky Ridge, Elliston, Graytown, Sugar Ridge, Dunbridge and Dowling are unsewered communities. Wood, Sandusky and Ottawa counties each have an approved Home Sewage Treatment System Plan which identifies critical areas and corrective actions for sewage problems in the Toussaint watershed.

Table 2.2 General NPDES Permits

Permitted Facility (Permit Number)	Receiving Stream	Type of Discharge
Ohio Turnpike Service Plaza # 3 (2GC00330)	Toussaint Creek	Construction Storm water
Ohio Turnpike Service Plaza # 3 (2GC00331)	Toussaint Creek	Construction Storm water
Blue Heron Service Plaza (2GU00074)	Toussaint Creek	Petroleum Corrective Action
Wyandot Service Plaza (2GU00075)	Toussaint Creek	Petroleum Corrective Action
Henry Filters Inc (2GR00318)	Toussaint Creek	Industrial Stormwater
Lamson & Sessions Company (2GR00341)	Unnamed Tributary Toussaint Creek	Industrial Stormwater
Lamson & Sessions Company (2GR00468)	Toussaint Creek	Industrial Stormwater
Seal Plant (2GG00079)	Toussaint Creek	Industrial Stormwater
Hose Plant (2GG00080)	Toussaint Creek	Industrial Stormwater
Capitol Plastics of Ohio Inc (2GR00140)	Unnamed Tributary Toussaint Creek	Industrial Stormwater
BP Site # 16400 (2GU00050)		Petroleum Corrective Action
Copper Tire & Rubber Co (2GG00080)	Toussaint Creek	Industrial Stormwater
Copper Tire & Rubber Co (2GG00079)	Toussaint Creek	Industrial Stormwater
Plant 14 (2GR00473)	Packer Creek	Industrial Stormwater
Fifth Third Bank (2GC00354)	Toussaint Creek	Construction Stormwater
OTT-2-3.0/5.03/6.96 (2GC00304)	Toussaint Creek	Construction Stormwater
Ohio Turnpike Maintenance Ramp (2GC00497)	Packer Creek	Construction Stormwater
WOO-20-11.05 (2GC00515)	Packer Creek	Construction Stormwater

2.2 Water Quality and Biological Assessment

Under the CWA, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimable/fishable" waters. A brief description of Ohio’s WQS is presented in Table 2.3. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (Ohio EPA, 1993).

Table 2.3. Summary of Ohio's Water Quality Standards.

Components	**Examples**	**Description**
Beneficial Use Designation	1. Water Supply • Public (drinking) • Agricultural • Industrial 2. Recreational Contact • Beaches (Bathing Waters) • Swimming (Primary Contact) • Wading (Secondary Contact) 3. Aquatic Life Habitats (partial list) • Exceptional Warmwater (EWH) • Warmwater (WWH) • Modified Warmwater (MWH) • Limited Resource Water (LRW)	Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water body in Ohio has a designated use or uses. However, not all uses apply to all waters (they are water body specific). Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent allowable concentrations of pollutants than would the average stream. Recreational uses indicate whether the water can potentially be used for swimming or if it may only be suitable for wading.
Numeric Criteria	1. Chemical	Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.
	2. Biological *Measures of fish health:* • Index of Biotic Integrity • Modified Index of Well Being *Measure of bug (macroinvertebrate) health:* • Invertebrate Community Index	Indicates the health of the instream biological community by using these three indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites. These criteria are the basis for determining aquatic life use attainment.
	3. Whole effluent Toxicity (WET)	Measures the harmful effect of an effluent on living organisms.
	4. Bacteriological	Represents the level of bacteria protective of the potential recreation use.
Narrative Criteria (a.k.a. Free Froms)	General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, and nutrients in concentrations that may cause algal blooms.	
Antidegradation Policy	This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need.	

Aquatic life use designations in the Toussaint River watershed include Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), and Limited Resource Water (LRW). Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms (note: a Coldwater Habitat is a trout stream). Waters designated as MWH are incapable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms due to permanent or persistent modifications to the physical habitat. Waters designated as LRW have been severely and irretrieveably altered such that no appreciable aquatic assemblage can persist.

To determine if aquatic life uses are being attained, fish and aquatic macroinvertebrate populations are measured and compared to established “biocriteria”, which employ multi-metric indices to determine quality. These biocriteria were established based on data gathered in areas demonstrating the lowest level of human impacts (least impacted areas) on the aquatic system for each respective eco-region and aquatic life use designation class within Ohio. Attainment benchmarks from these least impacted areas are established in the WQS and are compared to measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic macroinvertebrates: Invertebrate Community Index (ICI) the stream is considered in "non attainment". If the stream measurements achieve some of the biological criteria, but not others, the stream is said to be in "partial-attainment". A stream that is in "partial attainment" is not achieving its designated aquatic life use, whereas a stream that meets all of the biocriteria benchmarks is said to be in full attainment.

Another type of use in the WQS is for recreational purposes. The recreational use for the majority of the Toussaint River watershed is Primary Contact Recreation (PCR). This designation is appropriate for streams that have a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion, the Secondary Contact Recreation (SCR) use applies. Waters that are designated as Bathing Waters (BW) are suitable for swimming where a lifeguard and/or bathhouse facilities are present.

The method used by Ohio EPA to evaluate attainment of recreation uses is described in the 2004 Integrated Report (Ohio EPA, 2004). Fecal coliform were used as the indicator organism and an assessment unit is considered impaired if, when all the raw data are pooled, the 75^{th} percentile value exceeded the primary contact recreation (PCR) geometric mean criterion (1000 CFU/100 ml) or the 90^{th} percentile value exceeded the PCR single sample maximum criterion (2000 CFU/100 ml).

2.2.1 Aquatic Life Use Attainment

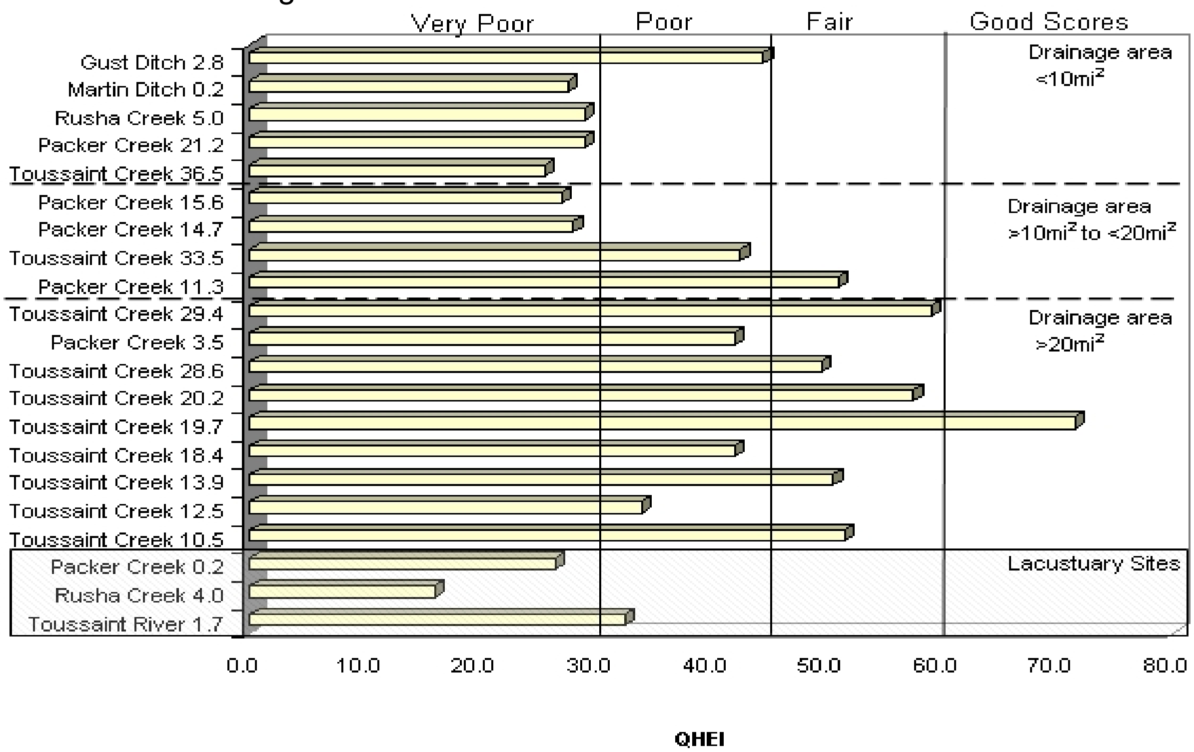
For the Toussaint River TMDL, the Ohio EPA conducted a detailed assessment in 2003 of chemical (water column, effluent, sediment), physical (flows, habitat), and biological (fish and aquatic insect) conditions in order to determine if streams and rivers in the study area were attaining their designated uses. Results of this study are reported in the Biological and Water Quality Study of the Toussaint River and Rusha Creek (Ohio EPA, 2005).

This TMDL addresses the results from the 2003 assessment. Aquatic life use attainment status for the study is provided in Appendix B. The table is arranged from upstream to downstream and includes sampling locations indicated by river mile (RM), the applicable biocriteria indices, the use attainment status (i.e. full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI- an indicator of habitat quality), and comments for the sampling location. Where the aquatic life use designation determined appropriate by the 2003 assessment is different than the use designation in effect prior to the survey, the attainment status for the recommended use designation is provided.

2.2.2 Habitat Quality

QHEI scores by drainage area of the Toussaint and Rusha Creek watersheds indicates that the majority of very poor habitat areas may be found in streams with <10mi^2 drainage area (Figure 2.2). Agricultural practices, including riparian cover removal, channelization, and dredging, have resulted in a degradation of available habitat to instream biological communities. The effects of these practices are noted not just where they occur in the headwaters, but also in the historically altered lacustuary areas. Though habitat quality improves as drainage area increases, the only sites scoring as ‘good’ were on Toussaint Creek near Fulkert Road (RM 19.7). The highly modified conditions present throughout the majority of the study area have resulted in a degradation of available habitat to instream biological communities.

Figure 2.2. QHEI scores of the Toussaint and Rusha Creek basins arranged by drainage area



2.2.3 Watershed Assessment Unit Attainment Score

Watershed Assessment Unit (WAU) Attainment Scores are used to grade aquatic life use status within an 11 digit HUC. Scores are determined using a combination of spatial and linear analysis. A score of 100 is possible if all monitored sites meet designated aquatic life uses. The method of calculating watershed assessment unit scores was first presented in the 2002 Integrated Water Quality Monitoring and Assessment Report, which can be found on the Ohio EPA website at: http://www.epa.state.oh.us/dsw/tmdl/2002IntReport/2002OhioIntegratedReport.html An update on progress toward our statewide water quality attainment goal is presented at: http://www.epa.state.oh.us/dsw/bioassess/AquaticLifeGoal.html. The Aquatic life use attainment status for the Toussaint Watershed Assessment Unit - 04100010 020 is based on sampling conducted in 2003. The attainment status of recommended aquatic life uses was used in lieu of existing uses when calculating the WAU score (Ohio EPA, 2005).

Within each assessment unit, first a "linear" attainment score was calculated for the stream segments with drainage areas >50 $mi.^2$ using the following expression: *(a/b)*100* where values for '*a*' and '*b*' are found in table 2.4 below. The Linear Attainment Score for the Toussaint WAU is **29.65**.

Table 2.4 WAU Linear Analysis for the Toussaint Watershed

Attainment Categories for sites ≥50mi²	Total number of miles >50mi²	Number of miles >50mi² in FULL attainment	Percent of miles >50mi² in FULL attainment
Toussaint mainstem, 0.3 to 20.20	19.9(a)	5.9(b)	**29.65%**

Then, a "spatial" attainment score was calculated for each assessment unit using information about the fraction or proportion of sites within data groups that demonstrated full aquatic life use attainment. Data was sorted into three groups according to the watershed size at the point of the sampling. To correct a bias in biosurvey design that generates a larger number of data points from small watersheds the following formula was used to give more weight in the final spatial score to results from larger streams.

Data Group 1 Data Group 2 Data Group 3

$$\frac{\frac{(a/b + a/b)}{2} + (a/b)}{2} \times 100 = c$$

Where: a= number of sites in full attainment
b= number of sites in data group
c= spatial attainment score for assessment unit

Values for '*a*' and '*b*' in each watershed size group are found in Table 2.5. The Spatial Attainment Score for Toussaint WAU is **36.11**

Table 2.5 WAU Spatial Analysis for the Toussaint Watershed

Attainment Categories for sites ≤50mi²	Data Group 1 ≤5mi²	Data Group 2 >5mi² to ≤20mi²	Data Group 3 >20mi² to ≤50mi²
Number of sites in FULL attainment	0(a)	4(a)	2(a)
Total Number of sites	0(b)	9(b)	4(b)

Finally, the WAU Attainment Score is calculated by averaging the Linear Attainment Score with the Spatial Attainment Score. For the Toussaint WAU, the overall attainment score is **32.88** (Ohio EPA, 2005).

Assessment unit scores of 80-99 generally indicate a localized water quality issue and are considered medium priority for TMDL development, since a targeted solution might address the problem better than a complete watershed restoration effort. Assessment unit scores 40-79 indicate a problem of such a scale that make them good candidates for a traditional TMDL and make them a high priority. Assessment unit scores 0-39 indicate severe basin wide problems that may require significant time and resources and make them a low priority for restoration. Education about how land use affects water quality and encouraging stewardship in these areas may be more effective than a traditional TMDL.

2.2.4 Recreation Use Attainment

The recreation use status throughout the Toussaint watersheds was assessed by bacterial sampling. The recreation use evaluation table (Table 2.6) lists the exceedances of the recreation use criteria, though not necessarily violations of the Ohio Water Quality Standards criteria. The results from the sampling indicated elevated bacterial levels throughout each watershed, potentially impairing the designated or recommended recreation use.

Table 2.6 Recreational use exceedances of the Ohio Water Quality Standards criteria (Ohio Administrative Code 3745-1-07, Table 7-13). Units for fecal coliform bacteria are #/100 ml. Recreational use designations within the study area include: Primary Contact Recreation (PCR).

Stream/River Mile	Use Designation	Fecal Coliform Result
Toussaint Creek		
20.20	PCR	4000 [a], 1200 [b], 1300 [b]
19.65	PCR	1500 [b]
18.40	PCR	1800 [b], 1400 [b]
13.88	PCR	1400 [b], 1500 [b], 1000 [b]
Toussaint River		
10.45	PCR	2200 [a]
Packer Creek		
21.16	PCR	
Martin Ditch		
0.22	none	

a – Exceeds PCR maximum criteria for protection of recreational use.
b – Exceeds PCR geometric mean criteria for protection of recreational use.

2.2.5 Luckey Beryllium Bioassessment

The Luckey Beryllium facility located on the west side of the Village of Luckey was owned by the Defense Plant Corporation from 1942 to 1945 as a magnesium reduction facility that produced metallic magnesium. In the late 1940s, Brush Beryllium Company leased the site from the Atomic Energy Commission to be utilized for the production of beryllium. In 1958, Brush Beryllium Company moved the operation to Elmore, Ohio. The current owner, Hayes Lemmerz International, Inc. leases the property to Uretech International, Inc. which produces urethane components for the automotive and health care industries.

As part of a remedial investigation (RI) of the Luckey Beryllium Site, the United States Army Corp of Engineers (USACE) conducted a bioassessment of Toussaint Creek in the vicinity of the Village of Luckey, Ohio. Primary contaminants of concern were beryllium and lead and their potential impacts to Toussaint Creek. The study consisted of an assessment of the chemical, physical and biological conditions of the Toussaint Creek in the vicinity of the site; sampling adhered to Ohio EPA methods and protocols. Sampling occurred at seventeen locations during the summer of 2001 (USACE, 2002) The study concluded that habitat modifications, nonpoint pollution impacts and discharge of untreated/poorly treated sewage from the Village of Luckey were the primary sources of impairment. Additionally, the study determined that beryllium may be a secondary biological stressor but to a much lesser degree. In March 2002, EnviroScience, Inc., a sub-contractor for U.S Army Corps, produced a final report "Biological and Water Quality Study of Toussaint Creek and Select Tributaries" (EnviroScience, Inc., 2002).

Ohio EPA reviewed the report and generally agreed with several of the findings. However, Ohio EPA disagreed with the recommendation within the report that the aquatic life use designation should be changed to MWH. Based on QHEI scores near or above 50, the stream should be capable of supporting a WWH biological community. Chemical, physical and biological assessment conducted by the Ohio EPA during the summer of 2003 revealed similar findings to the study conducted in 2001 for the USACE.

2.3 Causes of Impairment

The determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiter of aquatic life use attainment and impairment. The rationale for using biocriteria has been extensively discussed elsewhere (Karr, 1991; OEPA, 1987a; OEPA, 1987b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991).

Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent and land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g., agricultural runoff, municipal point sources, septic systems) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear in the section 303(d) list do not necessarily represent a true "cause and effect" relationship. Rather, they represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

The following paragraphs are provided to present the varied causes of impairment that were encountered during the 2003 study. While the various perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

2.3.1 Habitat and Flow Alterations

Habitat and flow alterations result from the manipulation of drainage. Common practices in agricultural areas include channelization, installation of subsurface tile systems, and removal of riparian vegetation. Channelized streams are constructed to increase the flow rate and efficiency of tiles. Tiles lower the water table to facilitate the cultivation of fields and the removal of vegetation facilitates long term maintenance. Habitat lost directly impacts biological communities by limiting the complexity of living spaces available to aquatic organisms. Consequently, communities are not as diverse. Both surface (ditch) and subsurface (tile) drainage systems keep water from ponding and slowly filtering through the soil and reduces groundwater recharge. This may result in stream flows becoming flashier (i.e., increased intensity and rate of change between high and low flow conditions).

There are other consequences that result from the loss of riparian vegetation. It eliminates an important source of coarse organic matter essential for a balanced ecosystem. In addition, an intact tree canopy limits the energy input from the sun and moderates temperature and evaporation.

Increased amounts of sediment are likely to enter streams altered for drainage by either overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosion process. Deep trapezoidal channels keep all but the highest flow events confined within the artificially high banks. As a result, areas that were formerly flood plains and allowed for the removal of sediment from the primary stream channel no longer serve this function. Drainage practices that reduce or eliminate beneficial water movement and sources of turbulence in the channel (riffles, woody debris, and meanders) can exacerbate organic enrichment impacts by limiting reaeration.

2.3.2 Sedimentation

Sediment is the leading cause of impairment in Ohio's rivers and streams (Ohio EPA, 2004). The effects of sedimentation include habitat degradation, direct or indirect impacts on aquatic organisms, increased chemical pollutant loading to the water column, and the storage of chemical pollutants in the bed material which are often released during critical low flow periods.

Sediment degrades habitat as interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macroinvertebrates is reduced. Organisms are impacted as silt can clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding sight-feeding fish species, and smother the nests of lithophilic fishes. Lithophilic spawning fish require clean substrates with interstitial voids in which to deposit eggs. Conversely, pioneering species benefit. They are generalists and best suited for exploiting disturbed and less heterogeneous habitats. The net result is a lower diversity of aquatic species compared with a typical warmwater stream with natural habitats.

Sediment also impacts water quality with regard to recreational and drinking water uses. Nutrients attached to soil particles remain trapped in the watercourse. Likewise, bacteria, pathogens, and pesticides which also attach to suspended or bedload sediments become concentrated in waterways where the channel is functionally isolated from the landscape. Community drinking water systems address these issues with more costly advanced treatment technologies.

2.3.3 Phosphorus

The form of phosphorus that can be readily used by plants is inorganic orthophosphate. It is an essential nutrient for plant growth and is often the limiting factor, so sudden inputs can stimulate nuisance algae blooms. The amount of phosphorus tied up in the nucleic acids of food and waste is actually quite low. Even so, it is eventually converted to orthophosphate by bacteria. The amount of orthophosphate contained in synthetic detergents, on the other hand, is a great concern. It was for this reason that the General Assembly of the State of Ohio enacted a law in 1990 to limit phosphorus content in household laundry detergents sold in the Lake Erie drainage basin to 0.5 % by weight.

2.3.4 Pathogens

Bacteria levels in streams are a concern because they are a human health issue and affect attainment of recreation uses. People can be exposed to organisms while wading, swimming, and fishing. In the Toussaint River watershed, fecal coliform and *Escherichia coli* (*E. coli*) were used as indicator organisms to evaluate risk of exposure to pathogens. Fecal coliform bacteria are relatively harmless in most cases, but their presence indicates that the water has been contaminated with feces from a warm-blooded animal. Although intestinal organisms eventually die off outside the body, some will remain virulent for a period of time and may be dangerous sources of infection. This is especially a problem if the feces contained pathogens or disease producing bacteria and viruses. Reactions to exposure can range from an isolated illness such as skin rash, sore throat, or ear infection to a more serious wide spread epidemic. Some types of bacteria that are a concern include *E. coli*, which cause diarrhea and urinary tract infections, *Salmonella*, which cause typhoid fever and gastroenteritis (food poisoning), and *Shigella*, which cause severe gastroenteritis or bacterial dysentery. Some types of viruses that are a concern include polio, hepatitis A, and encephalitis. Disease causing microorganisms such as cryptosporidium and giardia are also a concern.

Since fecal coliform bacteria are associated with warm-blooded animals, there are both human and animal sources. Human sources, including effluent from sewage treatment plants or discharges by septic systems, are a more continuous problem. Contamination from combined sewer overflows are associated with wet weather events. Animal sources are usually more intermittent and are also associated with rainfall, except when domestic livestock have access to the water. Large livestock farms store manure in holding lagoons and this creates the potential for an accidental spill. Liquid manure applied as fertilizer is a runoff problem if not managed properly and it sometimes seeps into field tiles.

2.3.5 Tainted Fish

Ohio's WQS do not describe sport fish consumption as an element of aquatic life protection, but they do include criteria applicable to all waters of the state that are derived using assumptions about bioaccumulation of chemicals in the food chain. These non-drinking water human health criteria are intended to protect people from adverse health impacts that could arise from consuming fish caught in Ohio's waters.

The Ohio Department of Health publishes an annual sport fish consumption advisory (FCA) in cooperation with the Ohio EPA and Ohio Department of Natural Resources. A statewide advisory for mercury was implemented in 1997 to protect sensitive populations. Women of child bearing age and children under age 15 were advised to not eat more than one meal per week of any species of fish caught from any body of water in Ohio. Mercury is a concern for these populations because extended exposure can damage the brain, kidneys, and developing fetus. This advisory was expanded to include all persons in 2003 because of an increasing number of location specific one meal per week advisories.

To determine if a waterbody should be listed as impaired because of an advisory it is necessary to compare the risk assessment parameters between the WQS criteria and FCA program. The two most common pollutants that drive a FCA are poly-chlorinated biphenyls (PCBs) and mercury. The advisory protocol used for PCBs in the Ohio River basin at the once per week and once per month levels are less protective than the WQS criterion. Therefore, water bodies with these advisories (or more restrictive) are considered impaired. The advisory protocol used for mercury in the Ohio River basin at the once per week and once per month levels are more protective than the WQS criterion. These situations do not result in a water body being considered impaired.

2.4 Sources of Impairment

Sources of pollution are usually classified as either point or non-point. The location of point sources is easy to identify at the end of a pipe and most are regulated by a permit to control quality of effluent. The location of non-point sources is difficult to identify because they come from all land uses. They are difficult to control and not often regulated, but have a major impact on water quality. Section 319 of the CWA was ratified in 1987 to require states to develop non-point source management programs.

2.4.1 Point Sources

Point sources include municipal and industrial types. The wastewater they discharge can contain a wide variety of pollutants, but of particular concern are organic matter and nutrients. Organic enrichment contributes to dissolved oxygen sags and is usually measured with the BOD test. Nutrient enrichment can stimulate plants and algae to grow to the point where they are a nuisance and detrimental to the environment. The compounds ammonia, nitrate, and phosphorus are measured to evaluate the extent of enrichment.

Sewage treatment plants are designed to provide conditions suitable for microbes to convert organic compounds into stable inorganic compounds. Two components that are important for a system to operate efficiently are a long retention time and oxygen. These conditions stimulate bacterial respiration, which converts organic carbon to carbon dioxide and water. Another important process performed by bacteria involves the nitrogen cycle, which converts organic nitrogen and ammonia to ammonium, then nitrite, and finally nitrate. The treatment of phosphorus usually requires the addition of chemicals to encourage particles to adsorb to their surface and coagulate in masses heavy enough to precipitate out of the wastewater. This is why most phosphorus ends up in sludge, making it an attractive fertilizer.

2.4.2 Combined Sewer Overflows

These types of sewer systems carry both sanitary waste and stormwater runoff. They are not a problem during dry weather, because treatment plants are designed to handle these flows. It is during wet weather that CSOs and bypasses become a concern, because they activate to prevent flooding of the system. Since this wastewater is not treated it contains a high amount of organic matter, nutrients, and pathogens. It can also contain a high amount of metals and oily waste.

2.4.3 Agriculture

Agriculture is the number one industry in Ohio and it is the predominant land use in the upper Toussaint River watershed. The major commodities produced include field, fruit, and vegetable crops and a variety of livestock. Pollution problems that arise include the introduction of sediment, organic matter, nutrients, pathogens, and pesticides.

The cultivation of land for crop production makes it susceptible to water and wind erosion and this increases the amount of sediment in streams. It also increases the amount of nutrients, especially phosphorus, and pesticides that are applied to crops to increase yield. Although nitrate passes easily thorough soil it still contributes to pollution problems because it enters through field tiles installed to improve drainage.

A major concern with livestock production is the management of manure. Confined feeding areas usually require the collection and storage of manure and this creates the potential for spills. Pasture land contributes to pollution too, from either soil erosion or nutrients, especially if the livestock have unrestricted access to the stream.

2.4.4 Septic Systems

Septic systems are used to treat sanitary sewage in areas where no municipal facilities exist. These systems usually employ a settling tank followed by either a leaching field or sand filters. They have a finite life span and require routine maintenance to operate properly. When poorly designed or neglected they contribute loads of organic matter, nutrients, and pathogens. Another problem that occurs in small towns is cross connecting failed systems to storm sewers. This solves the problem of sewage backing up in yards and basements, but severely harms the environment.

2.4.5 Stormwater

Stormwater runoff can be a significant source of impairment. Runoff from lands modified by human activities can harm surface water resources in several ways, including the changing of natural habitat and hydrologic patterns and elevating pollutant concentrations and loadings. Storm water runoff may contain or mobilize high levels of contaminants, such as sediment, nutrients, heavy metals, pathogens, toxins, oxygen-demanding substances, and general litter.

The origin of stormwater includes discharges from Phase II Municipal Separate Storm Sewer Systems (MS4s) and both Phase I and Phase II Industrial and Construction activities. An MS4 is any public entity (city, village, transportation department, university, military base, etc.) that owns or operates a separate storm sewer system.

2.4.6 Hydromodification

Hydromodification includes activities like channelization, removal of riparian vegetation, and dam construction. Channelization redefines the natural structure and form of a stream to make it straight, wide, and deep. This is done to increase capacity and flow rate and improve the operation of internal drainage systems, which enhances the overall drainage of the affected land area. The removal of woody riparian vegetation is often conducted as a part of channelization projects because it facilitates maintenance activities that will be ongoing. Such actions result in “smoother” banks and floodplain areas and eliminate sources for large woody debris within the channel. With fewer impediments to flow on the banks and in the channel, flow velocities, and ultimately stream power (i.e., the flow’s capacity to do work), increases.

The excessively high flow velocities and stream power that result from channelization and riparian removal increases channel erosion, degrades or destroys natural habitats and can often lead to the displacement and mortality of aquatic organisms.

3.0 TMDL DEVELOPMENT

A TMDL is a tool for implementing water quality standards, and is based on the relationship between pollution sources and instream water quality conditions. TMDLs establish allowable loadings or other quantifiable parameters for a waterbody, and thereby provide the basis for states to establish water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards.

A TMDL is the sum of its load allocations, wasteload allocations, and a margin of safety. Load allocations (LA) are the portion of the TMDL reserved for non-point sources of pollution. Wasteload allocations are the portion reserved for point sources. The margin of safety (MOS) is a portion of the TMDL reserved for uncertainty in the method of calculation. MOS may be included explicitly or implicitly. TMDLs are required to consider both critical condition and seasonality for each parameter of concern.

TMDLs may be expressed in terms of either mass per time, toxicity, or other appropriate measure. Additionally, TMDLs may be developed at variable temporal and spatial resolutions. The name "TMDL" implies the maximum load is expressed in days; however, TMDLs are often calculated on a monthly, seasonal, or annual basis dependent upon the nature of the parameter of concern. The spatial scale at which a TMDL is calculated is dependent upon the distribution of impairment within the TMDL study area. TMDLs can be calculated for individual stream segments, sub-watershed, or even entire basins.

TMDL development requires the definition of the existing load, calculation of the loading capacity, and allocation of the TMDL. The existing load is the quantity of a pollutant that is contributed to a waterbody prior to TMDL implementation. The existing load includes contributions from all sources, including point, non-point, and natural. The loading capacity is the quantity of a pollutant that a waterbody can receive and still maintain water quality standards. The loading capacity is dependent upon the physical, chemical, and biological processes occurring in the waterbody. Allocation of the TMDL involves the equitable distribution of the loading capacity to all known sources in consideration of technical and economical feasibility as well as water-quality related implications.

Ultimately, the goal of a TMDL is the attainment of use designation. Attainment of aquatic-life use designation in the State of Ohio is primarily dependent upon biocriteria (ORC 3745-1-07). Biocriteria are defined by multiple biological indices that measure the diversity and relative abundance of aquatic organisms. Aquatic organisms are affected by a combination of variables that are not limited to load based pollutants: those for which a TMDL are traditionally developed. Environmental conditions, such as instream dissolved oxygen and physical habitat quality, play an equally important role. As such, TMDLs are also developed for non-load based parameters in a method analogous to that for traditional TMDLs.

In the Toussaint Watershed TMDLs were developed to address the following causes of impairment: habitat alternation, nutrient enrichment, and siltation.

3.1 Habitat Alteration

Habitat alteration is a cause of impairment in the Toussaint Watershed. Habitat alteration includes the straightening, widening or deepening of a stream's natural channel. Habitat alteration can also include the degradation or complete removal of vegetated riparian areas that are essential to a healthy stream. Such activities can effectively transform a stream from a functioning ecosystem to a simple drainage conveyance.

Ohio EPA assesses habitat quality using the Qualitative Habitat Evaluation Index (QHEI). The QHEI is a visual assessment tool used to provide a measure of habitat. The metrics correspond to the physical factors that affect fish communities and that are generally important to other aquatic life (Rankin, 1989). The QHEI is a composite of six habitat categories: (1) substrate, (2) instream cover, (3) channel morphology, (4) riparian zone and bank erosion, (5) pool/glide and riffle/run quality, and (6) gradient. Each category is further divided into individual attributes that are assigned a weighted point-value reflective of the attribute's impact on aquatic life. The highest point-values are assigned to attributes correlated to streams with high biological diversity and integrity; lower values are assigned to less desirable habitat features. An example QHEI score sheet is included as Appendix A.

Habitat alteration – while a significant cause of impairment – is not a load-based chemical parameter for which a TMDL is traditionally developed. For this reason no loading capacity is calculated as part of the habitat TMDL. Rather, the QHEI is used as a surrogate for loading capacity in developing targets to achieve use attainment. In this context the QHEI serves as a measure of a quantitative non-chemical parameter as specified by EPA (1991).

The habitat quality of nineteen sites in the Toussaint Watershed was evaluated in 2003. A habitat TMDL is developed for each of the nineteen sites, and is presented in the following sections. QHEI assessment sites are specifically chosen to be representative of the stream segment on which they are assessed; therefore, the associated TMDLs are applicable to the entire stream segment, not just the assessment site.

3.1.1 Target Development and TMDL Methodology

For use in TMDL development, a target QHEI of 60 was selected. The target was determined by statistical analysis of a statewide database of paired QHEI and IBI scores. Linear and exponential regressions and frequency analyses of combined and individual components of the QHEI in relation to the IBI were examined. The analysis indicates the QHEI is significantly correlated with the IBI with the exponential model providing a better fit to the data than the linear. Sites with QHEI scores greater than or equal to 60 were generally associated with IBI scores supportive of a WWH use designation (Ohio EPA, 1999).

Further analysis of individual QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and were classified as high-influence or moderate-influence based on the statistical strength of the relationship. The presence of these modified attributes can strongly influence aquatic biology to a degree that the QHEI score itself may not reflect. The analysis indicates that a stream with more than one high-influence attributes or more than four total modified-habitat attributes will not typically achieve WWH biocriteria (using an IBI of 40 as representative of WWH biocriterion) (Ohio EPA, 1999). The implication is a stream can be impaired even with a QHEI score above 60. For example, the positive effects of a good riparian zone and high sinuosity may be overwhelmed by the negative impact of a thick muck substrate. In this hypothetical situation the QHEI may exceed 60 because some high-quality habitat features are in place; however, the stream is impaired because it is limited by very poor substrate. High- and moderate-influence attributes are presented in Table 3.1.

Table 3.1 Modified habitat attributes

High-Influence:
❶ Channelized with little to no recovery
❷ Silt or muck substrates
❸ Low sinuosity
❹ Sparse or no cover
❺ Max pool depth less than 40 cm
Moderate-Influence:
① Channelized, but recovering
② Sand substrate
③ Hardpan substrate origin
④ Fair or poor channel development
⑤ Cover-type scores less than 3
⑥ Intermittent or interstial flow with poor pools
⑦ No fast current
⑧ High to moderate substrate embeddedness
⑨ Extensive to moderate riffle embeddedness
⑩ No riffle

Table 3.2 Habitat TMDL equation

Component Measure	Score
QHEI score is greater than 60 =	+1
Less than 2 high-influence modified-habitat attributes =	+1
Less than 5 modified-habitat attributes =	+1
Habitat TMDL Target:	**3**

The habitat TMDL equation in Table 3.2 reflects the relationship between the QHEI score, modified-habitat attributes, and aquatic community performance. The equation is based upon a target of three (3), and is the sum of three component scores. Individual component scores exist for the target QHEI score, and for the presence or absence of high-influence attributes and total modified-habitat attributes. A QHEI score less than 60 or the presence of more than one high-influence attribute or more than four total modified-habitat attributes will prevent a stream segment from achieving its TMDL target.

3.1.2 Habitat TMDL Scores

The QHEI was evaluated at nineteen sites in the Toussaint Creek watershed in 2003. Results from the assessment are presented in Table 3.3. Table 3.3 also lists each site's observed modified-habitat attributes, component scores, and habitat TMDL score. Modified-habitat attribute codes correspond to Table 3.1.

Table 3.3: QHEI assessment results and habitat TMDL scores

Site RM	**Drainage Area** (mi^2)	**QHEI Score**	**Modified Attributes**		**Component Scores**			**TMDL Score**
			High Influence	Moderate Influence	QHEI Score	High Influence	Modified Attributes	
WWH Targets:		*>=60*	*<2* (*<5 Total*)	*NA* (*<5 Total*)	*1*	*1*	*1*	*3*
Toussaint Creek:								
36.5	8.0	25.5	❶❸❹❺	③⑥⑦⑧	0	0	0	0
33.5	18.0	42.5	❺	③⑥⑦	0	1	1	2
29.4	32.0	59.0		⑧	0	1	1	2
28.6	34.0	49.5		①⑦⑧	0	1	1	2
20.2	60.0	57.5	❸	①③⑥⑦⑧	0	1	0	1
19.7	61.0	71.5		⑧	1	1	1	3
18.4	62.0	42.0		①⑥⑧	0	1	1	2
13.9	76.0	50.5	❸❹	③⑥⑨	0	0	0	0
12.5	77.0	34.0	❷❹	①③⑥⑦⑧⑨	0	0	0	0
10.5	81.0	51.5		③⑥⑦⑨	0	1	1	2
Packer Creek:								
21.2	8.0	29.0	❶❸	③⑥⑧⑨	0	0	0	0
15.6	15.5	27.0	❷❸❹❺	①③⑤⑥⑦⑨	0	0	0	0
14.7	16.0	28.0	❶❸❺	③④⑥⑦	0	0	0	0
11.3	19.8	51.0	❺	①⑥	0	1	1	2
3.5	33.0	42.0	❹	③⑥⑨	0	1	1	2
Rusha Creek:								
5.0	6.6	29.0	❶❸❺	③⑥⑦⑧⑨	0	0	0	0
4.0	7.3	33.5	❶❸❺	③⑥⑦⑧	0	0	0	0
Martin Ditch:								
0.2	5.8	27.5	❶❷❸❺	③④⑥⑦⑧	0	0	0	0
Gust Ditch:								
2.8	2.1	44.5	❷	①③⑥⑦	0	1	1	2

3.1.3 Discussion

TMDL development by the preceding method necessitates examination of the QHEI on a site-specific basis; however, the QHEI is best used to evaluate the aggregate condition of a stream or sub-basin. This is because the biological performance of an individual site is more reflective of the prevailing watershed condition than the local condition of the site (Rankin, 1989). An individual site may be an oasis of outstanding attributes, but if it lies within a watershed that is highly channelized or otherwise degraded, expectations of the site's biologic performance remain low. As modified attributes accumulate throughout a watershed, the modified sections begin acting as sinks of biological integrity and affect sites even with high-quality habitat (Pulliam, 1988). This relationship between biologic performance and prevailing habitat condition emphasizes the need to protect and manage habitat on a watershed scale.

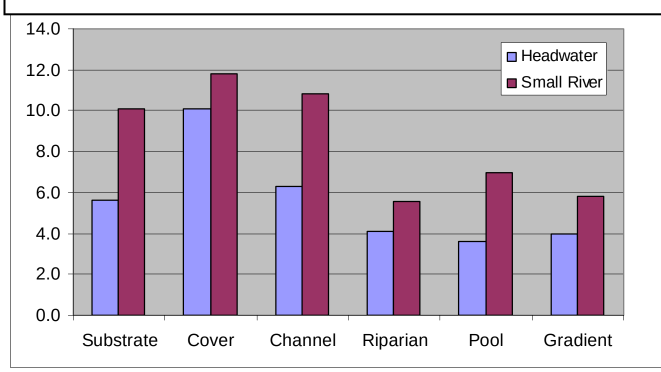
Related to the concept of habitat at the watershed scale, the following is taken directly from a technical report titled *Associations Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999):

> "The Concept of watershed scale habitat influence on biological integrity has even more consequences when the role of headwater streams is considered. The prevailing notion that headwater streams are of little or no value or importance to overall watershed function has, and will continue to have, serious negative consequences for downstream water bodies… [H]eadwater streams are the *primary interface* between the landscape and the aquatic ecosystem… For larger streams and rivers, a neglect of headwater stream habitats and riparian zones creates… problems where sediment delivery… causes headwater streams to act as point sources of sediment and nutrients." (Ohio EPA, 1999)

In the Toussaint Watershed most headwater streams are modified by channelization and the removal of riparian vegetation, and fail to serve their natural functions: filters of nutrients and sediment; storage and retention of storm water; and sources of coarse particulate matter vital to the natural energy dynamics of a stream network (Vannote, 1980). In their degraded condition the headwater streams of the Toussaint Watershed act as sources of impairment to the mainstem, lacustuary, and ultimately, Lake Erie.

To illustrate the relative health of headwater streams, it is useful to examine the QHEI on the basis on drainage area. The following paragraphs discuss the average habitat condition of stream segments based upon the drainage area breakpoint of 20 square miles. Drainage areas less than 20 square miles are considered headwater sites; areas greater than 20 square miles are considered small-river sites.

Figure 3.1 Average scores for each of the QHEI categories



The aggregate habitat condition of headwater sites in the Toussaint Watershed is poor. The average QHEI of the ten headwater sites is 33.8. This represents a level of habitat quality not conducive to Warmwater Habitat. The frequent occurrence of modified attributes such as channelization with little to no recovery, thick muck substrates, low sinuosity and sparse cover is also severely limiting.

The aggregate condition of small river sites in the Toussaint Watershed is better than that of headwater sites, yet sill falls short of the level associated with WWH. The average QHEI score of the nine small river sites is 50.8. Average category scores for headwater and small river sites are shown in Figure 3.1 above.

QHEI assessment results show that streams of the Toussaint Watershed are severely habitat limited. Habitat is insufficient to offer WWH communities the basic rudiments for existence, and effectively acts to prevent biological performance consistent with that use. The low QHEI scores result from silty, embedded substrates, channel morphology homogeneity, limited flow, functionless cover, and in a general sense from intense modification of the stream channel and immediate land use. These degraded habitat conditions result in an aquatic community that is less able to resist stressors, protracted periods of recovery from disturbance, and diminished effects towards the recovery of the ecosystem from reductions of pollutant loadings.

3.1.4 Critical Condition

The critical condition for the habitat TMDL is the summer when environmental stress upon aquatic organisms is greatest. It is during this period that the presence of high-quality habitat features, such as deep pools and un-embedded substrate, is essential to provide refuge for aquatic life. QHEI scores, the basis of the habitat TMDLs, are assessed during the summer field season. The habitat TMDLs are therefore reflective of the critical condition.

3.1.5 Margin of Safety

A MOS was implicitly incorporated into the habitat TMDL through the use of conservative target values. The target values were developed though comparison of paired IBI and QHEI evaluations. Using an IBI score of 40 as representative of the attainment of WWH, individual components of the QHEI were analyzed to determine their magnitude at which WWH attainment is probable (OEPA, 1999). Attainment does, however, occur at levels lower than the established targets. The difference between the habitat targets and the levels at which attainment actually occurs is an implicit margin of safety.

3.2 Nutrient Enrichment

Nutrient enrichment is a cause of impairment in the Toussaint Creek watershed. For the purpose of this report, phosphorus is used as an indicator of the degree of nutrient enrichment. Phosphorus is selected because it is frequently the limiting nutrient to primary production in streams and rivers of Ohio (Laws, 1981). In the foreground of

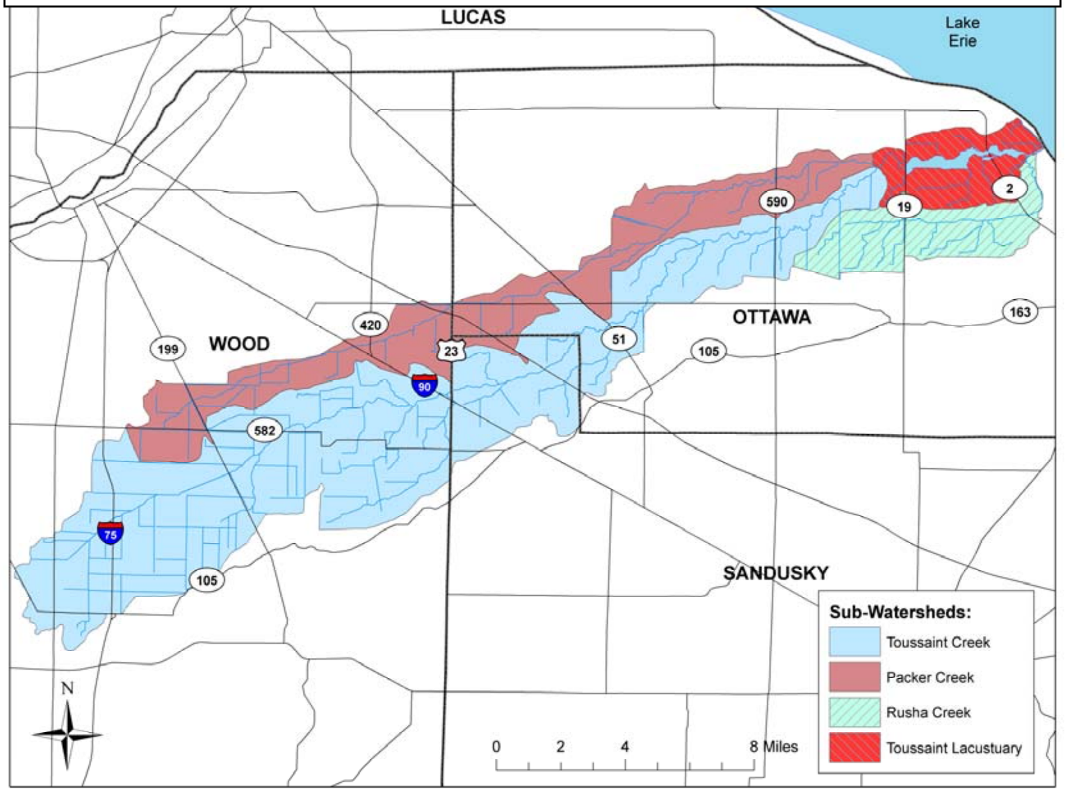
Figure 3.2 is bed of algae on Packer Creek that bloomed as a result of excessive nutrients.

Phosphorus TMDLs are developed for the Toussaint Creek, Packer Creek, and Rusha Creek sub-watersheds, and for the Toussaint Lacustuary Area. The Toussaint Creek and Packer Creek sub-watersheds end at the confluence of Toussaint and Packer, and the Rusha Creek sub-watershed ends where Rusha meets the Toussaint Lacustuary. The Toussaint Lacustuary area is defined as everything downstream of the confluence of Toussaint and Packer to Lake Erie, excluding Rusha. Figure 3.3 is a map of the sub-watersheds.

The existing load, loading capacity, and allocations that comprise the phosphorus TMDL are calculated on an annual basis. To promote understanding of the calculations and how they relate to sources and to facilitate implementation of actions to reduce loadings, all loads are presented and discussed in kilograms per year (kg/year). TMDL calculations expressed as daily loads are summarized in a table at the end of Section 3.2.2.

Figure 3.2 Algae bed on Packer Creek

Figure 3.3 Sub-watersheds for phosphorus TMDL development in the Toussaint watershed



3.2.1 Target Development

Table 3.4 Total phosphorus targets (mg/l)

Sub-Watershed	Drainage Area (mi^2)	Target Concentration
Toussaint Creek	86	0.10
Packer Creek	34	0.10
Rusha Creek	13	0.08
Toussaint Lacustuary	143	0.10

The Ohio EPA does not currently have statewide numeric criteria for phosphorus, but potential targets have been identified in *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients on aquatic biological communities of Ohio streams and rivers. Total phosphorus (TP) target concentrations are proposed based on observed concentrations associated with acceptable ranges of biological community performance. TP targets depend on drainage area, and are presented in Table 3.4 for each sub-watershed of the Toussaint.

Ohio's standards also include narrative criteria that limit the quantity of nutrients which may enter waters. Specifically, OAC Rule 3745-1-04 (E) states that all waters of the state shall be free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae. In addition, OAC Rule 3745-1-04(D) states that all waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal, or aquatic life and/or are rapidly lethal in the mixing zone. Excess concentrations of nutrients that contribute to non-attainment of biological criteria may fall under either OAC Rule 3745-1-04 (D) or (E) prohibitions.

3.2.2 TMDL Development

Phosphorus TMDL development requires definition of the existing load, calculation of the loading capacity, and allocation of the loading capacity to the identified sources. Each of these steps is described below.

The existing load is defined as the sum of the individual source loads. Source loads considered in this report include surface runoff, tile flow, ground water, municipal separate storm sewer systems (MS4s), point source discharge, home sewage treatment systems, and combined sewer overflow.

The phosphorus loads from surface runoff, tile flow, ground water, and MS4s are calculated using the Generalized Watershed Loading Function (GWLF) (Haith, 1992). GWLF is a loading model; the complexity of which falls between that of a detailed, process-based simulation model and a simple export coefficient model. GWLF provides a mechanistic, but simplified, simulation of precipitation-driven runoff, ground-water flow, and sediment delivery. The resulting sediment load, runoff volume, and ground-water volume are used to estimate particulate- and dissolved-phased phosphorus delivery to a stream. GWLF has been used for TMDL development in Pennsylvania, Iowa and Arizona, and is recommended in EPA's *Protocol for Developing Nutrient TMDLs* (EPA, 1999).

One modification is made to GWLF for modeling the Toussaint Creek watershed. A sub-routine is added to simulate the effect of sub-surface tile drainage upon the watershed's hydrology. The sub-routine functions by intercepting a specified percentage of the water percolating through the soil's unsaturated zone. Intercepted water is routed to a hypothetical tile storage zone, then released to the stream at a rate controlled by a coefficient. The phosphorus load from tile flow is estimated as the product of the volume of tile flow and a tile-flow phosphorus concentration.

Details of the GWLF model as applied to the Toussaint Creek watershed are described in Appendix C, including a complete presentation of input values and a description of the hydrologic calibration. Results of the model – including average annual surface-runoff, tile-flow, ground water, and MS4 phosphorus loads – are presented in Table 3.5.

Table 3.5 GWLF results; phosphorus loads in kg/year

Sub-Watershed	Surface Runoff	Tile Flow	Ground Water	MS4s
Toussaint Creek	4,971	1,587	525	477
Packer Creek	1,894	652	205	0
Rusha Creek	411	235	79	0
Toussaint Lacustuary	424	134	58	0

The existing load from point source dischargers is calculated for NPDES permitted and small, non-NPDES package plants. The phosphorus load from each facility is calculated as the product of a representative flow volume and effluent phosphorus concentration. Where possible the flow volume and effluent phosphorus concentration are determined from self-monitoring data the facility submits to the Ohio EPA. If such information is not available, then the load is estimated as the product of the design capacity of the facility and a probable phosphorus concentration based upon the treatment capability of the system. Annual phosphorus loads from each facility and the total to each sub-watershed are presented in Table 3.6.

Table 3.6 Point-source phosphorus loads in kg/year

Facility Name	Permit #	Total
Toussaint Creek:		
Blue Moon Motel	N/A	8
Eastwood School WWTP	2PT00026	49
Graymont Dolime Inc.	2IJ00063	25
Martin Marietta Materials, Inc.	2IJ00040	86
Otterbein-Portage Valley Retirement Village	2PS00005	128
Rocky Ridge Elementary	2PT00029	7
Troy Energy, LLC	2IB00018	52
Uretech International	2IR00008	12
Village of Genoa WWTP	2PB00008	882
Village of Luckey WWTP	2PA00080	21
	Total:	**1271**
Packer Creek:		
Camp Sabroske	N/A	8
Ernesto's Inc.	2PR00153	29
Greenwood Mobile Home Park	N/A	56
Stoneco, Inc.	2IJ00036	20
	Total:	**113**
Rusha Creek:		
USCO Distribution Services, Inc.	2IF00006	4
	Total:	**4**
Toussaint Lacustuary:		
Carroll Elementary	N/A	31
Paradise Acres Camp & Pool	2PR00192	131
Toussaint River Marina	N/A	25
Toussaint River Restaurant and Lounge	N/A	37
	Total:	**224**

The existing load from Home Sewage Treatment Systems (HSTSs) is estimated from the number of systems in each sub-watershed, a probable failure rate, and a representative phosphorus concentration in septic effluent. The number of systems in each sub-watershed is determined from aerial photography by locating and counting homes. The probable failure rate (40%) is referenced from Wood County’s HSTS

Management Plan (Wood County, 2005), and the representative phosphorus concentration (19 mg-P/l) is a literature value (Metcalf & Eddy, 1991). The annual phosphorus load contributed to each sub-watershed by HSTSs is presented in Table 3.7.

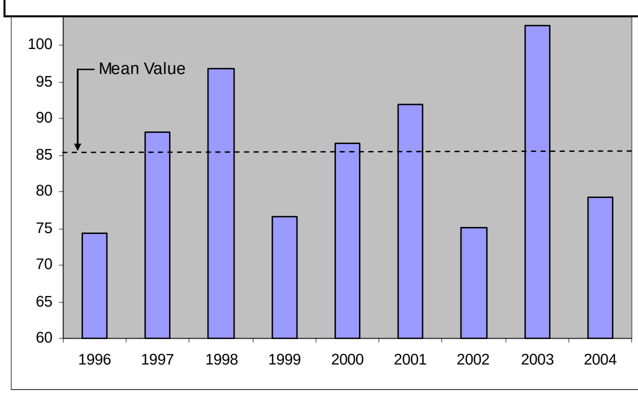
Table 3.7 HSTS phosphorus loads (kg/year)

Sub-Watershed	# of HSTSs	Load
Toussaint Creek	1,511	1,041
Packer Creek	619	403
Rusha Creek	325	197
Toussaint Lacustuary	198	71

The final source of phosphorus considered is combined sewer overflow (CSO). The Village of Luckey is served by a combined sewer collection system that sometimes overflows to Toussaint Creek during wet weather. Each of Luckey's five pump stations is preceded by an engineered relief structure (interceptor manhole) that regulates the volume of flow routed to Luckey's wastewater treatment lagoons. The lagoons are designed to handle 0.135 million gallons of wastewater per day; flow exceeding this rate will result in an overflow. The Village of Luckey is required by their NPDES permit to monitor the occurrence, duration, volume, and water quality (TSS) of CSO from their collection system.

The phosphorus load from CSO is estimated via the following method. The Village of Luckey has submitted to Ohio EPA information regarding CSO discharges for 2000 - 2004. Only the submissions from 2000 are used to estimate the CSO load because 2000 appears to be the most complete and is representative of an average year of precipitation (see Figure 3.4). In 2000 the Village of Luckey reported a total of 12 overflow events: six (6) from outfall 004 and six (6) from outfall 005. All overflows were reported to last 24 hours and totaled 14.1 million gallons. The Village of Luckey does not monitor CSO for phosphorus, but a typical CSO phosphorus concentration is 2.0 mg-P/l (Metcalf & Eddy, 1991). Based upon this concentration the estimated annual phosphorus load from CSO is 107 kg.

Figure 3.4 Annual precipitation (cm) at Bowling Green, Ohio from 1996 to 2004



To fit in the context of a TMDL, it is beneficial to categorize source loads as point source or non-point source. All source loads that are regulated by permit (individual NPDES or general) are categorized as point sources; all others are non-point source. By this method NPDES dischargers, package plants, urban washoff from Municipal Separate Storm Sewer System (MS4) communities, and CSO are point sources. Surface runoff, urban washoff from non-MS4 communities, tile flow, ground water, and HSTSs are non-point sources. Annual phosphorus point source and non-point source loads are summarized in Table 3.8. Also included in Table 3.8 is the total annual phosphorus load to each sub-watershed.

Table 3.8 Existing phosphorus loads in kg/year

Sub-watershed	NPS	PS	Total
Toussaint Creek	2,896	7,083	9,979
Packer Creek	516	2,751	3,267
Rusha Creek	201	725	926
Toussaint Lacustuary	295	616	911

The loading capacity of a stream is the quantity of a pollutant it can assimilate and still maintain water quality standards. Loading capacity is calculated as the product of each sub-watershed's annual flow volume and target phosphorus concentration. Each sub-watershed's annual flow volume is estimated as the sum of the predicted surface runoff, tile flow and ground water flow volumes from GWLF, and the annual contribution to flow from point sources and HSTSs. This method of calculation accounts only for physical dilution as a means of assimilation; no attempt is made to account for chemical or biological processing of phosphorus within the system. For the purpose of this report, this method is judged to provide a reasonable estimate of loading capacity with sufficient accuracy to guide management decisions. The loading capacity of each sub-watershed equals its TMDL and is presented in Table 3.9.

Allocation of the TMDL involves the equitable distribution of the loading capacity to all known sources. The portion of the TMDL reserved for point sources is called a wasteload allocation (WLA); the portion for non-point sources, a load allocation (LA). As stated in the introduction to this chapter, a portion of the TMDL is also reserved as a margin of safety (MOS) to account for uncertainty in the method of calculation. The allocations for the Toussaint and Packer Creek sub-watersheds also include a future-growth term (FG), which is a reservation for an expected increase in wastewater flow.

Table 3.9 Phosphorus TMDLs in kg/year

Sub-Watershed	TMDL
Toussaint Creek	6,847
Packer Creek	2577
Rusha Creek	757
Toussaint Lacustuary	617

The Toussaint Watershed allocation scheme is based on a focused reduction of the point source load, and a general reduction of non-point source load. The allocations for each sub-watershed are presented in Table 3.10.

The most significant point-source phosphorus load results from the Village of Genoa WWTP. Monthly operating reports (January 1998 to November 2004) submitted to Ohio EPA show Genoa discharged approximately 0.329 million gallons per day at a median phosphorus concentration of 1.94 mg/l, resulting in an average annual phosphorus load to Toussaint Creek of 882 kg/year. The annual phosphorus load from Genoa constitutes almost 69% of the total point-source load to the Toussaint Creek sub-watershed.

Table 3.10 Phosphorus allocations in kg/year

Sub-Watershed	WLA	LA	MOS	Future Growth
Toussaint Creek	1,684	3,793	685	685
Packer Creek	207	1,854	258	258
Rusha Creek	53	628	76	0
Toussaint Lacustuary	237	318	62	0

A 1.0 mg/l phosphorus limit is recommended for the Village of Genoa WWTP. Using Genoa's design flow of 0.6 million gallons per day, the resulting wasteload allocation is 829 kg/year. This waste-load allocation represents nearly a 50% reduction of the load from Genoa based upon the facility's currently average effluent concentration .

Complete elimination of CSO from the Village of Luckey's sewer system is recommended. To reflect this, the wasteload allocation for CSO is zero. The Village of Luckey has submitted plans to separate its storm and sanitary sewer systems to Ohio EPA. The Village of Luckey has also submitted a CSO Long-Term Control Plan (LTCP) and a CSO Operation and Maintenance Plan (OMP). It is the recommendation of this TMDL that the Village of Luckey moves forward with its plan for sewer separation, and continues to implement the recommendations of its LTCP and OMP.

A reduction of the urban-washoff load is recommended, and is reflected in the urban-washoff WLA and LAs. Urban washoff receives a WLA if it originates from an MS4 community and an LA if from non-MS4 areas. Currently there are no Phase I or Phase II MS4 communities in the Toussaint watershed; however, the City of Bowling Green, which is located in the Toussaint sub-watershed, will soon be designated as an Appendix 7 Phase II community. For this reason part of the total urban-washoff allocation, proportional to the percent of the total urban area Bowling Green represents (70%), is reserved as an MS4 WLA. The total urban-washoff allocation for the Toussaint Creek sub-watershed is 351 kg/yr; therefore, the MS4 WLA is 246 kg/year.

No reduction is recommended for the remaining point sources; however, monitoring to better characterize effluent quality and identify potential problems in treatment plant operation is recommended. There are currently five small package plants that are not regulated by the NPDES program in the Toussaint Watershed. Each should be evaluated to determine if it is appropriate to permit them under the NPDES system. If NPDES permitting is determined to be inappropriate, then a routine inspection schedule should be in place to ensure the package plants are operating properly.

The HSTS allocations result from a specific HSTS management scenario. The management scenario recommends the connection of the following communities to central sewer: Sugar Ridge, Dunbridge, Leymoyne, Elliston, Graytown, Rocky Ridge and Locust Point, as well the unsewered areas to the west and northeast of the Village of Genoa. The HSTS management scenario also recommends an improved HSTS inspection and maintenance program to decrease the current (estimated) 40% failure rate to 10% for all remaining systems. HSTS allocations are presented in Table 3.11.

Table 3.11 HSTS allocations in kg/year

Sub-Watershed	HSTSs Remaining	Allocation
Toussaint Creek	1,293	228
Packer Creek	448	76
Rusha Creek	322	49
Toussaint Lacustuary	128	13

The ground-water allocations equal the ground-water existing loads. No reduction of the ground-water load is recommended because it is considered a natural condition. There is no evidence to suggest significant ground-water phosphorus contamination.

The surface-runoff, tile-flow, and urban-washoff LAs are calculated from the remaining loading capacity after allocation to HSTSs, point sources, MS4s, ground water, MOS, and future growth. The sum of the existing loads from surface runoff, tile flow, and urban washoff are compared to the remaining loading capacity to calculate the percent reduction that is needed. The percent reduction is then applied to the individual existing source loads to determine their allocation. The percent reduction needed, surface-runoff LA, tile-flow LA, urban-washoff LA, and MS4 WLA are presented in Table 3.12A. A summary of the phosphorus TMDL, expressed as daily loads, is provided in Table 3.12B

Table 3.12A Remaining phosphorus allocations in kg/year

Sub-Watershed	Percent Reduction	Surface Runoff	Tile Flow	Ground Water	MS4 WLA
Toussaint Creek	50%	2,477	791	525	238
Packer Creek	35%	1,227	422	205	0
Rusha Creek	15%	349	200	79	0
Toussaint Lacustuary	53%	198	62	58	0

Table 3.12B Phosphorus TMDL summary in kg/day

Category	Source	Toussaint Creek	Packer Creek	Rusha Creek	Toussaint Lacustuary
Existing Loads	Surface Runoff	13.62	5.19	1.13	1.16
	Tile Flow	4.35	1.79	0.64	0.37
	Ground Water	1.44	0.56	0.22	0.16
	MS4	1.31	0.00	0.00	0.00
	NPDES	3.48	0.31	0.01	0.61
	CSO	0.29	0.00	0.00	0.00
	HSTS	2.85	1.10	0.54	0.19
	PS Total	19.41	7.54	1.99	1.69
	NPS Total	7.93	1.41	0.55	0.81
	Total Existing	27.34	8.95	2.54	2.50
TMDL	TMDL	18.76	7.06	2.07	1.69
	Needed % Reduction	31%	21%	18%	32%
Allocations	Surface Runoff	6.79	3.36	0.96	0.54
	Tile Flow	2.17	1.16	0.55	0.17
	Ground Water	1.44	0.56	0.22	0.16
	MS4	0.65	0.00	0.00	0.00
	NPDES	3.34	0.36	0.01	0.61
	CSO	0.00	0.00	0.00	0.00
	HSTS	0.62	0.21	0.13	0.04
	LA Total	10.39	5.08	1.72	0.87
	WLA Total	4.61	0.57	0.15	0.65
	Future Growth	1.88	0.71	0.00	0.00
	Margin of Safety	1.88	0.71	0.21	0.17

3.2.3 Critical Condition

The critical condition for nutrient enrichment is the summer warm season, when the potential for primary production is highest. However, the summer concentration of phosphorus in the water column is dependent upon more than summer phosphorus load contributed to the stream. As phosphorus readily attaches to sediment, detachment of adsorbed phosphorus in bottom sediments can lead to elevated in-stream concentrations regardless of the magnitude of short-term loads. As a result, it is the long-term, or chronic, phosphorus load that is more directly related to the degradation of water quality. For this reason phosphorus TMDLs were developed on an annual basis. The use of a 15-year record of daily weather and stream flow data in GWLF incorporates seasonal and hydrologic variability and protects for all conditions including critical ones.

3.2.4 Margin of Safety

A margin of safety was incorporated both implicitly and explicitly into the phosphorus TMDL. An implicit margin of safety is incorporated into the target development process. The explicit margin of safety is a portion of the loading capacity specifically reserved to account for any additional uncertainty.

A conservative assumption implicit in target development lies in the selection of the median to represent the phosphorus target that corresponds to an unimpaired biological community. Since Ohio EPA's evaluation of phosphorus data for generating target values is based on measured performance of aquatic life and since full attainment can be observed at concentrations above this target (reinforcing the concept that habitat and other factors play an important role in supporting fully functioning biological communities), water quality attainment can occur at levels higher than the target. The difference between the actual level where attainment can be achieved and the selected target is an implicit margin of safety.

Ten-percent of the loading capacity was reserved as an explicit margin of safety in all sub-watersheds. The explicit margin of safety was included to account for any remaining uncertainty following the application of the implicit measures described above.

3.3 Siltation

Siltation is a cause of impairment in the Toussaint Creek watershed. Excessive sediment loading from field erosion, gully erosion, bank erosion, and mass wasting is the source. Excessive sediment loading impacts aquatic life as suspended sand and silt falls from solution, filling the interstitial space between coarser substrates essential to bottom-loving organisms. Excessive sediment also affects water quality, recreational use, and the value of the waterbody as a drinking water supply. Further, it exacerbates nutrient and pathogen impairments because such contaminants readily adsorb to sediment particles.

Similar to the habitat TMDL, sediment targets and TMDLs are developed using the QHEI. The QHEI is used because measuring the sediment load contributed to a stream and establishing targets based upon a parameter concentration, such as total suspended solids (TSS) or suspended sediment (SS), is problematic. The causal link between instream TSS or SS concentrations and impairment is weak and often unpredictable (OEPA, 1999). This, perhaps, is because siltation is dependent upon more than an instream concentration; stream morphologic characteristics and surrounding land-uses may play an equal if not greater predictive role.

Use of the QHEI as a surrogate to loading capacity in developing sediment TMDLs can be advantageous because QHEI categories can provide insight regarding the type, quality, build-up, and source of bottom sediment. QHEI categories applicable to this role are the substrate, channel, and riparian metrics. The substrate category evaluates the type and quality of bottom deposits, as well as the degree to which coarser substrates are embedded by sand and silt. The channel category evaluates stream morphologic characteristics such as sinuosity, the extent of channelization, and overall stability. Finally, the riparian category measures the width of the riparian area and the extent of bank erosion, and is indicative of the surrounding land-use. The individual attributes associated with substrate, channel, and riparian categories – as listed above – cumulatively represent the source, degree, and extent of siltation, and thereby serve a as surrogate to loading capacity.

3.3.1 Target Development and TMDL Methodology

The sediment TMDL is based on a target score of 33. The TMDL target is the sum of the individual targets for the substrate, channel, and riparian categories of the QHEI. The individual targets for the substrate, channel, and riparian categories of the QHEI are 14, 14, and five (5), respectively. Stream segments achieve the TMDL by meeting or exceeding the target values. The sediment TMDL targets are analogous to a loading capacity in that they serve as a measurable endpoint to gage the success of TMDL implementation.

The substrate and channel targets are developed through frequency analyses comparing their category scores to aquatic community performance (Ohio EPA, 1999). The frequency analysis is conducted upon a dataset of paired QHEI and IBI evaluations of both minimally-impacted and physically-modified reference sites generally free of point source impacts. The analysis shows that substrate and channel scores of 14 each are generally correlated with the aquatic community performance of WWH, using an IBI of 40 as representative of WWH. Results of the analysis are illustrated in Figure 3.5 and 3.6.

Figure 3.5 Frequency analysis of the substrate category versus the IBI*

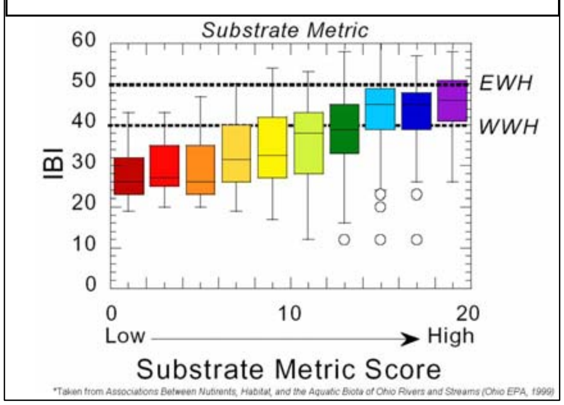
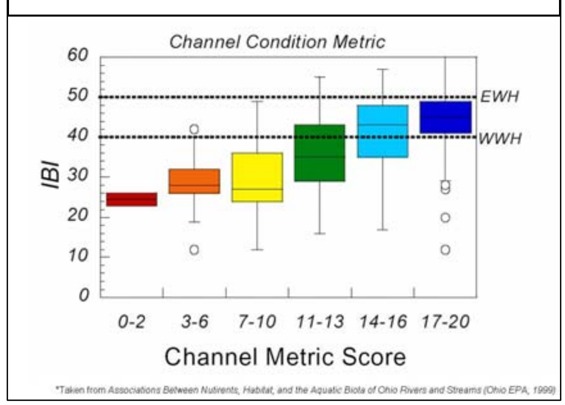


Figure 3.6 Frequency analysis of the channel category versus the IBI



The riparian sediment target is established by different means. Rankin (1989) found that riparian is the category least consistently correlated with the IBI. Stated otherwise, the riparian category appears to have the weakest *direct* effect upon aquatic performance. Rankin goes on to conclude, however, the *cumulative* effect of riparian quality is likely to be large. Since paired riparian and IBI scores are not significantly correlated, a target could not be developed by frequency analysis. In place of this, the riparian sediment target of five (5) is based upon the ratio of the QHEI target score (see section 3.1.1) to the total possible QHEI score, and the best professional judgment of Ohio EPA staff.

3.3.2 Sediment TMDL Scores

The QHEI was evaluated at nineteen sites in the Toussaint Watershed in 2003. Results of the assessment are presented below in Table 3.13. Also included in Table 3.13 are the resulting sediment TMDL scores for each site.

Table 3.13 QHEI assessment results and sediment TMDL scores

Stream/River	River Mile	2003 Assessment Results			TMDL Score
		Substrate	Channel	Riparian	
WWH Targets:		*>=14*	*>=14*	*>=5*	*>=33*
Toussaint Cr.	36.5	1	5.5	4	10.5
Toussaint Cr.	33.5	11	7.5	4	22.5
Toussaint Cr.	29.4	14	10	7	31
Toussaint Cr.	28.6	5	9.5	5	19.5
Toussaint Cr.	20.2	12.5	10	4	26.5
Toussaint Cr.	19.7	13.5	16.5	8.5	38.5
Toussaint Cr.	18.4	8	9	4	21
Toussaint Cr.	13.9	12	11.5	7	30.5
Toussaint Cr.	12.5	4.5	8.5	4	17
Toussaint Cr.	10.5	10	12	5.5	27.5
Packer Cr.	21.2	2	4	3	9
Packer Cr.	15.6	4.5	7	4.5	16
Packer Cr.	14.7	11	4	2	17
Packer Cr.	11.3	14	12	4.5	30.5
Packer Cr.	3.5	11.5	10.5	5	27
Rusha Cr.	5.0	0	4	3	7
Rusha Cr.	4.0	0	6	7.5	13.5
Martin Ditch	0.2	6	5	3.5	14.5
Gust Ditch	2.8	7	8	5	20

3.3.3 Discussion

Excessive sediment loads to streams originate from multiple sources. Field, gully, and channel erosion all contribute; as does mass-wasting. Field erosion results from the overland, sheet-like flow of water from areas of low to moderate relief. The impact of rainfall upon the surface acts as the primary mechanism for the detachment of soil particles (Hillel, 1998). The detached particles are then entrained and transported down current by the flow of water. Gully erosion occurs where overland flow is consolidated. The primary erosive force in gullies is the scouring action of water, as its energy and transport capacity increase with the focusing of sheet-like flow (Hillel, 1998). Figure 3.7 illustrates the formation of a gully in an agricultural field.

Figure 3.7 Gully formation in an agricultural field[1]

Channel erosion occurs in two forms: lateral streambank erosion and vertical degradation (down-cutting). Lateral streambank erosion is the result of horizontal sheer stress exerted upon the sides of a stream channel by flowing water. Streambank erosion is the most apparent at bends and meanders of the channel where force vectors become more acute relative to the channel. Degradation occurs when the vertical equilibrium of the stream network is disrupted (Leopold, 1964). Dredging and deepening of upstream reaches is an example of a disruption, and can result in severe down-cutting where the modified segment intersects the natural channel.

Mass-wasting is the down slope movement of rock and soil due to gravity. Mass-wasting occurs on steep slopes, especially where the natural soil structure is altered, vegetative cover is removed, or the upslope area is undermined. Sloughing of stream and ditch banks is the type of mass-wasting that occurs in the Toussaint Watershed. Bank sloughing is exacerbated by the saturation, freeze and thaw of the soil. Bank sloughing is illustrated in Figure 3.8

Figure 3.8 Sloughing of a ditch bank[2]

Streams transport sediment as primarily suspended or bed load. The suspended load is that which is entrained by the flow of water, and is held in solution by a combination of forces such as turbulence and the buoyancy of the particles. Suspended loads are estimated by measurement of the TSS or SS concentration of the water column.

Bed load is that which is pushed or rolled along the bottom of a stream channel. Bed load is composed of coarser soil particles that can not be held in solution and are transported mainly during high-flow storm events.

To illustrate the relative magnitude of individual sediment sources to the Toussaint, the sediment load contributed to the stream was predicted using a model, and the sediment load transported by the stream was calculated empirically. Results of the model and the empirical calculation are not used as part of the sediment TMDL; rather, they used in an explanatory capacity to better define the problem identified by the QHEI analysis.

GWLF, as described in Section 3.2.2 and Appendix C, was used to predict the sediment load contributed to the Toussaint Creek sub-watershed. The prediction is only representative of the load from field erosion due to the limitations of the model itself. GWLF simulates erosion as a two-stage computation that separately considers the generation of the field sediment supply via the revised universal soil loss equation (RUSLE) and its subsequent transport by runoff (Haith, 1987). GWLF does not explicitly simulate gully or channel erosion. By definition the RUSLE accounts only for erosion by unconsolidated flow (field erosion); therefore, GWLF is likewise limited (Renard et. al., 1997). Modeled sediment loads contributed to the Toussaint Creek sub-watershed from field erosion are presented in Table 3.14 in megagrams (1000 kg) per year.

Table 3.14 Predicted field erosion to Toussaint Cr.

Year	**Load** *(Mg/yr)*
1995	521
1996	808
1997	543
1998	1363
1999	681
2000	788
2001	728
2002	788
2003	1548
2004	388
Average:	**816**

The sediment load transported by Toussaint Creek was estimated empirically. The estimate is based upon the product of a flow volume and an instream sediment concentration. Baseflow and storm-flow volumes were simulated using GWLF. The product of annual baseflow volume and a median baseflow TSS concentration, summed with the product of annual storm-flow volume and a storm SS event mean concentration (EMC) equals the estimated load.

The TSS concentration used to calculate the load under baseflow conditions is the median of samples collected throughout the Toussaint Watershed in 2003 and 2004. The dataset is screened to eliminate high-flow samples by the use of concurrent flow measurements, field comments of the collector, or as a last resort by precipitation data. A median (n = 88) TSS concentration of 8.25 mg/l was used.

The SS EMC used to calculate the suspended load under storm conditions is referenced from a Heidelberg College study of storm discharge loads in Northwest Ohio rivers (Richards, 2001). Median SS EMCs from the Sandusky River, Honey Creek, and Rock Creek were used as representative of the Toussaint. EMCs from Heidelberg's study were used in place of storm data from the Toussaint, because insufficient high-flow data were collected to be representative of the entire storm hydrograph. Heidelberg's EMCs were calculated from thousands of samples representing hundreds of storms. The storm and base-flow loads transported by the Toussaint Creek, as calculated by the method described above, are presented in Table 3.3C.

Comparison of Tables 3.14 and 3.15 reveals that the sediment load contributed via field erosion is substantially less than the load transported by the stream. The contributed and transported loads are only estimations, but the magnitude of the difference illustrates that field erosion may not be the primary source of sediment loading in the Toussaint watershed. Based upon the previous estimate, field erosion accounts for only 25% of the transported load in the stream.

While this report does not wish to give undue credence to the methods described above, the presented loads are believed to be reasonable estimates. GWLF has been widely applied to simulate erosion from agricultural watersheds, and has consistently shown significant correlation (r^2 = 0.60 to 0.97) between predicted and observed sediment loads (Haith, 1984; Lee, 1999; Schneiderman, 2002). In the Portage River watershed neighboring the Toussaint, GWLF exhibited a hydrologic calibration with a r^2 value of 0.81, and the calibrated parameters were validated in the Toussaint (see Appendix C). GWLF is a proven tool for estimating sediment loading and flow.

Recognition of the relative importance of the various sources of sediment is important. If field erosion is on average only 25% of the transported load in Toussaint Creek, then other sources of sediment, such as gully erosion, channel erosion, and mass-wasting are likely significant. This conclusion is consistent with the results of a recent study conducted by the Toledo Harbor AGNPS Project Team (Bingner, 2005). The study was conducted in the Upper Auglaize Watershed – also in Northwest Ohio – and concluded that ephemeral gully erosion contributed nearly 72% of the total load; field erosion contributed the remainder.

Table 3.15 SS loads in Toussaint Cr. (Mg\year)

Year	Storm Flow	Base Flow	Total
1995	2295	398	2693
1996	2506	386	2892
1997	3230	468	3699
1998	4311	459	4770
1999	2285	288	2573
2000	2500	292	2793
2001	2563	575	3138
2002	2518	315	2833
2003	4321	484	4804
2004	1708	324	2032
Average:	**2824**	**399**	**3223**

3.3.4 Critical Condition

The critical condition for sediment loading is during storm events, because the primary source of sediment to the stream is non-point. One or two storms can contribute a large portion of the annual sediment load to the stream. There is, however, no critical condition for sediment with regard to its effect upon aquatic life. When sediment settles it reduces the diversity of habitat available to aquatic organisms. This effect is cumulative, rather than condition specific, and the extent of its impact is dependent upon the intensity of multiple storm events over a span of years, as well as various instream processes. The QHEI, as a visual assessment tool and the basis of the sediment TMDL, evaluates the cumulative condition of the stream, and is therefore reflective of the condition most related to attainment.

3.3.5 Margin of Safety

A margin of safety was implicitly incorporated into the sediment TMDL through the use of conservative target values. As illustrated by Figures 3.3A and 3.3B, aquatic community performance representative of WWH does occur at levels lower than the selected target values. The difference between the sediment targets and the level at which WWH attainment actually occurs is an implicit margin of safety.

4.0 PUBLIC PARTICIPATION

The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency in developing the TMDL program in Ohio. The EAG met multiple times over eighteen months and in July 2000 issued a report to the Director of Ohio EPA on their findings and recommendations. The Toussaint River TMDL has been completed using the process endorsed by the EAG.

Ohio EPA involved the partners and public stakeholders in the Toussaint River TMDL project. The Maumee Remedial Action Plan (RAP) was involved in identifying problems and developing recommended actions for restoration. This group will also be vital to the implementation of the Toussaint River TMDL recommendations.

The Maumee RAP was created in 1987 and involves a diverse cross-section of environmentally concerned businesses, industries, government agencies, non-profit organizations, educators, and citizens. This organization has been addressing issues in the Toussaint and Packer watersheds since 1992. The Maumee RAP was responsible for the implementation of two Section 319 grants from 1997-2004, that established streamside buffers and set aside floodplain lands to reduce sediment and fertilizer runoff.

In addition to soliciting input and recommendations from the Maumee RAP, the Ohio EPA requested input from additional local stakeholders. This was accomplished at a public information and stream sampling demonstration event on August 18, 2005. Attending the event was approximately three dozen people representing broad interests in the watershed including local officials and landowners. Attendees were asked to provide feedback on recommended solutions for restoration and protection of the watershed resources. Specifically, ideas to eliminate impairments and encourage voluntary actions to reduce nonpoint sources of pollution were discussed. The fish-shocking demonstration was an excellent educational event for the landowners, agency partners, and media that attended.

Throughout 2004 and 2005 the Maumee RAP and other local community partners have worked together to develop the *Maumee Area of Concern Stage 2 Watershed Restoration Plan*. This Plan has been created to be a State Endorsed Watershed Action Plan and a Maumee Area of Concern (AOC) Stage 2 Report for all of the watersheds of the Maumee AOC including Toussaint, Packer and Rusha Creeks. This ongoing planning effort involved

broad participation from local agencies, conservation organizations, and academic researchers working in the watershed area. The watershed action plan was submitted to ODNR and Ohio EPA for State Endorsement Review in December 2004. It will be revised and submitted for a second State Endorsement Review and a Lake Erie Program Stage 2 Report Review in early 2006. More information is available at www.MaumeeRAP.org .

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was public noticed from March 27 to April 27, 2006. A copy of the draft report was posted on Ohio EPA's web page (www.epa.state.oh.us/dsw/tmdl/index.html) and copies of the report were distributed to local libraries. A summary of the comments received and the associated responses are included in Appendix D.

Public involvement is key to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to bring the Toussaint, Packer and Rusha Creek watersheds into water quality attainment.

Table 4.1 Toussaint/Rusha Watershed Public Involvement

Date	Time	Activity/Objective
2/4/04	1:30-3:30	Form watershed action plan (WAP)development team for Lower Maumee watershed
12/15/04	-	Draft WAPsubmitted for state endorsement
8/15/05	-	Complete WAP revisions for targeted peer review
8/18/05	1:00 -3:00 PM	Meeting to discuss Draft TMDL Report with local stakeholders
8/18/05	4:00 -5:00 PM	Stream demonstration of fish shocking technique used by Ohio EPA to assess biological health of the Toussaint River
8/18/05	6:00 -8:00 PM	Meeting to discuss Draft TMDL Report with local stakeholders
October 2005	-	Public review of WAP
December 2005	-	Public notice of the Toussaint River and Rusha Creek TMDL Report
1/30/06	-	Re-submit Stage 2 Watershed Restoration Plan for state review and endorsements

5.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Restoration methods to bring an impaired water body into attainment with water quality standards generally involve an increase in the water body's capacity to assimilate pollutants, a reduction of pollutant loads, or some combination of both. As described in Section 3.0, the causes of impairment in the Toussaint River watershed are habitat alteration, nutrient enrichment, and siltation. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads, potentially combined with some additional means of increasing the assimilative capacity of the stream.

Potential restoration strategies used to achieve the TMDL restoration targets might include:

- NPDES program - permit limitations and compliance schedules
- Elimination/control of combined sewer overflows (CSOs)
- Municipal pretreatment program
- Centralized treatment for unsewered communities
- Limit and reuse point source discharge water
- Phase I and II Storm Water Pollution Prevention Plans (SWP3s) and Storm Water Management Programs (SWMPs)
- Post-construction storm water management practices
- Sediment and erosion control practices in urban and agricultural areas
- Conservation farming practices
- Comprehensive nutrient management plans
- Livestock waste management plans
- Proper use and storage of fertilizers and pesticides
- Reduce the use of residential fertilizers and pesticides
- Home sewage treatment system management and maintenance
- Flood plain management
- Wetlands creation and protection
- Riparian buffer initiatives
- Corridor protection ordinances
- Natural stream management principles
- Planned growth/development strategies
- Increase voluntary implementation of practices through education and outreach

5.1 Toussaint River TMDL Implementation Strategy

Ohio EPA is taking an iterative, adaptive approach to implementation for this TMDL project. Point source reductions will be achieved through effluent limitations, compliance schedules, special conditions in existing dischargers NPDES permits, and the designation of additional MS4s for NPDES permit coverage. A schedule will be developed for issuance of NPDES permits consistent with implementing the TMDL recommendations. Permits will be issued such that:

- a new discharge will not exceed the loading capacity of the receiving stream in relation to phosphorus
- stormwater management programs (SWMPs) will be developed and implemented which address the causes of impairment;
- trends in in-stream concentrations will be tracked, and the NPDES permits will include an option for permit modifications should data indicate in-stream total phosphorus and D.O. levels have achieved stable and desirable levels or the use designations are being fully met.

Implementation of nonpoint source reduction measures may be achieved through a locally adopted implementation strategy built around non-regulatory and voluntary incentive programs. The Maumee RAP was created in 1987 and involves a diverse cross-section of environmentally concerned businesses, industries, government agencies, non-profit organizations, educators, and citizens. This organization has been addressing issues in the Toussaint and Packer watersheds since 1992. The Maumee RAP was responsible for the implementation of two Section 319 grants from 1997-2004, that established streamside buffers and set aside floodplain lands to reduce sediment and fertilizer runoff. These projects resulted in establishment of 388,600 linear feet (74 miles) of new filter strips and 233.25 acres of protected floodplain, which has reduced the sediment loading rate in the watershed.

Local input to the implementation strategy will result in a planning and decision-making process that leads to reasonable and sustainable actions that will be the most effective in restoring water resources in the watershed. Throughout 2004 and 2005 the Maumee RAP and other local community partners have worked together to develop the *Maumee Area of Concern Stage 2 Watershed Restoration Plan (Plan)*. This Plan has been created to be a State Endorsed Watershed Action Plan and a Maumee Area of Concern (AOC) Stage 2 Report for all of the watersheds of the Maumee AOC including Toussaint, Packer and Rusha Creeks. As such, it will be a living document used by the community to guide water quality restoration activities. Volume 2 of the Plan contains tables of recommended restoration projects that are targeted to impaired segments or tributaries of the Toussaint River Watershed. Draft watershed project tables are located in Appendix C of this report.

This ongoing planning effort involves broad participation from local agencies, conservation organizations, and academic researchers working in the watershed. The draft plan was submitted to ODNR and Ohio EPA for State Endorsement Review in December 2004. A final plan will be revised and submitted for a second State Endorsement Review and a Lake Erie Program Stage 2 Report Review in 2006. More information is available at: http://www.maumeerap.org/stage2.html

Ohio EPA recommends an approach that directs resources to improve the overall habitat and physical stability of streams throughout the watershed. Often, we noted that impaired stream function was not the result of one discrete source, such as a wastewater discharge or runoff from a single farm field. The cumulative effect of multiple impairments like sediment and habitat degradation in the lacustuary (river/lake) area, or excess nutrients in a small stream with little or no habitat, appeared to work in concert to degrade the chemical water quality and aquatic communities.

A two-tiered approach that prescribes land management practices and promotes natural channel stability will be most effective in achieving nutrient and sediment load reductions. Traditional BMPs (best management practices) should be targeted at the stream segments most vulnerable to erosion during high flow storm events. Restoring stream habitat and maintaining channel stability will increase the nutrient and sediment assimilative capacity of streams during normal and lower flow conditions (Ohio EPA, 1999). In particular, phosphorus strategies will need to be targeted for implementation in the smaller drainage areas in order to achieve the recommended reductions.

5.2 Reasonable Assurances

As part of an implementation strategy, reasonable assurances provide a level of confidence that the waste load allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The local stakeholders will develop and document a list that differentiates the enforceable and non-enforceable selected actions necessary to achieve the restoration targets. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, will be a schedule for implementation of planned NPDES permit actions. Assurances for non-enforceable actions (certain nonpoint source activities), must include: 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with the Maumee RAP and those governmental entities that have jurisdiction and programs in place to implement the nonpoint source actions (e.g., county soil and water conservation district offices, county health departments, local Natural Resource Conservation Service offices of the U.S. Department of Agriculture, municipalities and local governmental offices).

5.2.1 Reasonable Assurances Summary

This is a summary of the regulatory, non-regulatory and incentive-based actions applicable to or recommended for the Toussaint River watershed. Many of these activities deal specifically with the point source discharge regulatory actions. Non-regulatory and incentive-based programs are currently delivered through existing local conservation authorities and nonpoint source reduction activities:

Regulatory:

- NPDES permit renewal with compliance schedule for achieving the recommended phosphorus limits at Genoa Wastewater Treatment Plant.
- NPDES permit schedule for CSO elimination in the Village of Luckey.
- Statewide Rules for Home Sewage Treatment/Disposal
- Agency approved county-wide Home Sewage Treatment System (HSTS) Plans
- Enforcement of Storm Water Phase I and II regulations
- Sediment and erosion control practices for construction projects
- Implementation of post-construction storm water controls on construction projects
- Implementation of the 208 Water Quality Plan in regards to development and sewer extensions.
- Enforcement of Section 404/401 of the Clean Water Act and Ohio Isolated Wetland Permit issues
- Designation of the City of Bowling Green for coverage under an NPDES Small MS4 permit.

Non-regulatory/Incentive based:

- Periodic stream monitoring to measure progress
- Development and local acceptance of an implementation plan which includes:
    - Watershed awareness education activities
    - Storm water management programs
    - Source protection of ground and surface drinking water supplies (SWAP)
    - Septic system improvements
    - Agricultural conservation practices
    - Riparian buffer initiatives
    - Manure nutrient management plans
    - Urban nutrient (fertilizer) management plans
    - Water table management/controlled drainage
    - Restoration of natural stream and flood plain function
    - Establish guidelines for construction and management of marsh projects
    - Design “managed marshes” for overall ecological/environmental gain
    - Encourage local health departments to implement HSTS Plans in watershed

Potential Funding Sources:

- Section 319 grant opportunities for implementation projects that support the strategy and goals of this TMDL
- USDA Farm Bill programs for agricultural BMPs, including the new Conservation Security Program (CSP) incentives (when it becomes available in this watershed)
- Lake Erie Conservation Reserve Enhancement Program (CREP) for buffer practices throughout the Lake Erie watersheds
- Clean Ohio Grant Fund opportunities for natural resource protection and improvement and farmland BMPs
- Low interest loan opportunities through WPCLF Linked Deposit program
- Funding opportunities through WRRSP program for riparian/habitat improvements
- USDA Rural Development Fund grants and WPCLF loan opportunities for centralized wastewater treatment in small communities

- Ohio Environmental Education Fund administered by Ohio EPA
- Lake Erie Protection Fund and Great Lakes Commission grant opportunities
- Ohio Coastal Nonpoint Source grant funding through ODNR/NOAA
- Funding through Ducks Unlimited, ONDR Division of Wildlife and provisions of the North American Waterfowl Conservation Act (NAWCA).

5.2.2 Point Source Controls

Implementation of the TMDL for the Toussaint River watershed NPDES permit holders will result in language in the Schedule of Compliance for NPDES permits and new limits for phosphorus.

Village of Genoa WWTP

Nutrient enrichment from phosphorus is listed as a cause of impairment, so a TMDL for phosphorus was done for the Toussaint River in the vicinity of the Village of Genoa WWTP. A target instream concentration of 0.10 mg/l was calculated for this section of the creek. The discharge from Genoa's wastewater treatment plant represents 40% of the total phosphorus point-source load to the stream. Monthly operating reports (January 1998 to November 2004) submitted to Ohio EPA show Genoa discharged approximately 0.329 million gallons per day at a median phosphorus concentration of 1.94 mg/l. Therefore, a reduction in the concentration limit to 1.0 mg/l is recommended. This represents a nearly a 50% reduction in the current discharge. A schedule of compliance for phosphorus reduction will be included in the Village's NPDES permit when it is renewed and/or modified. For the benefit of readers who may be unfamiliar with how such a permit condition could be structured, the following is an example compliance schedule:

> Part I, C - Schedule of Compliance
> A. Toussaint River Basin TMDL Phosphorus Reduction Implementation Schedule
> 1. Not later than 9 months from the effective date of this permit, the permittee shall submit a general plan for achieving the reductions necessary to meet the final allowable phosphorus limit of 1.0 mg/l at Outfall 2PB00008001. The general plan for achieving the loading reductions shall address, at a minimum, the following:
> a. The alternative(s) chosen to achieve the loading reductions.
> b. Cost estimates of implementing the chosen alternatives, including any applicable operation, maintenance, and replacement costs.
> c. A fixed date compliance schedule for meeting the reduction targets for total phosphorus. At a minimum, this schedule should include dates for: submission of approvable detail plans (if applicable); completion of implementation/construction; attainment of operational level; notification of the Ohio EPA Northwest District Office within 14 days of attaining operational level (if applicable); and the achievement of the loading reductions required by Schedule of Compliance Item A.2 not later than 48 months from the effective date of this permit.
> d. The financial mechanism to be used to fund the required improvements, operation, maintenance, and replacement costs (if applicable).
> 2. The permittee shall achieve the final allowable total phosphorus limit of 1.0 mg/l not later than 48 months from the effective date of this permit. (Event Code 5699).

This NPDES permit, Ohio EPA permit number 2PB00008*FD expires on August 31, 2009. In the event that evidence becomes available demonstrating to the Director's satisfaction that biological indices applicable to the Toussaint River Basin are in full attainment, or that monitoring data collected at appropriate locations within the TMDL study area show that the median total
phosphorus concentration measured at those locations is less than or equal to the instream target of 0.10 mg/l for two consecutive years, the Director will evaluate any proposed modification of the TMDL Implementation Schedule included in this NPDES permit. This permit may be modified or revoked and reissued for the following reasons:
- To include new or revised conditions based on new information resulting from implementation of the TMDL recommendations.
- To include new or revised conditions based on plans submitted by the permittee to upgrade the existing wastewater treatment facilities to achieve the allowable total phosphorus limit of 1.0 mg/l.

Village of Luckey WWTP
The Village of Luckey has a Compliance Schedule in their current NPDES permit which requires them to eliminate combined sewer overflows. The Village received a Permit to Install on October 18, 2005 which enables the Village to begin construction on sewer separation. Once the sewer separation is complete, the discharge from the Village's wastewater treatment plant will be evaluated to determine if additional work will need to be done on either the sewer system or on the wastewater treatment plant.

Unsewered Areas Recommendations
In small towns and unincorporated rural areas, water quality and public health can be severely impacted when multiple homes or businesses illegally bypass failed systems into the storm sewers or local streams. Individual sewage systems are used to treat sanitary wastewater in areas where no municipal treatment facilities exist. When poorly designed or neglected, they contribute loads of organic matter, nutrients, and pathogens. Site limitations such as lot size, soil type and depth to bedrock or groundwater further reduces the effectiveness of wastewater treatment, leading to surface or groundwater contamination.

Although there is not currently a recreational use impairment associated with bacteria in this watershed, there are elevated levels of fecal coliform bacteria in several locations. It is recommended that unsewered communities in the watershed work toward implementing the Section 208 Sewerage Facilities Plan to provide permanent solutions for areas such as Locust Point-Long Beach, Rocky Ridge, Elliston, Graytown, Sugar Ridge, Lemoyne, Dunbridge, and Dowling. In the rural areas, implementation actions to address this source of pollution would include identification and replacement of faulty septic systems, and public education on septic system maintenance. County Home Sewage Treatment System (HSTS) plans have been developed and approved for Wood, Sandusky and Ottawa Counties.

5.2.3 Storm Water Discharge Permits (and Storm Water Management Program)

In the Toussaint River Watershed, sources of stream impairment may include discharges from urban storm water runoff and storm water discharges from Phase 1 and II Industrial, Construction, and Municipal activities. Those industrial facilities with NPDES permit coverage for storm water discharges associated with industrial activities must develop and implement a Storm Water Pollution Prevention Plan (SWP3) which identifies potential sources of pollution. The SWP3 must also describe and ensure the implementation of practices to reduce pollutants in storm water discharges. It is recommended that these facilities review their SWP3's during their annual comprehensive site compliance evaluation to ensure that appropriate BMPs are implemented that address the causes of impairment for this watershed, including habitat alteration, nutrient enrichment, siltation, flow alteration, and bacteria.

Phase II Storm Water regulations now require prescribed management practices for construction activities be described in a site's SWP3 that include:

- Installation and maintenance of sediment and erosion control practices for construction projects which, either by themselves or as part of a total common plan of development or sale, collectively disturb one acre or more
- Implementation of post-construction storm water controls on construction projects which, either by themselves or as part of a total common plan of development or sale, collectively disturb one acre or more

So that a receiving stream's physical, chemical, and biological characteristics are protected and stream functions are maintained, the post-construction storm water practices shall provide perpetual management of runoff quality and quantity. To meet the post-construction requirements of the NPDES Construction General Permit, the SWP3 must contain a description of the post-construction BMPs that will be installed during construction for the site and the rationale for their selection. The rationale must address the anticipated impacts on the channel and floodplain morphology, hydrology, and water quality. To this end, appropriate BMPs are to be considered and implemented that address the causes of impairment for this watershed, including habitat alteration, nutrient enrichment, siltation, flow alteration, and bacteria. The post-construction BMP(s) chosen must be able to detain storm water runoff for protection of the stream channels, stream erosion control, and improved water quality.

Currently there are no regulated small MS4s in the watershed. While the Ohio Turnpike Commission and Ohio Department of Transportation (ODOT) have permit coverage under the Baseline NPDES General Permit for Small MS4s (Ohio EPA Numbers 3GC and 4GQ000000, respectively), their permit coverage at this time does not extend to, nor is required for, portions of their system outside of Urbanized Areas (UAs), as defined by the 2000 Census. As a condition of the Baseline NPDES General Permit for Small MS4s, entities are required to have a Storm Water Management Program (SWMP) implemented by March 2008 for all areas served by their MS4 within a UA. ODOT and the Ohio Turnpike have developed SWMPs. In the SWMP, BMPs addressing six Minimum Control Measures are implemented to minimize and to prevent storm water pollution. The six Minimum Control Measures are: Public Outreach and Education, Public Participation, Illicit Discharge Detection/Elimination, Sediment and

Erosion Control (construction site program), Post-Construction Storm Water Management, and Pollution Prevention for Municipal Operations.
While the Ohio Turnpike and ODOT operate roads passing through the Toussaint River watershed, their SWMPs are not required to be implemented in this area. Both entities should evaluate extending their Storm Water Management Programs in this watershed to areas outside the UA.

Under OAC 3745-39, Ohio EPA must consider certain small MS4s located outside of the UA for inclusion in the MS4 NPDES permit program. Under consideration are MS4s within municipalities with a population of 10,000 or more and a density of 1,000 per square mile. The City of Bowling Green meets these criteria. Ohio EPA is currently reviewing small MS4s against Ohio EPA's permit designation criteria, which is "when surface waters of the state within a county, township or municipality where a small MS4 is located are listed as impaired in the most recent final report submitted to the United States EPA by the director to fulfill the requirements of section 303(d) of the act (33 U.S.C. section 1313(d), effective October 10, 2000)." A preliminary notice has been sent to the City indicating Ohio EPA's intent to designate them. As the upper reaches of the Toussaint which receive urban runoff from Bowling Green are noted as impaired, it is recommended that Ohio EPA designate the City to obtain NPDES permit coverage.

For all regulated small MS4s, it is recommended that BMPs are considered and are implemented that address the causes of impairment for this watershed, including habitat alteration, organic and nutrient enrichment, siltation, flow alteration, and bacteria.

5.2.4 Section 401 Water Quality Certification, Isolated Wetland Permits, and Harbor Dredging Projects

Section 401 Water Quality Certifications and/or Isolated Wetland Permits are usually required whenever a project impacts waters of the state of Ohio, such as the placement of fill into wetlands, streams, or lakes. Many of these projects involve coordination with the US Army Corps of Engineers (ACOE). Procedures are already in place for evaluation of the applications that are required to be submitted for these projects. More information on the 401 Water Quality Certification and Isolated Wetlands permit program at: http://www.epa.state.oh.us/dsw/401/401Section.html.

Many times mitigation is required for these projects in order to offset the loss of aquatic resources. Ohio EPA encourages applicants to investigate the causes and sources of impairment in the watershed and to design their mitigation projects to address those impairments. The above web site also details changes to the Ohio regulations that affects permit fees, application review and public notice requirements, and the standards for mitigation. Additional information on Ohio's Mitigation Clearinghouse for wetland, stream or lake mitigation is located at:
http://www.epa.state.oh.us/dsw/MCH/index.html

The ACOE is also responsible for maintaining sufficient water depths within Great Lakes shipping ports. The mouth of the Toussaint River has been repeatedly dredged over the years with the last dredging occurring in 2004. The material dredged from the mouth of the Toussaint River is predominantly of fine to medium grain sand with some coarse sand and gravel. The composition of the dredged material indicates that much of this material originates from up-drift Lake Erie areas, not the Toussaint watershed. Therefore, efforts to reduce sediment runoff from within the Toussaint River watershed would probably have little affect in alleviating the need for repeated dredging of the Toussaint River mouth. The main beneficiaries of the dredging projects have been private and small commercial marinas

Additionally, within the lower reaches of the Toussaint River watershed are a sizable number of existing managed marshes with more managed marsh projects either proposed or being contemplated. Ohio EPA is working with the ACOE, Ottawa/Sandusky SWCD, USFWS, ODNR, NRCS, and Ducks Unlimited to establish guidelines for such projects, and procedures for consistent review of required permits. Many times these projects involve activities that can have both beneficial and detrimental affects on water quality and the environment in general. Therefore, each project needs to be designed and evaluated so that there is an overall net environmental gain. Typically these projects may require significant acreage to be set aside and managed as a marsh.

The construction, management, and maintenance of a marsh should be assessed with the following ecological goals in mind:

- How will the project affect the overall terrestrial and aquatic habitat?
- Will wetlands be restored, created, enhanced, or protected?
- Will the water level be managed by active or passive methods and what is the schedule for inundating/drawdown of the marsh?
- If berms or dikes will be used to create the marsh, what is the composition of these structures, and will they disconnect the stream from its floodplain?
- What may be the consequence of lost floodplain function?
- Will stream channels be modified in order to construct the marsh?
- Will fish be excluded from the proposed marsh or can it function as nursery habitat?
- Are invasive species a concern and how will they be managed or removed?
- What are the short and long-term maintenance issues with the project?

5.2.5 Nonpoint Source Controls

Agricultural Nutrient Enrichment and Sedimentation

The Toussaint River watershed is a predominately agricultural area used mostly for row crop production and, to a smaller degree livestock production. There are several horse farms of varying sizes and purposes in the watershed, and the number of facilities is continuing to grow. In the past ten to fifteen years, conservation efforts by farmers, local partnerships and units of government have reduced non-point sources of pollution significantly, and efforts in this direction continue.

Based on this study, agricultural contributions of sediment and nutrients continue to be problematic in the smaller tributary and headwater streams. Excessive sediment loading from field erosion, gully erosion, stream bank erosion, and mass-wasting or sloughing of unstable stream banks delivers large amounts of sediment to Lake Erie. Each of the four subwatersheds contains stream segments that have been identified as problem areas. They would benefit from restoration projects that prevent soil erosion, which in turn will reduce nutrient impairment, especially from phosphorus. The recommendations for reducing sediment are stated in terms of increasing the Qualitative Habitat Evaluation Index (QHEI) scores for the substrate, channel and riparian components of the QHEI. As displayed in Table 3.3, most of the 19 segments evaluated in this study would benefit from improved conservation farming methods to reduce field and gully erosion. A focused effort to improve the habitat scores in these stream segments with drainage areas less than 20 square miles will help reduce sediment and phosphorus:

- Toussaint Creek from RM 36.5 (Simonds Rd) to RM 33.5 (Webster Rd)
- Packer Creek between RM 21.2 (Stony Ridge Rd) and RM 14.7 (Billman Rd)
- Rusha Creek from headwaters to RM 4 (Leutz Rd)
- Martin Ditch
- Gust Ditch

Phosphorus contributions from other sources, such as wastewater treatment plants, failing home septic systems and urban runoff are covered in Chapter 3.2. Please refer to the tables in chapter 3.2 for estimates of the total phosphorus reductions needed to bring these streams into attainment

Landowners can take advantage of several incentive programs that will cover significant costs of adopting Best Management Practices on farmland, while educational initiatives exist to boost participation in these programs. Livestock Environmental Assurance Program (LEAP), and Environmental Quality Incentives Program (EQIP) for livestock exclusion and waste management practices, Lake Erie Conservation Reserve Enhancement Program (CREP), and other 2002 Farm Bill programs are available through the Farm Service Agency and Soil and Water Conservation Districts in each county of the watershed.

Habitat Degradation

In the Toussaint Watershed most headwater streams are modified by channelization and the removal of riparian vegetation, and fail to serve their natural function as nutrient and sediment filters, storage and retention of storm water; and sources of coarse particulate matter vital to the natural energy dynamics of a stream network. A lack of instream and riparian habitat, and low water levels in small tributary streams and maintained channels caused multiple impairments in the Toussaint watershed. The average habitat (QHEI) score of the ten headwater sites was 33.8, and the average score of the nine small river sites was 50.8. The water quality goal for Warmwater Habitat aquatic life use is a score of 60. The frequent occurrence of poor habitat characteristics such as channelization with little or no recovery, thick muck substrates in the channel, low sinuosity (curves) in the stream, and sparse vegetative cover is also severely limiting for the aquatic life communities.

In this study, the difference between small streams that were attaining their aquatic use designation and streams that were not, appeared to be related to the amount of nutrient enrichment and the presence or absence of good habitat conditions. In other words, the impacts of sediment and nutrients are magnified by poor physical habitat. Conversely, good physical habitat and adjoining conservation land use practices can be effective in assimilating these pollutants.

Habitat improvements are recommended throughout the watershed with special effort directed at the following non-attaining stream segments:

- Headwaters of Toussaint Creek from City of Bowling Green to Webster Rd
- Toussaint Creek from Graytown Rd to Harder/Rocky Ridge Rd
- Headwaters of Packer Creek to Billman Rd.
- Rusha Creek for entire length
- Martin Ditch for entire length

Restoration projects that yield an increase in the Habitat (QHEI) score to an average of 60 for WWH are desired. The target for the QHEI provides a means for evaluating success for any activities performed in terms of how likely it is for an aquatic life use to be restored. When QHEI values meet or exceed 60 for WWH, the likelihood that a warmwater aquatic fauna will be supported is greater than when the scores are lower (Ohio EPA, 1999). In these stream segments, all aspects of the habitat; substrate, instream cover, riparian and channel characteristics, and pool riffle quality need improvement.

Habitat Protection and Restoration

Preservation of natural habitat is key in maintaining the existing level of assimilative capacity of the watershed. Actions such as preserving natural drainage features, restoring and maintaining riparian areas, reconnecting riparian floodplains, minimizing impervious surface areas, and installing post-construction structural storm water management practices are recommended.

Unlike the standard practices for reducing sediment and nutrient runoff from crop land, the solutions for habitat and flow-impaired streams will not be familiar BMPs that have well-established incentive programs. Improved habitat will rely on long term changes and social acceptance of new trends in agricultural drainage practices. Implementation actions should include:

- Adopt riparian protection ordinances that prevent flood plain encroachment and riparian removal
- Protect riparian areas with conservation easements and/or buffer establishment
- Stabilizing severely eroding stream banks with bio-engineering techniques
- Reconnecting stream channels with active natural floodplains
- Promote riparian wetlands to provide flood water storage and enhance groundwater recharge, and seasonal flow augmentation
- Demonstrate drainage water management practices on agricultural fields with subsurface drainage systems
- Promote natural stream management and filter strips to reduce the frequency of maintenance on petition ditches

- Reduce the ditch maintenance assessment fee if filter strips are established and maintained
- Restore severely impaired waters using two-stage channel design

5.2.6 Stream Restoration and Protection Programs

There were two 319 grants for riparian corridor restoration and enhancement in this watershed. The FY 97 grant focused on the mainstem of just the Toussaint River. In FY2000, the same sponsor, TMACOG received a grant to expand the riparian program to the Toussaint tributaries including Packer Creek and Rusha Creek. Partners providing local match commitment to the project included the SWCDs in Wood, Sandusky, and Ottawa counties, the Ag/Rural Runoff Action group of the Maumee RAP, and the Ottawa and Wood County local health departments. For more information and a map of these projects please visit the Maumee RAP's Stage 2 Restoration Plan web page at http://www.maumeerap.org/stage2.html , then scroll down to Volume 1 and click on the link to the Toussaint River Watershed.

The Toussaint River watershed will be considered a priority watershed for TMDL implementation funding in FY2006 and beyond. Local partners will be encouraged to submit proposals that implement recommendations of the TMDL plan. Ohio EPA will be especially interested in funding projects that reduce or eliminate the habitat degradation and sedimentation impairments in this watershed. Fundable projects could include stream re-naturalization to restore natural stream ecology, flow and flood plain function, or demonstration of a two stage channel on a maintained drainage ditch. An example of a recent "2-stage ditch project" in the Portage River watershed can be found at http://east.osu.edu/anr/bbwntr7.htm . Other projects that will protect and help prevent NPS pollution threats to the already attaining main stem of the Toussaint watershed could include coastal and riparian wetland restorations or permanent riparian easements.

A loss of functional wetlands near Lake Erie has been identified as a priority for the current Section 319 Nonpoint Source Implementation grant administered by Ducks Unlimited, through the partnerships with SWCDs and conservation clubs in the lower Sandusky, Portage and Toussaint River watersheds. The three year grant began in 2003 and will conclude in March 2006. The goal of the grant is to restore 100 acres of coastal wetlands on private lands that do not qualify for cost share assistance through the CREP program for conversion of farm land. Additional information on the Nonpoint Source Program and 319 grants is available on Ohio EPA's web site at: http://www.epa.state.oh.us/dsw/nps/index.html

Ohio's Water Pollution Control Loan Fund (WPCLF) has two funding sources for nonpoint source pollution control available through the Ohio EPA Division of Environmental and Financial Assistance (DEFA). The Linked Deposit Loan Program provides low interest loans through local banks to aid landowners in implementing nonpoint source reduction projects such as residential on-lot septic system repair or replacement, agricultural BMPs, stream corridor restoration, and sanitary sewer connections.

The other WPCLF funding mechanism, Water Resource Restoration Sponsor Program (WRRSP), is a unique opportunity for municipalities and local partners to work together on a stream restoration project. When a publicly owned wastewater treatment system obtains a WPCLF loan for plant expansion or other improvements, the reduction in interest on the loan repayment can be used to sponsor a smaller local watershed project. There is an additional discounted loan rate for municipalities who enter these partnerships. Some uses of WRRSP could be to finance riparian easement purchase, stream channel and wetland restoration and protection, and match monies for other funding sources such as Section 319 grants. Additional information on Linked Deposit loans and WRRSP is available on the Ohio EPA web site at http://www.epa.state.oh.us/defa/wpclf.html

5.2.7 Resource Conservation Programs

The local implementation strategy will evaluate existing conservation programs and seek opportunities for new funding sources for landowners willing to try innovative practices. Several existing voluntary nonpoint source control programs available in this watershed are highlighted below.

The 2002 USDA Farm Bill provides funding for several programs including the Environmental Quality Incentive Program (EQIP), and the Conservation Reserve Program (CRP) which have reduced agricultural contributions of nutrients and sediment in this watershed. In addition, Lake Erie CREP, an enhanced conservation Reserve program is available in all Lake Erie watershed. Continued adoption of these conservation practices on new farmland acres in the smaller tributary streams and the headwaters of the Toussaint will contribute to water quality improvements in the whole watershed.

The Ohio Lake Erie CREP is a special conservation program to create 67,000 acres of riparian area and upland practices to reduce sediment pollution in Lake Erie and its watersheds. This voluntary program will improve the water quality of streams and increase wildlife habitat by reducing sediment transport to the lake. The Ohio Lake Erie CREP is a Federal-State agreement to commit environmentally sensitive agricultural land through the Conservation Reserve Program to a conserving use, through installation of filter strips, riparian buffers, wetlands, hardwood tress, wildlife habitat, and field windbreaks. More information on Lake Erie CREP can be found at the following web site: http://www.dnr.state.oh.us/soilandwater/crephome.htm

5.2.8 Source Water Protection Program

There are not currently any public drinking water systems that receive water directly from surface waters within the Toussaint watershed, however, there are several communities including Genoa, portions of Troy Township in Wood County, and Carroll Township in Ottawa County which obtain water from Lake Erie through regional or public water satellite systems.

Most of the businesses, schools, and mobile home parks in the watershed rely on groundwater wells for their drinking water. Each public drinking water system has received a drinking water assessment of their water supply well(s) from Ohio EPA. The document includes a delineation of the wellhead protection zone, a contaminant susceptibility analysis, and a checklist for developing a protection strategy. Rural homes and communities without public water systems rely on groundwater pumped from private wells that are under the regulatory authority of the local Health Department.

There are several public wells in the Village of Luckey that have experienced problems meeting the drinking water standard for total coliform bacteria and nitrate in recent years. This appears to be due to the karst geology (shallow fractured limestone) in that area of Wood County. The lack of a thick clay cover to protect the underground aquifer has made these wells highly susceptible to contamination from surface runoff. The affected facilities have either drilled new wells or resorted to hauled water to provide safe drinking water.

Strategies for protecting private and community drinking water wells in the Toussaint, Packer and Rusha Creek watersheds should include:

- Conduct watershed wide education and awareness about drinking water source protection for both public and private well
- Develop a protection strategy based on the potential contaminants in your area
- Contact local elected officials about issues that may impact drinking water protection zones
- Encourage connection to a regional public drinking water system
- Ensure proper construction of wells (no gaps around new or existing well casings)
- Reduce fertilizer and pesticide application in the well protection zones
- Properly store and mix fertilizers and pesticides in the well protection zones
- Determine location and status of leaking underground storage tanks
- Establish early warning and emergency response plan for spills
- Coordinate with local emergency response agencies

Additional information regarding the public water systems in this watershed can be obtained from the Ohio EPA Northwest District Office, 347 North Dunbridge Road, Bowling Green, Ohio 43402 or by calling 419-352-8461. For more information on the Ohio EPA's Source Water Assessment and Protection program (SWAP), please visit the agency website at http://www.epa.state.oh.us/ddagw/pdu/swap.html

5.2.9 Public Education Programs

The Maumee RAP Public Outreach and Education action group, the Western Lake Erie Audubon Society, and the county Soil and Water Conservation Districts have staff and/or volunteers that deliver programs and information to help local landowners and public officials understand the value of water and land resources. More information on this Maumee RAP action group can be found at: http://www.maumeerap.org/publicoutreachgroup.html. Education materials can be updated to include information on causes, sources and solutions to nonpoint pollution in the Toussaint watershed. The primary focus would be building public awareness about the value of a healthy watershed and the importance of reducing/eliminating these sources of pollution. Funding for nonpoint source (NPS) education is available through competitive grants from ODNR Division of Soil and Water Conservation and the Ohio

Environmental Education Fund administered by Ohio EPA. Links to the two Agency's environmental program web sites are: http://www.epa.state.oh.us/oeef/ and http://www.dnr.state.oh.us/soilandwater/education.htm.

5.3 Process for Monitoring and Revision

An initial monitoring plan to determine whether the TMDL has resulted in attainment of water quality standards and to support any revisions to the TMDL that might be required begins with in-stream water quality chemical monitoring. This sampling will be done at a minimum by those permit holders with Individual NPDES permit at locations upstream and downstream of their outfalls and at ambient monitoring stations to be collected by Ohio EPA.

A more detailed and inclusive monitoring plan could be developed by the local watershed group which would describe steps in a monitoring program, including timing and location of monitoring activities, parties responsible for monitoring, and quality assurance and quality control procedures. It should include a method to determine whether actions identified in the implementation plan are actually being carried out and criteria for determining whether these actions are effective in reaching the TMDL targets. For example, ongoing monitoring of habitat improvements could include assessments of bird populations. Measurement of aquatic life can be complemented by using censuses of birds along newly established or protected riparian corridors to provide evidence of quality habitat.

It is recommended that the Maumee RAP work together, with the Ohio EPA, OSU Extension and other local partners, such as Bowling Green State University, University of Toledo, and Wood County Parks District, and Audubon Ohio to develop a monitoring plan and locate resources to establish and maintain a volunteer monitoring program throughout their watershed. We believe that collaboration among local conservation organizations will strengthen the actions of traditional partners. An approach that uses both on-the-ground volunteer effort and public education to raise awareness for watersheds and water quality will encourage citizen groups to be involved in project implementation and evaluation efforts. Ohio EPA should support efforts by these local partners to compete for implementation funding for projects where local groups are most likely to become engaged to effect long term habitat improvements. Please visit the website for Maumee RAP at www.MaumeeRAP.org . Audubon Ohio has an established group of volunteer members that collect census of bird populations in the Western Lake Erie Important Bird Area. This is a large expanse of land and water including portions of Wood, Lucas, Ottawa and Erie Counties, the Lake Erie Islands and the waters of Lake Erie.

A biological and water quality study of the Toussaint River, similar to that conducted by the Ohio EPA in 2003 will be scheduled when indications suggest that major changes in the watershed have occurred. In addition, interim and/or surrogate measures that document progress in water quality improvement are recommended. Consideration must be given to the lag time between source control actions (habitat improvements and loading reductions) and observable/measurable instream effects, especially for nonpoint sources.

A tiered approach to monitoring progress and validating the TMDL will be followed; the tiered progression includes:
1. Confirmation of completion of implementation plan activities;
2. Evaluation of attainment of chemical water quality criteria;
3. Evaluation of biological attainment.

A TMDL revision will be triggered if any one of these three broad validation steps is not being completed, or if the WQS are not being attained after an appropriate time interval. If the implementation plan activities are not being carried forth within a reasonable time frame as specified in the implementation plan then an intercession by a local watershed group or other appropriate parties would be needed to keep the implementation activities on schedule. Once the majority of (or the major) implementation plan items have been carried out and/or the chemical water quality has shown consistent and stable improvements, then a full scale biological and chemical watershed assessment would be completed to evaluate attainment of the use designations. If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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APPENDIX A: TOUSSAINT RIVER WATERSHED TMDL FACT SHEET

OhioEPA State of Ohio Environmental Protection Agency

Fact Sheet

July 2006

Toussaint River Watershed TMDL

Where is the Toussaint River watershed?

The Toussaint, Packer and Rusha Creek watersheds are located in northwest Ohio in portions of Wood, Sandusky, and Ottawa counties that were formerly covered by the Black Swamp. The mainstem of the river is 37 miles long and drains 143 square miles or 91,613 acres. Land use in the watershed is mostly agriculture, with 77 percent cropland, 16 percent forest and pasture, and 3 percent urban or other use. Additionally there is 2% open water, and another 2% of land covered by marshes and reconstructed wetlands in the Ottawa National Wildlife Refuge and near the mouths of the Toussaint River and Rusha Creek. There is one city Bowling Green, and 6 villages including Luckey and Genoa in the Toussaint watershed.

The upstream segments of both Toussaint and Packer Creek are highly channelized for agricultural drainage. The Rusha Creek subwatershed and the lower 10 miles of the river are characterized by managed wetlands and diked farm fields. Shallow bedrock in the Luckey area makes groundwater highly susceptible to contamination from surface runoff.

How did Ohio EPA collect water quality data?

Comprehensive biological, chemical, and physical data were collected by Ohio EPA scientists in 2003 throughout all streams in the Toussaint watershed. Samples at 24 sites were evaluated, including monitoring the abundance and diversity of fish and aquatic insect communities, measuring the physical habitat of the stream and adjacent land use, and analysis of water samples to determine the chemical quality of the water and sediments.

The conditions of the watershed were compared with state water quality goals to determine which stream segments are impaired, and how much needs to be done to restore good stream habitat and water quality. This evaluation is done as part of Ohio EPA's Total Maximum Daily Load (TMDL) program.

How does your stream "measure up?"

All streams are designated Warm Water Habitat (the water will support plant and animal species accustomed to warm water), including the lake-affected lower 10 miles of the river. Of the 24 sites evaluated, only 11 meet the standard for Warm Water Habitat. The remaining 13 sites are not meeting that standard. The majority of low habitat evaluation scores occur in areas that drain less than 10 square miles and the lower ten miles of the river.

Is the Toussaint watershed polluted?

Yes and no. Some areas of the Toussaint River and its tributaries have good water quality and populations of fish and other aquatic life. The Toussaint River upstream of the lake-affected area meets the water quality standards,

Some areas of the watershed do not currently meet water quality standards. Toussaint Creek is impaired by municipal sewage from the villages of Luckey and Genoa. Communities with combined sanitary and storm sewer systems may have untreated human and industrial waste overflowing to the river during heavy rainstorms. The lower 10 miles of the Toussaint River are impaired by excessive nutrients and sediment deposits from upstream.

What else degrades the Toussaint watershed?

Many small streams like Martin Ditch, Gust Ditch and Rusha Creek, and the headwater segments of Toussaint and Packer Creeks are impaired by physical changes to the land. Stream channelization, drainage tiles, and loss of floodplains and streamside vegetation has impaired the upstream portions of Toussaint Creek in Wood County, the first 6.5 miles of Packer Creek, Most of Rusha Creek, and all of Martin Ditch and Gust Ditch. When streams are widened and deepened for agricultural drainage, they contribute excess soil to the stream which destroys habitat for fish and other aquatic life. Soil carried through ditches degrades Lake Erie.

When trees along the stream banks are removed, the lack of shade allows the water temperature to increase, which decreases the amount of dissolved oxygen for aquatic organisms. This is made worse by manure runoff and untreated sewage flowing from failing home septic systems and small communities without any wastewater collection or treatment.

Lack of water in the small headwater streams, especially in the summer, makes it hard for pollutants to be absorbed and treated by the natural stream biology. Agricultural drainage improvements such as tiling and routine dredging contribute to uneven and unsustainable water flow in these small streams, making it hard to support good aquatic life communities.

In the lower end of the river the loss of natural wetlands, and the shift to more managed (diked) marshes has degraded aquatic habitat.

The Army Corps of Engineers (ACOE) routinely dredges the mouth of the river for navigation, and removed some of the spent military ordnance from the former Erie Army Depot in 2002. The ACOE conducts ongoing monitoring of ordnance movement.

What is being done to improve the water resource?

The community is taking steps toward reducing pollution in the Toussaint River watershed. The Ohio EPA is working with the ACOE, the Fish and Wildlife Service and Ducks Unlimited to enhance wildlife habitat, while preserving floodplain function and fish movement. Also, many conservation measures such as no-till farming, crop residue management (leaving soybean stubble and corn husks on the field after harvest), planting winter cover crops, and creating buffer strips (small areas or strips of land in permanent vegetation) have been adopted to reduce soil erosion.

The TMDL program identifies measures to reduce pollution further. Some actions are already occurring. Two previous state/federal grants provided cost share for agricultural conservation practices, such as filter strips and flood plain set-aside areas. Programs funded through the U.S. Department of Agriculture have helped provide animal waste storage facilities and additional erosion control buffer practices.

The Village of Genoa began a ten year project to separate combined sewers that was completed in 2002. Luckey is required to address combined sewer overflow events by developing a long-term plan to control combined storm water and sewage overflows to the streams during rainfall. Genoa will also be required to make wastewater treatment plant improvements to achieve greater phosphorus removal.

Where will restoration projects help the river?

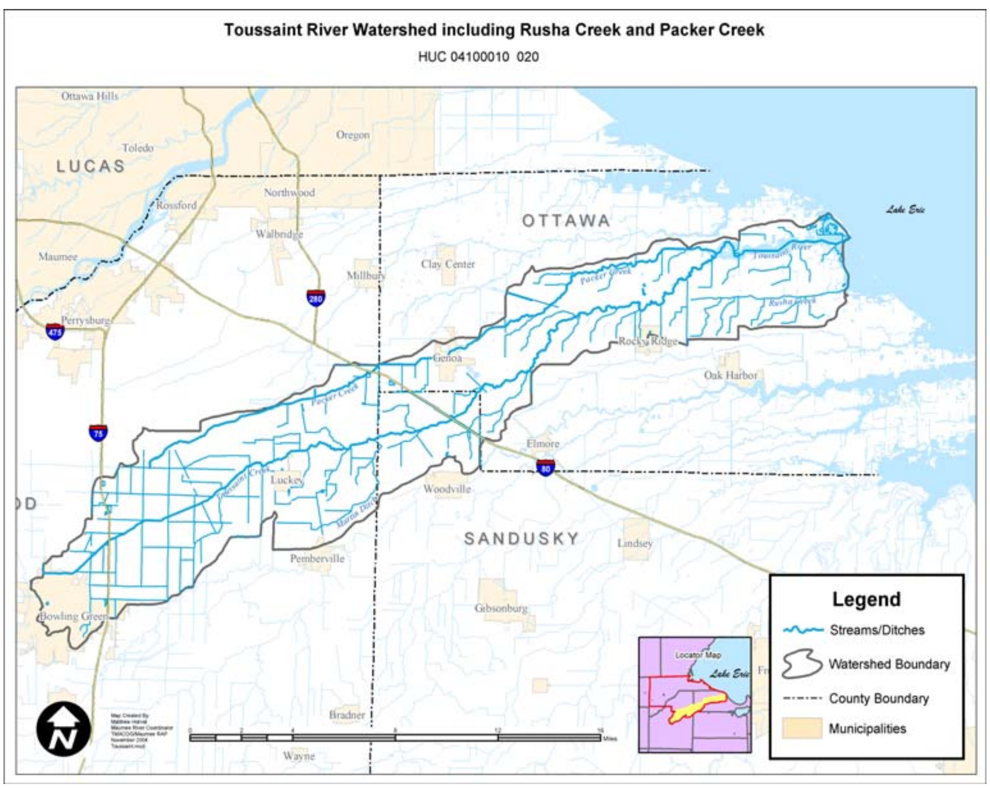
Due to the large percentage of land in crop production in Ohio’s agricultural watersheds, including the Toussaint River and Packer Creek, sediment and nutrients are the most pervasive pollutants that need to be controlled. Each of the four subwatersheds contain stream segments that have been identified as having low water quality. The following streams could benefit from restoration projects that prevent soil erosion and increase or protect the amount of good stream habitat:

- Toussaint Creek between City of Bowling Green and Webster Rd.
- Packer Creek between Stony Ridge Rd and Billman Rd.
- Rusha Creek
- Martin ditch
- Gust Ditch

It is expected that traditional best management practices and land management measures will be targeted at the stream segments most vulnerable to erosion during high-flow storm events

The Local Watershed Group

The Maumee Remedial Action Plan (RAP) was created in 1987, and partners of this local watershed group were involved in identifying problems and developing recommended actions for a watershed clean up plan. This organization will also be vital to the implementation of the Toussaint River TMDL recommendations. They have been addressing issues in the Toussaint and Packer watersheds since 1992. More information is available at: http://www.maumeerap.org/stage2.html



APPENDIX B: AQUATIC LIFE USE ATTAINMENT

Table 2. Aquatic life use attainment status for stations sampled in the Toussaint and Rusha Creek basins based on data collected July-October 2003. One site collected in 2002 (noted in **bold**) is included for a lacustuary site not sampled in 2003. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Fish / Macro Invertebrate	IBI	MIwb[a]	ICI[b] (LICI)[c]	QHEI	Attain ment Status[d]	Causes	Sources
Toussaint Creek			*WWH*				
36.5^{H}	20*	NA	F*	25.5	**NON**	Habitat alterations, Nutrient and organic enrichment Siltation	Riparian removal /Channelization-Ag. Failing septic systems
33.5^{H}/33.6	30	NA	38	42.5	FULL		
29.4^{W}	28^{ns}	7.2	32^{ns}	59.0	FULL		Luckey WWTP inputs raw sewage
28.6^{W}/28.5	27*	8.0	VG	49.5	**NON**	Siltation Nutrient and organic enrichment	Agriculture - Row crop Luckey WWTP
20.2^{W}/20.4	33	6.9^{ns}	42	57.5	FULL		
19.7^{W}/19.6	34	7.3	42	71.5	FULL		
18.4^{W}/18.5	29^{ns}	6.4*	38/32^{ns}	42.0	PARTIAL	Siltation	Agriculture - Row crop Genoa Quarry
13.9^{W}/14.0	27*	5.9*	24*	50.5	**NON**	Habitat alterations (channelization) Possible historical fish kill?	Channelization Unknown source, see page 7
12.5W/12.6	28^{ns}	5.7*	32^{ns}	34.0	**NON**	Siltation Habitat alteration Nutrient Enrichment	Recent woody removal and dredging Septic systems
10.5W	35	8.2	36	51.5	**FULL**		
Toussaint River			*WWH (Lacustuary)*				
--/**4.7**			(12*)		(**NON**)	Siltation Nutrient enrichment	Agriculture - Row crop

1.7[O]	22.5*	6.2*			(**NON**)	Siltation Nutrient enrichment	Agriculture - Row crop
0.3[O]	38	8.2[ns]			(FULL)		
Packer Creek			*WWH*				
21.2[H]	21*	NA	G		**NON**	Siltation Nutrient enrichment	Agriculture - Row crop Channelization
15.6[H]/--	18*	NA	---	29.0	**(NON)**	Siltation Nutrient and organic enrichment	Failing septic systems?
14.7[H]	32	NA	G	27.0	FULL		
11.3[H]	30	NA	G	28.0	FULL		
–/4.6	–	–	36	51.0	FULL		
3.5[W]	36	9.1	44	42.0	FULL		
0.2[A]	23*	7.4*	F	26.5	**NON**	Siltation Nutrient enrichment	Agriculture NPS run-off Channelization
Rusha Creek			*WWH Existing/Recommended MWH*				
5.0[H]/--	18*	NA	F*	29.0	**NON**	Siltation Nutrient enrichment	Channelization Agriculture - Row crop
4.0[A]**/3.0**	21*	4.8	(F*)	16.0	**NON**	Siltation Nutrient enrichment	Channelization
Martin Ditch		*Undesignated/Recommended WWH*					
0.2[H]	24[ns]	NA	MG[ns]	27.5	FULL		
Gust Ditch		*Undesignated/ Recommended PHWH* [g]					
2.8[H]	16	NA	NA	44.5	--	Natural	Ephemeral stream (Class 1 PHWH)

Ecoregion Biocriteria: Huron-Erie Lake Plain

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	28	50	20				34	46	22
Wading	32	50	22	7.3	9.4	5.6	34	46	22
Boat	34	48	20	8.6	9.6	5.7	34	46	22

H - Headwater site.

W - Wading site.

B - Boat straight electrode array.

a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.

b - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition (e.g., abundance of pollution sensitive taxa), EPT taxa richness, and total taxa richness scores was used when quantitative data were not available or considered unreliable due to sampling considerations (e.g., inadequate current velocity).

VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Lacustuary Invertebrate Community Index (LICI)

d - Attainment status is given for both existing and proposed use designations; status based on one organism group is parenthetically expressed.

ns - Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

d - Limited Warmwater Habitat is an archaic use designation.

e - Low flows precluded use of boat method on the second pass.

f - Modified Warmwater Habitat criteria for channel modified habitats.

g - This small stream can be best characterized as a Class III Primary Headwater Habitat (PHWH) water body as defined by a recent Ohio EPA technical document (Ohio EPA 2002). As such, no attempt has been made to determine attainment status since this use has not yet been promulgated in the Ohio Water Quality Standards. When the PHWH use becomes codified, this stream will be assigned an appropriate aquatic life use utilizing the Ohio EPA rulemaking process established for designating aquatic life uses for Ohio streams.

APPENDIX C: APPLICATION AND CALIBRATION OF GWLF

The purpose of this appendix is to describe the application of the Generalized Watershed Loading Function (GWLF) to the Toussaint Creek Watershed in Northwest Ohio. GWLF was used to quantify the hydrologic, sediment, and nutrient loading to Toussaint Creek to facilitate total maximum daily load (TMDL) development.

C.1 Introduction

A general four-step strategy was used to model the watershed using GWLF. First, GWLF was set-up and run for the Portage River Watershed above Woodville, Ohio. Second, hydrology of the Portage River Watershed Model (hereinafter the Portage Model) was calibrated to the U.S. Geological Survey (USGS) gage at the watershed outlet. Third, calibrated parameters from the Portage Model were transferred to the Toussaint Creek Watershed Model (hereinafter the Toussaint Model) and validated. Fourth and finally, validated parameters from the Toussaint Model were used to simulate the hydrologic, nutrient, and sediment loadings to each TMDL sub-watershed of the Toussaint Creek Watershed.

This general strategy was employed because insufficient flow data was available for Toussaint Creek to effectively calibrate a model. The Portage River watershed is benefited by a long-term flow record maintained by the USGS near Woodville. The Portage River gage provided a flow record of sufficient length to depict the seasonal and annual variations of flow that must be accurately characterized to calibrate a model. The physiographic, soil, land-use, and climatologic similarities between the Toussaint Creek and Portage River Watersheds, as well as their spatial proximity, justify the use of parameters calibrated to the Portage River Watershed in the Toussaint model.

C.2 GWLF Defined

GWLF is a mid-level watershed loading model that is a compromise between a simple, empirical export-coefficient model and a detailed, process-based mechanistic model. GWLF simulates the hydrologic, sediment, and nutrient loadings to a stream system. The hydrologic routines of the model operate on a daily time-step, while sediment and nutrient loads are calculated on a monthly basis.

For the purpose of this study, the procedures of GWLF 2.0 as described by Haith (1992 & 1985) were built into a Microsoft Excel™ spreadsheet. For details regarding the specific procedures of GWLF, please consult the *Generalized Watershed Loading Functions Version 2.0 User's Manual*.

Two modifications were made to GWLF for application to the Toussaint Creek Watershed. A sub-routine was added to simulate sub-surface tile drainage and the method to calculate the antecedent moisture condition was changed. The tile-drain sub-routine functions by intercepting a user-specified percentage of the water that percolates through the vadose zone. Intercepted water is routed to a hypothetical tile-storage zone, and is then released to the stream at a rate controlled by a coefficient.

The antecedent moisture condition is calculated as a function of vadose-zone storage. Previous version of GWLF have calculated the antecedent moisture condition for each day as the sum of the previous five-day's rainfall and snowmelt. The antecedent condition is then used to determine the appropriate curve number to calculate daily runoff. In place of this, the Toussaint model uses the moisture content of the vadose zone to determine the appropriate curve number. Each day's curve number is determined via a continuous function that uses vadose-zone storage as the independent variable.

C.3 GWLF Hydrologic Calibration

As previously stated, GWLF was first set-up and calibrated to the Portage River Watershed above Woodville, Ohio. Hydrologic parameters calibrated to the Portage River, which were assumed to be representative of regional values, were then used in the Toussaint model.

Hydrologic simulation in GWLF requires the following inputs: (1) daily precipitation in cm, (2) daily mean temperature in C, (3) land-use area in ha, (4) land-use curve number, (5) vadose-zone saturated capacity in cm, (6) percent of percolating water intercepted by tile, (7) saturated-zone recession coefficient, (8) tile-flow coefficient, (9) seepage coefficient, and (10) evapotranspiration cover coefficients . The following paragraphs detail the source of each parameter.

- Daily precipitation and mean temperature values used were from the Midwest Regional Climate Center gage #330862 located at the Bowling Green Wastewater Treatment Plant. Data from the period 1 January 1990 to 28 February 2005 were used in both the Toussaint and Portage models. It is recognized that the Bowling Green gage is not ideal from a geographic perspective. If the goal of this project was to accurately predict watershed response on a daily basis, then multiple gages spatially distributed throughout each watershed would be needed. However, the goal of this project was to characterize annual and seasonal variation and to accurately predict flow and contaminant loadings as monthly averages. For this purpose the use of a single gage to represent the regional condition is sufficient.

- Land use information was obtained from the National Land Cover Dataset (NLCD, USGS 1994). The NLCD was compiled from Landsat™ satellite imagery and supplemented with ancillary data where available. NLCD data was analyzed using ESRI ArcGIS™ on the basis of watershed boundary. Land-use was categorized as crop, pasture, forest, or urban. Individual land-uses that did not logically fall into one of these categories were place into forest, but are insignificant because of the small area they represent.

- Curve numbers (CNs) were area-weighted averages for each land use. Hydrologic response units (HRUs) were first determined based upon unique land-use and soil hydrologic-group pairings. CNs were assigned to each HRU based upon information in Tables D-2, D-3, D-4, and D-5 of the *GWLF 2.0 User's Manual*. CNs of like land-uses were then averaged based upon area.

- Vadose-zone saturated capacity was set at 10 cm. The *GWLF 2.0 User's Manual* recommends this value based upon a 100 cm rooting depth and a 0.1 cm/cm volumetric available water capacity (AWC). This value is used as a default because determination of the average watershed rooting depth and AWC is impractical.

- The percent of percolating water intercepted by tile (hereinafter percent tile) was initially set at 50%. As tile drainage is a new routine added to the model there is no recommended default value.

- Initial saturated-zone and tile-flow coefficients were set based upon hydrograph analysis of the Portage River USGS gage at Woodville. Flow from the period of record 1 January 1990 to 30 September 2003 was examined and days of receding flow were identified. For each day recession was calculated, then average recession was summarized based upon percentile flow. It was assumed tile flow dominates in normal to elevated conditions (percentile flow of 50-85%), and under low to normal conditions (percentile flow 0-50%) baseflow dominates. Average recession values for these flow ranges were 0.140 and 0.239, respectively, and were used as the initial saturated-zone and tile-storage recession coefficients.

- The initial seepage coefficient was set to zero, reflecting no loss to deep storage.

- Monthly evapotranspiration (ET) cover coefficients were referenced from the *GWLF 2.0 User's Manual.*

As previously stated, the goal of modeling was not to predict day-to-day or even month-to-month flow. Rather, the goal of modeling was to depict seasonal and annual variation and to accurately represent average conditions. Therefore, the specific objectives of the GWLF simulation were to match the flow-duration interval of the predicted and observed flow, and to produce reasonable agreement between the predicted and observed average monthly flows.

C.3.1 Initial Portage Model Run

Table C-1 summarizes the hydrologic input parameters used in the initial run of the Portage model. Figure D-1 is a plot of observed versus predicted monthly flow. Figure D-1 includes a linear trend-line, the equation describing the line, and an R^2 value indicating the strength of the relationship. Figure D-2 is a plot of percentile flow for both the predicted and monthly values.

Table C-1: Initial hydrologic-parameter values for the Portage Model

Parameter	Land Use			
	Crop	Pasture	Forest	Urban
Area (ha)	91,875	10,887	5,904	1,819
CN	87.5	85.2	71.6	91.1
Vadose-Zone Saturated Capacity (cm)	10	10	10	10
Percent Tile	50%	0%	0%	0%
Tile Recession	0.239	-	-	-
Saturated-Zone Recession	0.139	0.210	0.210	0.210
Seepage Coefficient	0	0	0	0
Monthly ET Coefficients	Jan: 0.6 May: 0.9 Sep: 1.1	Feb: 0.6 Jun: 0.9 Oct: 0.9	Mar: 0.6 Jul: 1.1 Nov: 0.6	Apr: 0.8 Aug: 1.1 Dec: 0.6

Figure D-1 Portage Model Initial Run: Predicted v. Observed Flow

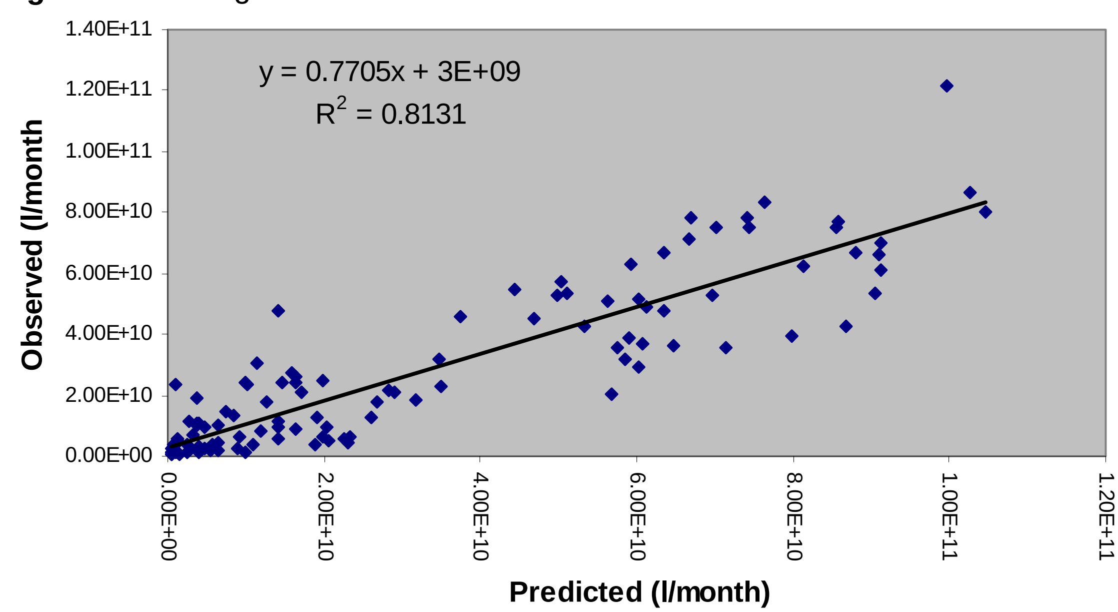


Figure D-2: Portage Model Initial Run: Percentile Flows

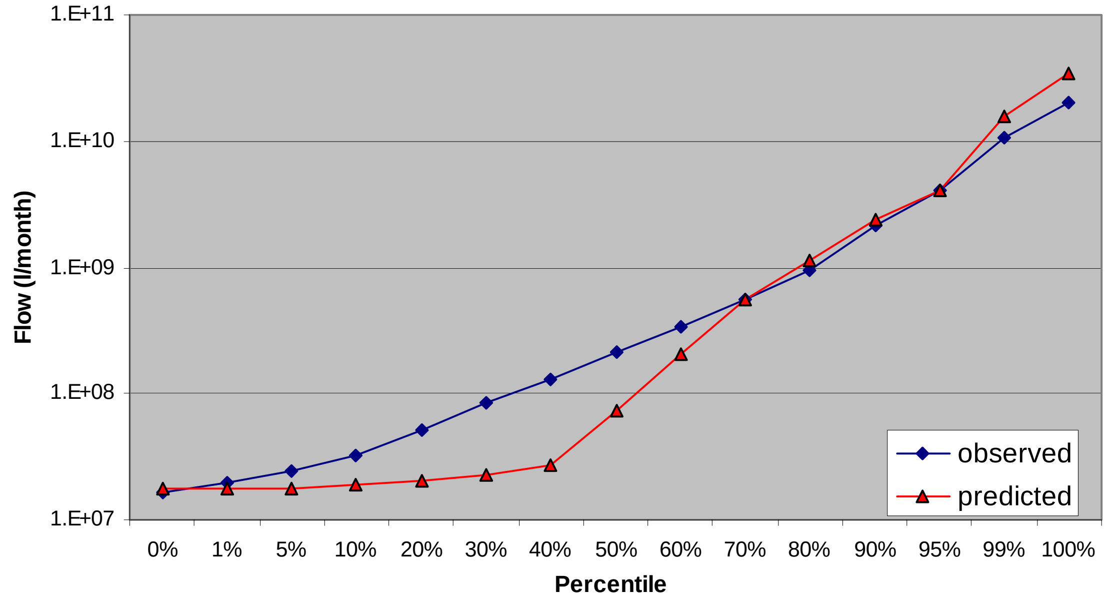


Figure D-1 illustrates that while a significant correlation exists between predicted and observed flow ($R^2 = 0.81$), the model is consistently over-predicting the hydrologic response of the watershed (slope = 0.77). Further, Figure D-2 illustrates that the model is not accurately characterizing the magnitude and frequency of flow. The model is over-predicting high flow, and is under-predicting low to moderate flow.

C.3.2 Portage Model Calibrated Run

Based upon results of the initial run, the goals of calibration were to reduced the overall volume of water reaching the channel, decrease peak-flow volume, and increase low- to moderate- flow volumes. To accomplish these goals the following assumptions were made:

- Peak flow is dominated by surface runoff, which is largely controlled by the CN.
- Elevated flows are dominated by tile flow, which is largely controlled by percent tile and the tile-recession coefficient.
- Low to moderate flows are dominated by baseflow, which is largely controlled by percent tile and the saturated-zone recession coefficient.

Based upon these assumptions, the following parameter adjustment were made:

- CN of crop and pasture land uses were lowered. Calibration focused on these two land uses because their hydrologic response is assumed to dominate the watershed. CN was significantly reduced to account the mild slope and artificial drainage systems that characterize the watershed.
- Lowering the CN resulted in more water infiltrating and percolating. This resulted in two problems in intermediate calibration runs. First, water in tile storage was released too slowly, which resulted in an over-prediction of median flow and an

under-prediction of elevated flow. Second, saturated-zone water was released too quickly, which resulted in an under-prediction of low flow. To correct these problems the tile-recession coefficient was increased and the saturated-zone recession coefficient was decreased for the final calibration run.

- The seepage coefficient was increased from zero to 0.01 to decrease the volume of water reaching the channel. This change made to reflect loss from the saturated zone to deep storage and channel transmission loss.

Table C.2 summarizes the hydrologic parameters used in the final calibration run of the Portage model. Figure D-3 is a plot of observed versus predicted monthly flow volume in liters per month. Figure D-3 includes a linear trend-line, the equation describing the line, and an R^2 value indicating the strength of the relationship. Figure D-4 is a plot percentile flow for both the predicted and observed values. Figure D-5 is a plot of average monthly flow for both the predicted and observed values.

Table C-2: Calibrated hydrologic-parameter values for the Portage Model

Parameter	**Land Use**			
	Crop	Pasture	Forest	Urban
Area (ha)	91,875	10,887	5,904	1,819
CN	72	76	71.6	91.1
Vadose-Zone Saturated Capacity (cm)	10	10	10	10
Percent Tile	50%	0%	0%	0%
Tile Recession	0.65	-	-	-
Saturated-Zone Recession	0.010	0.100	0.100	0.100
Seepage Coefficient	0.01	0.01	0.01	0.01
Monthly ET Coefficients	Jan: 0.6 May: 0.9 Sep: 1.1	Feb: 0.6 Jun: 0.9 Oct: 0.9	Mar: 0.6 Jul: 1.1 Nov: 0.6	Apr: 0.8 Aug: 1.1 Dec: 0.6

Figure D-3 Calibrated Portage Model: Predicted v. Observed Flow

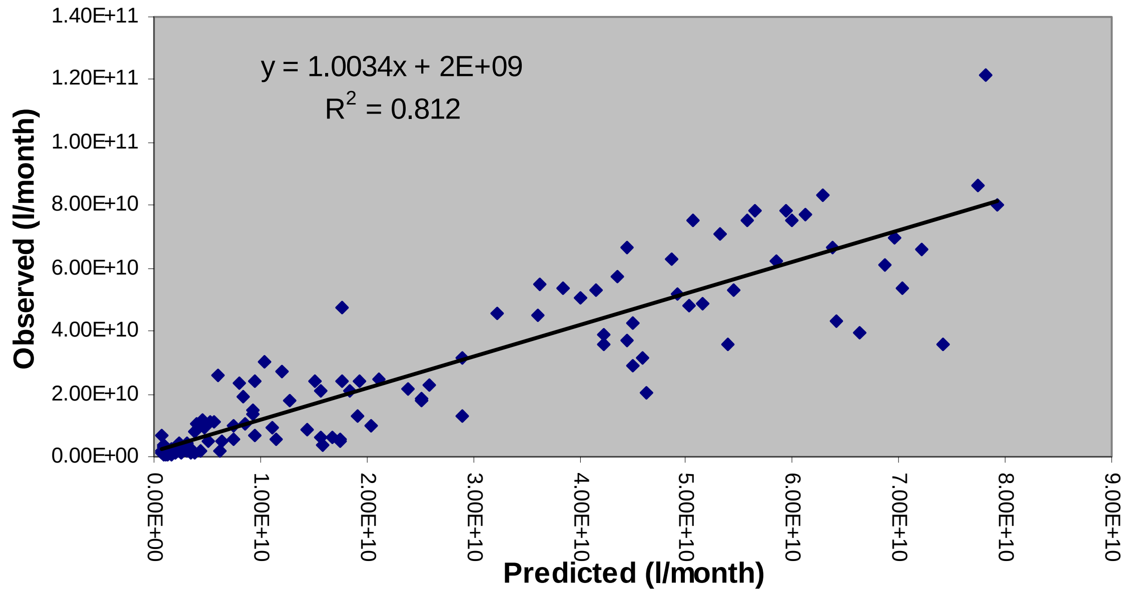


Figure D-4: Calibrated Portage Model: Percentile Flow

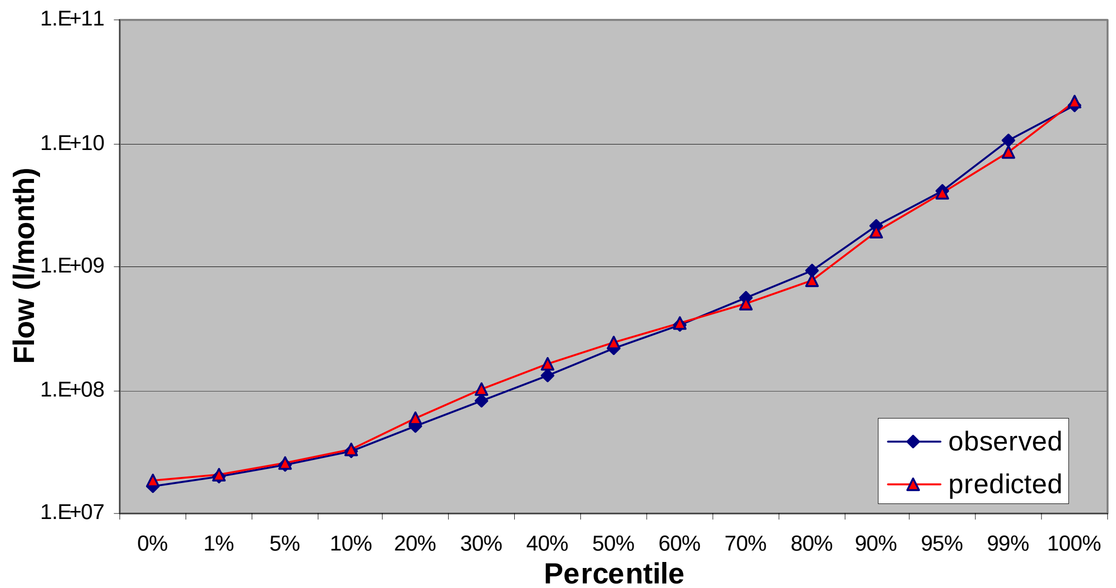


Figure D-5: Calibrated Portage Model: Average Monthly Flow

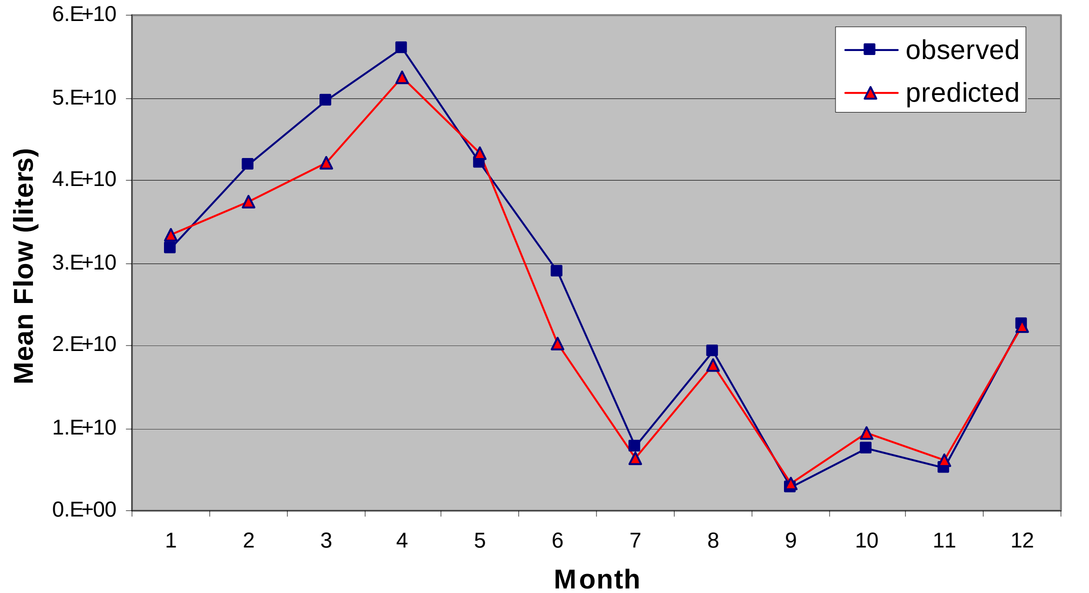


Figure D-3 illustrates the results of the calibration. The predicted values exhibit significant correlation to the observed values (R^2 = 0.81), and the slope of the trend-line (1.0034) indicates the model not generally under- or over-predicting flow. Figure D-4 illustrates that calibration was successful in reducing peak flow and increasing low to moderate flows. Finally, Figure D-5 illustrates that the model is capable of predicting variation of the average monthly condition.

C.4 GWLF Hydrologic Validation

Calibrated parameters from the Portage model were used to set-up to Toussaint model. All hydrologic parameters used in the Toussaint model were identical to those of the Portage with the exception of land-use area. Table C-3 presents the land-use area used in the Toussaint model.

Table C-3: Land-use area for the Toussaint Model

Parameter	Land Use			
	Crop	Pasture	Forest	Urban
Area (ha)	91,875	10,887	5,904	1,819

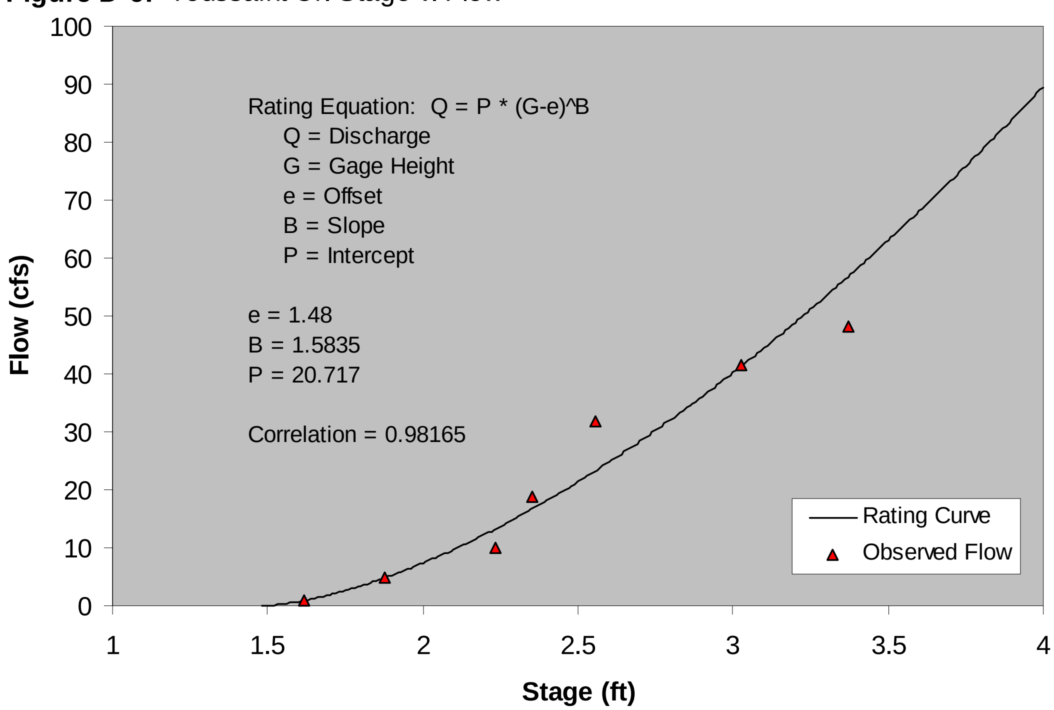
Hydrologic results of the Toussaint model were validated to a short-term flow record from the watershed outlet. From April through October 2004 the stage of Toussaint Creek was monitored by Ohio EPA at Rocky Ridge Road. Concurrently, multiple discharge measurements were made to correlate to stage and establish a flow-rating curve. Stage was monitored using with an ISCO 4210 ultrasonic level recorder. Discharge was measured using a SonTek FlowTracker™ ADV velocimeter. The flow-rating curve was established by methods described by USGS (1993).

Table C-4 present results of the discrete flow measurements and the corresponding concurrent stage. Figure D-6 presents the flow-rating curve, a plot of measured flow versus water level, and the correlation coefficient of the relationship between level and flow.

Table C-4: Toussaint level and flow

Date	Time	Stage *(ft)*	Flow *(cfs)*
4/7/2004	14:46	3.03	41.48
4/29/2004	11:24	2.35	18.85
5/18/2004	11:20	3.37	48.08
7/13/2004	11:48	2.56	31.71
8/18/2004	13:50	1.62	0.90
9/8/2004	13:11	1.88	4.85
11/3/2004	12:25	2.24	9.91

Figure D-6: Toussaint Cr. Stage v. Flow



Daily mean flow on Toussaint Creek at Rocky Ridge Road was calculated from the record of water level using the equation presented in Figure D-6. Daily mean flow was used to estimate daily flow volume, which was then compared to the results of the model. Figure D-7 presents the daily hydrograph derived from the stage/discharge relationship and from the predictions of the model. Figure D-8 presents percentile flow from the stage/discharge relationship and from the model.

Figure D-7: Toussaint Creek Hydrograph

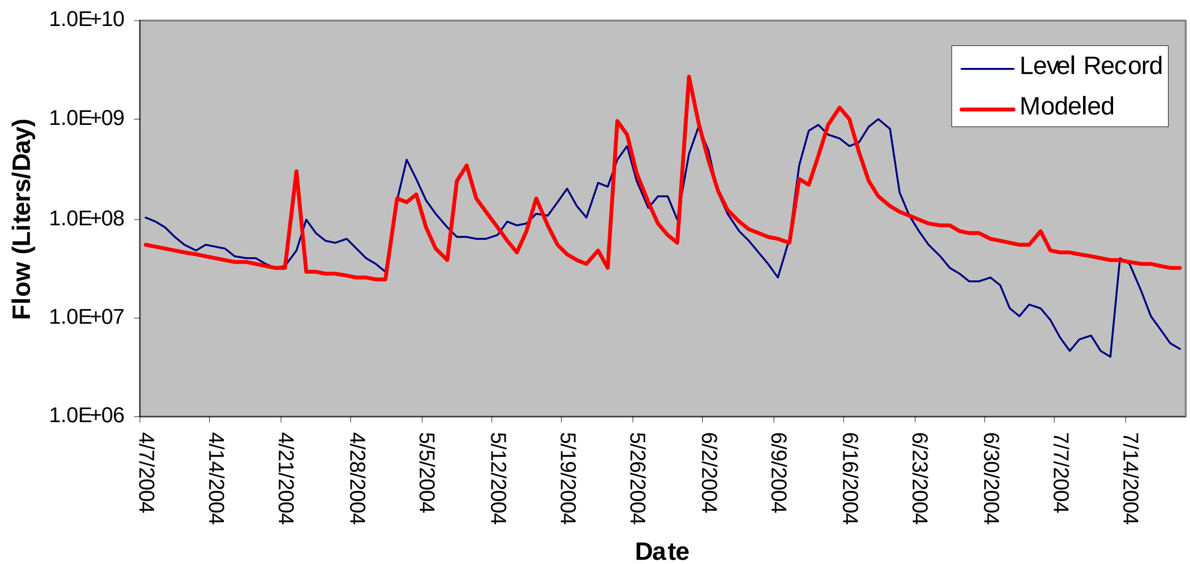


Figure D-8: Toussaint Creek Percentile Flow

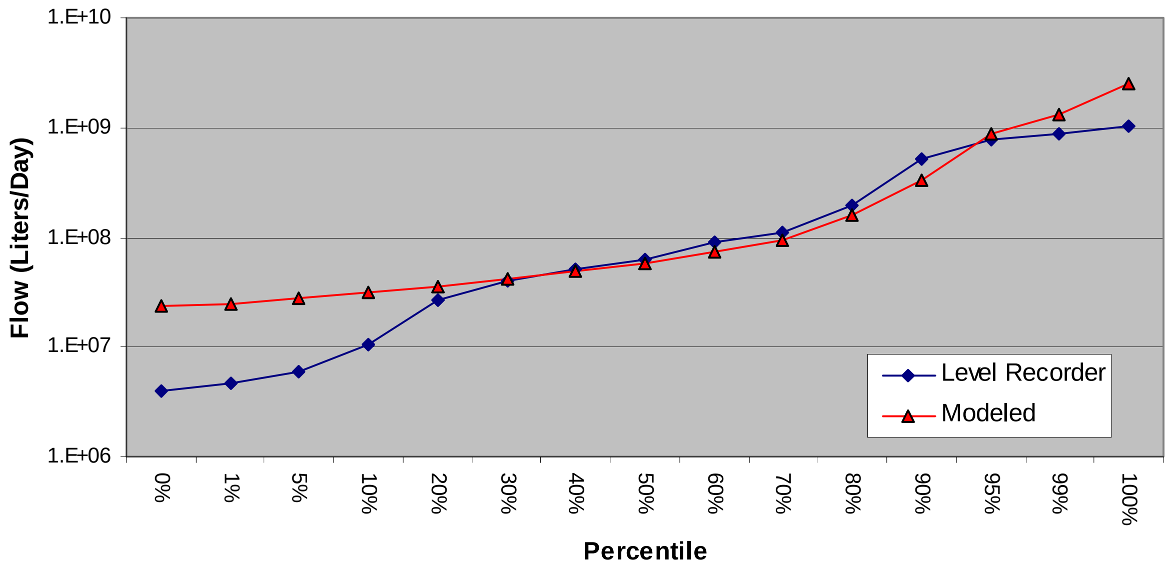


Figure D-7 illustrates that the model is able to reproduce some of the observed variation in flow. Considering GWLF is not intended to make accurate prediction of flow on a daily basis – GWLF results are typically summarized as monthly values – Figure D-7 shows the model functions reasonably well. Figure D-8 shows the model predicts moderate flows well, but it over-predicts both high and low flow. The over-prediction may not be a result of the model, rather the rating curve may be under-estimating under these conditions. None of the discharge measurements made on the Toussaint Creek were performed under very-high flow, so the rating curve is not well defined for these conditions. Regardless, the Toussaint model is judged to function sufficiently well for the purpose of this assessment.

C.5 Sediment and Nutrient Modeling

Validated hydrologic parameters from the Toussaint model were used to simulate hydrologic, sediment, and nutrient loading to each TMDL sub-watershed of the Toussaint Creek Watershed. The four TMDL sun-watersheds include: Toussaint Creek above Packer Creek, Packer Creek, Rusha Creek, and the Toussaint River below Packer Creek (hereinafter the Toussaint Lacustuary). A map of the TMDL watersheds is included as Figure 3.2B of Chapter 3.

Sediment and nutrient modeling in GWLF requires additional input parameters including values for the universal soil loss equation (USLE) and various nutrient concentrations in the water and soil. The following paragraphs detail the source of each input-parameter.

- Rainfall-erosivity coefficients for the dormant and growing seasons were reference from the *GWLF 2.0 User's Manual* Table B-14, and adjusted based upon recommendations for Northwest Ohio in the NRCS Field Office Technical Guide (FOTG, 1999).

- The USLE soil erodibility factor, K, was based upon an area-weighted average values from the Soil Survey Geographic Database (SSURGO, NRCS 2004). The area-weighted average was determined using ESRI ArcGIS™.

- Average watershed slope was calculated using the National Elevation Dataset (NED). The NED was analyzed using the Spatial Analyst extension of ArcGIS™.

- Average watershed slope length was based upon an area-weighted average from SSURGO. The area-weighted averages were determined using ESRI ArcGIS™.

- The USLE slope length/steepness factor, LS, was referenced from Tables 5.2 and 5.3 of *Predicting Rainfall Erosion Losses* from the Ohio NRCS FOTG (1999).

- The USLE cover management factor, C, was referenced from Table 6 of *Predicting Rainfall Erosion Losses* from the Ohio NRCS FOTG (1999).

- The USLE support practices factor, P, was set at one (1) because no contour farming, cross-slope farming, strip-cropping, or terracing is known to occur in the watershed.

- The sediment delivery ratio (SDR) was referenced from Figure B-2 of the *GWLF 2.0 User's Manual.*

- The phosphorus concentrations in surface runoff, ground water, and soil were referenced from the *GWLF 2.0 User's Manual.*

- The phosphorus concentration is tile flow was referenced from *Phosphate Concentrations in Subsurface Drainage Effluent in East-Central Illinois* (McIssac et al., 1997). The concentrations referenced from McIssac were verified using unpublished tile-effluent sampling results collected by Heidelberg College in 2004.

- The phosphorus daily accumulation and decay rates for urban areas were referenced from the *GWLF 2.0 User's Manual.*

Table C-5 presents sub-watershed-specific input parameters. Table C-6 presents land-use-specific input parameters. Only two parameters are applicable to all sub-watersheds and all land-uses: the dormant- and growing-season rainfall-erosivity coefficients, which were 0.11 and 0.26, respectively.

Sediment yield and nutrient load results from modeling of the Toussaint Creek TMDL sub-watersheds were not calibrated to any instream water-quality. Calibration was not possible in part because of the time-step of the sediment yield computation used in GWLF. Sediment yield, and consequently nutrient load, is calculated within GWLF on a monthly time-step. No daily sediment yield or nutrient load results are produced by the model. Calibration thus requires sufficient observed water-quality data to characterize monthly loads. Insufficient water-quality data exists from the Toussaint Watershed to quantify monthly loadings.

Table C-5: Sub-Watershed-Specific GWLF Inputs

Input Parameter	**TMDL Sub-Watershed**			
	Toussaint Creek	Packer Creek	Rusha Creek	Toussaint Lacustuary
Percent Slope	0.50	0.41	0.46	0.40
Slope Length	140	112	69	47
SL-Factor	0.09	0.09	0.08	0.07
K-Factor	0.28	0.28	0.30	0.30
Sediment Delivery Ratio	0.09	0.09	0.09	0.09

Table C-6: Land-Use-Specific GWLF Inputs

Input Parameter	**Land Use**			
	Crop	Pasture	Forest	Urban
C-Factor	0.08	0.025	0.003	-
P-Factor	1.0	1.0	1.0	1.0
Dissolved P in Surface Runoff (mg-P/l)	0.26	0.25	0.10	-
P in Tile Flow (mg-P/l)	0.07	-	-	-
P in Ground Water (mg-P/l)	0.025	0.025	0.025	0.025
Soil P (mg-P/kg)	1672	880	440	-
P surface accumulation rate (kg/ha)	-	-	-	0.006
P surface decay rate (1/d)	-	-	-	0.12

APPENDIX D: RESPONSES TO PUBLIC COMMENTS

The draft Toussaint River and Rusha Creek Watershed TMDL was made available for public comment from March 27 to April 27, 2006. One comment letter was received, from Mr. Joseph L. Green, Martin Marietta Magnesia Specialties (MMMS) on April 27, 2006.

Comment:
We believe the State should review (and revise, as needed) the strontium references provided in the 4/4/05 technical support document entitled Biological and Water Quality Study of the Toussaint River and Rusha Creek Basins. For example, the strontium concentrations reported on page 28 are compared to WQS criteria that do not seem consistent with the "Lake Erie Basin" values issued by the Ohio EPA's Division of Surface Water on 7/27/05. The reported strontium concentrations on Table 5 of this report evidently did not exceed the Outside Mixing Zone Average (OMZA) criterion "at every sampling location" on the Toussaint mainstem as was stated in the study.

Additionally, none of the reported Table 5 strontium concentrations exceeded the Outside Mixing Zone Maximum (OMZM) criterion, and thus none approached the even higher Inside Mixing Zone Maximum (IMZM) criterion. Finally, all reported strontium concentrations in this study were well below the 1,400,000 micrograms per liter (or 1,400 milligrams per liter) WQS criterion for protecting human health in non-drinking situations. Less than two (2) percent of the samples had reported strontium concentrations above the WQS criterion of 18,000 micrograms per liter for drinking water.

Unfortunately, the incorrect WQS citations in the "Results" section of this study (on pages 28 to 31) seem to have led to an inappropriate conclusion that elevated strontium levels are attributable to groundwater discharges mainly from stone quarries. Martin Marietta objects to publication of these erroneous WQS references and requests correction of the corresponding results. Since strontium concentrations were reported for all nineteen (19) sampling locations in the Toussaint study, it would seem that this element is a regional geologic phenomena and may be released by a number of different domestic and commercial activities, in addition to those identified by this study. Therefore, we respectfully request that the background references to WQS criteria and reported strontium concentrations for the subject Toussaint watershed be re-evaluated and revised, as is appropriate.

Response:
The comment highlights the fact that the water quality standard (WQS) for strontium changed between the time that the watershed was monitored and the TMDL was completed.

The Toussaint River basin survey occurred in 2003 and the technical support document ("Biological and Water Quality Study of the Toussaint River and Rusha Creek Basins") was completed in April 2005. The WQS change was published in July 2005. The TMDL is being completed in 2006. The following table shows the change in the WQS over this time period.

Lake Erie Basin Aquatic Life and Human Health Tier I Criteria, and Tier II and Screening Values

Strontium	**Aquatic Life (µg/l)**				**Human Health (µg/l)**		
Publication date	Tier	IMZM	OMZM	OMZA	Tier	Drink	Nondrink
12/30/2002	II	14,000	6,900	770	I	18,000	1,400,000
7/27/2005	II	95,000	48,000	5,300	I	18,000	1,400,000

IMZM: Inside Mixing Zone Maximum
OMZM: Outside Mixing Zone Maximum
OMZA: Inside Mixing Zone Average

The technical support document used the WQS available when it was completed. We do share the concern that the change in WQS could potentially result in a misunderstanding of the situation, so we have posted a clarification about this issue on the web site with the report. See http://www.epa.state.oh.us/dsw/documents/ToussaintStrontiumClarification060705.pdf.

Further, Ohio EPA agrees that strontium concentrations reported within the Toussaint River watershed are largely the result of “regional geologic phenomena” (background) and that numerous domestic and commercial sources may contribute. However, sample results do indicate that stream concentrations of strontium are significantly elevated downstream of stone quarry discharges within the Toussaint River watershed, as shown in the following graph (excerpted from the technical support document (Figure 6)).

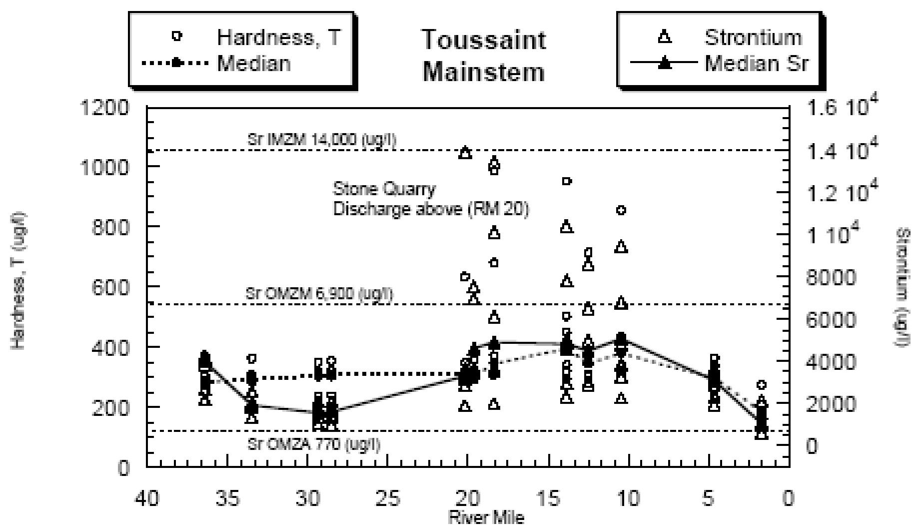


Figure 6. Strontium and hardness values from Toussaint mainstem. June - September 2003.

Finally, we note that the draft TMDL report does not include strontium as a parameter of concern. Strontium is not listed as a cause of impairment on the 2006 303(d) list (see page E.2-26 at http://www.epa.state.oh.us/dsw/tmdl/2006IntReport/2006OhioIntegratedReport.html).