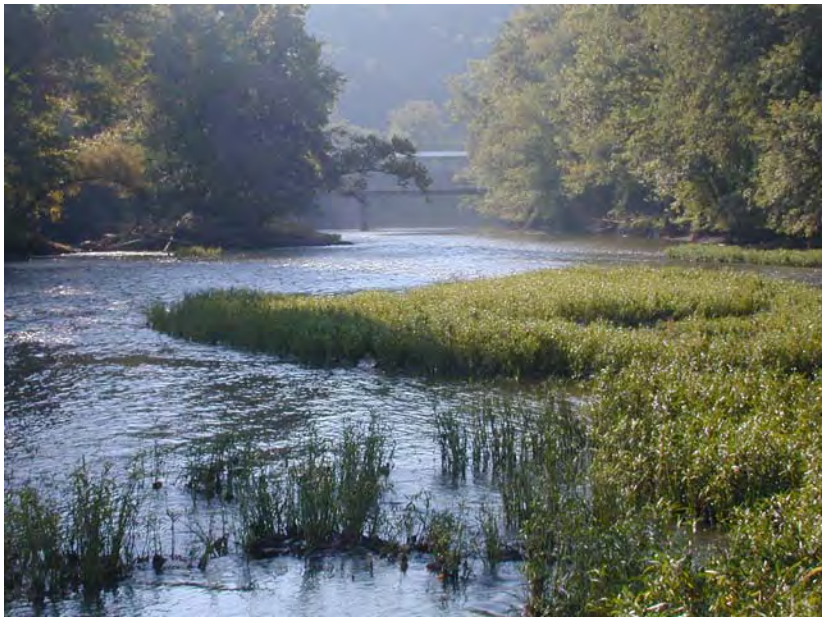
State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Mohican River and Selected Tributaries, 2007

Crawford, Morrow, Richland, Ashland, Wayne, Holmes, Coshocton and Knox Counties, OH



July 20, 2009

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study of the Mohican River and Selected Tributaries 2007

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Table of Contents

NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1988), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

___ 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

___ 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecological Assessment Section, Columbus, Ohio.

___ 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

___ 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

___ 2006a. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Revised by the Midwest Biodiversity Institute for Div. of Surface Water, Ecol. Assess. Sect., Groveport, Ohio.

___ 2008a. 2008 Updates to Biological criteria for the protection of aquatic life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Groveport, Ohio.

___ 2008b. 2008 Updates to Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Groveport, Ohio.

___ 2006a. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Revised by the Midwest Biodiversity Institute for Div. of Surface Water, Ecol. Assess. Sect., Groveport, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents, the following new publications by the Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by the Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

Yoder, C.O. and M.A. Smith. 1999. Using fish assemblages in a State biological assessment and criteria program: essential concepts and considerations, pp. 17-63. in T. Simon (ed.). Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. CRC Press, Boca Raton, FL.

These documents and this report may be obtained by writing to:

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ACKNOWLEDGMENTS

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FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year the Ohio EPA conducts biosurveys in 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by the Ohio EPA (*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure 1). The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes

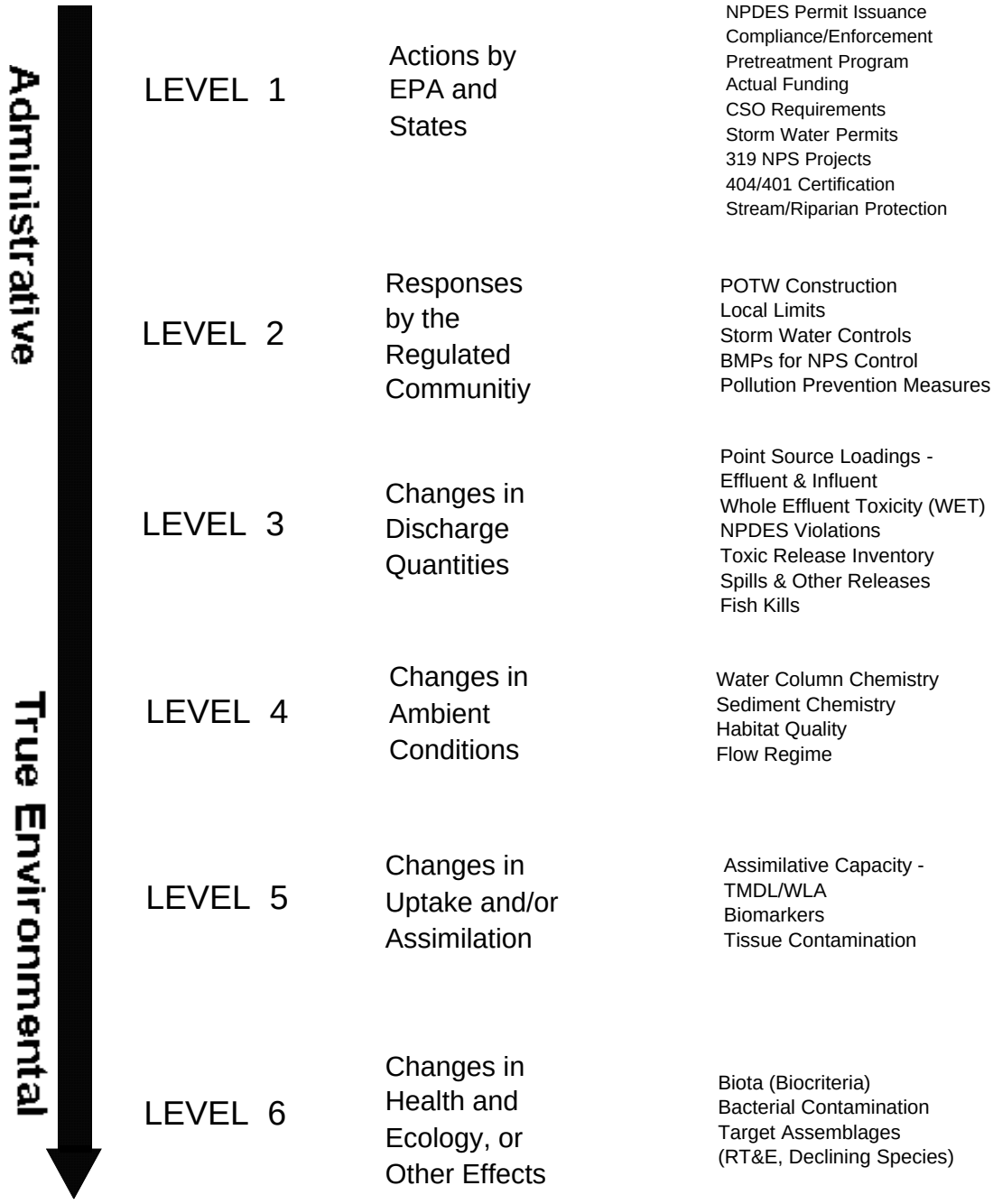

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Report, the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Use

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the*

principal restoration target for the majority of water resource management efforts in Ohio.

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of coldwater organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2 drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same WQS criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use can be having a water depth of at least one meter over an area of at least 100

square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliform, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Attainment of recreation uses are evaluated based on monitored bacteria levels. The Ohio Water Quality Standards state that all waters should be free from any public health nuisance associated with raw or poorly treated sewage (Administrative Code 3745-1-04, Part F). Additional criteria (Administrative Code 3745-1-07) apply to waters that are designated as suitable for full body contact such as swimming (PCR) or for partial body contact such as wading (SCR). These standards were developed to protect human health, because even though fecal coliform bacteria are relatively harmless in most cases, their presence indicates that the water has been contaminated with fecal matter.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health.

MECHANISMS FOR WATER QUALITY IMPAIRMENT

The following paragraphs are provided to present the varied causes of impairment that affect the resource quality of lotic systems in Ohio. 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.

Habitat and Flow Alterations

Habitat alteration, such as channelization, impacts biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include the removal of riparian trees and field tiling to facilitate drainage. Following a rain event, most of the water is quickly removed from tiled fields rather than filtering through the soil, recharging ground water, and reaching the stream at a lower volume and more sustained rate. As a result, small streams more frequently go dry or become intermittent.

Tree shade is important because it limits the energy input from the sun, moderates water temperature, and limits evaporation. Removal of the tree canopy further degrades conditions because it eliminates an important source of coarse organic matter essential for a balanced ecosystem. Erosion impacts channelized streams more

severely due to the lack of a riparian buffer zone to slow runoff, trap sediment and stabilize banks. Additionally, deep trapezoidal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses.

The lack of water movement under low flow conditions can exacerbate impacts from organic loading and nutrient enrichment by limiting re-aeration of the stream. The amount of oxygen soluble in water decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion, but channelization eliminates turbulence produced by riffles, meanders, and debris snags. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Oxygen is also used by bacteria that decay dead organic matter. Nutrient enrichment can promote the growth of nuisance algae that subsequently dies and serves as food for bacteria. Under these conditions, oxygen can be depleted unless it is replenished from the air.

Sedimentation

Whenever the natural flow regime is altered to facilitate drainage, increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosion process. Channelization keeps 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. As water levels fall following a rain event, interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macroinvertebrates is reduced. Silt also can clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding site 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, recreation, and drinking water. Nutrients absorbed 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.

Nutrients

The element of greatest concern is phosphorus because it critical for plant growth and it is often the limiting nutrient. The form that can be readily used by plants and therefore can stimulate nuisance algae blooms is orthophosphate (PO_4^{-3}). The amount of

phosphorus tied up in the nucleic acids of food and waste is actually quite low. This organic material is eventually converted to orthophosphate by bacteria. The amount of orthophosphate contained in synthetic detergents is a great concern however. 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. Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Another characteristic of point sources is they have a continuous impact and are human in origin, for instance, effluents from municipal sewage treatment plants. The contribution from failed on-lot septic systems can also be significant, especially if they are concentrated in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l and after secondary treatment is generally 4-6 mg/l. Further removal requires the added cost of chemical addition. The most common methods use the addition of lime or alum to form a precipitate, so most phosphorus (80%) ends up in the sludge.

A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and associated with storm water runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban storm water is more of a concern if combined sewer overflows are involved. The impact from rural storm water varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills. Land management is an issue because erosion is worse on streams without any riparian buffer zone to trap runoff. The impact is worse in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). Phosphorus loadings from large volume point source dischargers in the Lake Erie drainage basin are regulated by NPDES permit limits. The permit limit is a concentration of 1.0 mg/l in final effluent. Research conducted by the Ohio EPA indicates that a significant correlation exists between phosphorus and the health of aquatic communities (Association Between Nutrients, Habitat, and Aquatic Biota in Ohio Rivers and Streams, MAS/1999-1-1). It was concluded that biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. It was also determined that the lowest phosphorus concentrations were associated with the highest quality habitats, supporting the notion that habitat is a critical component of stream function. The report recommends WWH biocriteria of 0.08 mg/l in headwater streams (<20 mi^2 watershed size), 0.10 mg/l in wadeable streams (>20-200 mi^2) and 0.17 mg/l in small rivers (>200-1000 mi^2).

Organic Enrichment and Low Dissolved Oxygen

The amount of oxygen soluble in water is low and it decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion. Drainage practices such as channelization eliminate turbulence produced by riffles, meanders, and debris snags. Although plant photosynthesis produces oxygen by day, it is consumed by the reverse process of respiration at night. Oxygen is also consumed by bacteria that decay organic matter, so it can be easily depleted unless it is replenished from the air. Sources of organic matter include poorly treated waste water, sewage bypasses, and dead plants and algae.

Dissolved oxygen criteria are established in the Ohio Water Quality Standards to protect aquatic life. The minimum and average limits are tiered values and linked to use designations (Administrative Code 3745-1-07, Table 7-1).

Ammonia

Ammonia enters streams as a component of fertilizer and manure run-off and wastewater effluent. Ammonia gas (NH_3) readily dissolves in water to form the compound ammonium hydroxide (NH_4OH). In aquatic ecosystems an equilibrium is established as ammonia shifts from a gas to undissociated ammonium hydroxide to the dissociated ammonium ion (NH_4^{+1}). Under normal conditions (neutral pH 7 and 25 C) almost none of the total ammonia is present as gas, only 0.55% is present as ammonium hydroxide, and the rest is ammonium ion. Alkaline pH shifts the equation toward gaseous ammonia production, so the amount of ammonium hydroxide increases. This is important because while the ammonium ion is almost harmless to aquatic life, ammonium hydroxide is very toxic and can reduce growth and reproduction or cause mortality.

The concentration of ammonia in raw sewage is high, sometimes as much as 20-30 mg/l. Treatment to remove ammonia involves gaseous stripping to the atmosphere, biological nitrification and de-nitrification, and assimilation into plant and animal biomass. The nitrification process requires a long detention time and aerobic conditions like that provided in extended aeration treatment plants. Under these conditions, bacteria first convert ammonia to nitrite (*Nitrosomonas*) and then to nitrate (*Nitrobacter*). Nitrate can then be reduced by the de-nitrification process (*Pseudomonas*) and nitrogen gas and carbon dioxide are produced as by-products.

Ammonia criteria are established in the Ohio Water Quality Standards to protect aquatic life. The maximum and average limits are tiered values based on sample pH and temperature and linked to use designations (Administrative Code 3745-1-07, Tables 7-2 through 7-8).

Bacteria

High concentrations of either fecal coliform bacteria or Escherichia coli (E. coli) in a lake or stream may indicate contamination with human pathogens. People can be exposed to contaminated water while wading, swimming, and fishing. 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 *Escherichia*, 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 on-lot septic systems, are a more continuous problem. Bacterial 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.

Bacteria criteria are established in the Ohio Water Quality Standards to protect human health. The maximum and average limits are tiered values and linked to use designation, but only apply during the May 1-October 15 recreation season (Administrative Code 3745-1-07, Table 7-13). The standards also state that streams must be free of any public health nuisance associated with raw or poorly treated sewage during dry weather conditions (Administrative Code 3745-1-04, Part F).

Revisions to Ohio's recreation criteria will likely be effective by the end of the 2009 calendar year. The draft criteria (3745-1-41) will result in several changes when they become effective;

1) E. coli will be the only indicator organism used to evaluate recreation. The use of fecal coliform will be discontinued.
2) The recreation season will be May 1 – Oct. 31 instead of ending on Oct. 15.
3) Geometric mean content will be computed on a seasonal basis instead of monthly.
4) Geometric mean content will be the sole basis of use attainment status when 2 or more samples are taken.
5) Primary Contact Recreation (PCR) will be divided into three separate categories each with specific numerical criteria: Class A – high use paddling streams, Class B – most typical streams and Class C – historically channelized streams that drain < 3.1 mi^2.

Sediment Contamination

Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles and are persistent in the environment. Some of these compounds accumulate in the aquatic food chain and trigger fish consumption advisories, but others are simply a contact hazard because they cause skin cancer and tumors. The physical and chemical nature of sediment is determined by local geology, land use, and contribution from manmade sources. As some materials enter the water column they are attracted to the surface electrical charges associated with suspended silt and clay particles. Others simply sink to the bottom due to their high specific gravity. Sediment layers form as suspended particles settle, accumulate, and combine with other organic and inorganic materials. Sediment is the most physically, chemically, and biologically reactive at the water interface because this is where it is affected by sunlight, current, wave action, and benthic organisms. Assessment of the chemical nature of this layer can be used to predict ecological impact.

The Ohio EPA evaluation of sediment chemistry results are evaluated using a dual approach, first by ranking relative concentrations based on a system developed by Ohio EPA (2005) and then by determining the potential for toxicity based on guidelines developed by MacDonald et al (2000). The Ohio EPA system was derived from samples collected at ecoregional reference sites. Specific Reference Values are site specific ecoregional based metals concentrations and are used to identify contaminated stream reaches. The MacDonald guidelines are consensus based using previously developed values. The system predicts that sediments below the threshold effect concentration (TEC) are absent of toxicity and those greater than the probable effect concentration (PEC) are toxic.

Sediment samples collected by the Ohio EPA are measured for a number of physical and chemical properties. Physical attributes included percent particle size distribution (sand .60 , silt 5-59 , clay .4), percent solids, and percent organic carbon. Most locations sampled had an abundance of sediment, and no difficulties were experienced in locating ample volumes of sediment for analysis. Chemical attributes included metals, volatile and semi-volatile organic compounds, pesticides, and poly-chlorinated biphenyls (PCBs).

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INTRODUCTION

Ambient biological, water column chemical, and sediment sampling was conducted in the Mohican River basin from June to October 2007 as part of the five-year basin approach for monitoring, assessment, and issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment. Subwatersheds within the study area included the Black Fork Mohican River, Clear Fork Mohican River, Rocky Fork Mohican River, Lake Fork Mohican River and the Mohican River mainstem.

Specific objectives of this evaluation were to:

1) Monitor and assess the chemical, physical and biological integrity of the streams within the 2007 Mohican River study area;

2) Characterize the consequences of various land uses on water quality within the Mohican River watershed;

3) Evaluate the influence of the Mansfield, Shelby, Ashland, and other wastewater treatment plants (WWTPs) and unsewered communities;

4) Evaluate the potential impacts from spills, nonpoint source pollution (NPS), and habitat alterations on the receiving streams; and

5) Determine the attainment status of the current designated aquatic life uses and non-aquatic use designations and recommend changes where appropriate.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], and Water Quality Permit Support Documents [WQPSDs]) and are incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment and the biennial Integrated Water Quality Monitoring and Assessment (305[b] and 303[d]) Report.

SUMMARY

Thirty streams in the Mohican River watershed were evaluated for aquatic and recreational use potential in 2007 (see Figure 2 and Table 1 for sampling locations). All of the streams listed in the Ohio Water Quality Standards for the Mohican River watershed are assigned the Warmwater Habitat (WWH) aquatic life use designation but many of the smaller streams and the mainstem Mohican River had never had uses verified via biological sampling. Based on the biological data collected in 2007, the Exceptional Warmwater Habitat (EWH) use designation was found to be appropriate for the Mohican River mainstem. Several streams supported viable coldwater fish and/or macroinvertebrate faunas. Streams where the CWH use was indicated included: Negro Run, Redhaw Creek, Oldtown Run, Quaker Springs Run, Newel Run, Kakotawa Creek, Honey Creek (Black Fork tributary) -from the headwaters to RM 4.19 (upstream from unnamed tributary), Pine Run, Switzer Creek, Slater Run, and Honey Creek (Clear Fork Trib.). One stream, Kiser Ditch, was deficient in typical warmwater habitat attributes and did not have adequately diverse biological communities to warrant the Warmwater Habitat use designation. Given the conditions encountered in Kiser Ditch, a Modified Warmwater Habitat use (MWH) is recommended. Conditions of all other tributary streams evaluated in 2007 (14 waterbodies) were adequate to recommend maintaining the WWH aquatic life use. All streams in this study should retain the Primary Contact Recreation use, along with the Agricultural and Industrial uses.

Clean Water Act Biological Goals
FULL: 67%
PARTIAL: 16%
NON: 17%

A significant portion of the Mohican River basin is meeting the biological goals of the Clean Water Act with 67% of the surveyed area fully attaining, 16% partially attaining and 17% in non-attainment of the goals. Aquatic life use attainment status of all sampling locations is provided in Table 1. The Mohican River mainstem fully attained the recommended
EWH aquatic life use and the Clear Fork Mohican River met the WWH use. The remaining major tributaries supported lower quality biological communities by comparison. The most severe impairment was generally in areas affected by urban runoff, historical sediment contamination and major WWTP discharges. This was particularly evident in the Rocky Fork Mohican River. Siltation and alteration of the physical habitat were significant impairments on the Black Fork Mohican River. While many of the streams in the Mohican River watershed are meeting the goals of the Clean Water Act, activities such as direct access by cattle and livestock waste management pose a threat to biological communities in rural Mohican River tributaries.

These potential sources of aquatic life impairment also likely contributed to elevated fecal coliform bacteria levels recorded throughout the watershed. The applicable Primary Contact Recreation Use (PCR) criteria presented in Table 7-13 of OAC 3745-1-07 stipulates that “geometric mean E. coli content (either MPN or MF), based upon not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and E. coli content (either MPN or MF) shall not exceed 298 per 100 ml in more than ten percent of the samples taken during any thirty-day period.” Bacteriological samples were collected multiple times from 81 locations in the Mohican River basin. All 81 sites

had at least one sample that exceeded the 298 per 100 ml maximum. Sampling that met the five samples in thirty day requirement was conducted at 17 locations in reaches where public and private access, including several canoe liveries, is provided to the rivers. Violation of the PCR geometric mean criterion was recorded at 15 of the 17 sites (Table .).

Revisions to Ohio's recreation criteria will likely be effective by the end of the 2009 calendar year. Information provided in Appendix B of this report was generated to facilitate agreement in the recreation use attainment status determinations described in the 2007 Mohican Basin Technical Support Document (TSD) with subsequent Mohican Basin Total Maximum Daily Load (TMDL) and Integrated Water Quality Monitoring and Assessment Reports (IR). In addition to the new criteria, the assessment methodology used to determine recreation use attainment status is also scheduled to be revised in the 2010 IR.

Recreation is considered impaired in all 9 Mohican Basin assessment units independent of criteria or methodology. Under the revised criteria, 5 of 81 individual sites (6%) are considered in full attainment of their recreation use.

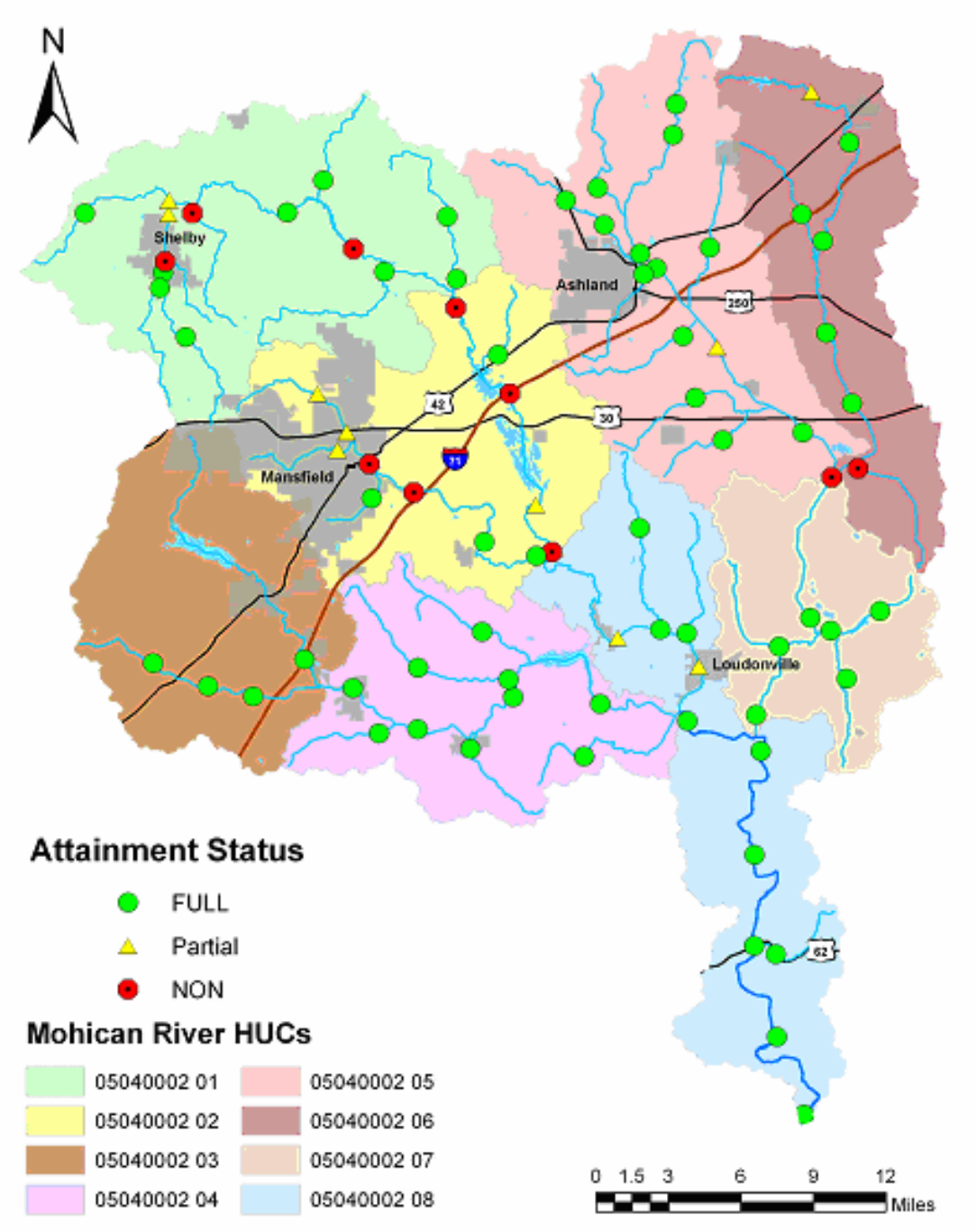

Figure 2. Mohican River Sampling Locations and Biological Community Performance, June 15 to October 15, 2007.

Table 1. Aquatic life and attainment status for sampling locations in the Mohican River basin, 2007. The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as an Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Rile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Mohican River	27.00	EWH-R	FULL	49	10.3	48	87.0		
Mohican River	22.54	EWH-R	FULL	57	9.9	50	85.0		
Mohican River	16.40	EWH-R	FULL	55	10.9	E	83.0		
Mohican River	11.66	EWH-R	FULL	57	10.4	50	91.0		
Mohican River	6.53	EWH-R	FULL	58	10.2	52	86.0		
Mohican River	0.47	EWH-R	FULL	58	10.1	54	82.0		
Black Fork Mohican River	57.72	WWH	FULL	42		G	55.5		
Black Fork Mohican River	53.88	WWH	FULL	40	8.0	VG	72.0		
Black Fork Mohican River	51.32	WWH	Partial	38	6.9*	G	64.5	Direct habitat alterations; Other flow regime alterations	Channelization, Urban Runoff/ Storm Sewers
Black Fork Mohican River	43.40	WWH	FULL	36ns	8.1	44	72.5		
Black Fork Mohican River	36.55	WWH	NON	20*	4.6*	48	35.5	Direct habitat alterations; Other flow regime alterations; Turbidity	Channelization, Sediment Resuspension (Clean Sediment)
Black Fork Mohican River	29.67	WWH	NON	19*	5.3*	G	57.5	Sedimentation/Siltation, Nutrient/Eutrophication Biological Indicators	Crop Production with Subsurface Drainage Channelization
Black Fork Mohican River	23.30	WWH	(NON)	21*	5.2*		56.0	Direct habitat alterations; Other flow regime alterations; Oxygen, Dissolved; Turbidity	Channelization, Non-irrigated Crop Production, Dam or Impoundment
Black Fork Mohican River	17.81	WWH -R	Partial	40	10.0	14*	68.0	Suspended Algae; Nutrient/Eutrophication Biological Indicators; Other flow regime alterations	Dam or Impoundment

Stream	Sample Location River Rile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Black Fork Mohican River	14.70	WWH -R	(NON)	35*	7.6*		60.5	Nutrient/Eutrophication Biological Indicators; Oxygen, Dissolved	Dam or Impoundment
Black Fork Mohican River	6.90	WWH -R	Partial	42	8.9	28*	83.0	High flow regime, Direct alterations	Major flooding
Black Fork Mohican River	2.53	WWH -R	Partial	39ns	8.4ns	28*	80.5	High flow regime, Direct alterations	Major flooding
Trib. to Black Fork (RM 54.46)	0.08	WWH-R	FULL	44		G	54.0		
Tuby Run	0.01	WWH	NON	56		VP*	53.5	Impairment Unknown	Industrial point source discharge
Marsh Run	4.55	WWH-R	FULL	42		G	35.0		
Marsh Run	0.13	WWH-R	Partial	32*	7.5ns	G	27.0	Sedimentation/Siltation	Channelization, Non-irrigated Crop Production, Dam or Impoundment
Bear Run	0.48	WWH-R	NON	40		P*	26.0	Organic Enrichment (Sewage) Biological Indicators; Oxygen, Dissolved; Direct Habitat Alterations	Manure runoff, Unrestricted Cattle Access; Channelization; Non-irrigated Crop Production
Shipp Creek	0.95	WWH-R	FULL	52		MGns	62.5		
Brubaker Creek	0.30	WWH-R	Partial	36ns	6.6*	G	66.0	Nutrient/Eutrophication Biological Indicators	Non-irrigated Crop Production
Whetstone Creek	3.88	WWH-R	(FULL)	52			63.0		
Whetstone Creek	0.69	WWH-R	FULL	46		G	67.5		
Trib. to Black Fork (RM25.16)	1.60	WWH-R	(FULL)	48			74.5		
Honey Creek	5.19	CWH-R	FULL	46		E	64.0		
Honey Creek	0.11	WWH-R	FULL	46		G	61.0		
Big Run	0.19	WWH-R	FULL	42		G	57.5		
Rocky Fork Mohican River	16.43	WWH	Partial	32*		G	66.5	Natural Conditions (Flow or Habitat)	Natural sources (upstream wetland, low gradient)

Stream	Sample Location River Rile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Rocky Fork Mohican River	14.23	WWH	Partial	36ns		F*	45.0	Nutrient/Eutrophication Biological indicators, Metals	Unspecified Urban Stormwater, Contaminated Sediments
Rocky Fork Mohican River	12.49	WWH	NON	28*	5.0*	P*	50.5	Nutrient/Eutrophication Biological indicators	Unspecified Urban Stormwater
Rocky Fork Mohican River	10.13	WWH	NON	33*	7.0*	P*	88.5	Nutrient/Eutrophication Biological indicators, Organic Enrichment (Sewage) Biological Indicators	Unspecified Urban Stormwater Municipal Point Source Discharges
Rocky Fork Mohican River	4.38	WWH	FULL	37ns	7.4ns	32ns	91.5		
Rocky Fork Mohican River	0.57	WWH	FULL	46	9.8	G	88.0		
Touby Run	1.00	WWH	Partial	36ns		F*	48.5	High flow regime, Impairment unknown (toxicity?)	Unspecified Urban Stormwater
Trib. to Rocky Fork (RM 10.70)	1.30	WWH-R	(FULL)	44			68.5		
Clear Fork Mohican River	35.68	WWH-R				G			
Clear Fork Mohican River	29.57	WWH				MGns			
Clear Fork Mohican River	23.35	WWH	FULL	44	8.9	42	86.5		
Clear Fork Mohican River	19.83	WWH	FULL	41	9.5	G	78.0		
Clear Fork Mohican River	16.17	WWH	FULL	39ns	8.4	48	82.0		
Clear Fork Mohican River	10.55	WWH	FULL	45	9.0	54	76.5		
Clear Fork Mohican River	4.03	WWH	FULL	53	10.4	36	83.0		
Cedar Fork	8.25	WWH	FULL	48		E	81.0		
Cedar Fork	5.60	WWH	FULL	44		VG	78.5		
Cedar Fork	3.25	WWH	FULL	48	8.8	54	81.5		
Honey Creek	0.80	CWH-R	FULL	50		E	75.0		
Slater Run	0.82	CWH-R	FULL	52		E	73.0		
Opossum Run	4.57	WWH	FULL	48		E	76.5		
Opossum Run	0.35	WWH	FULL	40		G	77.0		

Stream	Sample Location River Rile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Switzer Creek	2.83	CWH-R	FULL	48		VG	73.0		
Pine Run	5.71	CWH-R	FULL	48		E	85.0		
Muddy Fork Mohican River	23.29	WWH	Partial	34*		G	73.5	Flow alteration	Dam or impoundment
Muddy Fork Mohican River	18.37	WWH	FULL	50		G	73.0		
Muddy Fork Mohican River	13.43	WWH	FULL	38ns	8.6	G	55.0		
Muddy Fork Mohican River	8.20	WWH	FULL	49	10.1	42	70.5		
Muddy Fork Mohican River	4.30	WWH	(FULL)	40	7.7ns		44.0		
Redhaw Creek	2.54	CWH-R	FULL	54		VG	66.5		
Kiser Ditch	0.38	MWH-R	NON	24		VP*	32.5	Sedimentation/Siltation, High flow regime, Dissolved oxygen, Biological Oxygen Demand	Channelization, Dam or Impoundment.
Jerome Fork	12.98	WWH	FULL	47	10.0	54	50.0		
Jerome Fork	12.08	WWH	FULL	42	9.0	G	52.5		
Jerome Fork	7.90	WWH	Partial	33*	7.4ns	G	56.5	Nutrient/Eutrophication biological Indicators, Sedimentation/Siltation	Channelization, Municipal Point Source Discharges
Jerome Fork	2.56	WWH	FULL	41	7.7ns	48	50.0		
Leidigh Mill Creek	1.91	WWH-R	FULL	46		G	66.5		
Orange Creek	6.32	WWH-R	FULL	50		G	69.5		
Orange Creek	4.85	WWH-R	FULL	48		MGns	81.0		
Jamison Creek	0.30	WWH	FULL	54		G	65.0		
Lang Creek	5.26	WWH	FULL	48		MGns	63.0		
Lang Creek	3.15	WWH	FULL	48		VG	51.5		
Katotawa Creek	3.49	CWH-R	FULL	48		E	83.0		
Newell Run	1.00	CWH-R	FULL	54		E	80.5		
Quaker Springs Run	1.97	CWH-R	FULL	54		E	67.5		
Oldtown Run	4.31	CWH-R	FULL	52		E	53.5		

Stream	Sample Location River Rile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Lake Fork	14.04	WWH-R	NON	30*	5.8*	18*	47.5	Direct habitat alterations; Other flow regime alterations; Dissolved Oxygen; Sedimentation, Nutrient/Eutrophication Biological indicators	Non-irrigated Crop Production, Channelization, Dam or Impoundment.
Lake Fork	7.43	WWH-R	FULL	50	8.9	42	69.0		
Lake Fork	0.95	WWH-R	FULL	51	9.6	50	87.0		
Crab Run	2.17	WWH-R	FULL	52		E	74.5		
Odell Lake Outlet	3.03	WWH-R	FULL	42		G	44.0		
Odell Lake Outlet	0.59	WWH-R	FULL	50	9.0	50	68.5		
Plum Run	0.13	WWH-R	FULL	50		G	75.5		
Negro Run	1.04	CWH-R	FULL	52		E	76.0		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 2. Summary E. coli bacteria data for 17 high recreational use locations in the Mohican River Basin, July 5 to August 2, 2007. Attainment status is based on comparing the geometric mean and single sample maximum values to the Primary Contact Recreation (PCR) criteria (Ohio Administrative Code 3745-1-07, Table 7-13). All values are expressed as colony forming units per 100 ml of water.

Stream / Location	River Mile	Geometric Mean E.Coli	# exceeding single sample maximum (298 cfu))	PCR Attainment Status
Mohican River Adj. TR 3175	27.00	**506**	**3**	**NON**
Mohican River at TR 211, Dst. Lake Fork	22.54	**295**	**2**	**NON**
Mohican River at SR 514, Nashville Rd.	16.92	**272**	**2**	**NON**
Mohican River at Canal St., Dst. Brinkhaven dam	11.66	**174**	**2**	**NON**
Mohican River at TR 365, Ust. Flat Run, Cavallo Station	6.53	**257**	**2**	**NON**
Mohican River at SR 715, MWCD Mohawk Area	0.50	87	**1**	**NON**
Black Fork Mohican River dst. Charles Mill Lake	18.30	**173**	**1**	**NON**
Black Fork Mohican River at SR 39	14.65	107	**1**	**NON**
Black Fork Mohican River at SR 39, Dst. Perrysville WWTP	7.09	**604**	**4**	**NON**
Black Fork Mohican River at SR 39, Loudonville	2.50	**1302**	**5**	**NON**
Clear Fork Mohican River at CR 144, LexingtonOntario Rd.	29.57	**700**	**3**	**NON**
Clear Fork Mohican River at TR 348, Ritter Rd., Dst. I71	23.35	**767**	**4**	**NON**
Clear Fork Mohican River at SR 13	19.83	**631**	**3**	**NON**
Clear Fork Mohican River at TR 392, Cutnaw Rd.	16.17	**400**	**2**	**NON**
Clear Fork Mohican River at CR 350, Bunker Hill Rd.	10.55	**238**	**3**	**NON**
Lake Fork Mohican River at SR 3	7.33	**1126**	**5**	**NON**
Lake Fork Mohican River at Washington TR 451	1.00	**529**	**4**	**NON**

Yellow shaded values violate PCR criteria.

From Table 7-13: for Primary Contact Recreation (in part):
E. coli - geometric mean E. coli content (either MPN or MF), based on not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and E. coli content (either MPN or MF) shall not exceed 298 per 100 ml in more than ten per cent of the samples taken during any thirty-day period.

The Mohican River basin is comprised of eight 10-digit Hydrologic Unit Code (HUC10) watersheds, subdivided into thirty-six 12-digit HUC (HUC12) watersheds, and one large river assessment unit (LRAU). Data from individual sampling locations in an assessment unit are accumulated and analyzed; summary information for each Mohican River watershed assessment unit (WAU) are presented in this section. Table presents the number of assessed headwater, wading and principal stream sites within each HUC 12. High magnitude causes and sources contributing to the biological impairment (partial and non-attainment) are noted. This information was used in aggregate statewide statistics for Ohio's universe of assessed principal streams and large rivers, and will be reported in Ohio's 2010 Integrated Water Quality Monitoring and Assessment Report.

Table 3. Number of number of assessed headwater, wading and principal stream sites within HUC 12 assessment units in the Mohican River basin, 2007. Cause(s) and source(s) of the impairment are noted for the eight HUC10 .

HUC-10 HUC-12 (drainage area in mi^2)	Headwater Sites (<20 mi^2)			Wading Stream Sites (≥ 20 mi^2 <50 mi^2)			Principal Stream Sites (≥ 50 mi^2 <500 mi^2)		
	Full	**Partial**	**Non**	**Full**	**Partial**	**Non**	**Full**	**Partial**	**Non**
0504000201	**Headwaters Black Fork Mohican River**								
050400020101 (20.8)	1	0	0	0	1	0	0	0	0
050400020102 (39.4)	2	0	2	1	1	0	0	0	0
050400020103 (23.0)	0	0	0	1	0	0	0	0	0
050400020104 (17.1)	2	0	0	0	0	0	0	0	0
050400020105 (61.6)	1	0	0	0	0	0	1	0	1
TOTAL	**6**	**0**	**2**	**2**	**2**	**0**	**2**	**0**	**0**
Causes/Sources of Impairment **Black Fork Mohican River** - Direct habitat alterations; Other flow regime alterations; Turbidity/ Channelization, Urban Runoff/ Storm Sewers, Sediment Resuspension (Clean Sediment) **Tuby Run** - Impairment Unknown/ Industrial point source discharge **Brubaker Creek** - Nutrient/Eutrophication Biological Indicators/ Non-irrigated Crop Production **Bear Run** - Organic Enrichment (Sewage) Biological Indicators; Oxygen, Dissolved; Direct Habitat Alterations/ Manure runoff, Unrestricted Cattle Access; Channelization; Non-irrigated Crop Production **Marsh Run** - Sedimentation/Siltation/ Channelization, Non-irrigated Crop, Production, Dam or Impoundment									
0504000202	**Rocky Fork-Black Fork Mohican River**								
050400020201 (31.9)	1	0	0	0	0	0	0	0	2
050400020202 (21.6)	0	0	0	0	0	0	0	0	0
050400020203 (29.4)	0	3	0	0	0	0	0	0	0
050400020204 (47.8)	1	0	0	0	0	1	1	0	2
050400020205 (9.0)	0	0	0	0	0	0	0	1	1
TOTAL	**2**	**3**	**0**	**0**	**0**	**1**	**1**	**1**	**5**

HUC-10 HUC-12 (drainage area in mi^2)	Headwater Sites (<20 mi^2)			Wading Stream Sites (≥ 20 mi^2 <50 mi^2)			Principal Stream Sites (≥ 50 mi^2 <500 mi^2)		
	Full	**Partial**	**Non**	**Full**	**Partial**	**Non**	**Full**	**Partial**	**Non**
Causes/Sources of Impairment **Black Fork Mohican River** - Sedimentation/Siltation, Nutrient/Eutrophication Biological Indicators, Direct habitat alterations; Other flow regime alterations; Oxygen, Dissolved; Turbidity Suspended Algae/ Crop Production with Subsurface Drainage Channelization, Non-irrigated Crop Production, Dam or Impoundment **Rocky Fork Mohican River** - Natural Conditions (Flow or Habitat), Nutrient/Eutrophication Biological indicators, Metals, Organic Enrichment (Sewage) Biological Indicators/ Natural sources (upstream wetland, low gradient), Unspecified Urban Stormwater, Contaminated Sediments, Municipal Point Source Discharges **Touby Run** - Impairment unknown (toxicity?)/ Unspecified Urban Stormwater									
0504000203	**Headwaters Clear Fork Mohican River**								
050400020301 (33.8)	0	0	0	0	0	0	0	0	0
050400020302 (47.7)	2	0	0	1	0	0	0	0	0
050400020303 (29.6)	0	0	0	1	0	0	1	0	0
TOTAL	**3**	**0**	**0**	**2**	**0**	**0**	**1**	**0**	**0**
Causes/Sources of Impairment None									
0504000204	**Possum Run-Clear Fork Mohican River**								
050400020401 (24.6)	1	0	0	0	0	0	2	0	0
050400020402 (15.6)	2	0	0	0	0	0	0	0	0
050400020403 (22.9)	1	0	0	0	0	0	1	0	0
050400020404 (14.1)	1	0	0	0	0	0	0	0	0
050400020405 (29.3)	1	0	0	0	0	0	1	0	0
TOTAL	**6**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**
Causes/Sources of Impairment None									
0504000205	**Muddy Fork Mohican River**								
050400020501 (28.6)	1	1	0	0	0	0	0	0	0
050400020502 (27.5)	1	0	0	1	0	0	0	0	0
050400020503 (49.5)	0	0	1	0	0	0	2	0	0
TOTAL	**3**	**3**	**1**	**1**	**0**	**0**	**2**	**0**	**0**
Causes/Sources of Impairment **Kiser Ditch** - Sedimentation/Siltation, High flow regime, Dissolved oxygen, Biological Oxygen Demand/ Channelization, Dam or Impoundment. **Muddy Fork Mohican River** - Flow alteration/ Dam or impoundment									

HUC-10 HUC-12 (drainage area in mi^2)	Headwater Sites (<20 mi^2)			Wading Stream Sites (≥ 20 mi^2 <50 mi^2)			Principal Stream Sites (≥ 50 mi^2 <500 mi^2)		
	Full	Partial	Non	Full	Partial	Non	Full	Partial	Non
0504000206	**Jerome Fork-Mohican River**								
050400020601 (34.1	3	0	0	0	0	0	0	0	0
050400020602 (37.5)	3	0	0	0	0	0	0	0	0
050400020603 (13.5)	1	0	0	0	0	0	0	0	0
050400020604 (23.1)	2	0	0	0	0	0	0	0	0
050400020605 (35.5)	1	0	0	0	1	0	1	1	0
050400020606 (17.8)	0	0	0	0	0	0	1	0	0
TOTAL	**10**	**0**	**0**	**0**	**1**	**0**	**2**	**1**	**0**
Causes/Sources of Impairment **Jerome Fork Mohican River** - Nutrient/Eutrophication biological Indicators, Sedimentation/Siltation/ Channelization, Municipal Point Source Discharges									
0504000207	**Lake Fork Mohican River**								
050400020701 (34.1)	2	0	0	1	0	0	0	0	0
050400020702 (24.5)	0	0	0	0	0	0	1	0	1
050400020703 (20.9)	1	0	0	0	0	0	1	0	0
TOTAL	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**
Causes/Sources of Impairment **Lake Fork Mohican River** - Direct habitat alterations; Other flow regime alterations; Dissolved Oxygen; Sedimentation, Nutrient/Eutrophication Biological indicators/ Non-irrigated Crop Production, Channelization, Dam or Impoundment.									
0504000208	**Mohican River**								
050400020801 (17.3)	2	0	0	0	0	0	0	0	0
050400020802 (17.7)	0	0	0	0	0	0	0	1	0
050400020803 (19.2)	1	0	0	0	0	0	0	1	0
050400020804 (28.4)	0	0	0	0	0	0	0	0	0
050400020805 (28.6)	1	0	0	0	0	0	0	0	0
050400020806 (27.4)	0	0	0	0	0	0	0	0	0
TOTAL	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
Causes/Sources of Impairment **Black Fork Mohican River**- High flow regime, Direct alterations/ Major flooding									

RECOMMENDATIONS

All of the streams listed in the Ohio Water Quality Standards for the Mohican River watershed are assigned the Warmwater Habitat (WWH) aquatic life use designation. Many were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. The 2007 sampling effort represented the first opportunity to apply biological data to evaluate and establish

aquatic life uses for 30 of 39 streams in the Mohican River watershed (Table). Significant findings include the following:

- Mohican River should receive an EWH use designation from the confluence of the Clear Fork Mohican River and Black Fork Mohican River to the mouth. Currently, the entire length of stream is listed as WWH. Exceptional fish and macroinvertebrate communities were documented throughout the reach.
- The CWH use is recommended for Negro Run, Redhaw Creek, Oldtown Run, Quaker Springs Run, Newel Run, Kakotawa Creek, Honey Creek (Black Fork tributary) -from the headwaters to RM 4.19, Pine Run, Switzer Creek, Slater Run, and Honey Creek (Clear Fork Trib.). These streams supported native coldwater faunas characterized by the presence of a) $\geq$4 coldwater macroinvertebrate taxa or, b) populations of two species of coldwater fish, and two taxa of primary coldwater macroinvertebrates
- Kiser Ditch was deficient in typical warmwater habitat attributes and did not have adequately diverse biological communities to warrant the Warmwater Habitat use designation. Given the conditions encountered in Kiser Ditch, a Modified Warmwater Habitat use (MWH) is recommended.
- All other tributary streams evaluated in 2007 (14 waterbodies) had sufficient habitat quality and/or demonstrated attainment of the WWH use.
- All 39 streams in this study should retain the Primary Contact Recreation use, along with the Agricultural and Industrial uses.

Table 4. Waterbody use designations for the Mohican River basin. Designations based on the 1978 water quality standards appear as asterisks (*). A plus sign (+) indicates a new recommendation or confirmation of an existing use. A delta (Δ) indicates a new recommendation based on the findings of this report.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Mohican river			Δ						*+	*+		*+		
Flat run		*							*	*		*		
Negro run						Δ			*+	*+		*+		
Sigafoos run		*							*	*		*		
Lake fork		*+							*+	*+		*+		
Plum run		*+							*+	*+		*+		
Unnamed stream (Odell Lake outlet)		*+							*+	*+		*+		
Crab run		*+							*+	*+		*+		
Muddy fork		+							+	+		+		
Kiser ditch				Δ					Δ	Δ		Δ		
Fox run		*							*	*		*		
Redhaw creek						Δ			+	+		+		
Wolf run		*							*	*		*		
Jerome fork		+							+	+		+		
Glenn run		*							*	*		*		
Oldtown run						Δ			*+	*+		*+		
Quaker Springs run						Δ			*+	*+		*+		
Scott run		*							*	*		*		
Newell run						Δ			*+	*+		*+		
Kakotawa creek						Δ			*+	*+		*+		
Lang creek		+							+	+		+		
Jamison creek		+							+	+		+		
Unnamed tributary (RM 0.2)							+		+	+			+	
Town run		+							+	+		+		
Orange creek		*+							*+	*+		*+		
Leidigh Mill creek		*+							*+	*+		*+		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Ball Alley run		*							*	*		*		
Black fork - Charles Mill reservoir to confluence with Mohican river	*	*+							*+	*+		*+		
- at RMs 50.82, 53.88 and 54		+						+	+	+		+		
- all other segments		+							+	+		+		
Big run		*+							*+	*+		*+		
Honey creek – headwaters to Unnamed tibutary(RM 4.19)						Δ			*+	*+		*+		
- Unnamed tributary (RM 4.19) to the mouth		*+							*+	*+		*+		
Rocky fork		+							+	+		+		
Unnamed tributary (RM10.70)		Δ							Δ	Δ		Δ		
Fleming Falls creek		+							*	*		+		
Unnamed tributary (Fleming Falls creek RM 2.7)		+							*	*			+	
Touby run		+							+	+		*		
Unnamed tributary (RM 25.16)		Δ							Δ	Δ		Δ		
Seymour run		*							*	*		*		
Whetstone creek		*+							*+	*+		*+		
Brubaker creek		*+							*+	*+		*+		
Friends creek		*							*	*		*		
Shipp creek		*+							*+	*+		*+		
Leatherwood creek		*							*	*		*		
Bear run		*+							*+	*+		*+		
Marsh run		*+							*+	*+		*+		
Tuby run		+							+	+			+	
Unnamed tributary (RM 54.46)		Δ							Δ	Δ		Δ		
Clear fork - Clear fork reservoir (RM 30.5) to the mouth	*	+							+	+		+		
- at RM 30.6		*						o	*	*		*		
- all other segments		*							*	*		*		
Pine run	*					Δ			+	+		+		
Horsetail run		*							*	*		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Switzer creek						Δ			*+	*+		*+		
Opossum run		+							+	+		+		
Slater run						Δ			*+	*+		*+		
Babble brook		*							*	*		*		
Smoky run		*							*	*		*		
Pleasant Valley run		*							*	*		*		
Honey creek						Δ			*+	*+		*+		
Robinson run		*							*	*		*		
Cedar fork		+							+	+		+		
Steel run		*							*	*		*		

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.

Two streams (or stream segments) in the Mohican River watershed are included or have been recommended for inclusion in the list of Superior High Quality Waters (SHQW) in the Antidegradation Rule (OAC 3745-1-05) of the Ohio Water Quality Standards (Table 5). The recommendation is based on the presence of threatened or endangered species and a high level of biological integrity. Included in evaluating exceptional biological value was a determination of declining fish species, high quality habitat to support declining and threatened fish species, and a display of biological integrity equivalent to the Exceptional Warmwater Habitat Index of Biotic Integrity and /or Invertebrate Community Index criteria listed in rule 3745-1-07 of the Ohio Administrative Code. An Outstanding State Waters (OSW) listing has been recommended for the Mohican River and the Clear Fork Mohican River in the Antidegradation Rule. Outstanding State Waters are waters that have special significance for the state because of their exceptional ecological values. To qualify on the basis of exceptional ecological values they must meet the qualifications for superior high quality waters and be further distinguished as being demonstratively among the best waters of the state from an ecological perspective.

Table 5. List of existing or recommended Superior High Quality Water (SHQW) and Outstanding State Water (OSW) streams for the Mohican River watershed.

Stream/ Segment	River Mile	Antidegradation Category
Mohican River (Black Fk./Clear Fk. confluence to mouth*)	27.58 – 0.0	OSW- Recommended
Clear Fork Mohican River (dst. Pleasant Hill Reservior to mouth)	4.8 - 0.0	OSW- Recommended
Cedar Fork	Entire length	SHQW- Existing
Pine Run (Trib to Pine Run @ RM 6.77 to the mouth	6.77 to 0.0	SHQW- Recommended

(*Existing SHQW from Black Fork/ Clear Fork to Trib to Mohicn R. @ RM 16.10.)

METHODS

All chemical, physical, and biological field, EPA laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 2006b), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b, 2008a, 2008b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989), and Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (Ohio EPA 2006a). Sampling locations are listed in Table 2.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - Full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995, Ohio EPA 2006a). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the

existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores that exceed 75 frequently typify habitat conditions with the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location using decontaminated stainless steel scoops. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and shipped to the Ohio EPA Division of Environmental Services. Sediment data is reported on a dry weight basis. Surface water samples were collected, preserved and delivered in appropriate containers to either an Ohio EPA contract lab or the Ohio EPA Division of Environmental Services. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000) and Ohio Specific Reference Values (2003).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats. The artificial substrate collection provided quantitative data and consisted of a composite sample of five modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b, Ohio EPA 2008b).

Fish Community Assessment

Fish were sampled using pulsed DC electrofishing methods. Fish were processed in the field, and included identifying each individual to species, counting, weighing, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b, Ohio EPA 2008b).

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

WATERSHED ASSESSMENT UNIT REPORTS

Each WAU10 and LRAU in the basin was sampled to evaluate the status of aquatic life uses. Water column and sediment sampling was done to evaluate recreation and water supply uses and to help identify causes of biological impairment. Biological index scores and water quality were evaluated based on Ohio WQS criteria (OAC 3745-1). Values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrients. These nutrient target values are being used as guidelines in lieu of criteria that are under development. Preliminary findings support the validity of these targets and that a correlation exists between nutrients and aquatic life attainment status. When nutrient criteria are adopted they will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Nutrient data were therefore evaluated using the applicable targets of either 0.10 or 0.17 mg/L for phosphorus and 1.00 or 1.50 mg/L for nitrate-nitrite based on a streams drainage area at the mouth. Many criteria are tiered within the standards based on specific use designations. All data were evaluated based on the uses listed in rule 3745-1-24 unless a recommended use is suggested. This is done for streams not previously assessed in the field where the assigned use is considered inappropriate. Geographic location is also an important consideration, especially for biological criteria. Most of the basin lies within the Erie-Ontario Lake Plain (EOLP) ecoregion, except much of the mainstem is within the Western Allegheny Plateau (WAP).

The recreation use was evaluated overall for each WAU and on a site specific basis for streams where fishing and canoeing are prevalent. This was done by comparing levels of *Escherichia* coliform (E. coli) in the stream to numerical criteria developed to protect human health. Although this organism is harmless in most cases, it indicates that water has been contaminated by feces from warm blooded animals. This creates a potential that pathogens or disease producing bacteria (*Salmonella*, *Shigella*), viruses (hepatitis A, Norovirus, Rotavirus), and parasites (*Cryptosporidium*, *Giardia*) are present. People can be exposed to pathogens in water through skin contact and ingestion. A resulting illness can be as minor as a skin rash, sore throat, or ear infection. However, some reactions may lead to diarrhea, gastroenteritis, and dysentery or even more serious wide spread epidemic. The status of each WAU was determined by pooling all data collected during the recreation season (May 1-October 15). The geometric mean from this data set should not exceed 126 CFU/100 ml and not more than 10% of the individual results should exceed 298 CFU/100 ml.

Certain water quality constituents are important to the survival of aquatic life. A few of these include dissolved oxygen, ammonia, nutrients, and dissolved solids. Dissolved oxygen is important from several aspects. Most organisms require a minimum amount to sustain life, but supersaturated levels are also a concern. An ailment known as gas bubble disease can restrict or stop blood flow, damage tissues, and eventually cause mortality. There is also mounting evidence that diurnal swings greater than 5 mg/L cause undue stress. Certain forms of ammonia are extremely toxic and cause mortality if diffusion into the blood is faster than excretion. Nutrients like phosphorus and nitrogen rarely approach toxic levels, but they stimulate algae blooms that

influence dissolved oxygen and pH. Alkaline pH caused by intense photosynthetic activity shifts the ammonia equilibrium from harmless ammonium ion to toxic ammonium hydroxide. Elevated levels of dissolved solids disrupt osmoregulation and can reduce egg survival in fish. When average concentrations for any of these constituents are discussed, a value equal to one half the limit is used in the calculation when the result is less than the quantitation limit.

Sediment was mainly tested to provide screening data, although some samples were collected for trend analysis. The top 10 cm was targeted because this zone is the most physically, chemically, and biologically reactive. Samples with at least 30% silt and clay are desired since these particles tend to attract contaminants due to surface electrical charges. Sand and other more coarse particles are generally inert. Sediment quality was evaluated based on ecoregion reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Sediment reference values (SRV) represent background concentrations in Ohio streams. The toxicity guidelines include a threshold effect concentration (TEC) considered absent of toxicity and a probable effect concentration (PEC) that is likely toxic to benthic organisms.

The public water supply use was evaluated where appropriate based on Ohio River basin human health criteria (OAC 3745-1-34). These criteria are designed to protect source waters to the extent that public water systems meet MCLs for finished water using conventional treatment only. The criteria apply to samples collected within 500 yards (0.28 mile) of an intake and follow Safe Drinking Water Act and Ohio Public Drinking Water Standards. Primary Drinking Water Standards (OAC 3745-81) are set for pollutants with serious human health implications. A few of these include nitrate, pesticides, and trihalomethanes. Water with elevated levels of nitrate can cause oxygen starvation in tissues if it is fed to pregnant women or babies. Severe cases can result in a potentially fatal condition known as methemoglobinemia (blue babies). Certain pesticides are suspected carcinogens and others have been shown to retard fetal growth and cause premature births in lab animals. Trihalomethanes are suspected human carcinogens and a by product of the disinfection process. They form when chlorine is added to water that contains excess organic matter. Secondary Contaminant Standards (OAC 3745-82) are set for pollutants associated with aesthetics like taste, odor, and color. Dissolved salts and minerals affect the taste of drinking water and add to the cost of treatment.

An effort was made to identify the causes and sources of biological and recreation use impairment and water quality degradation where it was documented. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources. These are grouped into point and nonpoint categories.

The origin of a point source is easy to identify at the end pipe. Ohio Water Pollution Control Laws (ORC 6111) require that all discharges to waters of the state be

regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes and General permits are issued to facilities with similar operations that exert a minimal impact on the environment. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

The origin of a nonpoint source is difficult to identify. Their impact is diffuse and a direct function of the surrounding land use. They are found in both rural and urban settings. Pollutants like silt, nutrients, pesticides, heavy metals, and oil are carried in storm water. Overflows from combined sewage collection systems and failed or poorly maintained home sewage systems discharge organic matter and bacteria. Livestock in pasture damage habitat and contribute pollutants if they are not excluded from streams.

In areas with flat topography and poor drainage, land used for crop production is often managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. However, practices like channelization, removal of riparian vegetation, and installation of tile result in significant flow and habitat alterations. They exacerbate low flow during dry weather by lowering the water table and limiting ground water recharge and by increasing evaporation due to lack of tree shade. Conversely, they exacerbate flooding during wet weather due to accelerated delivery of runoff. This is also a problem in urban areas because of impervious surfaces like roads and parking lots and sources of inflow like down spouts and sump pumps. In some areas, dams are constructed to control flooding, but they submerge riffles, block fish migration, and ultimately change trophic structure.

Some drainage projects are done by individual landowners, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance.

Headwaters Black Fork Mohican River Watershed Assessment Unit

The Headwaters Black Fork Mohican River WAU (0504000201) covers a land area of 161.4 mi^2 and lies almost entirely within Richland County. The boundary encompasses the Black Fork Mohican River from its origin (RM 62.8) to below Whetstone Creek (RM 31.00).

Aquatic life impairment was documented in portions of the Black Fork through Shelby in 1998. Reduced habitat conditions from channel modifications and extensive substrate embeddedness were partly to blame. The 2006 *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2006) identifies nutrients, siltation, and habitat alterations as high magnitude causes of impairment. All of these components were measured during the 2007 survey. Nutrients were included in routine water chemistry analysis and assessed by comparing to target values. Siltation and habitat are measured in the Qualitative Habitat Evaluation Index.

Aquatic Life Use Designations
Biological and habitat assessments were conducted at 15 sites within the Headwaters Black Fork Mohican River WAU in 2007.

The Black Fork Mohican River is designated as WWH, PCR, PWS, AWS, and IWS based on previous field assessments. A small dam and pump house located at RM 53.88 supplies raw water to Shelby Reservoir #2. Habitat quality at the five fish sampling locations was, in large part, consistent with the WWH use. QHEI scores at sites between RM 57.7 (Stivings Rd.) and RM 43.2 (Ganges Five Points Rd.) ranged from 55.5 to 72.5. One site on the Black Fork within the assessment unit that lacked typical WWH features was at the most downstream sampled location at RM 36.6 (St. Rt. 13). The QHEI score at RM 36.6 was 35.5. This reach suffered from previous channelization and low gradient which limited habitat diversity kept a heavy silt load confined within the banks of the stream.

Tuby Run was the only sampled tributary to the upper Black Fork with a verified aquatic life use (WWH). The Unnamed Tributary to Black Fork (RM 45.88) had no assigned aquatic life use. The remaining streams, Whetstone Creek, Shipp Creek, Bear Run and Marsh Run, had an unassessed WWH designation. The 2007 sampling effort confirmed that warmwater habitat (WWH) was the appropriate aquatic life use for these streams.

Instream and riparian habitat attributes along Bear Run were severely compromised. Modified habitat attributes exceeded those favorable to the maintenance of WWH communities by a ratio of 10:1. However, the fish community was in relatively good condition and the degraded habitat and water quality present at RM 0.48 could be improved.

Even though the Unnamed Tributary to Black Fork (RM 45.88) and Marsh Run are maintained to facilitate agricultural drainage, free flowing reaches of both streams supported warmwater fish and macroinvertebrate assemblages. The demonstrated attainment of the WWH use verifies the appropriateness of the use for both these

streams. The only less than goal index score (IBI = 30 at RM 0.2) was in a reach of Marsh Run impounded to allow water supply withdrawals for the city of Shelby. Judicious drainage maintenance practices should be employed so as not to impede continued attainment of the WWH goal.

Whetstone Creek and Brubaker Creek both possessed a mixture of modified and typical WWH habitat attributes that reflected the largely agricultural land use of the two watersheds. QHEI scores were consistent with a WWH use, ranging from 62.5 to 67.5.
The WWH use was appropriate for Shipp Creek, as well. High quality habitat features included a rubble and bedrock substrate and intact riparian canopy.

Aquatic Life Use Attainment Status
Aquatic life use attainment status is presented in Table 1a and Figure 1a.

Attainment status was determined for fourteen sites in the Headwaters Black Fork Mohican River watershed, representing approximately 42 stream miles in the assessment unit. Eight sites representing 24 assessed stream miles, fully met the current or recommended aquatic life use. Three sites, representative of ten assessed miles, partially met and three sites, totaling eight assessed stream miles, were in non-attainment of the current or recommended WWH aquatic life use.

Sub par biological communities identified at 18 of 43 assessed stream miles in the Headwaters Black Fork Mohican River WAU were impacted, largely, by a combination of factors related to agricultural practices, channelization, and stormwater runoff.

Macroinvertebrate collections reflected good to exceptional community condition at the five sampled locations on the Black Fork Mohican River. The fish community results were more variable. Both organism groups met ecoregional expectations upstream from the city of Shelby. The fish community was reflective of a moderate nutrient enrichment contributed from surrounding agricultural areas, particularly at RM 57.72 (Stivings Rd.) where central stonerollers predominated. Central stonerollers are herbivores and tend to be most numerous where elevated nutrients promote the growth of attached algae. Within and downstream from Shelby, the stream had been channelized. Consequently, unconsolidated gravel substrates confined within the banks limited the development of stable riffle/run/pool habitats. The combination of channelization and impervious surfaces in Shelby also likely led to the rapid delivery of polluted stormwater runoff. An unidentified septic discharge was located at RM 51.4 and discharges from Shelby Welded Tube and Northside MHP may have affected the biology of the stream. As a result, the fish community was disordered. The MIwb was in the fair range (MIwb=6.9) and the community was numerically predominated by tolerant Creek Chubs and White Suckers at London West Rd. (RM 51.32).

The Black Fork Mohican fish community was marginally improved at RM 43.40 (Ganges Five Points Rd.) and the macroinvertebrate community yielded an ICI score in the very good range. Attainment of WWH expectations was largely a reflection of a localized stream reach with improved riparian habitat and stream morphology (QHEI= 72.5). An intact flood plain with a canopy of large trees and a mixture of rubble and

gravel substrates was particularly beneficial to the fish community. Most of the Black Fork had a more monotonous habitat and predominance of sand substrates. A moderate increase in enrichment was noted in the macroinvertebrate assemblage reflecting an influence of the Shelby WWTP discharge.

The large affect that habitat quality had on the condition of the fish community was evident at RM 36.55 (SR13). While chemical water quality was acceptable, this reach was perpetually turbid, had minimal discernable current under low flow conditions and a straight sand bottom channel (QHEI= 35.5). Modified habitat attributes exceeded typical warmwater features by a ratio of 7:2. Very low numbers of only six fish species were collected at this site. The IBI and MIwb scores were in the poor to very poor range, respectively, and pollution tolerant carp predominated. Conversely, the macroinvertebrate community produced an ICI score in the exceptional range. The artificial substrates yielded 19 relatively pollution sensitive taxa among the recorded 37 taxa. These disparate results are understandable given that the macroinvertebrate sampling protocol provides a suitable substrate for colonization which was located in a microhabitat that offered some current. Conversely, the fish were sampled from the limited available in-stream habitat.

Effluent from ArcelorMittal Inc. dominated Tuby Run under dry weather conditions. The stream failed to meet WWH biocriteria due to the very poor condition of the macroinvertebrate community. A toxic response was evident in the limited types of macroinvertebrate taxa collected at RM 0.10. Only fifteen macroinvertebrate taxa were collected and pollution tolerant midges of the genus *Cricotopus* predominated. No mayfly, caddisfly or stonefly taxa were collected. In addition, the water had a bright green tint that has yet to be explained. The toxicity suggested by the sampling results may have been episodic or specific to invertebrates because a relatively diverse fish assemblage was collected (IBI= 56). It is possible that fish, under periodic chemical stress, are killed or migrate out the stream. Following the return of acceptable water quality, they could repopulate the reach from out of the Black Fork Mohican.

One particular chemical constituent that likely affected the macroinvertebrate community in Tuby Run was an elevated level of total dissolved solids (TDS). Grab sample concentrations ranged from 1540-2460 mg/L, with a median value of 2140 mg/L. MOR data reported by ArcelorMittal from the same June-August time period had an average dissolved solids concentration of 2501 mg/L (n=8). An Ohio EPA analysis of the relationship between total dissolved solids, mayfly sensitivity and ICI attainment suggests that a TDS concentration in excess of 1000 mg/l coincides with high likelihood for sub par ICI results and, in particular, a depressed mayfly fauna.

The unnamed tributary to the Black Fork (54.46) was a small cool stream. Both fish and macroinvertebrates were meeting the recommended WWH use even though the habitat was modified and the stream is maintained to facilitate row crop agriculture. Fifty macroinvertebrate taxa were collected including 17 that were relatively pollution sensitive. Fish sampling produced an IBI score in the good range. The stream also supported a population of redside dace (*Clinostomus elongatus*), a specie whose occurrence has been declining from Ohio waters in recent years.

Biological sampling of Whetstone Creek demonstrated attainment of a WWH use even though cattle had direct access to the stream. The macroinvertebrate community reflected an enriched condition at RM 0.69 and damage to the stream bank was noted upstream from the site. Enrichment was also indicated by the collection of over 1200 central stonerollers at RM 3.8. Nevertheless, IBI scores in the exceptional and very good range were recorded at RM 3.8 and 0.69, respectively and the macroinvertebrate community was in good condition at RM 0.69. A relatively high diversity of macroinvertebrate taxa were collected including 16 EPT taxa (ephemeroptera, plecoptera, and trichoptera).

The Shipp Creek macroinvertebrate community marginally met ecoregional expectations based on sampling of the natural substrates at RM 0.95. The diversity of sensitive taxa (n=8) was reduced relative to higher quality communities in the Mohican River watershed. An IBI of 50 placed the fish community condition in the exceptional range but a predominance of central stonerollers in the collection suggested that nutrients contributed from the surrounding watershed were moderately elevated. Based on the combined biological sampling results, Shipp Creek was in attainment of the WWH aquatic life use.

Direct access by dairy cattle and past channelization affected both the fish and macroinvertebrate assemblages in Bear Run at RM 0.48 (Figure 1b). Habitat quality was poor. The channel lacked sinuosity, offer limited in-stream cover and the banks of the stream were slumped. The fish assemblage was relatively diverse with 22 species recorded and scored an IBI in the good range (IBI=40). A large number of white suckers (*Catostomus commersoni)* reflected both the contribution of cool groundwater to flow in the stream and enriched conditions. The macroinvertebrate community was more severely impacted and indicative of high enrichment and low diurnal dissolved oxygen levels. Facultative and tolerant taxa predominated and just five EPT taxa were recorded. Bear Run failed to attain the recommended WWH aquatic life use, as a result.

Marsh Run was highly modified at RM 4.55 specifically to encourage the rapid conveyance of water away from surrounding agricultural areas. Typical stream habitat features were limited but fish and macroinvertebrate assemblages met WWH expectations. Both groups were indicative of relatively good water quality. A high diversity of fish was collected (21 species) and the macroinvertebrate community was in good condition. Impoundment of water behind a small dam impinged on continued attainment of the WWH aquatic life use at RM 0.13. The fish community was in fair condition with gizzard shad (*Dorsoma cepadianum*) predominating and overall diversity was reduced. Immediately downstream from the dam, the macroinvertebrate community was in relatively good condition. The sampling at RM 0.13 identified the limited habitat within the dam pool rather than water quality as the cause for depressed fish results and the partial attainment of the recommended WWH use.

Recreation Use Status

The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 52 separate samples collected at 13 sites.

Bear Run at London West Road (RM 0.48) was the most impaired site with a geometric mean count of 14661 CFU/100 ml. This was likely due to a farm located here with cows that had unrestricted watering access to the stream (Figure 1a). Two small package plants located further upstream are also potential sources. The next highest geometric mean count was 2310 CFU/100 ml in the Black Fork at Stivings Road (RM 57.72). A farm and livestock pasture is located at this site, but animals were never seen wading in the river here. Another site with high counts was the Black Fork at London West Road (RM 51.31) where the geometric mean was 2089 CFU/100 ml. A septic discharge was discovered by one of the field staff about 0.1 mi. upstream from the bridge. Package plant discharges from Shelby Welded Tube and Northside MHP are also located here.

No Class A stream assessments were done in this WAU. In stream recreation in this area is limited and, in fact, none was observed during the field season. This is probably due to the fact that the Black Fork here is low gradient and channelized.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 1c and 1d, respectively. The City of Shelby WWTP and ArcelorMittal, Inc. are the only facilities classified as major dischargers.

Shelby WWTP (permit # 2PD00036) is located at 3626 London West Road, Shelby, OH. It serves about 9,800 people and eight industrial users that contribute 0.4 MGD. The plant was originally built in 1955 and expanded in 1988. Preliminary treatment includes bar screens and comminution. The sewage is then lifted by pumps into an aerated grit removal chamber. Advanced treatment is by conventional activated sludge in a series of primary settling tanks, aeration tanks, and final settling tanks. The treated wastewater is disinfected with chlorine and de-chlorinated before discharge to the Black Fork from Outfall 001 at RM 50.07. The plant is designed to treat 2.5 MGD and has a peak capacity of 5.0 MGD, with an annual average discharge of about 1.8 MGD. Flows in excess of 5.0 MGD overflow to a 2.0 MG equalization basin. A new 18 MG equalization basin was completed in 2006 and a manual slide gate was recently installed to control overflows. Sludge is treated with anaerobic digesters and the liquid is hauled and land applied at agronomic rates. The collection system consists of 100% separate sewers and there are no lift stations. Infiltration and inflow into the collection system is estimated at 0.5 MGD. These clean water sources are a serious problem during rain events.

Facilities regulated by an NPDES permit are required to conduct routine self monitoring of effluent quality and quantity. Results are reported to Ohio EPA as monthly operating report (MOR) data. Each permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. They also include monthly average limits and daily or weekly maximum limits,

depending on the monitoring requirements. This MOR data can be used to track compliance as well as to evaluate historical trends. Only two permit limit violations were documented at the Shelby WWTP in 2007. These were a daily maximum concentration limit for oil and grease in June and a daily minimum concentration limit for dissolved oxygen in August.

The Ohio EPA conducts 48-hr acute screening bioassays to evaluate toxicity during the permit compliance and renewal process. Grab and composite derived outfall 001 effluents and the Black Fork upstream and in the near field mixing zone were tested in 2005. The fathead minnow *Pimephales promelas* and daphnid *Ceriodaphnia dubia* were used as test organisms. Test number 05-3306-NW was done in September and the effluents were not acutely toxic. Test number 05-3337-NW was done in October and the effluents were not acutely toxic.

Pollutant loadings over the last 20 years were evaluated based on monthly operating report data using the Liquid Effluents Analysis Processing System (LEAPS). Annual summaries of $cBOD_5$ and suspended solids loadings are displayed in Figures 1b and 1c, respectively. The graphs show large decreases in loads for these pollutants after the plant was expanded in 1988. A slight increasing trend is exhibited over the last 5 years, especially regarding suspended solids during peak flows. An annual summary for nitrate-nitrite is displayed in Figure 1d. This graph shows a significant decrease in loads over the last 4 years.

Arcelor Mittal (permit # 2ID00002) is located at 132 W. Main Street, Shelby, OH. The company has changed ownership several times over the years and is f.k.a. ArcelorMittal, Copperweld, and Ohio Steel Tube. The facility manufactures welded and seamless steel tubing through a variety of processes, including hot forming, acid pickling, alkaline cleaning, and cold forming. Caustic and acidic wastewater and boiler blowdown are neutralized, gravity thickened, and pressure filtered and pumped to a series of four 1 MG settling lagoons. Water counter flows by gravity through at least two lagoons at all times and discharges from a stand pipe. This waste stream is identified as internal outfall 601. Recirculation mill water, contact and non-contact cooling water, and storm water are treated in scale pits, an oil and water separator, and cooling tower and pumped to the west pond for storage and re-use in the plant. The west pond is a 7 MG lagoon equipped with an oil skimmer. If necessary, it overflows into a 1 MG pond and discharges from a stand pipe. This waste stream is identified as internal outfall 602. Overflows from outfall 601 and 602 combine and discharge to Tuby Run at RM 0.66 through outfall 005.

Several storm water outfalls are also under permit. The plant #1 grounds (002, 003, 004, 006, 020), plant #1 roads (015, 016, 018, 021), and wastewater plant grounds (017) all drain to Tuby Run. Outfalls 003, 004, 006, and 020 all discharge without treatment and the rest are treated by oil and water separators. The plant #2 retention pond drains to Tuby Run after passing through oil and grit separators (022, 023). The ferrous park landfill drains to the Black Fork without treatment (013, 014). This landfill was used from 1943-1968 to dispose of neutralized sulfuric acid pickle liquor sludge and is located on the right bank below Spring Street (RM 52.18). A remediation project was completed in 1991 to grade the bank and place rip-rap to prevent erosion

and install a clay cutoff wall to prevent ground water seepage. The top of the landfill was graded, capped, and seeded.

The Ohio EPA conducts 48-hr acute screening bioassays to evaluate toxicity during the permit compliance and renewal process. Grab and composite derived outfall 005 effluents and Tuby Run upstream and in the near field mixing zone were tested in 2006. The fathead minnow, *Pimephales promelas,* and daphnid, *Ceriodaphnia dubia,* were used as test organisms. Test number 06-3408-NW was done in May and the effluents were found to be toxic to *C. dubia*, but no fathead minnows died or displayed any adverse effects. Test number 06-3421-NW was done in June and the effluents were not acutely toxic.

No permit limit violations were documented at the ArcelorMittal facility in 2007.

Water Quality Status

Results for select water quality constituents are summarized in Table 1b. The standard (minimum/maximum, average) or target used to evaluate each constituent is included in the table. Results above these levels are considered degraded and highlighted in bold. The seasonal geometric mean computed for E. coli is presented in parenthesis.

Although the 2006 Integrated Report identified nutrients as a high magnitude cause of impairment, the 2007 data does not reflect this. Nutrient levels in the Black Fork were assessed based on statewide target values for small rivers of 0.17 mg/L for phosphorus and 1.50 mg/L for nitrate-nitrite. Levels of phosphorus are not a major concern, even though there is a considerable increase below the Shelby WWTP. Only 2 of 25 (8%) samples tested were above the target (Figure 1e). The WWTP does not have permit limits for phosphorus and does not chemically treat for enhanced removal. Levels of nitrate-nitrite may be more problematic. A total of 14 of 25 (56%) samples tested were above the target (Figure 1f). Again, there is a considerable increase below the Shelby WWTP. However, sewage plants are designed to promote the nitrification of organic nitrogen and ammonia into nitrate since this is preferred over discharging toxic ammonia. It may be necessary to consider upgrading plants for denitrification in the future because nitrate has been identified as the cause of hypoxia in the Gulf of Mexico. This process is completed by anaerobic bacteria that convert nitrate into nitrogen gas, carbon dioxide, and water.

Dissolved oxygen was not identified as a problem in any of the grab samples tested in the Black Fork. All 25 samples tested were above the 5.0 mg/L OMZA criterion for WWH streams. Four automatic meters were also deployed in this segment of the mainstem and they were programmed to measure diurnal levels over a 48-hr period. A summary of the hourly readings is presented in Table 1e. The meter deployed at London West Road (RM 51.32) recorded low levels during the late evening to early morning hours. This may result from oxygen being consumed by algal respiration. This meter also detected a large spike in specific conductance, presumably coinciding with discharges from ArcelorMittal.

Results of testing for organic compounds in the Black Fork suggest that a source of chlorinated volatile hydrocarbons exists in Shelby between State Street (RM 52.18) and London West Road (RM 51.32). The main compounds detected were trichloroethene (TCE) and cis-1,2-dichloroethene, which TCE transforms into as it breaks down in the environment. These chemicals are used in dry cleaning and as solvents to degrease metal parts. The proximity of detections with C&T Dry Cleaners and Snowhite Cleaners likely eliminate them as sources. ArcelorMittal and the city maintenance garage are probably not sources either since the compounds were not detected in any samples collected from Tuby Run. The most likely source is the former Wilkins Air Force Station. Much of this area is now used as an industrial park. A remedial investigation feasibility study at this former defense site is being overseen by the US Army Corps of Engineers.

Seven different tributary streams were sampled in the WAU. Nutrient levels were assessed based on statewide target values for wadeable streams of 0.10 mg/L for phosphorus and 1.00 mg/L for nitrate-nitrite. Results were similar to those found in the mainstem, with phosphorus mostly below target and nitrate-nitrite mostly above target. Bear Run at London West Road (RM 0.48) was the only site that had a median phosphorus value above the target. This is the location of a farm with cows that have unrestricted watering access, along with a package plant that discharged further upstream. Brubaker Creek at Eby Road (RM 0.30) had the lowest levels of nitrate-nitrite and the median value was below the target. Bear Run had the only other median value below the target, but also had the highest levels of organic nitrogen and ammonia. The highest levels of nitrate-nitrite were found in Tuby Run at Gamble Street (RM 0.10) where the median value was 5.12 mg/L. During dry weather conditions, water quality here is dominated by treated process water from ArcelorMittal (outfall 005). MOR data from the same June-August time period had an average nitrate-nitrite concentration of 8.83 mg/L (n=19). Shipp Creek at State Route 603 (RM 0.95) and Marsh Run at London West Road (RM 4.55) and State Route 61 (RM 0.17) also had somewhat higher levels. These streams are channelized in the upper reaches and land use is dominated by row crop agriculture.

Most other water quality constituents were considered in good condition, except there is a concern for levels of dissolved solids in Tuby Run at Gamble Street (RM 0.10). As mentioned above, water quality at this site is dominated by ArcelorMittal outfall 005 effluent during dry weather conditions. Results for all five samples were above the OMZA criterion of 1500 mg/L. Concentrations ranged from 1540-2460 mg/L, with a median value of 2140 mg/L. MOR data reported by ArcelorMittal from the same June-August time period had an average dissolved solids concentration of 2501 mg/L (n=8).

Sediment Quality Status

Sediment samples were collected in the Black Fork at Park Avenue (RM 53.88), Black Fork at Ganges Five Points Road (RM 43.18), and Marsh Run at State Rt. 61 (RM 0.17). The Black Fork at London West Road (RM 51.32) and Tuby Run below Walnut Street (RM 0.25) were probed, but no sediments were found. Most fine sediment was flushed out of the watershed during a major flood event in late August. Samples were tested for metals, PAH, PCB, and organochlorine insecticides.

No organic compounds were detected in any of the samples. Results for most metals were below their respective SRV. The only exception was in Marsh Run, where levels of nickel and zinc were slightly above and cadmium was nearly double background. The cadmium level is also above the TEC, but considerably below the PEC. Since the drinking water intake for Shelby Reservoir #3 is located here, further investigation may be warranted.

Historical sediment data from Tuby Run documented the presence of PCBs and several organochlorine insecticides. These compounds are a concern in the environment because they do not readily break down, bioaccumulate in the aquatic food chain, and are strongly suspected human carcinogens. Since they bind tightly to soil particles, it is likely that the contaminated sediments were flushed downstream.

Public Water Supply Use Status

The Shelby WTP is a public utility that produces and distributes potable water. It is classified as a community public water system by the Ohio EPA, DDAGW. The treatment plant is located at 115 N. Gamble Street, Shelby, OH. Source water is pumped from both the Black Fork and Marsh Run into upground reservoirs for storage and subsequent treatment. This storage capability allows operators to selectively pump water when quality good.

Community public water systems are required to prepare and distribute an annual Consumer Confidence Report that summarizes finished water quality. The 2006 report for Shelby showed a violation for total trihalomethanes. The MCL for these compounds is 80 µg/L and concentrations ranged from 60.6-108.4 µg/L. They typically form during the disinfection process when a source of organic matter is present. It is likely that some of the organic matter comes from algae that grow in the reservoirs. Seasonal blooms also cause taste and odor problems and certain blue greens have been shown to emit micocystins that can cause liver damage.

No violations were documented for nitrate. The MCL is 10.0 mg/L and concentrations ranged from 0.09-5.44 mg/L. Raw water was tested at two public water supply (PWS) intakes during the 2007 survey. Levels ranged from 0.70-2.71 mg/L at the Black Fork intake and 1.14-6.36 mg/L at the Marsh Run intake.

No violations were documented for Atrazine. The MCL is 3.0 µg/L and concentrations ranged from 0.48-2.09 µg/L. Raw water was tested at PWS intakes during the 2007 survey. Several compounds were detected, including, with trade name in parenthesis; Acetochlor (Harness), Atrazine (AAtrex), Metolachlor (Dual), and Simazine (Princep). Most concentrations were quite low, but Atrazine was usually in the 1.5 µg/L range. These chemicals are used for selective weed control in corn and soybeans and are sometimes used in mixtures. For example, Atrazine and Metolachlor are commonly mixed and marketed under the trade name of Bicep. Some of these chemicals are also used for turf management, such as on residential lawns and golf courses. The fact that they are detected in surface water indicates that non point runoff is a source and that they persist in the environment.

Secondary contaminants were measured at the raw water intakes during the survey. All five samples from the Black Fork were above the 300 µg/L OMZA for iron and concentrations ranged from 533-855 µg/L. All five samples were also above the OMZA at the Marsh Run intake and ranged from 990-2320 µg/L. One of these was also above the 500 mg/L OMZA for dissolved solids.

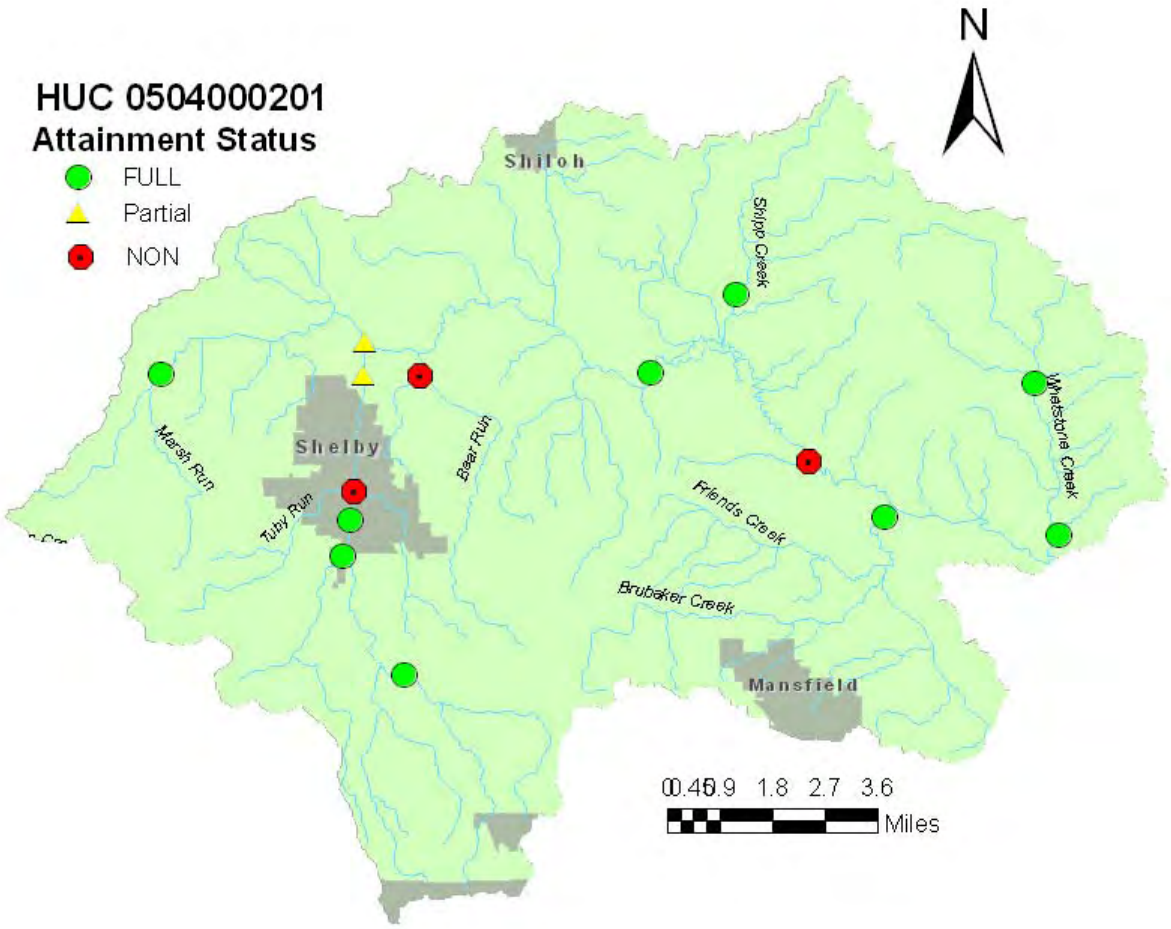

Figure 1a. Sampling Locations and Aquatic Life Use Attainment Status in the Headwaters Black Fork Mohican River WAU (0504000201), June 15 to October 15, 2007.

Figure 1b. Cows wading in Bear Run at London West Rd. (RM 0.48) on June 11, 2007.

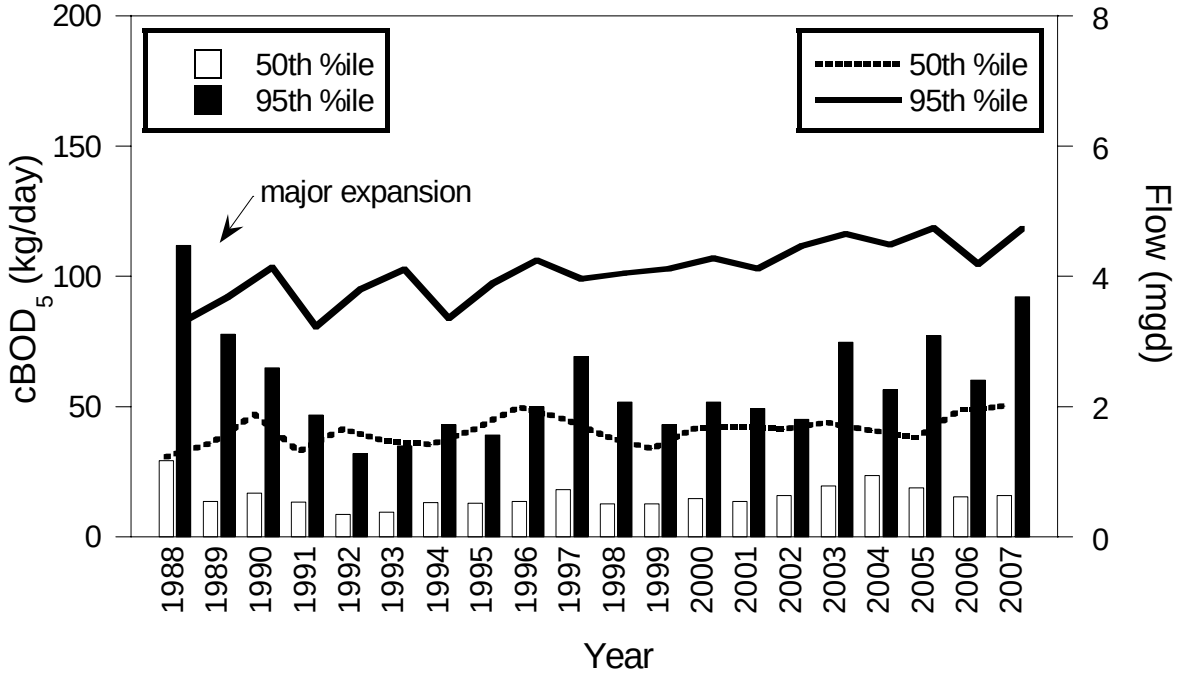

Figure 1c. Annual summary for cBOD5 calculated at the Shelby WWTP based on MOR data.

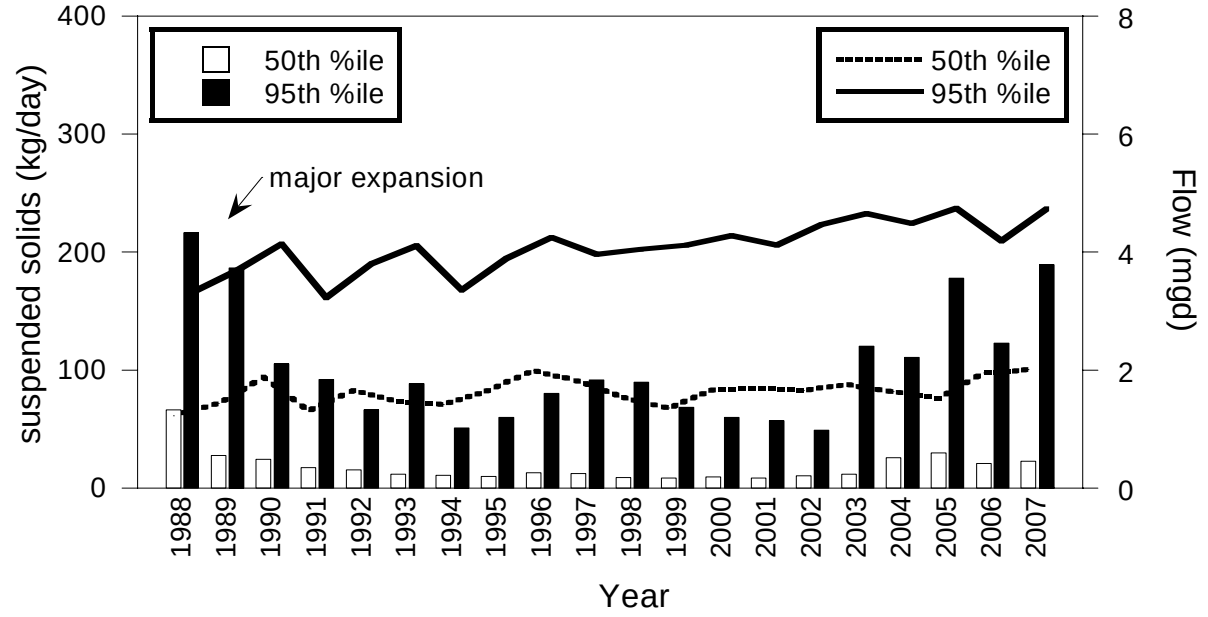

Figure 1c. Annual summary for suspended solids calculated at the Shelby WWTP based on MOR data.

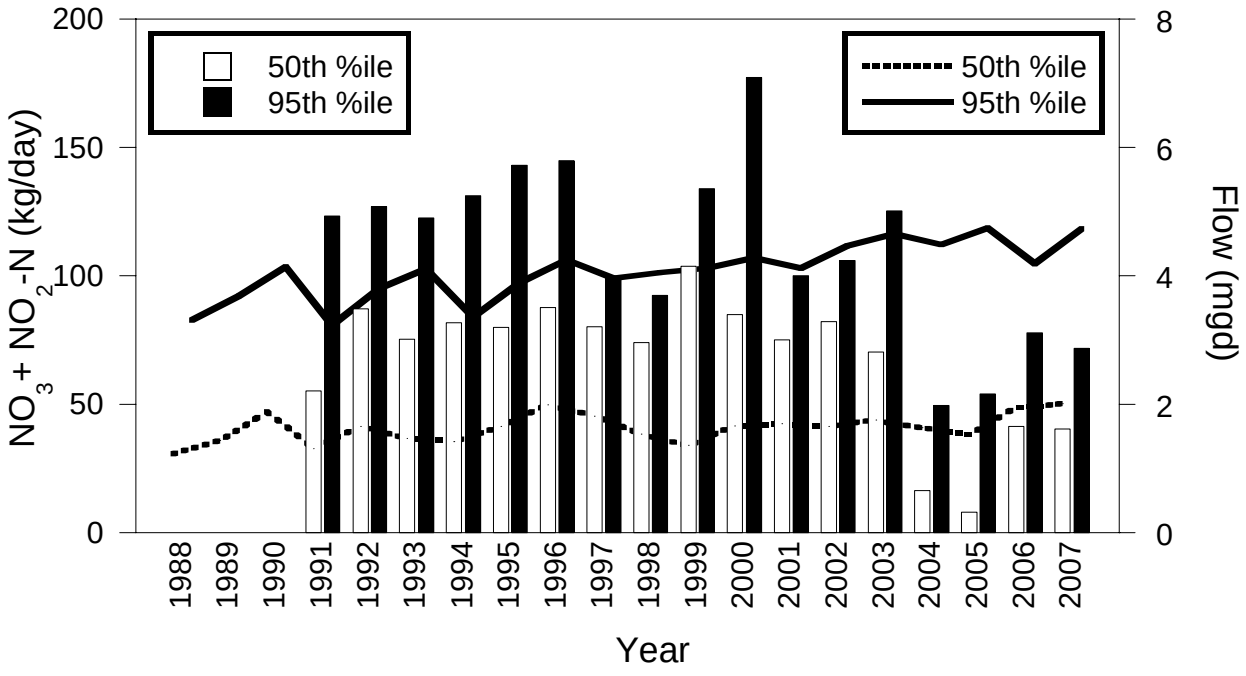

Figure 1d. Annual summary for nitrate-nitrite calculated at the Shelby WWTP based on MOR data.

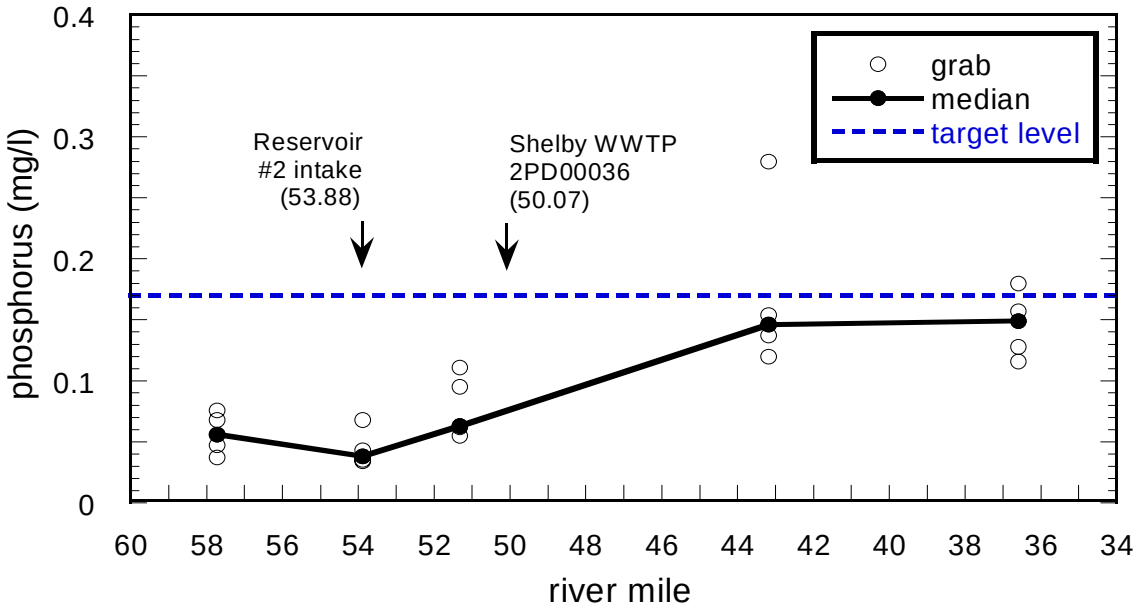

Figure 1d. Summary of phosphorus concentration measured in grabs from the Black Fork plotted against the target level.

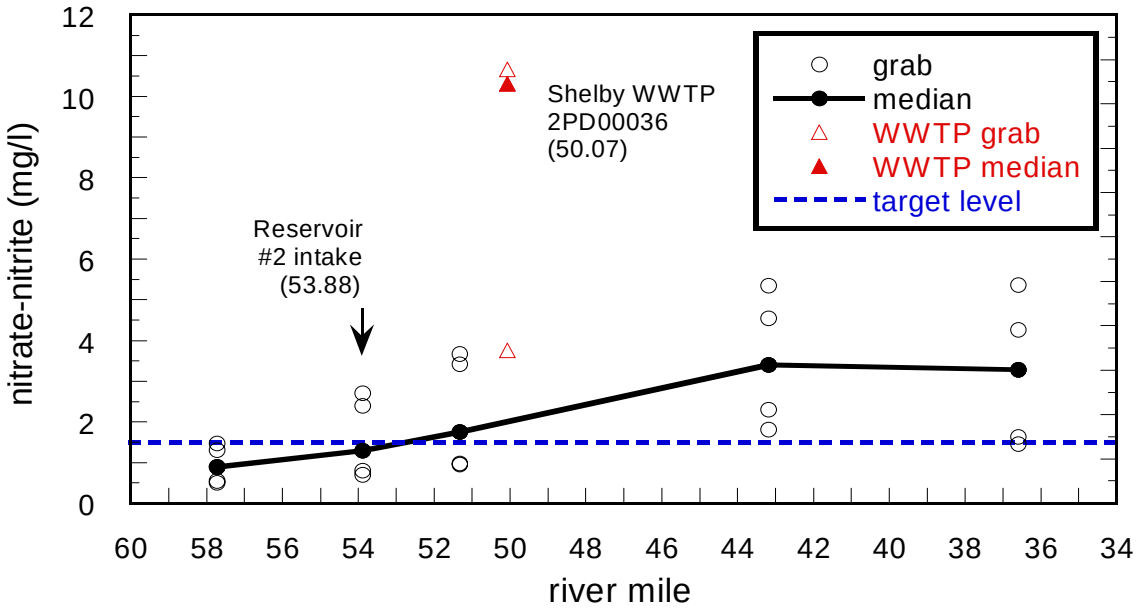

Figure 1f. Summary of nitrate-nitrite concentration measured in grabs from the Black Fork and Shelby WWTP effluent (MOR data) plotted against the target level.

Table 1a. Aquatic life use attainment status for sampling locations in the Headwaters Black Fork Mohican River WAU (0504000201). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Black Fork Mohican River	57.72	WWH	FULL	42		G	55.5		
Black Fork Mohican River	53.88	WWH	FULL	40	8.0	VG	72.0		
Black Fork Mohican River	51.32	WWH	Partial	38	6.9*	G	64.5	Direct habitat alterations; Other flow regime alterations	Channelization, Urban Runoff/ Storm Sewers
Black Fork Mohican River	43.40	WWH	FULL	36ns	8.1	44	72.5		
Black Fork Mohican River	36.55	WWH	NON	20*	4.6*	48	35.5	Direct habitat alterations; Other flow regime alterations; Turbidity	Channelization, Sediment Resuspension (Clean Sediment)
Trib. to Black Fork (RM 54.46)	0.08	WWH-R	FULL	44		G	54.0		
Tuby Run	0.01	WWH	NON	56		VP*	53.5	Impairment Unknown	Industrial point source discharge
Marsh Run	4.55	WWH-R	FULL	42		G	35.0		
Marsh Run	0.13	WWH-R	Partial	32*	7.5ns	G	27.0	Sedimentation/Siltation	Channelization, Non-irrigated Crop, Production, Dam or Impoundment
Bear Run	0.48	WWH-R	NON	40		P*	26.0	Organic Enrichment (Sewage) Biological Indicators; Oxygen, Dissolved; Direct Habitat Alterations	Manure runoff, Unrestricted Cattle Access; Channelization; Non-irrigated Crop Production
Shipp Creek	0.95	WWH-R	FULL	52		MGns	62.5		
Brubaker Creek	0.30	WWH-R	Partial	36ns	6.6*	G	66.0	Nutrient/Eutrophication Biological Indicators	Non-irrigated Crop Production
Whetstone Creek	3.88	WWH-R	(FULL)	52			63.0		
Whetstone Creek	0.69	WWH-R	FULL	46		G	67.5		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 1b. Results for select water quality constituents tested in grab samples from the Headwaters Black Fork Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Bear Run WWH, PCR, AWS, IWS headwater stream (8.8 mi^2)	0.48	WWH	t-P (mg/L) (0.08)	0.104, 0.238, 0.218, 0.205, 0.481
			NO_3-NO_2 (mg/L) (1.00)	**4.75**, **1.49**, 0.51, 0.77, 0.49
			DO (mg/L) (4.0, 5.0)	7.00, 10.71, 5.84, 7.31, **4.97**
		PCR	E. coli. (#/100 ml) (298, 126)	10500, 11000, >20000, >20000 (14661)
Shipp Creek WWH, PCR, AWS, IWS headwater stream (8.2 mi^2)	0.95	WWH	t-P (mg/L) (0.08)	**0.102**, 0.074, 0.054, 0.075, 0.078
			NO_3-NO_2 (mg/L) (1.00)	**5.34**, **2.23**, <0.10, **4.75**, 0.78
		PCR	E. coli. (#/100 ml) (298, 126)	300, 620, >20000, 260 (992)
Brubaker Creek WWH, PCR, AWS, IWS wadeable stream (22.7 mi^2)	0.30	WWH	t-P (mg/L) (0.10)	0.027, 0.031, 0.025, 0.047, 0.038
			NO_3-NO_2 (mg/L) (1.00)	**1.46**, **1.03**, 0.72, 0.74, 0.55
		PCR	E. coli. (#/100 ml) (298, 126)	3900, 720, 810, 290 (901)
Whetstone Creek WWH, PCR, AWS, IWS headwater stream (17.8 mi^2)	0.69	WWH	t-P (mg/L) (0.08)	0.055, 0.058, 0.029, 0.079, **0.152**
			NO_3-NO_2 (mg/L) (1.00)	**3.39**, **2.29**, 0.16, **1.44**, 0.52
		PCR	E. coli. (#/100 ml) (298, 126)	1400, 60, 3600, 980 (738)

Table 1b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Unnamed Tributary headwater stream (4.8 mi^2)	0.08	WWH	t-P (mg/L) (0.08)	0.030, 0.022, 0.041, 0.039, 0.046
			NO_3-NO_2 (mg/L) (1.00)	**2.75**, **2.15**, **1.34**, 0.56, 0.59
		SCR	E. coli. (#/100 ml) (576, -)	**1200**, 480, **1000**, 270 (**628**)
Tuby Run WWH, SCR, AWS, IWS headwater stream (4.5 mi^2)	0.01	WWH	t-P (mg/L) (0.08)	0.046, 0.087, 0.098, 0.101, 0.125
			NO_3-NO_2 (mg/L) (1.00)	5.55, 4.65, 7.12, 5.12, 4.50
			TDS (mg/L) (- , 1500)	1540, 2140, 2460, 2220, 1600
		SCR	E. coli. (#/100 ml) (576, -)	3600, 470, 7600, 590 (1660)
Marsh Run WWH, PCR, AWS, IWS PWS (RM 0.10) wadeable stream (20.0 mi^2)	4.55	WWH	t-P (mg/L) (0.10)	0.016, 0.029, 0.041, 0.041, 0.040
			NO_3-NO_2 (mg/L) (1.00)	7.59, 2.41, 2.10, 0.94, 1.04
		PCR	E. coli. (#/100 ml) (298, 126)	490, >20000, 1400, 190 (1271)
	0.17	WWH	t-P (mg/L) (0.10)	0.068, 0.070, **0.103**, **0.123**, 0.062
			NO_3-NO_2 (mg/L) (1.00)	6.36, 2.70, 3.50, 1.31, 1.14
		PCR	E. coli. (#/100 ml) (298, 126)	570, 600, 1300, 340
		PWS	Fe (µg/L) (-, 300)	1670, 1920, 2320, 1620, 990
			TDS (mg/L) (750, 500)	476, 472, 398, 452, **538** (**624**)

Table 1b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Black Fork WWH, PCR, AWS, IWS PWS (RM 53.88) small river (356 mi^2)	57.72	WWH	t-P (mg/L) (0.17)	0.047, 0.037, 0.068, 0.056, 0.076
			NO_3-NO_2 (mg/L) (1.50)	1.47, 1.31, 0.55, 0.89, 0.51
		PCR	E. coli. (#/100 ml) (298, 126)	1700, 1300, 5600, 2300 (2310)
	53.88	WWH	t-P (0.17)	0.035, 0.034, 0.043, 0.038, 0.068
			NO_3-NO_2 (mg/L) (1.50)	**2.39**, **2.71**, 1.30, 0.81, 0.70
		PCR	E. coli. (#/100 ml) (298, 126)	540, 570, 2500, 180 (610)
		PWS	Fe (µg/L) (-, 300)	729, 632, 533, 855, 556
	51.32	WWH	t-P (mg/L) (0.17)	0.055, 0.095, 0.111, 0.063, 0.062
			NO_3-NO_2 (mg/L) (1.50)	**3.42**, **3.67**, **1.76**, 0.99, 0.96
		PCR	E. coli. (#/100 ml) (298, 126)	7200, 1200, 4500, 490 (2089)
	43.18	WWH	t-P (0.17)	0.154, **0.280**, 0.120, 0.137, 0.146
			NO_3-NO_2 (mg/L) (1.50)	5.35, 4.55, 3.40, 2.31, 1.82
		PCR	E. coli. (#/100 ml) (298, 126)	1300, 760, 3800, 580 (1215)
	36.60	WWH	t-P (mg/L) (0.17)	0.128, 0.116, **0.180**, 0.149, 0.157
			NO_3-NO_2 (mg/L) (1.50)	4.26, 5.36, 3.28, 1.63, 1.46
		PCR	E. coli. (#/100 ml) (298, 126)	3300, 1100, 4500, 780 (1889)

Table 1c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Briarwood Estates	2PY00018	UT to UT to Black Fork	0.2	0.030 MGD package plant
ArcelorMittal, Inc.	2ID00002	Tuby Run	0.66	
Shelby WWTP	2PD00036	Black Fork	50.07	2.5 MGD activated sludge plant
Voisard Mfg.	2PR00139	UT to Bear Run		0.0015 MGD package plant
Lust Subdivision	2PG00077	UT to Black Fork	6.86	0.008 MGD package plant
Country Meadows	2PG00074	Leatherwood Creek	3.17	0.009 MGD package plant
Pin Oaks Estates	2PR00072	UT to Black Fork	2.8	0.030 MGD package plant
Dayspring	2PG00114	UT to Brubaker Creek	1.5	0.009 MGD package plant

Table 1d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Abraxas Foundation	2GS00002	UT to UT to Black Fork	Small Sanitary
UPS Ground Freight	2GG00067	Black Fork	Industrial Storm Water
City of Shelby	2GR00555	Black Fork	Industrial Storm Water
Voisard Mfg., Plant 2	2GR01472	UT to Bear Run	Industrial Storm Water

Table 1d. continued.

Northside MHP	2GV00002	Black Fork	Small Sanitary
Shelby Welded Tube	2GS00009	Black Fork	Small Sanitary
Central Ohio Associates	2GG00192	UT to Marsh Run	Industrial Storm Water
Central Ohio Associates	2GG00225	UT to Marsh Run	Industrial Storm Water
Voisard Mfg., Plant 1	2GR01471	UT to Black Fork	Industrial Storm Water
Crestview Schools	2GS00004	UT to Black Fork	Small Sanitary
Proservices USA	2GR00272	UT to Brubaker Creek	Industrial Storm Water
Madison Township	2GQ00025		MS4s
Richland County	2GQ00009		MS4s
Mansfield	2GQ00008		MS4s
Ontario	2GQ00000		

Table 1e. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the Black Fork.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
53.88	42	6.41	6.35	5.74	7.40	1.66
51.32	41	6.05	6.13	1.96	9.87	7.91
43.18	41	6.98	6.98	6.68	7.44	0.76
36.60	40	5.28	5.28	5.15	5.62	0.47

Rocky Fork Mohican River Watershed Assessment Unit

The Rocky Fork-Black Fork Mohican River WAU (0504000202) drains a total of 139.7 mi2 and lies within Ashland and Richland and Counties. The boundary of this watershed encompasses the Black Fork Mohican River from downstream Whetstone Creek (RM 30.0) to downstream Rocky Fork (RM 14.12). Other streams include the unnamed tributary to Black Fork (RM 54.46), Rocky Fork a tributary to the Black Fork, Touby Run and unnamed tributary to Rocky Fork at (RM 10.70).

The Black Fork Mohican River portion of the WAU has previously not been assessed. Aquatic life impairment was documented in the Rocky Fork through Mansfield in both 1998 and 2004. Sediment contamination, urban runoff, channelization and nutrient enrichment were mainly to blame. The 2006 *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2006) identified priority organics, metals, nutrients, organic enrichment and habitat alterations as a high magnitude cause of impairment. This component was measured during the 2007 survey in the Qualitative Habitat Evaluation Index.

Aquatic Life Use Designations
Biological and habitat assessments were conducted at 15 sites within the Rocky Fork-Black Fork Mohican River WAU in 2007.

Black Fork is a tributary of the Mohican River confluent at RM 27.57 that is about 62.8 miles in length and drains an area of 356 mi^2. The mainstem within the Rocky Fork-Black Fork Mohican River WAU has been extensively modified. It was impounded in 1935 by the construction of a dam at RM 18.47 to form the Charles Mill Reservoir. Upstream from the reservior, the stream is designated as WWH, PCR, PWS, AWS, and IWS based on the 1978 Ohio WQS. The Black Fork Mohican River is recognized as a state scenic river downstream from Charles Mill Reservoir and a WWH use is recommended for the lower reach beginning downstream from the dam. QHEI scores recorded at four locations were generally consistent with the WWH use and ranged between 56.0 at RM 23.30 and 68.0 at RM 17.18. Stream morphology exhibited recovery from past channelization both upstream and downstream from the reservior but a heavy silt layer and significant substrate embeddedness were pervasive.

Rocky Fork is a tributary of Black Fork confluent at RM 14.12 that is about 20.7 miles in length and drains an area of 77.3 mi^2. It is within the EOLP ecoregion and is designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998. Upstream from Mansfield, habitat in the Rocky Fork was reflective of the predominant agricultural land use within the water shed. Larger substrates were embedded by a heavy silt layer and limited in-stream cover was available to fish and other aquatic organisms. Downstream from Mansfield, the lower ten miles of the Rocky Fork contained some of the most diverse habitat to be found in the entire 2008 study area. Numerous beneficial WWH features were noted at

each of three sites and QHEI scores ranged from 88.0 at RM 0.57 to 91.5 at RM 10.13.

A WWH aquatic life use for Touby Run was based on a previous assessment. The unnamed tributary to the Black Fork Mohican River (RM 25.16) and the unnamed tributary to the Rocky Fork (RM 10.70) should also be considered for the WWH use. Habitat features were consistent with the use on both streams and each supported typical warmwater fish assemblages

Aquatic Life Use Attainment Status
Aquatic life use attainment status is presented in Table 2a and Figure 2a

Biological and habitat assessments were conducted at 13 sites in 2007, representing approximately 37 stream miles in the Rocky Fork-Black Fork Mohican River assessment unit. Aquatic life use attainment status is presented in Table 2a. Three sites representing three assessed stream miles, fully met the current or recommended aquatic life use. Five sites, representative of twelve assessed miles, partially met and five sites, totaling 22 assessed stream miles, were in non-attainment of the current or recommended WWH aquatic life use.

Sub par biological communities identified at 34 of 37 assessed stream miles in the Rocky Fork-Black Fork Mohican River WAU were impacted, largely, by a combination of factors related to crop production, impoundment formed behind Charles Mill dam, stormwater/CSOs within the Mansfield urban area and effluent from the Mansfield WWTP.

Neither reach of the Black Fork Mohican River upstream and downstream from Charles Mill reservior met ecoregional expectations. The fish community was in poor condition upstream from the reservior at RMs 29.67 and 23.30 owing largely to a monotonous habitat and heavy sedimentation. The fish community attained WWH expectations but the macroinvertebrate community was significantly affected by impoundment and subsequent release of water from the Charles Mill dam. An ICI in the low fair range was recorded at RM 17.81. A high density of the midge genera *Glyptotendipes* and aquatic worms was reflective of the excessive amount of organic material suspended in water released from the dam. Algae that flourished within the reservoir provided a large food source for organisms that can tolerate the highly eutrophic condition and altered flow regime. The response of fish community to the impacted water quality was more delayed; as evidenced by a decline into the fair range at RM 14.70, approximately 3.8 miles downstream from the dam.

Just one of the six sampling locations on the Rocky Fork Mohican River fully met ecoregional expectations. Natural conditions in the upper portion of the watershed, principally low gradient and upstream wetlands, limited the establishment of a typical warmwater fish assemblage at RM 16.43 even though the macroinvertebrate sampling results suggested acceptable water quality.

Persistent degradation from contaminated sediments and general urban runoff within the Mansfield city limits along with organic enrichment and nutrients contributed by the Mansfield WWTP resulted in fair to poor fish and/or macroinvertebrate communities in approximately 14 miles of the Rocky Fork beginning at RM 14.23 (Longview Ave.). The pollution tolerant fish accounted for over half of the total number of fish collected both upstream and downstream from the WWTP. A significant volume of black solids were noted downstream from the WWTP which indicated raw or inadequately treated sewage was entering the Rocky Fork via the treatment plant discharge or from elsewhere in the collection system. Near the confluence with the Black Fork the stream met WWH biological criteria, however, the lingering odor of treated effluent and remnant deposits of black solids were noted by OEPA staff when the macroinvertebrate sampling was conducted at RM 0.57.

Three additional streams were sampled in the Rocky Fork-Black Fork Mohican River assessment unit: the unnamed tributary to the Black Fork Mohican River (RM 25.16), the unnamed tributary to the Rocky Fork (RM 10.70) and Touby Run. Fish sampling results from the two unnamed tributaries were consistent with the WWH aquatic life use. Touby Run at RM 1.0 yielded a marginally attaining fish assemblage and a macroinvertebrate collection that reflected only fair condition. Typical numbers of EPT and sensitive macroinvertebrate taxa were not present, rather, isopods predominated. It appeared that the macroinvertebrate community was depressed possibly by some episodic toxicity and/or flashy high flow events that scoured of the gravel and rubble substrates due to urban/industrial stormwater runoff. Additional investigation of the Touby Run watershed would be helpful to ascertain how land use may be impacting the stream.

Recreation Use Status

The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 58 separate samples collected at 13 sites.

Class A stream assessments were done on the Black Fork downstream from the Charles Mill Reservoir. Public and private access to the river is provided at several locations including numerous private canoe liveries. A set of five samples collected between 7/5 and 7/30 was used in the calculations. Downstream from Charles Mill Reservoir (RM 18.30) the geometric mean count was 173 CFU/100 ml and at State Route 39 (RM 14.65) it was 106 CFU/100 ml. Results at RM 18.30 violate the PCR criterion.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 3c and 3d, respectively. Mansfield WWTP and AK Steel Corporation-Mansfield Works are the only facilities classified as major dischargers in this WAU.

Mansfield WWTP (permit # 2PE00001) is located at 385 South Illinois Avenue, Mansfield and discharges to the Rocky Fork at RM 11.18. The existing system was built in 1957 and major modifications occurred in 1997. Treatment consists of a conventional activated sludge system designed to treat 15.0 MDG. Flows in excess of the 25.0 MDG hydraulic capacity are discharged to an EQ basin and disinfected before blending with secondary effluent. About 20% of the hydraulic load originates from industrial users. The collection system consists of a 100% separated sewers system with 9 lift stations.

Acute bioassays preformed in 2005 by Ohio EPA staff indicted no toxicity to aquatic test organisms. A review of monthly self-monitoring data which is submitted to the Ohio EPA revealed 21 permit limit violations in 2007. Parameter which exceeded limits includes total copper, total suspended solids and pH. Annual loadings (kg/day) of total phosphorous, nitrate+nitrite and total suspended solids were evaluated using the Liquid Effluent Analysis Processing (LEAP) system and are presented in Figure 2f, 3g & 3h.

AK Steel Corporation (permit # 2ID00003) is located at 913 Bowman Street, Mansfield and discharges to the Rocky Fork. Operations consist of electric arc furnaces, argon oxygen decarburization, thin slab continuous caster and a hot strip mill. Outfall 001 discharges at RM 14.95 with a permit limit of 1.109 MGD and include blowdown from the continuous caster and hot strip mill recirculation, non contact cooling water from the electric arc furnaces, stormwater and groundwater. Wastewater is treated in a recirculation settling pond equipped with an oil skimmer and passes through an oil water separator to a polishing settling pond. Outfall 002 discharges at RM 14.28 and includes non contact cooling water from the cold mill which is currently idled, stormwater and groundwater. Outfall 003 discharges at RM 14.73 and includes non contact cooling water from the cold mill and pickling operation which is currently idled, stormwater and groundwater. Outfall 004 discharges at RM 14.70 and includes boiler blowdown which is currently idled, stormwater and an overflow from the office pond.

Acute bioassays preformed in May and April of 2004 indicted no toxicity to either aquatic test organisms. A review of monthly self-monitoring data which is submitted to the Ohio EPA revealed no permit violations in 2007

Water Quality Status

Results for select water quality constituents are summarized in Table 2b. Water quality was tested at four sites in the Rocky Fork-Black Fork Mohican River and found to be in fair condition for the most part. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of limited nutrient enrichment in the samples. Nutrient levels in the Black Fork were assessed based on statewide target values for small rivers of 0.17 mg/L for phosphorus and 1.50 mg/L for nitrate-nitrite. Levels of

phosphorus are not a major concern; however nitrate-nitrite levels were slightly elevated. The stream wide average (n=34) for phosphorus was 0.1119 mg/L and for nitrate-nitrite was 2.16 mg/L. An impact from Charles Mill Reservoir is noted at RM 18.30 downstream from the dam. The average daytime dissolved oxygen concentration measured in grab samples at this site was 11.03 mg/L. Levels sag to below the average criterion of 5.0 mg/L and the minimum criterion of 4 mg/l during periods of algal respiration as presented in Figure 2i. This phenomenon was documented using an automatic meter deployed July 24-26. Of 44 hourly readings 31 actually fell below 5.0 mg/L.

Water quality was tested at six sites in the Rocky Fork and found to be degraded at and downstream from State Route 39 (RM 10.13). However, none of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of severe nutrient enrichment at RM 10.13 and downstream on the Rocky Fork. Nutrient levels in the Rocky Fork were assessed based on statewide target values for wadable stream of 0.10 mg/L for phosphorus and 1.00 mg/L for nitrate-nitrite. Samples collected at Eastlawn Avenue (RM 12.49) and at sites upstream exhibited good water quality. The stream wide average (n=37) for phosphorus was 0.444 mg/L and for nitrate-nitrite was 3.20 mg/L. Sites sampled downstream from the Mansfield WWTP outfall at RM 11.18 were severely enriched by nutrients as presented in Table 2j & 3k.

Sediment Quality Status

Sediment sample results were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et al*. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. In addition, the Ohio Sediment Reference Values were used which represents ecoregion background conditions based on data collected at Ohio reference sites.

The chemical sediment quality was assessed at two locations within the Rocky Fork-Black Fork Mohican River WAU. Several additional sites were not sampled due to the lack of fine grain sediments. Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment and accumulate in the food chain.

Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. Sediments with chemical concentrations reported above the Consensus-Based Probable Effect

Concentration (PEC) and/or the Ohio Sediment Reference Value may result in negative environmental impacts and warrant further evaluation. Only the results which exceeded a guidance values are reported in Table 2l. Results from a sediment sample collected from the Rocky Fork at Bowman Road (RM 16.44) did not exceed any sediment guidance value and exhibited good quality. Results from sediment sample collected from the Rocky Fork at Longview Ave. (RM 14.23) did exceed several guidance values. However, sediment contaminate concentrations did improve when compared to results from a sample collected in the same general area in 1993 with the exception of several metals.

Public Water Supply Use Status

There are no facilities in the WAU that use surface water as a drinking supply.

Table 2a. Aquatic life and recreational use attainment status for sampling locations in the Rocky Fork-Black Fork Mohican River Mohican River WAU (0504000202). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Black Fork Mohican River	29.67	WWH	NON	19*	5.3*	G	57.5	Sedimentation/Siltation, Nutrient/Eutrophication Biological Indicators	Crop Production with Subsurface Drainage Channelization
Black Fork Mohican River	23.30	WWH	(NON)	21*	5.2*		56.0	Direct habitat alterations; Other flow regime alterations; Oxygen, Dissolved; Turbidity	Channelization, Non-irrigated Crop Production, Dam or Impoundment
Black Fork Mohican River	17.81	WWH -R	Partial	40	10.0	14*	68.0	Suspended Algae; Nutrient/Eutrophication Biological Indicators; Other flow regime alterations	Dam or Impoundment
Black Fork Mohican River	14.70	WWH -R	(NON)	35*	7.6*		60.5	Nutrient/Eutrophication Biological Indicators; Oxygen, Dissolved	Dam or Impoundment
Black Fork Mohican River	6.90	WWH -R	Partial	42	8.9	28*	83.0	High flow regime, Direct alterations	Major flooding
Black Fork Mohican River	2.53	WWH -R	Partial	39ns	8.4ns	28*	80.5	High flow regime, Direct alterations	Major flooding
Trib. to Black Fork (RM25.16)	1.60	WWH-R	(FULL)	48			74.5		
Honey Creek	5.19	CWH-R	FULL	46		E	64.0		
Honey Creek	0.11	WWH-R	FULL	46		G	61.0		
Big Run	0.19	WWH-R	FULL	42		G	57.5		
Rocky Fork Mohican River	16.43	WWH	Partial	32*		G	66.5	Natural Conditions (Flow or Habitat)	Natural sources (upstream wetland, low gradient)
Rocky Fork Mohican River	14.23	WWH	Partial	36ns		F*	45.0	Nutrient/Eutrophication Biological indicators, Metals	Unspecified Urban Stormwater, Contaminated Sediments

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Rocky Fork Mohican River	12.49	WWH	NON	28*	5.0*	P*	50.5	Nutrient/Eutrophication Biological indicators	Unspecified Urban Stormwater
Rocky Fork Mohican River	10.13	WWH	NON	33*	7.0*	P*	88.5	Nutrient/Eutrophication Biological indicators, Organic Enrichment (Sewage) Biological Indicators	Unspecified Urban Stormwater Municipal Point Source Discharges
Rocky Fork Mohican River	4.38	WWH	FULL	37ns	7.4ns	32ns	91.5		
Rocky Fork Mohican River	0.57	WWH	FULL	46	9.8	G	88.0		
Touby Run	1.00	WWH	Partial	36ns		F*	48.5	High flow regime, Impairment unknown (toxicity?)	Unspecified Urban Stormwater
Trib. to Rocky Fork (RM 10.70)	1.30	WWH-R	(FULL)	44			68.5		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 2b. Results for select water quality constituents tested in grab samples from the Rocky Fork-Black Fork Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Black Fork WWH, PCR, AWS, IWS small river (356 mi^2)	29.67	WWH	t-P (mg/L) (0.17)	0.107, 0.101, 0.149, 0.130**, 0.213**
			NO_3-NO_2 (mg/L) (1.50)	4.51, 4.28, 1.76, 2.10, 1.25
		PCR	E. coli. (#/100 ml) (298, 126)	1200, 540, 1200, 2400
	23.21	WWH	t-P (0.17)	0.106, 0.068, 0.072, 0.129, 0.164
			NO_3-NO_2 (mg/L) (1.50)	**4.79, 4.77**, 1.44, **1.69**, 1.10
		PCR	E. coli. (#/100 ml) (298, 126)	800, 300, 2900, 280
	18.30	WWH	t-P (0.17)	0.041, 0.062, 0.097, 0.090, 0.135
			NO_3-NO_2 (mg/L) (1.50)	**3.43**, 1.09, 0.18, 0.15, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	70, 140, 150, 80, **580**, 160, 30 **(173)**
	14.65	WWH	t-P (0.17)	0.042, 0.042, 0,030, 0.133, 0.141
			NO_3-NO_2 (mg/L) (1.50)	**5.16**, 1.24, 0.33, <0.10, 0.16
		PCR	E. coli. (#/100 ml) (298, 126)	<10, <10, 60, 40, **2300**, 250, 90 (107)
Trib. to Black Fork (RM 25.16) wadable stream	1.68	WWH	t-P (0.10)	<0.010, <0.010, <0.010, 0.064 <0.010
			NO_3-NO_2 (mg/L) (1.00)	0.50, 0.46, 0.29, 0.74, 0.14
		PCR	E. coli. (#/100 ml) (298, 126)	240, 370, 1200, 150

Table 2b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Rocky Fork WWH, PCR, AWS, IWS wadable stream ($77.3\ mi^2$)	16.44	WWH	t-P (mg/L) (0.10)	0.036, 0.071, <0.010, 0.043, 0.043
			NO_3-NO_2 (mg/L) (1.00)	0.58, 0.39, 0.55, 0.46, 0.39
		PCR	E. coli. (#/100 ml) (298, 126)	350, 940,1500, 370
	14.23	WWH	t-P (mg/L) (0.10)	**0.105**, 0.037, **0.332**, 0.057, 0.059
			NO_3-NO_2 (mg/L) (1.00)	0.51, 0.39, 0.34, 0.50, 0.53
			D.O. (mg/L) (4.00)	7.23, 6.65, **3.18**, 7.12, 7.43
		PCR	E. coli. (#/100 ml) (298, 126)	2300, 20000, 5800, 580
	12.49	WWH	t-P (mg/L) (0.10)	0.041, 0.049, 0.058, 0.053, 0.051
			NO_3-NO_2 (mg/L) (1.00)	0.42, 0.25, <0.10, 0.53, 0.37
		PCR	E. coli. (#/100 ml) (298, 126)	2100, 20000, 1600, 370
Mansfield WWTP 2PE00001 (RM 11.18)	10.13	WWH	t-P (mg/L) (0.10)	1.120, 1.510, 0.800, 0.642, 1.110
			NO_3-NO_2 (mg/L) (1.00)	7.00, 9.72, 4.71, 4.69, 7.38
		PCR	E. coli. (#/100 ml) (298, 126)	590, 510, 1600, 210
	4.38	PCR	t-P (mg/L) (0.10)	0.924, 1.080, 0.847, 0.500, 1.000
			NO_3-NO_2 (mg/L) (1.00)	6.37, 7.96, 5.89, 4.11, 7.63
Lucas WWTP 2PB00038 (RM 3.65)		WWH	E. coli. (#/100 ml) (298, 126)	180, **340, 2100**, 240

Table 2b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Rocky Fork (continued)	0.57	WWH	t-P (mg/L) (0.10)	0.632, 0.769, 0.589, 0.377, 0.634
			NO_3-NO_2 (mg/L) (1.00)	3.67, 5.62, 3.48, 2.88, 5.10
		PCR	E. coli. (#/100 ml) (298, 126)	200, 280, **1000**, 230
Touby Run WWH, PCR, AWS, IWS wadable stream (10.7 mi^2)	1.00	WWH	t-P (mg/L) (0.10)	0.023, 0.012, <0.010, 0.018, 0.020
			NO_3-NO_2 (mg/L) (1.00)	<0.10, <0.10, <0.10, 0.26, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	1000, 480, 2700, 550
Trib. to Rocky Fork at (RM 10.70) wadable stream	1.33	WWH	t-P (mg/L) (0.10)	0.020, 0.025, 0.013, 0.039, 0.018
			NO_3-NO_2 (mg/L) (1.00)	0.59, 0.44, **1.25**, 0.56, 0.52
		PCR	E. coli. (#/100 ml) (298, 126)	240, **340, 850**, 230

Table 2c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Hillside MHP	2PV00700	Fleming Falls(RM25.12)	2.3	17,000 gpd package plant
Eastview Subdivision	2PH00005	unnamed trib. Fleming Creek (RM 25.12)	0.1	0.90 MGD oxidation ditch w/UV
Blust Apartments	2PW00021	unnamed trib. Fleming Creek (RM 25.12)	1.0	1,500 gpd package plant
Sites Lake Cottage	2PP00216	Black Fork	22.4	45,000 3-lagoons
Oak Park Tavern	2PR00216	unnamed trib. Black Fork (RM 20.90)	1.0	4,000 gpd package plant
Mansfield Country, Inc.	2PR00071	unnamed trib. Black Fork (RM 20.90)	0.7	40,000 gpd package plant
Phantom Fireworks	------	unnamed trib. Black Fork (RM 20.90)	----	1,000 gpd package plant
Econolodge	2PR00136	unnamed trib. Black Fork (RM 20.90)	0.2	15,000 gpd package plant
Johnny Appleseed Heritage	2PR00169	unnamed trib. Seymour Run (RM 0.2)	----	8,250 gpd package plant
Tube City	2IN00076	Rocky Fork	15.85	stormwater lagoons/oil skimmer
Harp Subdivision	2PG00075	unnamed trib. Rocky Fork (RM 9.38)	1.2	40,000 gpd package plant
Joez Lounge	2PR00238	unnamed trib. Rocky Fork (RM 7.07)	3.8	21,000 gpd package plant
Lucas WWTP	2PB00038	Rocky Fork	3.65	activates sludge system
Ohio Air National Guard	2IN00189	unnamed trib. Rocky Fork (RM 15.5)	----	stormwater/deicing

Table 2c. Facilities regulated by an individual NPDES permit. (continued)

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
AK Steel, Mansfield	2ID00003 006	Rocky Fork	15.75	stormwater and dust suppression runoff from slag processing areas
	2ID00003 001	Rocky Fork	14.95	blowdown/non-contact cooling/stormwater/oil skimmer
	2ID00003 003	Rocky Fork	14.73	non-contact cooling/ stormwater/groundwater
	2ID00003 004	Rocky Fork	14.70	boiler blowdown/ stormwater/pond overflow
	2ID00003 002	Rocky Fork	14.48	non-contact cooling/ stormwater/groundwater
Sensmeier Oil	2IG00033 001	Touby Run (RM 13.74)	0.2	stormwater/oil & water separator
	2IG00033 002	Touby Run (RM 13.74)	0.4	stormwater/oil & water separator
Ideal Electric	2IN00011	Rocky Fork	12.4	non contact cooling water
Mansfield WWTP	2PE00001	Rocky Fork	11.18	conventional activates sludge system
Therm-O-Disk	2IS00028	unnamed trib. Rocky Fork (RM 10.70)	4.75	non contact cooling water

Table 2d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Mansfield Paint Co.	2GN00003	Rocky Fork	non-contact cooling
Mansfield Paint Co.	2GR00023	Rocky Fork	industrial storm water
Stone Container	2GN00011	Rocky Fork	non contact cooling
AK Steel, Mansfield	2GN00074	Rocky Fork	industrial storm water
Ashland Petroleum	2GG00283	Rocky Fork	industrial storm water
BFI Waste Systems	2GG00258	Rocky Fork	industrial storm water
BFI Waste Systems	2GG00178	Rocky Fork	industrial storm water
Buckeye Vault Services	2GG00229	Rocky Fork	industrial storm water
Con-Way Freight	2GR00281	Rocky Fork	industrial storm water
Con-Way Freight	2GR01473	Rocky Fork	industrial storm water
Crane Plumbing	2GR00077	Rocky Fork	industrial storm water
Duff Warehouse, Inc.	2GG00150	Rocky Fork	industrial storm water
Federal Express Corp.	2GG00095	Rocky Fork	industrial storm water
Federal Express Freight	2GR00450	Rocky Fork	industrial storm water
Fisher Services Co.	2GR00155	Rocky Fork	industrial storm water
G&T Industries	2GR00062	Rocky Fork	industrial storm water
HS Automotive, Inc.	2GR00222	Rocky Fork	industrial storm water
HS Automotive, Inc.	2GR00223	Rocky Fork	industrial storm water
HS Automotive, Inc.	2GR00224	Rocky Fork	industrial storm water
Jay Industries, Inc.	2GR00167	Rocky Fork	industrial storm water
Kerry Food& Beverage	2GR00618	Rocky Fork	industrial storm water
Kokosing Mansfield, Inc.	2GR00461	Rocky Fork	industrial storm water
Mansfield Industries, Inc.	2GR00435	Rocky Fork	industrial storm water

Table 2d. Facilities regulated by a general NPDES permit. (continued)

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Newman Technology	2GR00375	Rocky Fork	industrial storm water
Omni-Source Corp.	2GG00125	Rocky Fork	industrial storm water
Richland County Landfill	2GR00231	Rocky Fork	industrial storm water
Richland County Transfer	2GR00232	Rocky Fork	industrial storm water
Rolling Frito-Lay Sales	2GR00588	Rocky Fork	industrial storm water
United Parcel Service	2GG00228	Rocky Fork	industrial storm water
Warren Rupp, Inc.	2GR00129	Rocky Fork	industrial storm water
Weiss Industries, Inc.	2GG00119	Rocky Fork	industrial storm water
Consolidated Freightways	2GR00286	Touby Run	industrial storm water
Gorman Rupp Co.	2GR00132	Touby Run	industrial storm water
Hartman Electrical Mfg.	2GR00085	Touby Run	industrial storm water
Jay Industries, Inc.	2GR00163	Touby Run	industrial storm water
Jay Industries, Inc.	2GR00427	Touby Run	industrial storm water
Jones Potato Chip Co.	2GR00399	Touby Run	industrial storm water
Longview Steel	2GR00426	Touby Run	industrial storm water
Mar-Zane, Inc.	2GG00176	Touby Run	industrial storm water
Milark Industries, Inc.	2GR00244	Touby Run	industrial storm water
New Artesian Ltd.	2GR00227	Touby Run	industrial storm water
Taylor Metal Products Co.	2GR00271	Touby Run	industrial storm water
Taylor Planting Corp.	2GR00297	Touby Run	industrial storm water
Tyco Plastics	2GR00448	Touby Run	industrial storm water
US Postal Services	2GG00221	Touby Run	industrial storm water
Brettinger Co.	2GR00051	Rocky Fork	industrial storm water

Table 2d. Facilities regulated by a general NPDES permit. (continued)

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Bunting Bearings Corp.	2GG00218	Rocky Fork	industrial storm water
Cement Products, Inc.	2GG00294	Rocky Fork	industrial storm water
Designed Metal Products	2GR00266	Rocky Fork	industrial storm water
Englefield Oil Co.	2GR00083	Rocky Fork	industrial storm water
Gorman Rupp Co.	2GR00133	Rocky Fork	industrial storm water
Grasan Equipment Co.	2GR00245	Rocky Fork	industrial storm water
Jay Industries, Inc.	2GR00175	Rocky Fork	industrial storm water
Jay Industries, Inc.	2GR00432	Rocky Fork	industrial storm water
Kokosing Materials	2GR00460	Rocky Fork	industrial storm water
Ledgebrook Corp.	2GR00527	Rocky Fork	industrial storm water
Leppert Machine Co.	2GR00418	Rocky Fork	industrial storm water
Shiloh Industries	2GR00028	Rocky Fork	industrial storm water
Stone Container Corp.	2GR00025	Rocky Fork	industrial storm water
Stone Container Corp.	2GG00282	Rocky Fork	industrial storm water
Stone Container Corp.	2GG00091	Rocky Fork	industrial storm water
Them-O-Disk Inc.	2GR00091	Rocky Fork	industrial storm water
Tucker Brothers Auto	2GR00049	Rocky Fork	industrial storm water
JRM Realty Ltd.	2GR00031	Rocky Fork	industrial storm water
Milliron Auto Parts	2GR00032	Rocky Fork	industrial storm water
Mansfield, Madison Twp., Washington Twp.	2GQ00024		MS4
Mifflin Twp.	2GQ00023		MS4
Richland County	2GQ00009		MS4

Table 2e. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
Black Fork						
18.30	44	4.64	4.22	3.81	6.60	2.79
14.65	42	10.28	9.68	7.57	14.89	7.32
Rocky Fork						
12.49	45	8.31	7.10	6.16	15.76	9.6
10.13	45	7.32	7.02	5.96	10.20	4.24
4.38	42	7.99	6.88	5.26	14.29	9.03
0.57	43	8.53	8.03	7.43	11.17	3.74

Table 2f Sediment results which exceeded guidance values.

Metals (mg/kg)	1993	2007	SRV	TEC	PEC
Rocky Fork at Longview Ave. (RM 14.23)					
cadmium	1.20	4.20 J	0.79	0.99	4.98
chromium	1670	108	29	43.4	111
copper	711	127	32	31.6	149
arsenic	22.7	10.2	---	9.79	33.0
lead	79.5	100	47	35.8	128
nickel	54.9	53.0	33.0	31.6	459
mercury	---	0.145	0.12	---	---
zinc	339	431	160	121	459
organochlorine pesticides (µg/kg)					
Total DDT	43.53J	16.0	---	5.28	572
4,4'-DDD	---	8.7	---	4.88	28.0
4,4'-DDE	---	7.3	---	3.16	31.3
polychlorinated biphenyls (µg/kg)					
Total PCB	2977.39	289	---	59.8	676
PCB-1242		155	---	---	---
PCB-1248	2977.39	<29.5	---	---	---
PCB-1260		134	---	---	---

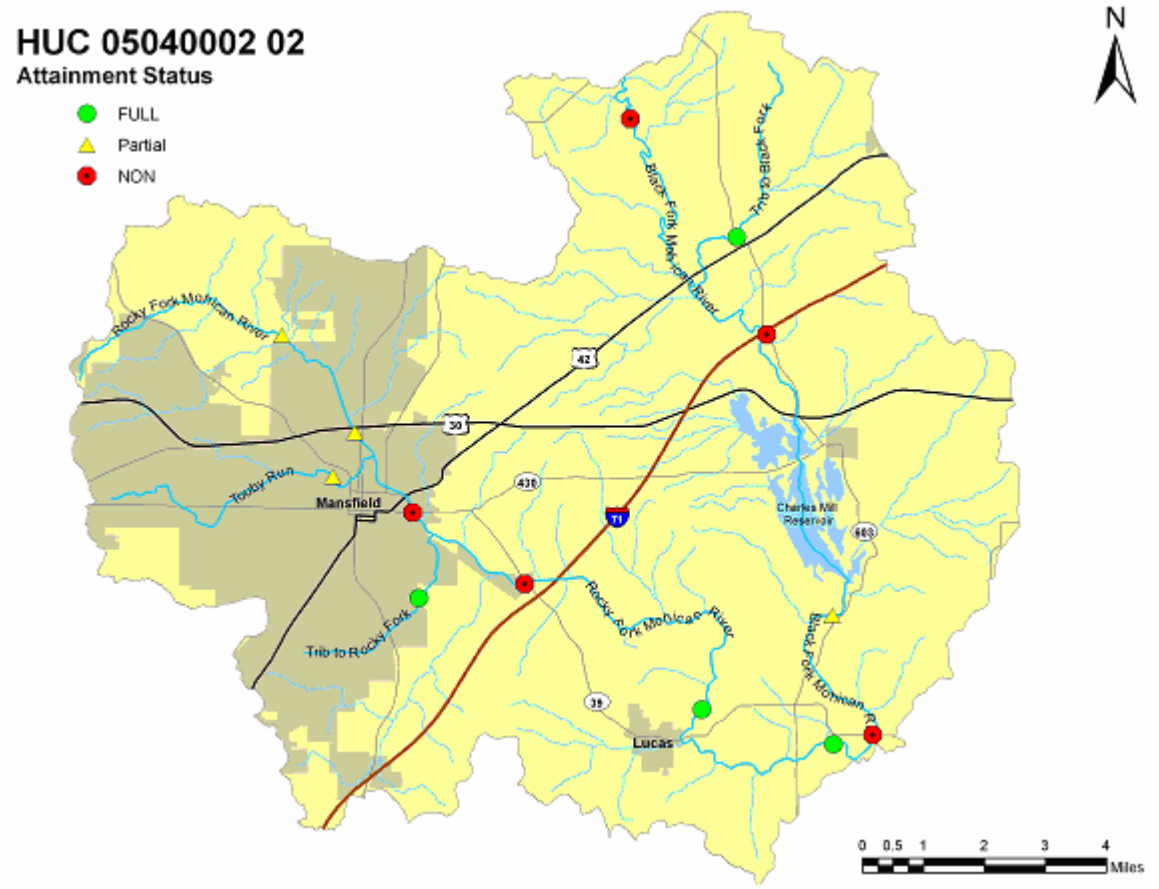

Figure 2a. Sampling Locations and Aquatic Life Use Attainment Status in the Rocky Fork-Black Fork Mohican River WAU (0504000202), June 15 to October 15, 2007.

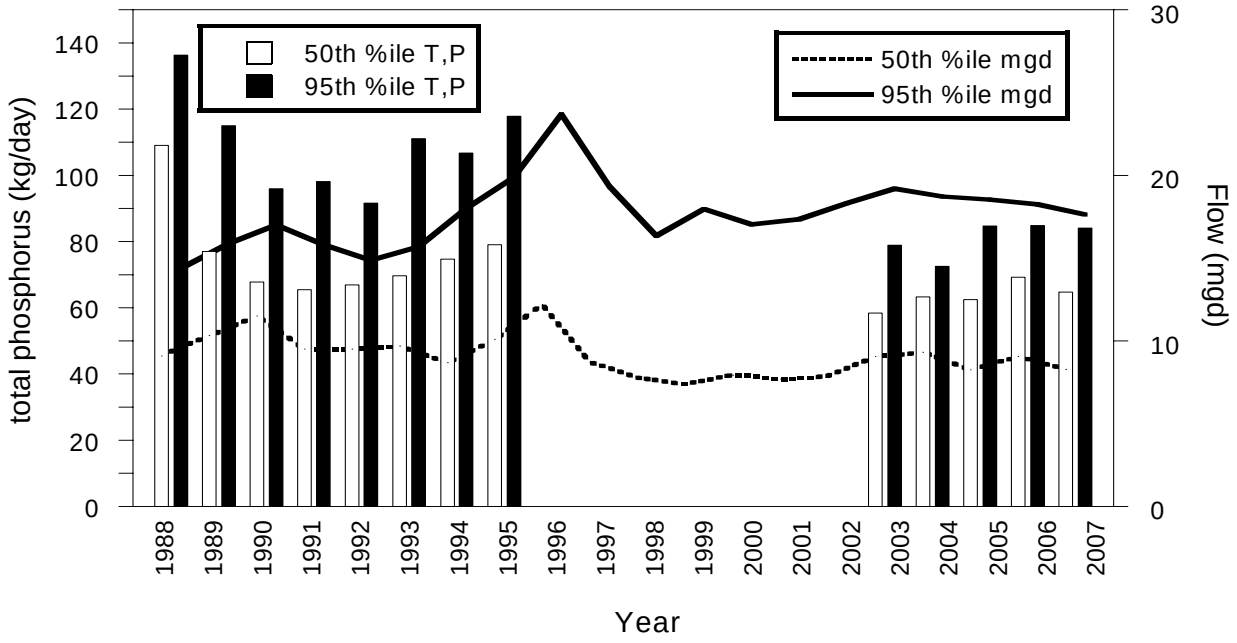

Figure 2b Annual total phosphorous loadings (kg/day) and flow from the Mansfield WWTP, 1988 to 2007.

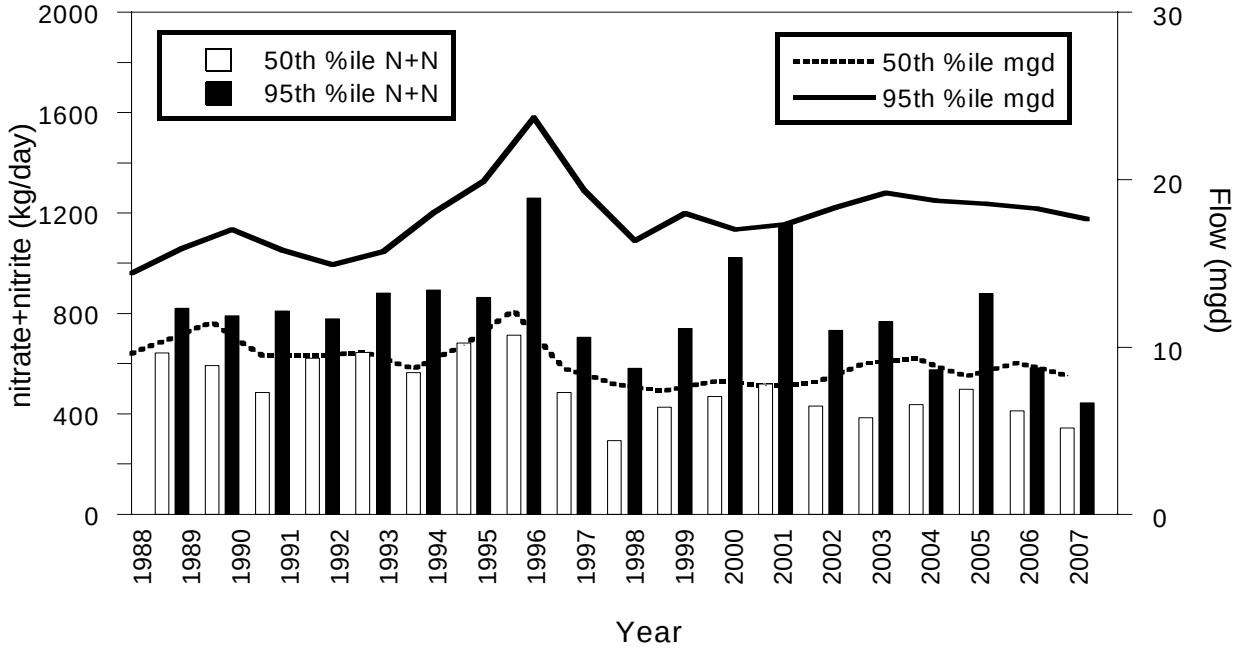

Figure 2c Annual nitrate+nitrite loadings (kg/day) and flow from the Mansfield WWTP, 1988 to 2007.

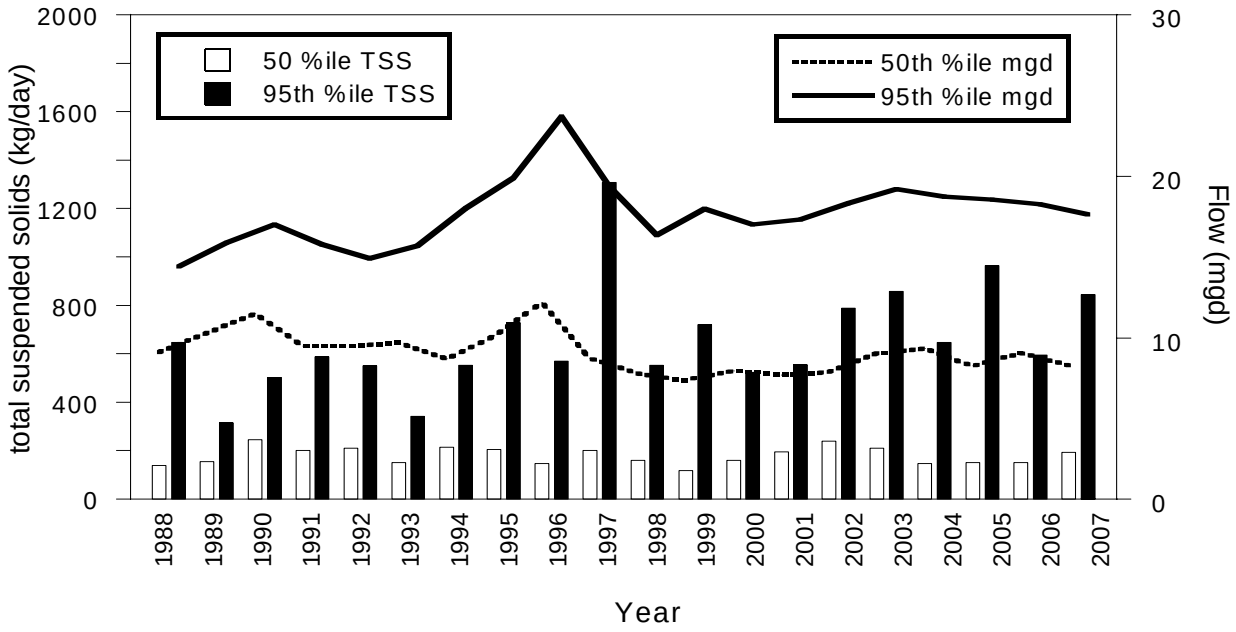

Figure 2d Annual total suspended solids loadings (kg/day) and flow from the Mansfield WWTP, 1988 to 2007.

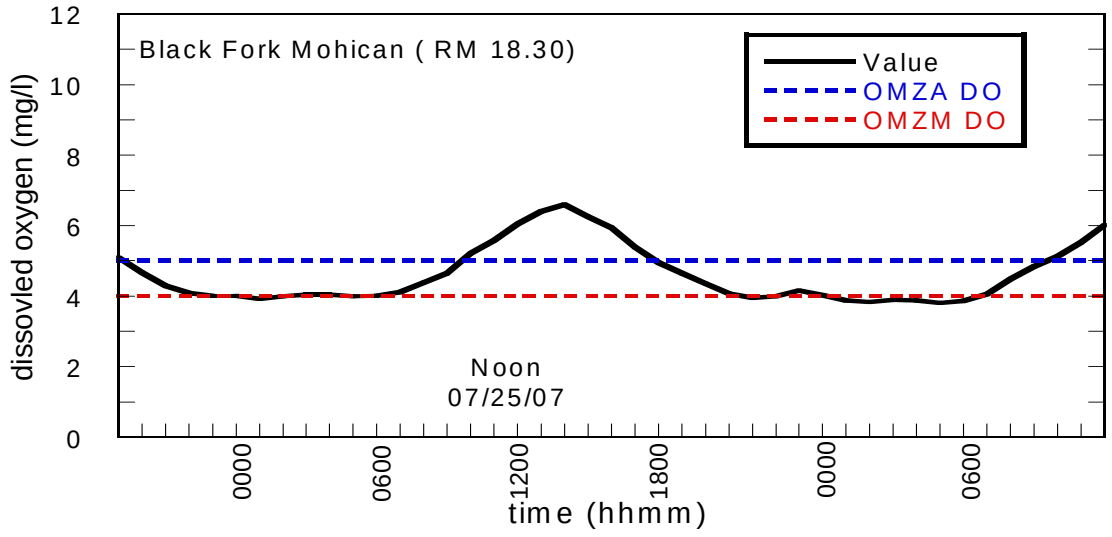

Figure 2e Dissolved oxygen levels measured be an automatic meter deployed July 24-26

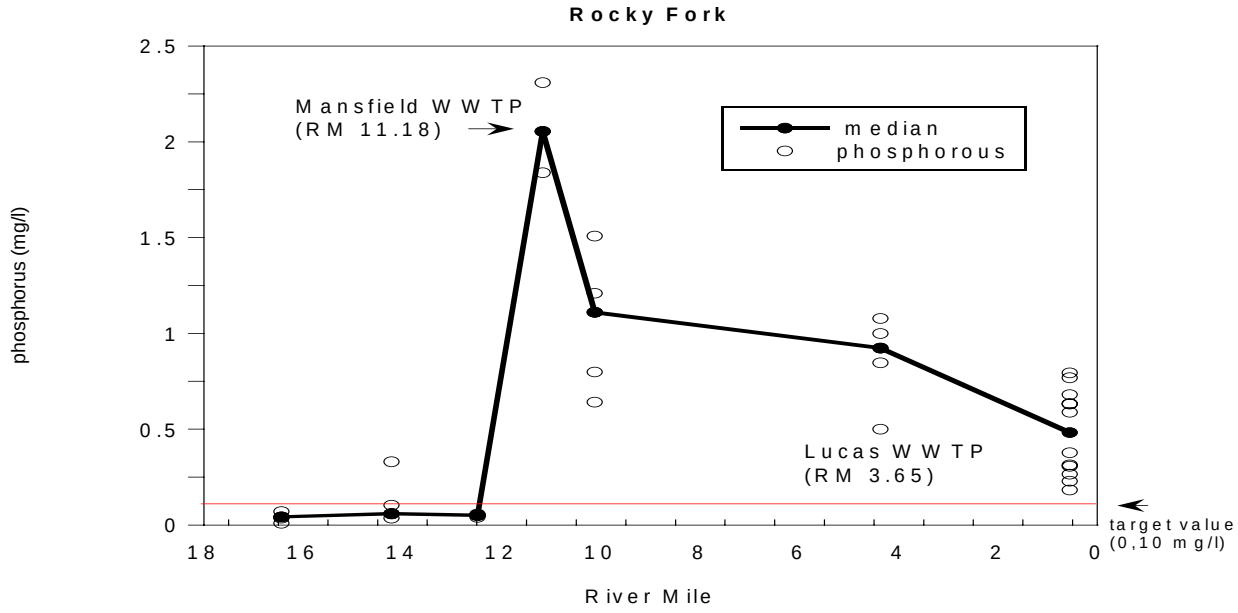

Figure 2 f Phosphorous levels from the Rocky Fork.

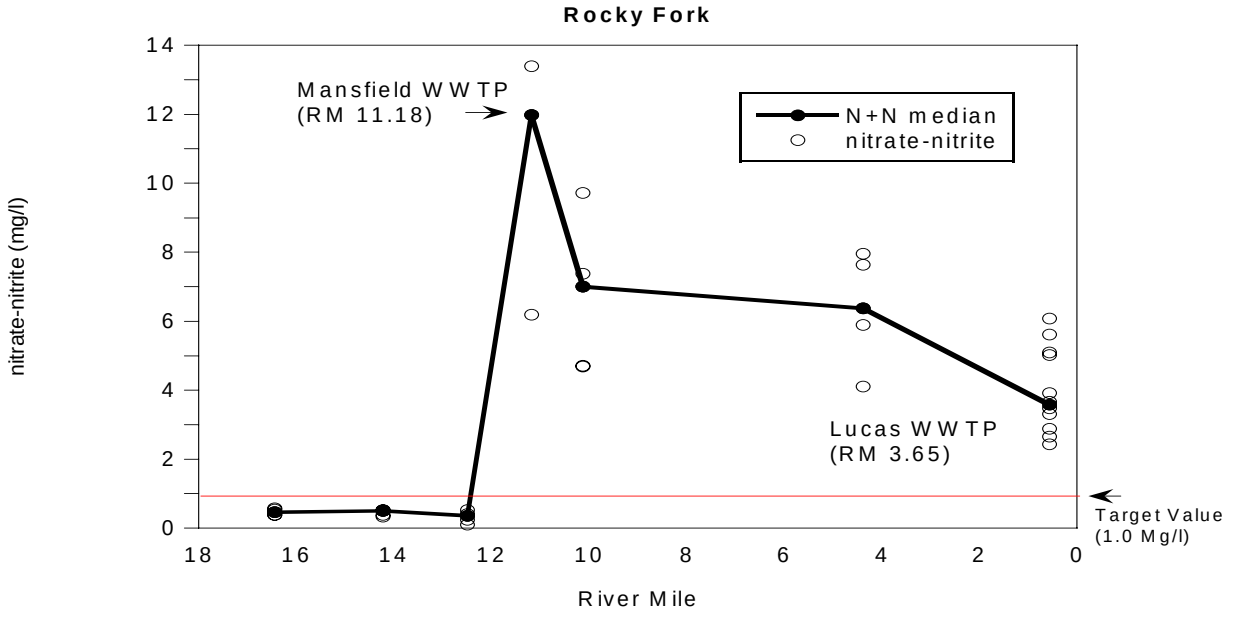

Figure 2g Nitrate-nitrite levels from the Rocky Fork.

Headwaters Clear Fork Mohican River Watershed Assessment Unit

The Headwaters Clear Fork Mohican River WAU (0504000203) covers a land area of 112.1 mi^2 and lies within Richland and Morrow Counties. The boundary encompasses the Clear Fork Mohican River from its origin (RM 38.03) to below Cedar Fork (RM 21.45).

Aquatic life impairment was documented in portions of the Clear Fork through Lexington in both 1998 and 2004. Reduced habitat conditions from channel modifications and extensive substrate embeddedness were partly to blame. The 2006 *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2006) identified siltation as a high magnitude cause of impairment. This component was measured during the 2007 survey in the Qualitative Habitat Evaluation Index.

Aquatic Life Use Designations

Clear Fork is a tributary of the Mohican River confluent at RM 27.58 that is about 38 miles in length and drains an area of 217 mi^2. Within this WAU the mainstem has been extensively modified. It was impounded in 1949 by the construction of a dam at RM 30.59 to form the Clear Fork Reservoir and provide the City of Mansfield with a reliable drinking water supply. It is also in various stages of recovery from being channelized from roughly the Village of Lexington to I-71. It is within the EOLP ecoregion and designated as WWH from Clear Fork Reservoir (RM 30.5) to the mouth, PCR, PWS (RM 30.6), AWS, and IWS based on previous field assessments. Additional macroinvertebrate sampling upstream from Clear Fork Reservior at RM 35.67 confirmed that the WWH use should also be applied to the headwaters of the Clear Fork Mohican River.

Cedar Fork is a tributary of Clear Fork confluent at RM 21.45 that is about 12.3 miles in length and drains an area of 47.7 mi^2. It has generally retained natural instream conditions except in a few areas that have been modified for agricultural production. QHEI scores of between 78.0 and 81.5 at three survey locations reflected the largely intact nature of the in-stream and riparian habitat ranged It is within the EOLP ecoregion and is designated as WWH, PCR, AWS, and IWS based on previous field assessments.

Aquatic Life Use Attainment Status

Biological and habitat assessments were conducted at 6 sites in 2007. Aquatic life use attainment status is presented in Table 3a and Figure 3a.

The four sites in the assessment unit for which Aquatic Life Use status was assessed, one on Clear Fork and three on Cedar Fork; represented approximately thirteen miles of WWH attainment. Additionally, macroinvertebrate sampling was conducted at RMs 35.67 and 29.57 on the Clear Fork Mohican. The uppermost site yielded a good macroinvertebrate assemblage, however, an obviously septic discharge from an on-site residential

sewage system was observed immediately downstream from CR 146 (RM 35.67). The macroinvertebrate community at RM 29.57 appeared to be somewhat affected by the release enriched and organic laden water from Clear Fork reservior. A limited diversity of EPT and sensitive taxa was collected but the community still marginally met WWH expectations.

Macroinvertebrate sampling of Cedar Fork produced markedly higher numbers of sensitive macroinvertebrate taxa compared to the Clear Fork Mohican. The three sites on Cedar Fork produced between 17 and 20 sensitive taxa from the natural substrates. The three sites on the Clear Fork yielded no more that 13 sensitive taxa. The fish communities of the two streams yielded comparable index scores in the good to very good range. Bigeye chubs and redside dace, two increasingly rare fish species in Ohio streams was collected from Clear Fork Mohican at RM 23.35. Cedar Fork also supported bigeye chub and redside dace; additionally, another declining species, rosyface shiners was recorded.

Recreation Use Status
The overall recreation use for this watershed unit is considered impaired. Data used in the evaluation included E. coli counts from 36 separate samples collected at 6 sites.

A seasonal geometric mean was computed at each site and individual results were compared to the PCR single sample maximum criterion of 298 CFU/100 ml to help identify problem areas. Cedar Fork at Wirick Road (RM 5.60) had the highest geometric mean of 838 CFU/100 ml and 4 of 5 results exceeded the maximum. A cow pasture is located here and the livestock have unrestricted watering access. Clear Fork at Ritter Road (RM 23.35) had the next highest geometric mean of 793 CFU/100 ml and 6 of 8 results exceeded the maximum. This indicates an impact from the Lexington WWTP. Results for the Clear Fork are presented in Figure 3a. The highest overall counts were recorded in samples collected after an isolated rain storm. This suggests a significant contribution from some type of non point source, such as runoff from livestock and home sewage treatment. Another source is a lift station in Ontario that bypasses to the Clear Fork at State Route 430 and Rock Road (RM 37.18).

Class A stream assessments were done at two sites on the Clear Fork below the reservoir. Public access to the river is available below the dam at Gass Road and in Lexington Bicentennial Park. A set of five samples collected between 7/5 and 7/31 was used in the calculations. Both sites violated the PCR time weighted geometric mean of 126 CFU/100 ml. At Lexington Ontario Road (RM 29.57) the value was 700 CFU/100 ml and 3 of 5 exceeded the single sample maximum. At Ritter Road (RM 23.35) the value was 767 CFU/100 ml and 4 of 5 exceeded the single sample maximum.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 3c and 3d, respectively. The Village of Lexington WWTP is the only facility classified as a major discharger.

Lexington WWTP (permit # 2PB00019) is located at 205 S. Mill Street, Lexington, OH. The existing system was built in 1970 and serves about 4,165 people. Treatment consists of a series of two aerated lagoons with a continuous discharge. The treated wastewater is disinfected with chlorine and de-chlorinated before discharge to the Clear Fork from Outfall 001 at RM 27.20. The plant is designed to treat 0.678 MGD with an annual average discharge of about 0.674 MGD. The collection system consists of 100% separate sewers and there is 1 lift station with no overflow. Infiltration and inflow into the collection system is unknown. A major upgrade and expansion is scheduled to begin in 2008. This will convert the existing system into an activated sludge plant with UV disinfection and expand capacity to 1.5 MGD.

Facilities regulated by an NPDES permit are required to conduct routine self monitoring of effluent quality and quantity. Results are reported to Ohio EPA as monthly operating report (MOR) data. The permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. They also include monthly average limits and daily or weekly maximum limits, depending on the monitoring requirements. This MOR data can be used to track compliance as well as to evaluate historical trends. A few permit limit violations were documented at the Lexington WWTP in 2007 and they were all for $cBOD_5$. The monthly average loading and concentration limits were violated in February and this included a weekly maximum concentration violation in 1 sample. The monthly average loading limit was violated in March and it was caused by a violation of one weekly maximum. The monthly average loading was violated in December.

Pollutant loadings over the last 20 years were evaluated based on monthly operating report data using the Liquid Effluents Analysis Processing System (LEAPS). Judging by permit compliance at the plant, most problems seem to be related to $cBOD_5$. This is probably due to the fact that the lagoons are operating at capacity and there is not enough retention time for bacteria to sufficiently consume organic matter. An annual summary of $cBOD_5$ loading is displayed in Figure 3b. This shows a noticeable increase in loads over the last 5 years.

Water Quality Status

Results for select water quality constituents are summarized in Table 3b. The standard (minimum/maximum, average) or target used to evaluate each constituent is included in the table. Results above these levels are considered degraded and highlighted in bold. The seasonal geometric mean computed for E. coli is presented in parenthesis.

Water quality was tested at three sites in the Clear Fork and found to be very good for the most part. None of the physical or chemical constituents tested in grab samples exceeded their respective criteria. There is no indication of nutrient enrichment based on the chemistry data. No phosphorus concentrations and only 1 of 15 (7%) for nitrate-nitrite were above target. Within this river segment, the average value for phosphorus was 0.050 mg/L and for nitrate-nitrite was 0.67 mg/L. A few areas did show somewhat degraded conditions. A failed home sewage treatment system on the Clear Fork at Marion Ave. (RM 35.68) had a negative impact on the macroinvertebrate community, but since water samples were collected above the discharge they were not conclusive. An impact from Clear Fork Reservoir is noted at Lexington Ontario Rd. (RM 29.57), where the water had a distinct green coloration. The lake is considered eutrophic and contains a high amount of primary productivity in the form of algae. As a result, some algae wash over the dam and into the Clear Fork. The average daytime dissolved oxygen concentration measured in grab samples at this site was 6.19 mg/L. Levels sag to near the average criterion of 5.0 mg/L during periods of algal respiration. This phenomenon was documented using an automatic meter deployed July 24-26 (Table 3e). Only 1 of 46 hourly readings actually fell below 5.0 mg/L. Oxygen levels here are also affected by habitat alteration (Figure 3c). Flow can be sluggish at times and this limits reaeration from the atmosphere. Nutrient concentrations increase considerably below the Lexington WWTP at Ritter Rd. (RM 23.35), but are still below target.

Water quality was tested at three sites in Cedar Fork and found to be very good. None of the physical or chemical constituents tested in grab samples exceeded their respective criteria. There is no indication of nutrient enrichment based on the chemistry data. No nitrate-nitrite and only 1 of 15 (7%) phosphorus samples tested were above target. The stream wide average for phosphorus was 0.028 mg/L and for nitrate-nitrite was 0.26 mg/L. The only site that had somewhat degraded conditions was at Wirick Rd. (RM 5.60). A pasture is located here and livestock have unrestricted access to the stream for watering (Figure 3d). Water temperatures were generally 3-4 °C higher at this site and dissolved oxygen saturation was consistently above 110% (110.5-120.3%). This is likely due to the lack of any riparian vegetation to limit the energy from sunlight.

Sediment Quality Status

No sediment samples were collected in this WAU. In general, Clear Fork and Cedar Fork contain very little in the way of silt and clay sediment deposits. Stream segments with channel modifications usually have some sediment, but most is sand since there is enough flow to wash out fine particles.

Public Water Supply Use Status

The Mansfield WTP is a public utility that produces and distributes potable water. It is located at 2010 Lexington Springmill Road, Mansfield, OH. The raw water supply is a blend of well water and surface water pumped from Clear Fork Reservoir. This lake is a 966 acre impoundment constructed in 1949 to provide a reliable source of water for the city. Fish and game are propagated and managed by the Ohio DNR Division of Wildlife and an 8 mph speed limit is enforced. The fish community is in excellent condition and the lake is a top Muskellunge fishing destination. The lake is classified as eutrophic based on the trophic state index (Carlson, 1977). The TSI value calculated using chlorophyll a concentration was 64 in both 1993 and 1998. An updated water quality study of the lake is planned for 2008 and the results may lead to the development of a TMDL.

Mansfield is classified as a community public water system by the Ohio EPA, DDAGW. This requires the city to prepare and distribute an annual Consumer Confidence Report that summarizes finished water quality. The report for 2006 showed no MCL violations.

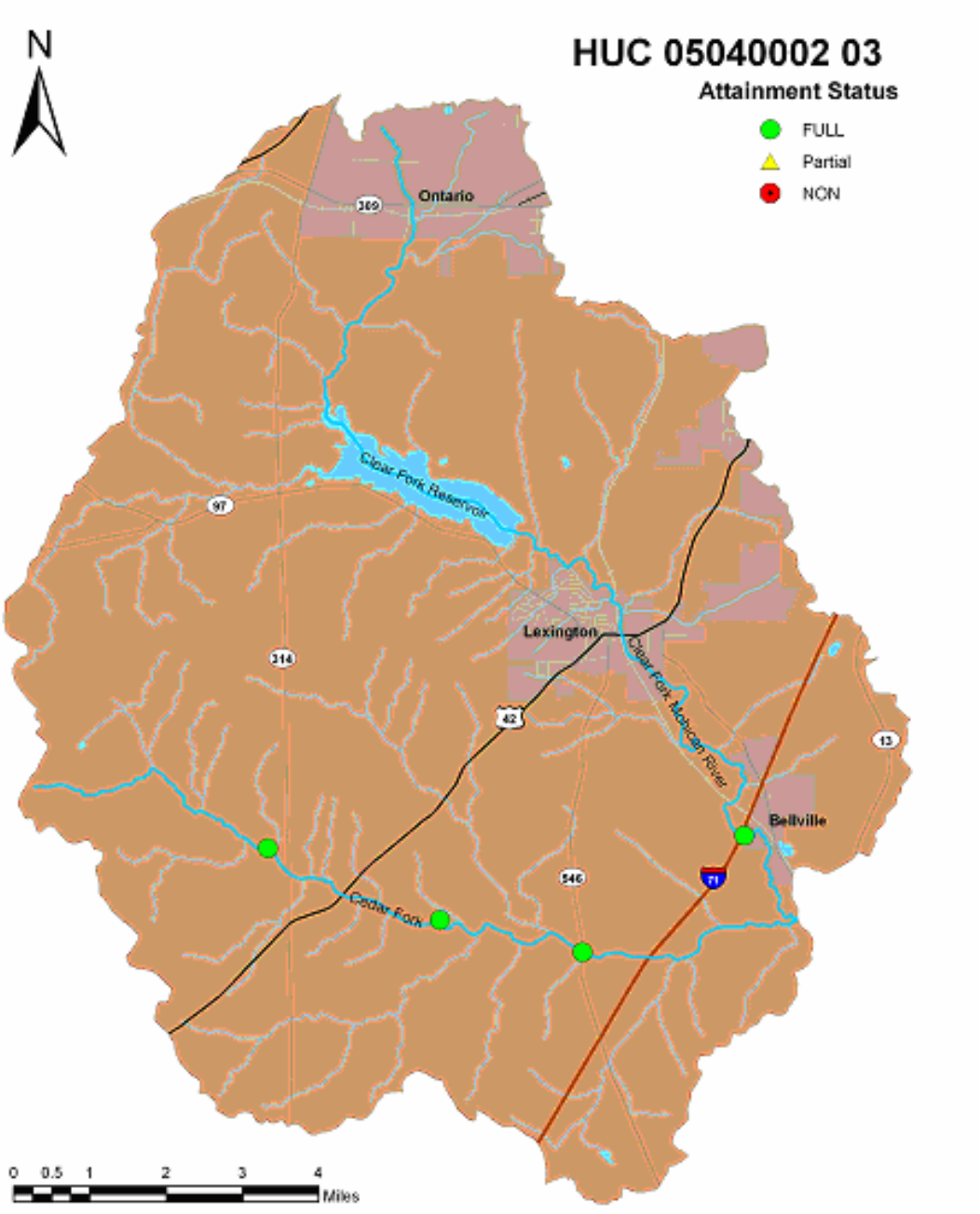

Figure 3a. Sampling Locations and Aquatic Life Use Attainment Status in the Headwaters Clear Fork Mohican River WAU (0504000202), June 15 to October 15, 2007

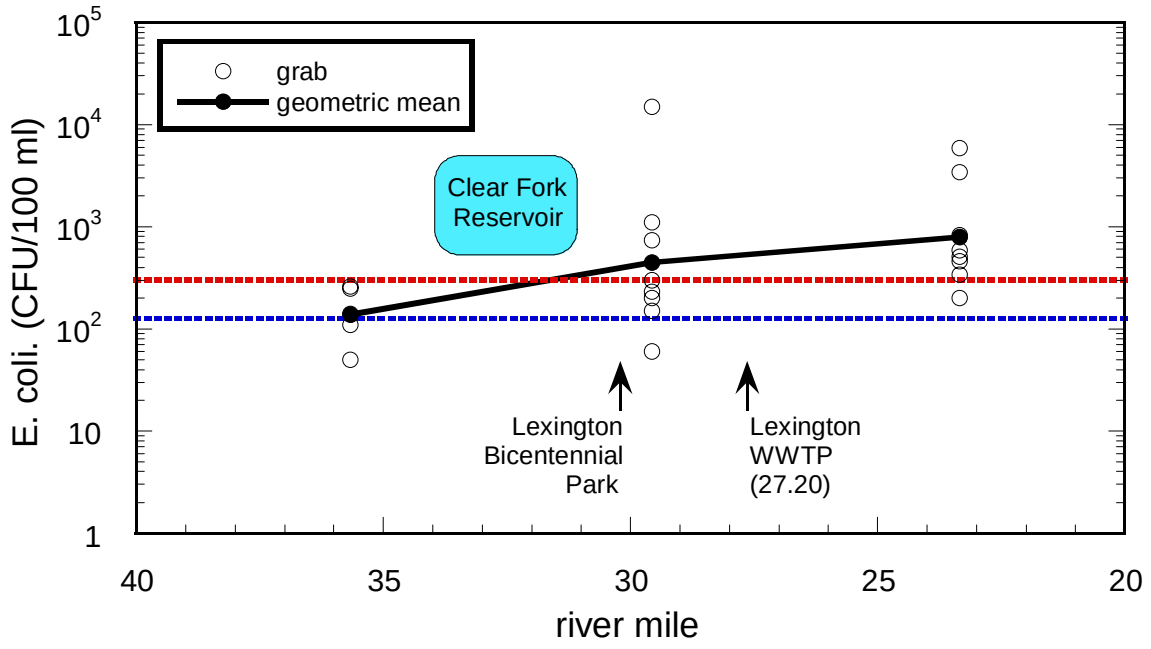

Figure 3b. Bacteria levels in the Clear Fork from all samples collected during the 2007 recreation season (5/1-10/15). The blue line represents the time weighted PCR geometric mean criterion of 126 CFU/100 ml and the red line the maximum criterion of 298 CFU/100 ml.

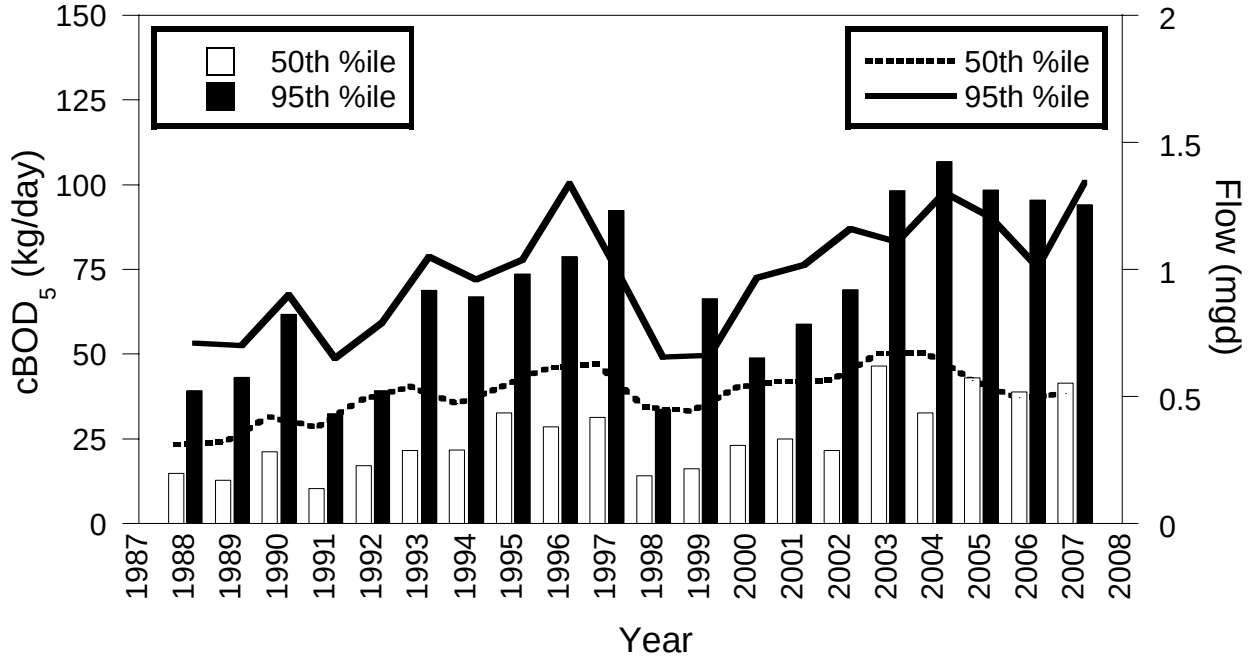

Figure 3c. Annual summary for cBOD5 calculated at the Lexington WWTP based on MOR data.

Figure 3d. View of Clear Fork at Lexington Ontario Rd. (RM 29.57) showing altered habitat and green colored water

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Figure 3e. View of Cedar Fork at Wirick Rd. (RM 5.60) showing lack of riparian vegetation and eroded stream bank.

Table 3a. Aquatic life and recreational use attainment status for sampling locations in the Headwaters Clear Fork Mohican River WAU (0504000203). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Clear Fork Mohican River	35.68	WWH-R				G			
Clear Fork Mohican River	29.57	WWH				MGns			
Clear Fork Mohican River	23.35	WWH	FULL	44	8.9	42	86.5		
Cedar Fork	8.25	WWH	FULL	48		E	81.0		
Cedar Fork	5.60	WWH	FULL	44		VG	78.5		
Cedar Fork	3.25	WWH	FULL	48	8.8	54	81.5		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 3b. Results for select water quality constituents tested in grab samples from the Headwaters Clear Fork Mohican RiverWAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and considered degraded are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Clear Fork WWH, PCR, AWS, IWS small river (217 mi^2)	35.68	WWH	t-P (mg/L) (0.17)	<0.01, <0.01, <0.01, 0.047, <0.01
			NO_3-NO_2 (mg/L) (1.50)	0.21, 0.20, **1.82**, 0.23, 0.33
		PCR	E. coli. (#/100 ml) (298, 126)	50, 250, 140, 110, 260 (**138**)
	29.57	WWH	t-P (0.17)	0.029, <0.01, 0.024, 0.022, 0.021
			NO_3-NO_2 (mg/L) (1.50)	0.34, 0.45, 0.30, 0.40, 0.24
		PCR	E. coli. (#/100 ml) (298, 126)	**300**, 150, **15000**, 230, 60, **1100**, **740**, 200 (**444**)
	23.35	WWH	t-P (0.17)	0.095, 0.076, 0.132, 0.142, 0.142
			NO_3-NO_2 (mg/L) (1.50)	1.11, 1.42, 1.21, 1.08, 0.75
		PCR	E. coli. (#/100 ml) (298, 126)	**510**, **3400**, **5900**, **460**, 200, **590**, **830**, 340 (**793**)

Table 3b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Cedar Fork WWH, PCR, AWS, IWS wadeable stream (47.7 mi^2)	8.25	WWH	t-P (mg/L) (0.10)	0.022, <0.01, 0.027, 0.021, 0.020
			NO_3-NO_2 (mg/L) (1.00)	0.19, 0.10, 0.20, 0.11, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	120, **550**, **430**, 280, **410** (**318**)
	5.60	WWH	t-P (mg/L) (0.10)	**0.199**, <0.01, 0.032, 0.017, 0.018
			NO_3-NO_2 (mg/L) (1.00)	0.21, 0.10, 0.12, 0.18, <0.10
			DO (%)	120.3, 119.3, 110.5, 113.6, 112.9
		PCR	E. coli. (#/100 ml) (298, 126)	800, 600, 290, 800, 3700 (838)
	3.25	WWH	t-P (mg/L) (0.10)	0.016, <0.01, 0.017, 0.011, <0.01
			NO_3-NO_2 (mg/L) (1.00)	0.68, 0.72, 0.52, 0.38, 0.30
		PCR	E. coli. (#/100 ml) (298, 126)	280, **480**, 280, 270, 220 (**295**)

Table 3c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
General Motors	2IS00045	UT to Clear Fork	2.5	storm water settling pond
Brown Derby Restaurant	2PR00049	UT to Clear Fork	2.0	0.005 MGD package plant
BP Oil Bulk Plant	2IN00179	UT to Clear Fork		storm water settling pond
Greenball Corp.	2PR00243	UT to Clear Fork		0.002 MGD package plant
Mansfield WTP	2IV00052	Buck Creek	0.77	lime sludge settling lagoons
United Tech.	2IN00107	UT to Clear Fork	0.1	air stripping towers
Lexington WWTP	2PB00019	Clear Fork	27.20	0.678 MGD aerated lagoons
Griffeth Nursing Home	2PR00118	UT to UT to Clear Fork	0.1	0.006 MGD package plant
Cedar Creek Court	2PY00068	UT to Cedar Fork	1.7	0.017 MGD package plant

Table 3d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Yellow Transportation	2GR01474	UT to Clear Fork	Industrial Storm Water
Universal Enterprises	2GR00036	UT to Clear Fork	Industrial Storm Water
Burner Systems	2GR00270	UT to Clear Fork	Industrial Storm Water
EGS Electrical	2GR00537	Clear Fork	Industrial Storm Water
Lexington Concrete	2GR00298	Clear Fork	Industrial Storm Water
Stoneridge Inc.	2GR00058	Clear Fork	Industrial Storm Water
Country Meadows Care	2GS00001	Cedar Fork	Small Sanitary
City of Ontario	2GQ00000		MS4
Village of Lexington	2GQ00030		MS4
Washington Township	2GQ00024		MS4
Mansfield	2GQ00008		MS4
Richland County	2GQ00009		MS4
Washington Twp.	2GQ00024		MS4

Table 3e. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the Clear Fork.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
29.57	46	5.83	5.74	4.88	6.70	1.82
23.35	38	7.07	6.54	6.04	9.44	3.40

Possum Run-Clear Fork Mohican River Watershed Assessment Unit

The Possum Run-Clear Fork Mohican River WAU (0504000204) drains a total of 105.3 mi^2 and lies within Ashland and Richland Counties. The boundary of this watershed encompasses the Clear Fork Mohican River from downstream of the Cedar Fork (RM 21.45) to the mouth of the Mohican at RM 27.57 (forming its mainstem along with the Black Fork). The stream was impounded in 1936 creating Pleasant Hill Lake. The dam is operated and maintained by the U.S. Army Corps of Engineers to provide flood control and recreation. The impounded reach of the Clear Fork extends upstream from the dam at RM 4.91 to approximately RM 8.7. Downstream from the dam, the Clear Fork flows through the Mohican State Park. Free flowing reaches of Clear Fork both upstream and downstream from Pleasant Hill Lake are stocked by the Ohio Department of Natural Resources to maintain a recreational fishery for brown trout.

Several small tributaries confluent with the Clear Fork were sampled in order to characterize overall conditions with in the assessment unit. These other streams included: Opossum Run, Switzer Creek, Honey Creek, Slater Run and Pine Run.

Aquatic Life Use Designations
In-stream and riparian habitats were consistently in good to very good condition throughout the Possum Run-Clear Fork Mohican River assessment unit. QHEI scores measured at mainstem and tributary sites ranged between 73.0 at RM 0.82 on Slater Run and 85.0 at RM 5.71 on Pine Run.

Clear Fork is a tributary of the Mohican River confluent at RM 27.57 that is about 38.3 miles in length and drains an area of 217 mi^2. It is designated as WWH, PCR, PWS, AWS, and IWS based on a field assessment done in 1998. Biological sampling results from 2007 were consistent with the WWH Aquatic Life Use.

Several of the tributaries to the Clear Fork were designated WWH in the 1978 WQS but no biological sampling was conducted to evaluate the appropriateness of the use. The 2007 sampling effort identified several instances in which streams are more accurately categorized with a Coldwater Habitat Aquatic Life Use. Recently developed methods for delineating coldwater streams include the presence of four or more coldwater macroinvertebrate taxa or a minimum of two coldwater fish in combination with at least two primary coldwater macroinvertebrates. These criteria were also applied to streams that may have had biological sampling but were not evaluated based on the current method.

Honey Creek is a tributary of Clear Fork confluent at RM 17.15 that is about 5.4 miles in length and drains an area of 9.88 mi^2. It is designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. However, a CWH use is recommended. Four coldwater macroinvertebrates and four coldwater fish

species (brown trout, redside dace, central mudminnow and mottled sculpin) were recorded at RM 0.80.

Slater Run is a tributary of Clear Fork confluent at RM 13.13 that is about 5.0 miles in length and drains an area of 8.52 mi^2. It is designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. Based on biological sampling results, a CWH use is recommended. Four coldwater macroinvertebrates and two coldwater fish species (redside dace and mottled sculpin) were recorded at RM 0.82 (SR 97).

Opossum Run is a tributary of Clear Fork confluent at RM 9.27 that is about 9.7 miles in length and drains an area of 15.6 mi^2. It is designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998. Opossum Run was designated WWH based on fish community results at RM 1.40 in 1998. Five coldwater macroinvertebrate taxa were collected from the natural substrates at RM 4.57 which is sufficient evidence for recommending CWH for an upper reach of Opossum Run. Two coldwater macroinvertebrate taxa were collected at RM 0.35 along with one coldwater fish species. This result more strongly aligns with maintaining the designated WWH in the lower portion of the creek. The collection of two coldwater fish species (mottled sculpin and redside dace) at RM 1.40 in 1998 suggests that CWH is appropriate, as well; however, an inventory of coldwater macroinvertebrates would strengthen the case for the CWH at this site. When all the data is considered, the CWH use is recommended for Opossum Run from the headwaters to the confluence of the unnamed tributary at RM 1.37. The WWH use would then apply to the remainder of the stream.

Switzer Creek is a tributary of Clear Fork confluent at RM 8.55 that is about 8.0 miles in length and drains an area of 12.4 mi^2. It is designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. Based on the 2007 sampling of Switzer Creek and current designation protocols, a CWH Aquatic Life Use is recommended. Two coldwater fish (redside dace and mottled sculpin) and three primary coldwater macroinvertebrates were recorded at RM 2.83.

Pine Run is a tributary of Clear Fork confluent at RM 0.22 that is about 8.8 miles in length and drains an area of 14.2 mi^2. It is designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998. The stream was originally designated as WWH based on a single fish collection at RM 0.10. Additional sampling conducted at RM 5.71 in 2007 necessitated a reexamination of the appropriate aquatic life use. Two coldwater fish species, redside dace and mottled sculpins were collected from both RM 0.10 in 1998 and RM 5.71 in 2007. A third coldwater fish, brown trout, was also collected from RM 0.1. The 2007 sampling at RM 5.71 produced a diverse macroinvertebrate assemblage that included six coldwater taxa. These results support a change of the aquatic life use to CWH for Pine Run. Sampling of both fish and macroinvertebrates near the confluence with the Clear Fork would be helpful to further clarify this issue.

Aquatic Life Use Attainment Status

Biological and habitat assessments were conducted at 11 sites in 2007. Aquatic life use attainment status is presented in Table 4a and Fi.

The eleven sites in the assessment unit for which Aquatic Life Use status was assessed represented approximately 26 stream miles that fully attained verified or recommended aquatic life uses.

Slater Creek and Honey Creek are recommended for a CWH aquatic life use. Fish and macroinvertebrate communities performed at an exceptional level based on IBI scores and qualitative macroinvertebrate sampling results. Pine Run and Switzer Creek supported biological communities with population dynamics that were of a slightly lower quality but still reflected a very good resource condition.

The sampled streams within the Lower Clear Creek watershed assessment unit were notable because they supported reproducing populations of a number of declining fish species. Opossum Run supported least brook lampreys. Both least brook lampreys and redside dace were collected from Clear Creek, Pine Run, Slater Run, Honey Creek and Switzer Creek. Pine Run proved to be a candidate for all available mechanisms for preservation given the unique combination of both declining fish and rare macroinvertebrates. Two rare caddisfly taxa, *Molana* sp. and *Psilotreta indecisa*, were collected from RM 5.71.

Recreation Use Status

The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 62 separate samples collected at 10 sites.

Class A stream assessments were done on the lower Clear Fork. Public and private access to the river is provided at several locations including public and private canoe liveries. A set of five samples collected between 7/5 and 7/31 was used in the calculations. Clear Fork at State Route 13 (RM 19.83) the geometric mean count was 631 CFU/100 ml, Clear Fork at Cutnaw Road (RM 16.17) it was 400 CFU/100 ml., Clear Fork at Bunker Hill North Road (RM 10.55) it was 238 CFU/100 ml. and at Clear Fork at Forest Road 58 (RM 4.03) it was 68 CFU/100 ml. All sites with the exception of RM 4.03 violate the PCR criterion.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 3c and 3d, respectively. No facilities classified as a major discharger exist in this WAU.

Water Quality Status

Results for select water quality constituents are summarized in Table 4b. Water quality was tested at four sites on the lower Clear Fork and found to be of very good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective criteria. There is also no indication of nutrient enrichment in the samples. The stream wide average (n=32) for phosphorus was 0.064 mg/L and for nitrate-nitrite was 1.01 mg/L.

Water quality was assessed at one site on Honey Creek and found to be of good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. Nitrate-nitrite levels were slightly elevated above the target value of 1.0 mg/l. The site average (n=5) for phosphorus was 0.012 mg/L and for nitrate-nitrite was 1.36 mg/L.

Water quality was assessed at one site on Slater Run and found to be of good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. Nitrate-nitrite levels were elevated above the target value of 1.0 mg/l. The site average (n=5) for phosphorus was 0.024 mg/L and for nitrate-nitrite was 2.40 mg/L.

Water quality was assessed at two sites on Opossum Run and found to be of very good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is also no indication of nutrient enrichment in the samples. The stream wide average (n=10) for phosphorus was 0.016 mg/L and for nitrate-nitrite was 0.23 mg/L.

Water quality was assessed at one site on Switzer Run and found to be of very good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is also no indication of nutrient enrichment in the samples. The stream wide average (n=5) for phosphorus was 0.013 mg/L and for nitrate-nitrite was 0.89 mg/L.

Water quality was assessed at one site on Pine Run and found to be of fair quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of nutrient enrichment in the samples. The stream wide average (n=5) for phosphorus was 0.047 mg/L and for nitrate-nitrite was 4.94 mg/L. Nitrate-nitrite levels were elevated well above the target value of 1.0 mg/l.

Sediment Quality Status

Only one sediment sample was collected in this WAU from Pine Run at McCurdy Road and results indicated good sediment quality. In general, Clear Fork contain very little in the way of fine silt and clay sediment deposits.

Sediment sample results were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines*

for Freshwater Ecosystems (MacDonald *et al*. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. In addition, the Ohio Sediment Reference Value represents ecoregion background conditions based on data collected at Ohio reference sites.

Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment and accumulate in the food chain.

Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. Sample results indicate that no Sediment Quality Guidelines were exceeded.

Table 4a. Aquatic life and recreational use attainment status for sampling locations in the Possum Run-Clear Fork Mohican River WAU (0504000204). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Clear Fork Mohican River	19.83	WWH	FULL	41	9.5	G	78.0		
Clear Fork Mohican River	16.17	WWH	FULL	39ns	8.4	48	82.0		
Clear Fork Mohican River	10.55	WWH	FULL	45	9.0	54	76.5		
Clear Fork Mohican River	4.03	WWH	FULL	53	10.4	36	83.0		
Honey Creek	0.80	CWH-R	FULL	50		E	75.0		
Slater Run	0.82	CWH-R	FULL	52		E	73.0		
Opossum Run	4.57	WWH	FULL	48		E	76.5		
Opossum Run	0.35	WWH	FULL	40		G	77.0		
Switzer Creek	2.83	CWH-R	FULL	48		VG	73.0		
Pine Run	5.71	CWH-R	FULL	48		E	85.0		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 4b. Results for select water quality constituents tested in grab samples from the Possum Run-Clear Fork Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Clear Fork WWH, PCR, AWS, IWS small river (217mi^2)	19.83	WWH	t-P (mg/L) (0.17)	0.033, 0.037, 0.062, 0.046, 0.039
			NO_3-NO_2 (mg/L) (1.50)	0.76, 0.75, 0.59, 0.56, 0.51
		PCR	E. coli. (#/100 ml) (298, 126)	160, **510. 2200**, 260, **1100, 570**, 280, 200, **(631)**
	16.17	WWH	t-P (mg/L) (0.17)	0.039, 0.034, 0.082, 0.084
			NO_3-NO_2 (mg/L) (1.50)	0.75, 0.80, 0.78, 0.80
		PCR	E. coli. (#/100 ml) (298, 126)	160, 100, **2600**, 140, 140, **960**, 210, **380 (400)**
	10.55	WWH	t-P (mg/L) (0.17)	0.037, 0.049, 0.046, 0.041, 0.058
			NO_3-NO_2 (mg/L) (1.50)	0.89, 0.93, 0.97, 1.05, 0.97
		PCR	E. coli. (#/100 ml) (298, 126)	130, 140, **1700**, 50, 80**, 320, 350**, 140 **(238)**
	4.03	WWH	t-P (mg/L) (0.17)	0.047, 0.043, 0.096, 0.073, 0.096
			NO_3-NO_2 (mg/L) (1.50)	0.10, <0.10, 0.66, <0.10, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	10, **830, 2000,** <10, 20, 110, 30, 80 **(68)**
Honey Creek (RM 17.15) WWH, PCR, AWS, IWS wadable stream (9.88mi^2)	0.81	WWH	t-P (mg/L) (0.10)	0.010, <0.010, 0.017, 0.012, 0.010
			NO_3-NO_2 (mg/L) (1.0)	1.56, 1.38, 1.35, 1.09, 1.43
		PCR	E. coli. (#/100 ml) (298, 126)	280, 3300, 300, 1100, 490

Table 4b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Slater Run (RM 13.13) WWH, PCR, AWS, IWS wadable stream ($8.52\ mi^2$)	0.82	WWH	t-P (mg/L) (0.10)	0.025, 0.016, 0.029, 0.036, 0.012
			NO_3-NO_2 (mg/L) (1.00)	1.91, 1.38, 0.71, 5.60, 2.40
		PCR	E. coli. (#/100 ml) (298, 126)	2800, 4000, 770, 4500, 230
Opossum Run (RM 9.72) WWH, PCR, AWS, IWS wadable stream ($15.6\ mi^2$)	4.57	WWH	t-P (mg/L) (0.10)	0.025, <0.010, 0.018, 0.016, 0.015
			NO_3-NO_2 (mg/L) (1.00)	0.32, 0.26, 0.13, 0.18, 0.12
		PCR	E. coli. (#/100 ml) (298, 126)	210, 260, 220, 200, 170
	0.35	WWH	t-P (mg/L) (0.10)	0.018, <0.010, 0.023, 0.011, <0.010
			NO_3-NO_2 (mg/L) (1.00)	0.59, 0.27, 0.11, 0.18, 0.11
		PCR	E. coli. (#/100 ml) (298, 126)	220, 270, **300, 600**, 270
Switzer Creek (RM 8.55) WWH, PCR, AWS, IWS wadable stream ($12.4\ mi^2$)	3.23	WWH	t-P (mg/L) (0.10)	0.015, <0.010, 0.015, 0.013, <0.010
			NO_3-NO_2 (mg/L) (1.00)	0.97, **1.07**, 0.82, 0.72, 0.85
		PCR	E. coli. (#/100 ml) (298, 126)	3700, 530, 680, 880, 260
Pine Run (RM 0.22) WWH, PCR, AWS, IWS wadable stream ($14.2\ mi^2$)	5.71	WWH	t-P (mg/L) (0.10)	0.033, 0.040, 0.060, 0.047, 0.054
			NO_3-NO_2 (mg/L) (1.00)	5.25, 5.61, 4.92, 3.96, 4.95
		PCR	E. coli. (#/100 ml) (298, 126)	550, 2100, 630, 1400, 550

Table 4c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
BP Oil Bellville Bulk Plant	2IN00175	Clear Fork	19.80	Oil and water separator
Bellville WWTP	2PB00057	Clear Fork	19.17	0.33 MGD rotating biological contactor system
United Precast	2IJ00101	unnamed trib. (RM18.09)	----	gravel quarry wash water
Donley Ford	2PR00065	unnamed trib. Honey Creek (RM 1.77)	0.7	1,500 gpd package plant
Honey Creek Valley Campground	no permit	unnamed trib. Honey Creek (RM 4.03)	----	package plant
Clear Fork High School	2PT00024	unnamed trib. (RM 16.82)	0.6	20,000 gpd package plant
Clear Fork MHP	2PY00024	Clear Fork	16.35	15,000 gpd package plant
Butler WWTP	2PA00044	Clear Fork	13.09	0.12 MGD rotating biological contactor system
Clear Fork Ski Area	closed	Slater Run	----	package plant
Camp Otyokwah	2PR00226	unnamed trib. (RM 12.15)	1.0	9,600 gpd package plant
Snow Trails	2PR00220	Opossum Run	8.2	12,000 gpd package plant
Malabar Farm State Park Restaurant	2PP00050	unnamed trib. Switzer Creek (RM 0.60)	----	4,000 gpd package plant
Columbia Gas Weaver Compressor Station	2IN00066	Switzer Creek	2.45	oil and water separator/activated carbon
Pleasant Hill Outdoor Center	2PR00173	unnamed trib. (RM 6.77)	----	10,000 gpd package plant
Camp Nuhop	2PR00131	Clear Fork	5.80	9,000 gpd package plant
Mohican State Park Lodge	2PP00033	Clear Fork	5.68	80,000 gpd package plant
Mohican Youth Center	2PP00005	Clear Fork	3.70	32,000 gpd package plant
Butler/Mohican KOA Campground	no permit	Pine Run	----	package plant w/settling pond

Table 4d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
DH Bowman & Son, Inc.	2GG00038	Clear Fork	industrial storm water

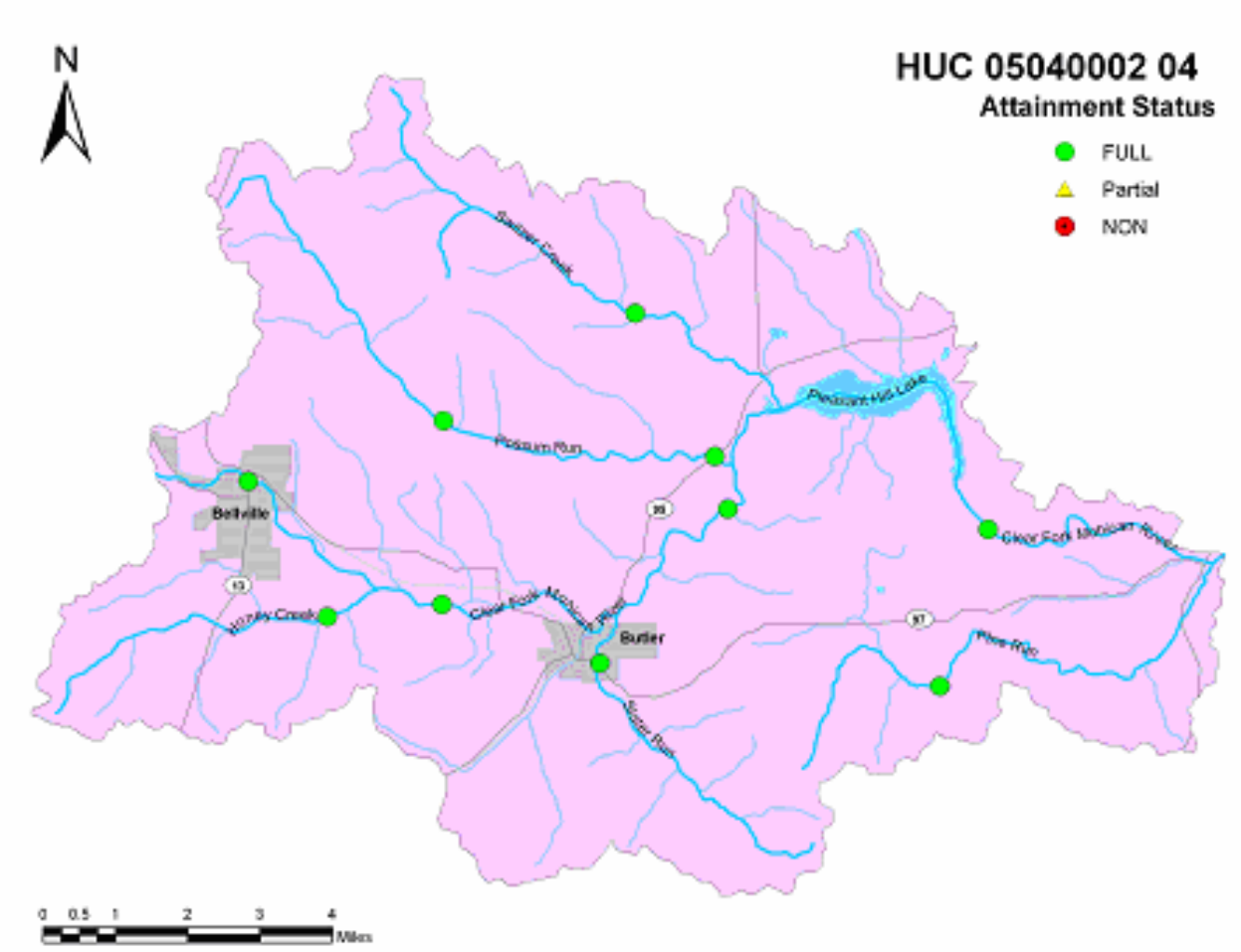

Figure 4a. Sampling Locations and Aquatic Life Use Attainment Status in the Possum Run-Clear Mohican River WAU (0504000204), June 15 to October 15, 2007.

Jerome Fork Mohican River Watershed Assessment Unit

The Jerome Fork-Mohican River WAU (0504000206) covers a land area of 161.5 mi^2 and lies almost entirely within Ashland County. The boundary encompasses the headwaters of Orange Creek and Leidigh Mill Creek and subsequently Jerome Fork Mohican River from its origin (RM 14.72) to its confluence with the Lake Fork Mohican River.

Nutrients were listed as a high magnitude cause of impairment in the 2006 *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2006). During the 2007 survey, nutrients were measured as part of routine water chemistry analysis and assessed by comparing concentrations to target values.

Aquatic Life Use Designations
In-stream and riparian habitats were in marginally good to very good condition throughout the Jerome Fork-Mohican River WAU. QHEI scores measured at mainstem and tributary sites ranged between 50.0 at RM 2.56 on Jerome Fork and 84.0 at RM 3.49 on Katotawa Creek. The effects of sedimentation and historical channelization were two of the more widespread negative habitat features observed in the study area, particularly along Jerome Fork.

Jerome Fork is a tributary of Lake Fork confluent at RM 14.11 that is about 14.72 miles in length and drains an area of 161.5 mi^2. It originates at the junction of Orange Creek and Leidigh Mill Creek. It was channelized in the 1930's by the US Army Corps of Engineers and the Corps maintained drainage until sometime in the 1960's. A log jam removal project was done by the Ashland County SWCD in 2007. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998.

Several of the tributaries to Jerome Fork were designated WWH in the 1978 WQS but no biological sampling was conducted to evaluate the appropriateness of the use. The 2007 sampling effort identified several instances in which streams are more accurately categorized with a Coldwater Habitat Aquatic Life Use. Recently developed methods for delineating coldwater streams include the presence of four or more coldwater macroinvertebrate taxa or a minimum of two coldwater fish in combination with at least two primary coldwater macroinvertebrates. These criteria were also applied to streams that may have had biological sampling but were not evaluated based on the current method.

Orange Creek is a tributary of Jerome Fork confluent at RM 14.72 that is about 10.8 miles in length and drains an area of 24.4 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. Substrates in Orange Creek were somewhat embedded due, in part, to free access of livestock along the banks of the stream. Nevertheless, the overall habitat easily met expectations for a WWH use. QHEI scores of 69.5 and 81.0 were recorded at RMs 6.32 and 4.85, respectively.

Leidigh Mill Creek is a tributary of Jerome Fork confluent at RM 14.71 that is about 8.3 miles in length and drains an area of 11.5 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. Evaluation of the stream at RM 1.91 verified the WWH use. A QHEI score of 66.5 was recorded and typical warmwater attributes predominated.

Lang Creek is a tributary of Jerome Fork confluent a RM 12.28 that is about 9.3 miles in length and drains an area of 34.6 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998.

Jamison Creek is a tributary of Lang Creek confluent at RM 0.38 that is about 5.1 miles in length and drains an area of 13.9 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998.

Katotawa Creek is a tributary of Jerome Fork confluent at RM 9.90 that is about 7.4 miles in length and drains an area of 13.6 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. The stream had a diverse instream and riparian habitat features (QHEI = 83.0). Four coldwater bugs and four coldwater fish (central mudminnow, redside dace, southern redbelly dace and mottled sculpin) were collected at RM 3.49. Based on the current method of delineation, a CWH aquatic life use is recommended for Katotawa Creek.

Newell Run is a tributary of Jerome Fork confluent at RM 9.31 that is about 6.5 miles in length and drains an area of 9.0 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. The 2007 sampling at RM 1.0 produced a diverse macroinvertebrate assemblage that included five coldwater taxa. Three coldwater fish species were collected. These results support a change of the aquatic life use to CWH for Newell Run.

Oldtown Run is a tributary of Jerome Fork confluent at RM 4.29 that is about 8.5 miles in length and drains 23.0 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS.. However, a CWH use is recommended. Four coldwater macroinvertebrates and two coldwater fish species (redside dace, brook stickleback) were recorded at RM 4.31.

Quaker Springs Run is a tributary of Oldtown Run confluent a RM 1.26 that is about 5.7 miles in length and drains an area of 9.6 mi^2. It is within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. Based on the 2007 sampling of Quaker Springs Run and current designation protocols, a CWH Aquatic Life Use is recommended. Two coldwater fish (redside dace and southern redbelly dace) and three primary coldwater macroinvertebrates were recorded at RM 1.97

Aquatic Life Use Attainment Status

Biological and habitat assessments were conducted at 14 sites in 2007. Aquatic life use attainment status is presented in Table 5a and Figure 5a, representing approximately 25 stream miles in the Jerome Fork Mohican assessment unit. Thirteen sites representing 20 assessed stream miles, fully met the current or recommended aquatic life use. One site, representative of five assessed miles of Jerome Fork, partially met the WWH aquatic life use.

Biological sampling results from Lang Creek met ecoregional expectations; however there was evidence that moderate nutrient enrichment was contributed via runoff from the surrounding agricultural areas. Water column concentrations were relatively low but growths of attached algae indicated that nutrients were introduced into the stream and subsequently utilized in the algal biomass. The fish community in Lang Creek yielded IBI scores in the very good to exceptional range at RMs 5.26 and 3.1 but pollution tolerant creek chubs were the single most numerous species at both sites. The macroinvertebrate community similarly at least marginally met ecoregional expectations but also reflected an enriched condition. Additional nutrients were contributed by the Ashland WWTP effluent which discharges to Lang Creek at RM 0.34 and affected Jerome Fork.

Much of Jerome Fork was confined within steep banks. Consequently, there was effectively no floodplain upon which fine substrates could be deposited. Larger substrates and interstitial spaces were buried by sediment and limited riffle/run/ pool development was present. The watercourse had been historically channelized and recent log removal was evident at RM 2.56. The removal of woody debris and trees from within and adjacent to the stream may temporarily allow for better drainage. However, increased erosion is likely and the cycle of stream bank destabilization and log jam creation is perpetuated.

A significant increase in nutrients was documented in the water chemistry results downstream from Lang Creek. Effluent from the Ashland WWTP reaches Jerome Fork via Lang Creek. Three of four sites on Jerome Fork fully met the WWH aquatic life use including upstream from and immediately downstream from the Lang Creek. Partial attainment was documented at RM 7.90 due to impacts realized on the fish community. The fish community generated a sub par IBI score at RM 7.90, apparently in response to the accumulated impacts from habitat conditions and the introduction of nutrients from the Ashland WWTP. Recovery in the fish community to a level that marginally met ecoregional expectations was documented at RM 2.56. The occurrence of pollution sensitive fish was limited at all four sampled locations. The macroinvertebrate community exceeded ecoregional expectation at the four sampled locations on Jerome Fork; however an enrichment affect was also noted downstream from Ashland.

Oldtown Run, Quaker Springs Run, Newell Run and Katotawa Creek supported diverse fish and macroinvertebrate communities that not only met CWH expectations but also rated as exceptional based on IBI scores and qualitative macroinvertebrate sampling. Of this group, Newell Run yielded the highest diversity of fish (21 species) and

macroinvertebrates (73 taxa), possibly due to increased primary productivity, as evidenced by a heavier level of algal growth observed at RM 1.00. Redside dace were collected from all four streams and southern redbelly dace were collected from Quaker Springs Run, Newell Run and Katotawa Creek. Populations of these dace have been declining on a statewide basis so there occurrence in these streams is notable.

Fish and macroinvertebrate sampling was conducted on Jamison Creek at RM 0.30. Most of the watershed is within the city limits of Ashland and receives significant urban runoff. Relatively brief rainfall events can generate flashy flow events as a result. Nevertheless, instream and riparian habitat features were of sufficient quality to expect attainment of the WWH use (QHEI= 65.0). Qualitative macroinvertebrate sampling yielded a fairly typical warmwater assemblage. The fish community generated an IBI score in the exceptional range (IBI=54). Full attainment of the WWH was documented and chemical sampling did not suggest any chronic problems, however, bacteria sampling demonstrated that runoff from the surrounding area is of variable quality. *E. coli* concentrations ranged from 210 per 100 ml to in excess of 20000 /100ml.

Orange Creek became nearly intermittent during the sampling period and experienced occasional low dissolved oxygen levels, due to a lack of reaeration. Livestock had ready access to the stream along much of the water course and severe bank erosion was noted at RM 6.32. These were factors that likely affected the stream biology but not so severely that the WWH use was threatened. The macroinvertebrate community condition was rated as good and marginally good at RMs 6.32 and 4.85, respectively. The fish community yielded IBI scores in the very good to exceptional range and reside dace, a declining species, were collected from both locations.

Leidigh Mill Creek at RM 1.91 was similar to the Orange Creek, in that minimal downstream flow occurred between the pools thus reaeration was limited. The fish and macroinvertebrate communities, nevertheless, met expectations of the recommended WWH aquatic life use.

Recreation Use Status

The overall recreation use for this watershed unit is considered impaired. Data used in the evaluation included E. coli counts from 66 separate samples collected at 13 sites.

A seasonal geometric mean was computed at each site and individual results were compared to the PCR single sample maximum criterion of 298 CFU/100 ml to help identify problem areas. Bacteria levels were consistently elevated throughout the Jerome Fork (Figure 5a) and much lower in the tributary streams. Jerome Fork at Ashland CR 1302 (RM 12.08) had the highest counts among mainstem sites. The geometric mean was 2003 CFU/100 ml and 4 of 5 exceeded the maximum, including one > 20000 CFU/100 ml. Jamison Creek at Ashland CR 1302 (RM 0.30) had the highest counts among tributary streams. The geometric mean was 794 CFU/100 ml and 4 of 5 exceeded the maximum, including one > 20000 CFU/100 ml. Two SSOs in the Ashland sewage collection system discharge to Jamison Creek. Both samples with counts > 20000 were collected on July 11, 2007 following an isolated rain storm.

No Class A stream assessments were done in this WAU. Recreation in this area is limited and, in fact, none was observed during the field season. This is probably due to the fact that the Jerome Fork is channelized and low gradient.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 5c and 5d, respectively. The City of Ashland WWTP is the only facility classified as a major discharger located in the watershed unit.

Ashland WWTP (permit # 2PD00010) is located at 865 US Route 42, Ashland, OH. It serves 21,249 people and ten industrial users that contribute about 0.44 MGD. The city implements an industrial pretreatment program that was approved in 1984. The plant was originally built in 1930 and has been expanded and upgraded several times since. The influent line directs sewage through coarse bar screens and into a wet well where it is lifted by pumps into the treatment plant. Preliminary treatment includes medium bar screens and an aerated grit chamber. Advanced treatment is done by the solids contact process in a series of primary settling tanks, plastic media trickling filters, and final settling tanks. The wastewater is disinfected with UV light and post aeration is done by a cascade structure. Final effluent discharges to Lang Creek from outfall 001 at RM 0.34. The plant is designed to treat 5.0 MGD with a capacity of 10.0 MGD. Flows above capacity are screened and enter a 4.34 MGD equalization basin that was completed in 2006. This basin is divided into two aerated cells that drain back into the influent wet well when the water level goes down. The basin currently has an overflow that combines with outfall 001 to form outfall 003. The EQ basin was made necessary because of an estimated 0.8 MGD of infiltration and inflow (I/I) into the sewer system. The collection system consists of 100% separate sewers and includes 11 lift stations and two SSOs that overflow into Jamison Creek. Ashland is undertaking an extensive plan to limit I/I, ranging from the elimination of inflow from sump pumps and down spouts to rehabilitation or replacement of lines to prevent groundwater infiltration. Once the project is completed, it should be possible to eliminate the remaining SSOs and discontinue overflows from the EQ basin. Sludge generated at the plant is stabilized using hydrated lime, dewatered with a filter press, and land applied at agronomic rates under an approved management plan.

Facilities regulated by an NPDES permit are required to conduct routine self monitoring of effluent quality and quantity. Results are reported to Ohio EPA as monthly operating report (MOR) data. Each permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. They also include monthly average limits and daily or weekly maximum limits, depending on the monitoring requirements. For example, copper is tested once per week, while $cBOD_5$ and suspended solids are tested 3 times per week. This MOR data can be used to track compliance as well as to evaluate historical trends. Several permit limit violations were documented at the Ashland WWTP in 2007. The monthly average loading and concentration limits for copper were violated in February. The weekly maximum concentration was violated in 3 samples and the weekly maximum loading was violated

once. During August there was a major flood event that resulted in monthly average loading and concentration limit violations for $cBOD_5$ and suspended solids. The weekly average concentration for $cBOD_5$ was violated twice and for suspended solids once. There was also a daily maximum violation for pH. The monthly average loading and concentration limits for $cBOD_5$ were violated again in September and October. The weekly average loading and concentration was violated once each month. The monthly average concentration limit for copper was violated again in November and was caused by one violation of a weekly maximum.

Several overflows from the EQ basin were reported in 2007 due to heavy snow melt or rainfall (1/8, 1/16, 3/2, and 8/22). This blends with final effluent from the rest of the plant after the UV disinfection system.

The Ohio EPA conducts 48-hr acute screening bioassays to evaluate toxicity during the permit compliance and renewal process. Grab and composite derived outfall 001 effluents and Lang Creek upstream and in the near field mixing zone were last tested in 2003. The fathead minnow *Pimephales promelas* and daphnid *Ceriodaphnia dubia* were used as test organisms. Test number 03-2731-NW was done in March and the effluents were not acutely toxic. Test number 03-2751-NW was done in April and again the effluents were not acutely toxic.

Pollutant loadings over the last 20 years were evaluated based on monthly operating report data using the Liquid Effluents Analysis Processing System (LEAPS). Annual summaries of $cBOD_5$ and suspended solids loadings are displayed in Figures 5b and 5c, respectively. They show a very large decrease in loads for these pollutants after the plant was upgraded to an advanced treatment system in 1989. Load rates have remained fairly stable since then. An annual summary for nitrate-nitrite is displayed in Figure 5d. This pollutant has shown a steady increase in loads over the last eight years or so. Nutrient levels in the Jerome Fork are a concern because they are consistently above desired target levels.

Water Quality Status

Results for select water quality constituents are summarized in Table 5b. The standard (minimum/maximum, average) or target used to evaluate each constituent is included in the table. Results above these levels are considered degraded and highlighted in bold. The seasonal geometric mean computed for E. coli is presented in parenthesis. In general, water quality was good and only a few problems were documented.

Four sites were sampled on the Jerome Fork. Nutrient levels were assessed based on statewide target values for wadeable streams of 0.10 mg/L for phosphorus and 1.00 mg/L for nitrate-nitrite. All results for both parameters were below target at US Route 42 (RM 12.98). However, all of the remaining results were well above target due to the Ashland WWTP discharge via Lang Creek (Figure 5b, 5c). The process of nitrification that occurs within the plant is effective at converting organic nitrogen and ammonia into nitrate. This is desired because ammonia is toxic to aquatic life, but the unfortunate consequence is nutrient enrichment and subsequent algae blooms.

Dissolved oxygen was not identified as a problem in any of the grab samples tested in the Jerome Fork. All 27 samples tested were above the 5.0 mg/L OMZA criterion for WWH streams. Four automatic meters were also deployed in this segment of the mainstem and they were programmed to measure diurnal levels over a 48-hr period. A summary of the hourly readings is presented in Table 5e. Only one of the meters showed any problems. The meter deployed at US Route 42 (RM 12.98) recorded levels below 5.0 mg/L in 10 of 45 hourly intervals. All of the low readings were during the late evening to early morning hours of the second day. The minimum reading was 3.70 mg/L and the diurnal flux was 6.37 mg/L.

Metals were elevated in the sample collected from Jerome Fork at Ashland CR 1302 (RM 12.08) following an isolated rain storm. Levels of copper, lead, zinc, and iron were all above normal compared to the other results. The copper concentration exceeded the OMZA set for WWH and the iron concentration exceeded the OMZA set for AWS. This is likely an impact from urban storm water that washes into the river following a rain event. It might also reflect an impact from an SSO or upset at the WWTP.

Nine sites on eight different tributary streams were sampled in the WAU. Nutrient levels were assessed based on statewide target values for wadeable streams of 0.10 mg/L for phosphorus and 1.00 mg/L for nitrate-nitrite. Levels of phosphorus are not a major concern. Overall only 2 of 45 (4%) samples tested were above the target and the average concentration was 0.035 mg/L. Levels of nitrate-nitrite might be more problematic. A total of 19 of 45 (42%) samples tested were above the target and the average concentration was 0.99 mg/L.

Dissolved oxygen was a problem in a couple of the tributary streams. Orange Creek at Ashland CR 620 (RM 6.32) had 2 of 5 grab samples below 3.0 mg/L. Leidigh Mill Creek adjacent State Route 511 (RM 1.91) had 1 of 5 grab samples below 5.0 mg/L. All of the low readings were recorded during periods of dry weather and stagnant flow. These conditions limit reaeration from the atmosphere because turbulence helps to diffuse oxygen. Newell Run at Montgomery TR 655 (RM 1.00) consistently had saturation levels above 100%. Rocks in the stream had a lot of attached algae, indicating the high saturation levels are due to accelerated photosynthetic activity.

Sediment Quality Status

Sediment samples were collected in the Jerome Fork at US Route 42 (RM 12.98), Ashland CR 1302 (RM 12.08), and Ashland CR 175 (RM 2.56). Most fine sediment was flushed out of the river during a major flood event in late August. Samples were tested for metals, PAH, PCB, and organochlorine insecticides.

Low levels of PAH and phthalate were detected at Ashland CR 1302 below Ashland. These types of compounds are common in urban areas. PAHs come from the incomplete combustion of fossil fuels and phthalates are an additive used to soften plastics. The compound 4,4-DDD was detected at 13.8 µg/kg, which exceeds the TEC of 5.28 µg/kg for total DDT (sum of DDD, DDE, and DDT). This insecticide has been

banned in the US since 1973, but it is extremely persistent in the environment. No organic compounds were detected at the other two sites and all metals results were below their respective SRV.

Public Water Supply Use Status
There are no facilities in the WAU that use surface water as a drinking supply.

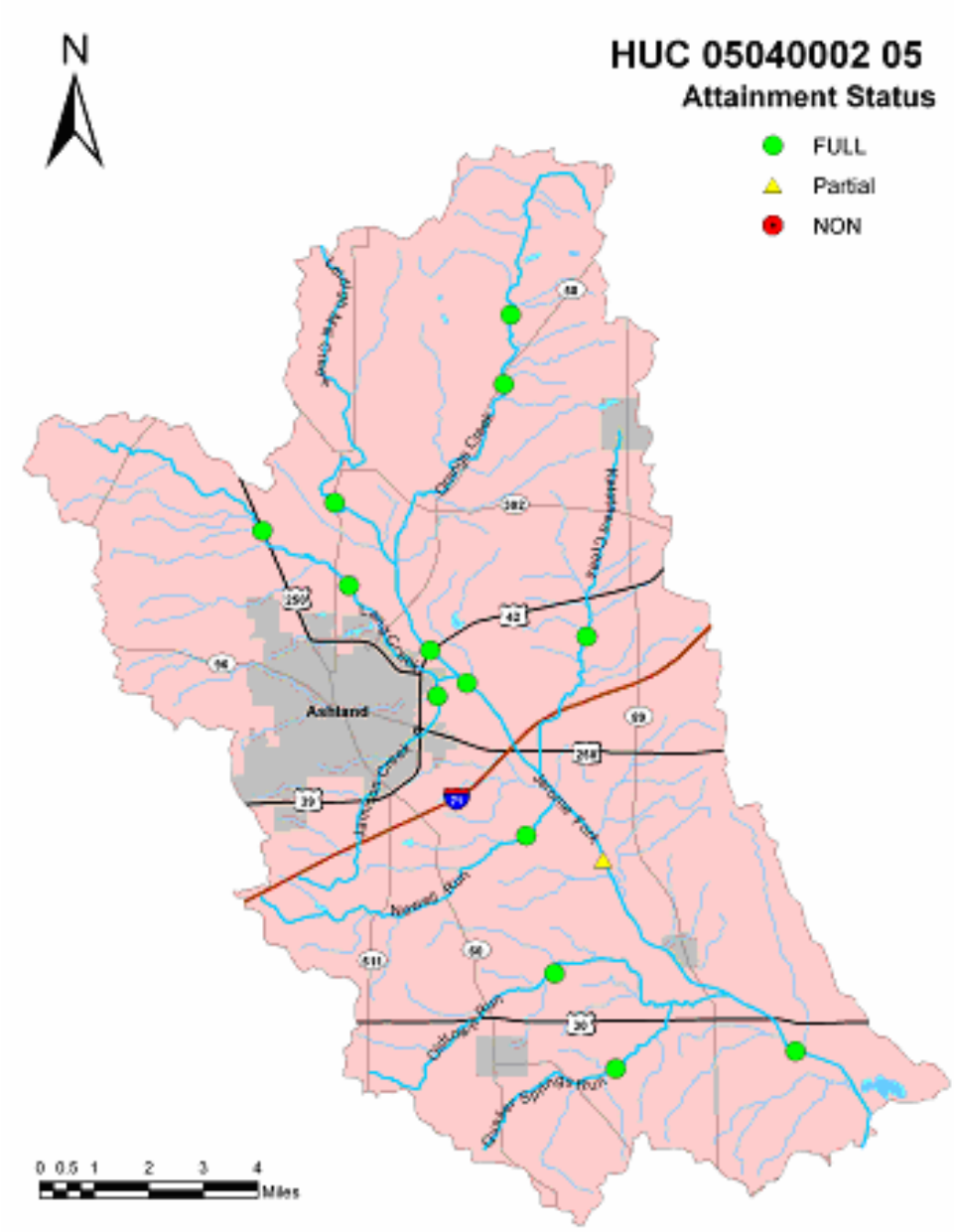

Figure 5a. Sampling Locations and Aquatic Life Use Attainment Status in the Jerome Fork Mohican River WAU (0504000206), June 15 to October 15, 2007.

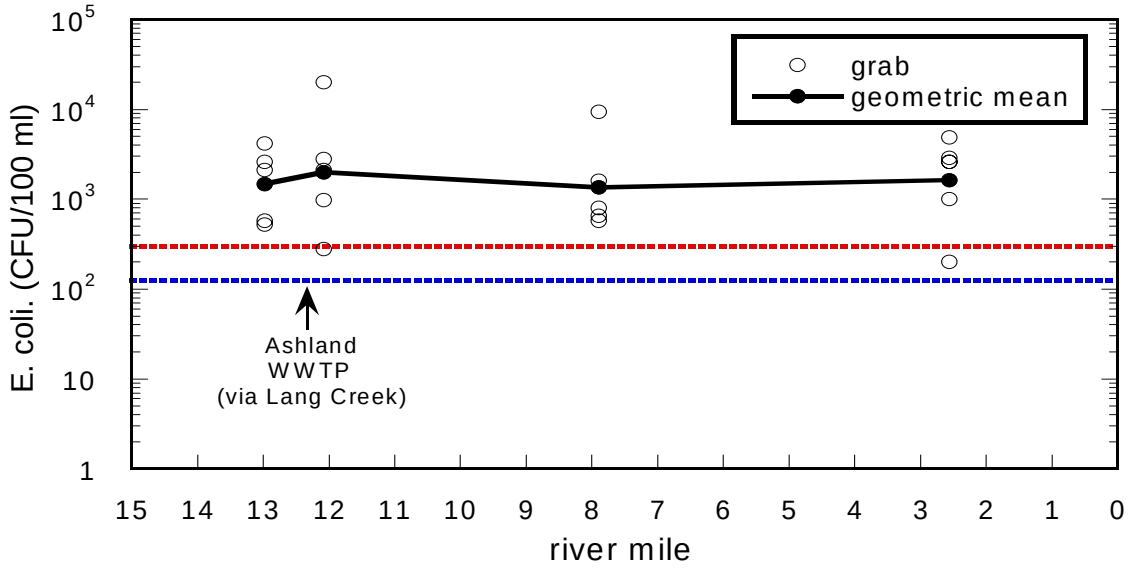

Figure 5b. Bacteria levels in Jerome Fork from all samples collected during the 2007 recreation season (5/1-10/15). The blue line represents the time weighted PCR geometric mean criterion of 126 CFU/100 ml and the red line the maximum criterion of 298 CFU/100 ml.

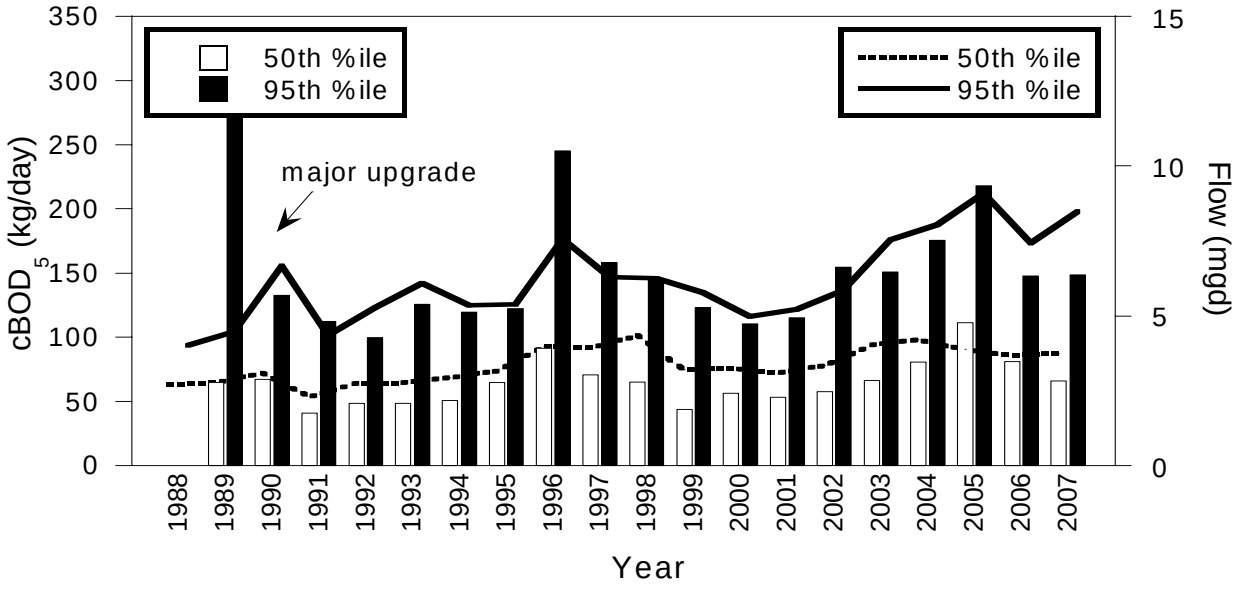

Figure 5c. Annual summary for cBOD5 calculated at the Ashland WWTP based on MOR data.

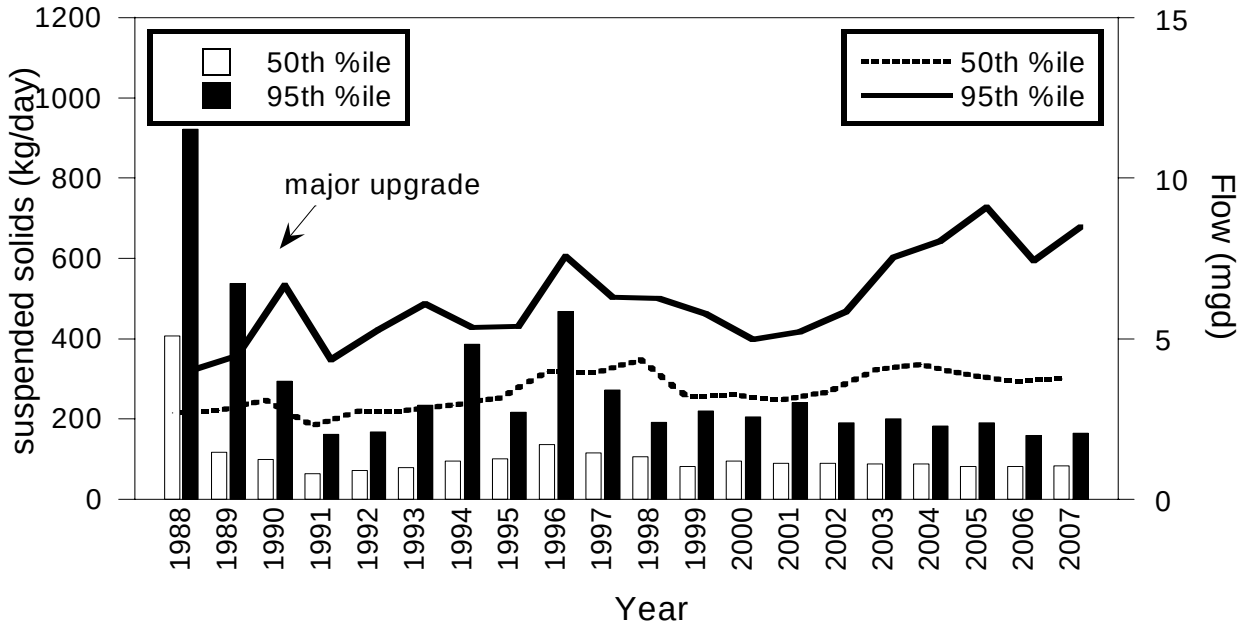

Figure 5d. Annual summary for suspended solids calculated at the Ashland WWTP based on MOR data.

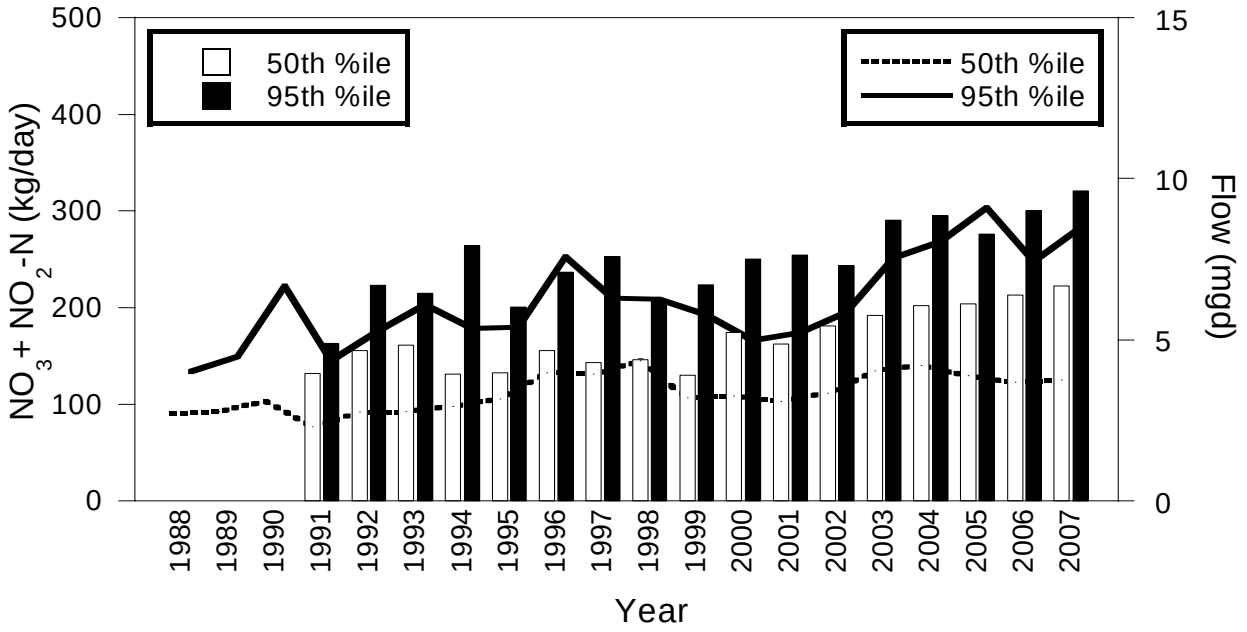

Figure 5e. Annual summary for nitrate-nitrite calculated at the Ashland WWTP based on MOR data.

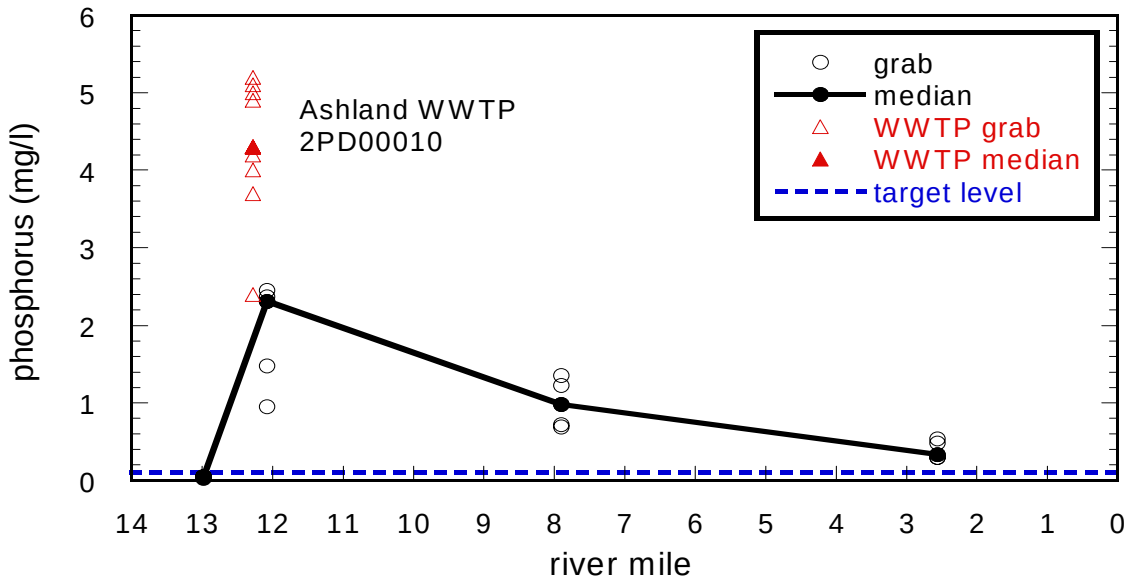

Figure 5f. Summary of phosphorus concentration measured in grabs from the Jerome Fork and Ashland WWTP effluent (MOR data) plotted against the target level.

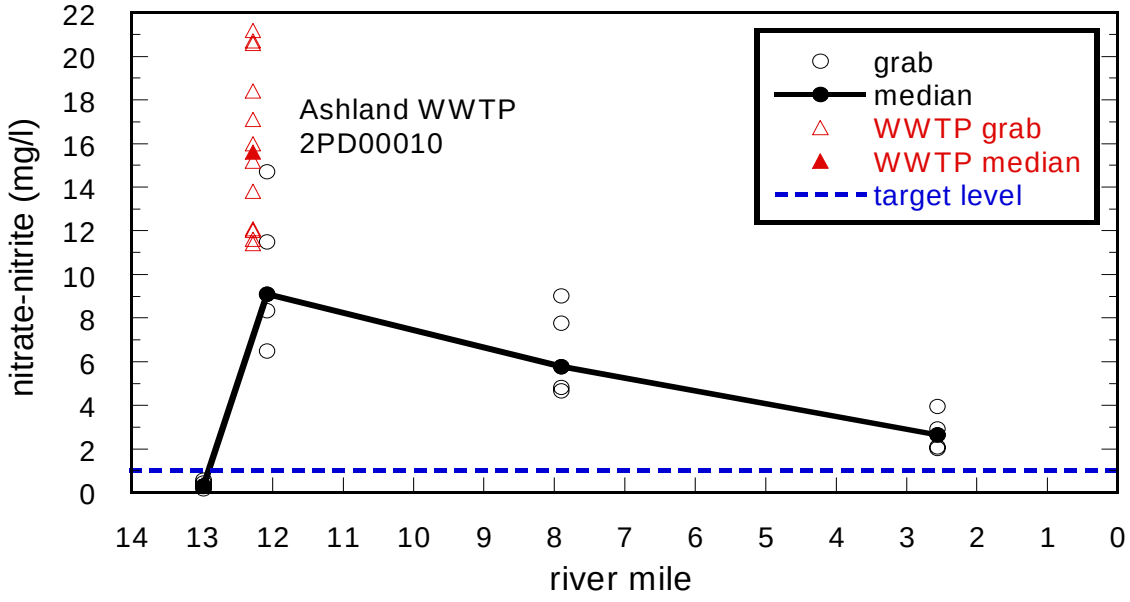

Figure 5 g Summary of nitrate-nitrite concentration measured in grabs from the Jerome Fork and Ashland WWTP effluent (MOR data) plotted against the target level.

Table 5a. Aquatic life and recreational use attainment status for sampling locations in the Jerome Fork Mohican River WAU (0504000206). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Jerome Fork	12.98	WWH	FULL	47	10.0	54	50.0		
Jerome Fork	12.08	WWH	FULL	42	9.0	G	52.5		
Jerome Fork	7.90	WWH	Partial	33*	7.4ns	G	56.5	Nutrient/Eutrophication biological Indicators, Sedimentation/Siltation	Channelization, Municipal Point Source Discharges
Jerome Fork	2.56	WWH	FULL	41	7.7ns	48	50.0		
Leidigh Mill Creek	1.91	WWH-R	FULL	46		G	66.5		
Orange Creek	6.32	WWH-R	FULL	50		G	69.5		
Orange Creek	4.85	WWH-R	FULL	48		MGns	81.0		
Jamison Creek	0.30	WWH	FULL	54		G	65.0		
Lang Creek	5.26	WWH	FULL	48		MGns	63.0		
Lang Creek	3.15	WWH	FULL	48		VG	51.5		
Katotawa Creek	3.49	CWH-R	FULL	48		E	83.0		
Newell Run	1.00	CWH-R	FULL	54		E	80.5		
Quaker Springs Run	1.97	CWH-R	FULL	54		E	67.5		
Oldtown Run	4.31	CWH-R	FULL	52		E	53.5		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 5b. Results for select water quality constituents tested in grab samples from the Jerome Fork-Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Orange Creek WWH, PCR, AWS, IWS wadeable stream (24.4 mi^2)	6.32	WWH	DO (mg/L) (5.0, 4.0)	7.29, **3.22**, **2.92**, 6.79, 7.00
			t-P (mg/L) (0.08)	0.014, 0.010, 0.010, 0.030, 0.032
			NO_3-NO_2 (mg/L) (1.00)	<0.10, <0.10, 0.12, 0.10, 0.10
		PCR	E. coli. (#/100 ml) (298, 126)	360, 440, 400, 340, 200 (336)
Leidigh Mill Creek WWH, PCR, AWS, IWS headwater stream (11.5 mi^2)	1.91	WWH	DO (mg/L) (5.0, 4.0)	8.36, 7.83, **4.64**, 6.57, 6.05
			t-P (mg/L) (0.08)	0.076, <0.010, 0.040, 0.010, 0.069
			NO_3-NO_2 (mg/L) (1.00)	0.93, 0.36, 0.11, **1.18**, 0.84
		PCR	E. coli. (#/100 ml) (298, 126)	590, 490, 2000, 680, 240 (624)
Lang Creek WWH, PCR, AWS, IWS wadeable stream (34.6 mi^2)	5.26	WWH	t-P (mg/L) (0.10)	<0.010, 0.014, 0.027, 0.023, 0.034
			NO_3-NO_2 (mg/L) (1.00)	<0.10, <0.10, 0.77, <0.10, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	140, 120, **5100**, **440**, 230 (**387**)
	3.15	WWH	t-P (mg/L) (0.10)	0.017, <0.010, 0.043, 0.015, 0.017
			NO_3-NO_2 (mg/L) (1.00)	1.40, 1.63, 2.10, 1.69, 1.55
		PCR	E. coli. (#/100 ml) (298, 126)	250, **890**, **2600**, 270, **570** (**616**)

Table 5b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Jerome Fork WWH, PCR, AWS, IWS wadeable stream (159 mi^2)	12.98	WWH	t-P (mg/L) (0.10)	0.043, 0.029, 0.042, 0.046, 0.055
			NO_3-NO_2 (mg/L) (1.00)	0.58, 0.29, 0.17, 0.43, 0.30
		PCR	E. coli. (#/100 ml) (298, 126)	2100, 520, 580, 2600, 4200 (1472)
	12.08	WWH	t-P (mg/L) (0.10)	1.48, 2.45, 0.95, 2.37, 2.31
			NO_3-NO_2 (mg/L) (1.00)	8.33, 14.7, 6.48, 9.09, 11.5
			Cu (µg/L) (23.3, 14.8)	<10, <10, **17**, <10, 10
		PCR	E. coli. (#/100 ml) (298, 126)	980, 280, >**20000**, **2800**, **2100** (**2003**)
		AWS	Fe (µg/L) (- , 5000)	654, 578, **5520**, 688, 706
	7.90	WWH	t-P (mg/L) (0.10)	0.695, 1.23, 1.35, 0.725, 0.985
			NO_3-NO_2 (mg/L) (1.00)	4.66, 7.76, 9.01, 4.83, 5.79
		PCR	E. coli. (#/100 ml) (298, 126)	660, 580, 9400, 1600, 800 (1357)
	2.56	WWH	t-P (mg/L) (0.10)	0.133, 0.146, 0.458, 0.268, 0.122, 0.210, 0.257, 0.296, 0.487, 0.533, 0.300, 0.336
			NO_3-NO_2 (mg/L) (1.00)	4.54, 3.45, 2.85, 3.63, 3.00, 2.46, 2.26, 2.10, 2.93, 3.95, 2.02, 2.64
		PCR	E. coli. (#/100 ml) (298, 126)	200, 1000, 2600, 4900, 2600, 2900 (1636)

Table 5b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Jamison Creek WWH, PCR, AWS, IWS headwater stream (13.9 mi^2)	0.30	WWH	t-P (mg/L) (0.08)	0.032, <0.010, **0.101**, 0.041, 0.064
			NO_3-NO_2 (mg/L) (1.00)	<0.10, <0.10, 0.76, 0.14, <0.10
		PCR	E. coli. (#/100 ml) (298, 126)	360, 440, >20000, 390, 210 (764)
Katotawa Creek WWH, PCR, AWS, IWS headwater stream (13.6 mi^2)	3.49	WWH	t-P (mg/L) (0.08)	**0.159**, 0.010, <0.010, 0.014, 0.012
			NO_3-NO_2 (mg/L) (1.00)	0.73, 0.84, 0.40, 0.75, 0.63
		PCR	E. coli. (#/100 ml) (298, 126)	60, 170, **400**, **440**, 140 (**191**)
Newell Run WWH, PCR, AWS, IWS headwater stream (9.0 mi^2)	1.00	WWH	DO (%)	109.2, 128.5, 107.3, 122.0, 136.6
			t-P (mg/L) (0.08)	0.024, 0.011, 0.013, <0.010, 0.012
			NO_3-NO_2 (mg/L) (1.00)	**1.71**, **1.42**, **1.28**, 0.58, 0.27
		PCR	E. coli. (#/100 ml) (298, 126)	**520**, **710**, **2000**, 260, 270 (**553**)
Oldtown Run WWH, PCR, AWS, IWS wadeable stream (23.0 mi^2)	4.31	WWH	t-P (mg/L) (0.10)	0.034, 0.063, 0.046, 0.054, 0.053
			NO_3-NO_2 (mg/L) (1.00)	2.32, 1.67, 1.52, 1.23, 1.42
		PCR	E. coli. (#/100 ml) (298, 126)	**670**, 280, **1000**, **810**, 180 (**487**)
Quaker Springs Run WWH, PCR, AWS, IWS headwater stream (9.6 mi^2)	1.97	WWH	t-P (mg/L) (0.08)	0.030, 0.050, 0.057, 0.056, 0.052
			NO_3-NO_2 (mg/L) (1.00)	3.52, 3.67, 2.60, 1.99, 1.90
		PCR	E. coli. (#/100 ml) (298, 126)	200, 260, **380**, **360**, 200 (**270**)

Table 5c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Mapleton School	2PT00040	UT to Orange Creek	3.0	0.022 MGD package plant
Agape Acres	2PY00037	Leidigh Mill Creek	2.0	0.020 MGD package plant
Ashland WWTP	2PD00010	Lang Creek	0.34	10.0 MGD trickling filter
BP Oil Co.	2IN00181	Town Run	1.5	storm water pond
Southwood Estates	2PW00014	UT to Jamison Creek	0.1	0.020 MGD package plant
Ashland WTP	2IW00002	Lang Creek	0.98	lime sludge lagoons
Perkins	2PR00221	Jerome Fork	10.50	0.020 MGD package plant
Truckstops of Amer.	2IN00071	Jerome Fork	10.49	storm water pond
Green Acres MHP	2PY00058	UT to Jerome Fork	2.2	0.018 MGD package plant
Fin, Feather & Fur	2PR00145	Katotawa Creek	0.45	0.005 MGD package plant
Jeromesville WWTP	2PA00092	UT to Jerome Fork	0.1	0.066 MGD package plant
Jeromesville WTP	2IZ00072	UT to Jerome Fork	0.6	ion exchange backwash
Coburn Inc.	2PR00140	UT to Oldtown Run	0.3	0.0045 MGD package plant
Hayesville WWTP	2PA00089	UT to Oldtown Run		0.060 MGD package plant
Ashland Co. JVS	2PT00011	UT to Oldtown Run		0.040 MGD package plant

Table 5d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Altec Industries	2GR00575	Lang Creek	Industrial Storm Water
Archway Cookies	2GG00013	Jamison Creek	Industrial Storm Water
Ashland Chemical Co.	2GR00124	UT to Sprinkle Lake	Industrial Storm Water
Ashland Precision Tooling	2GR00463	Jamison Creek	Industrial Storm Water
City of Ashland	2GR00558	Lang Creek	Industrial Storm Water
Hedstrom Corp.	2GR00411	Town Run	Industrial Storm Water
Hospira Inc.	2GR00436	Town Run	Industrial Storm Water
Ashland Specialty Chemical	2GR00124	Town Run	Industrial Storm Water
Budd Co.	2GR00115	Town Run	Industrial Storm Water
Dalton Corp.	2GR00002	Town Run	Industrial Storm Water
FE Myers	2GR00376	Town Run	Industrial Storm Water
Garber Co.	2GR00127	Town Run	Industrial Storm Water
General Hone Corp.	2GR00135	Town Run	Industrial Storm Water
General Latex & Chemical	2GN00023	Jamison Creek	Non Contact Cooling
Hess & Clark Inc.	2GR00185	Town Run	Industrial Storm Water
Hydromatic Pump	2GR00409	Jamison Creek	Industrial Storm Water
Kehl Kolor Inc.	2GR00066	Town Run	Industrial Storm Water
National Latex Products	2GR00211	Town Run	Industrial Storm Water
Ashland Precast Concrete	2GG00094	Town Run	Industrial Storm Water

Table 5d. Continued

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Packaging Corp. of Amer.	2GG00141	Town Run	Industrial Storm Water
Patterson & Sons Inc.	2GR00238	Town Run	Industrial Storm Water
Philway Products Inc.	2GR00213	Town Run	Industrial Storm Water
Sarver Paving Co. Inv.	2GG00270	Town Run	Industrial Storm Water
Tremco Inc.	2GR00206	Town Run	Industrial Storm Water
Miller Brothers Paving	2GG00263	Katotawa Creek	Industrial Storm Water
Maverick Innovative	2GR00039	Jerome Fork	Small Sanitary
Coburn Inc.	2GR00037	UT to Jerome Fork	Industrial Storm Water
Custom Hoist Inc.	2GR00156	UT to Jerome Fork	Industrial Storm Water

Table 5e. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the Jerome Fork.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
12.98	45	6.59	6.27	3.70	10.07	6.37
12.08	39	6.87	6.65	6.21	8.16	1.95
7.90	44	7.27	7.02	6.35	9.50	3.15
2.56	43	7.68	7.57	6.60	9.26	2.66

Muddy Fork Watershed Assessment Unit

The Muddy Fork Mohican River WAU (0504000205) drains a total of 105.7 mi^2 and lies within Ashland and Wayne Counties. The boundary of this watershed encompasses the entire Muddy Fork of the Mohican River. Other streams include Redhaw Creek and Kiser Ditch.

The Muddy Fork was previously assessed in 1998. No aquatic life impairment was documented.

Aquatic Life Use Designations
In-stream and riparian habitats varied from poor to very good condition for the seven sites sampled in the Muddy Fork Mohican River WAU. QHEI scores measured at mainstem and tributary sites ranged between 32.5 at RM 0.38 on Kiser Ditch and 73.5 at RM 23.29 on Muddy Fork. Limited in-stream cover was a negative habitat attribute at all sampled locations.

Muddy Fork is a tributary of the Lake Fork confluent at RM 14.10 that is about 28.9 miles in length and drains an area of 105 mi^2. It is within the EOLP ecoregion and is designated as WWH, PCR, PWS, AWS, and IWS based on a field assessment conducted in 1998. Various modifications of the channel and degrees of recovery were noted at the sampled locations on Muddy Fork. Still, the WWH aquatic life use was appropriate and, with exception of the uppermost site, reinforced by the fish and macroinvertebrate sampling results.

Redhaw Creek is a tributary of Muddy Fork confluent at RM 11.78 that is about 7.2 miles in length and drains an area of 12.7 mi^2. It is within the EOLP ecoregion and is designated as WWH, PCR, AWS, and IWS based on a field assessment done in 1998. Recently developed methods for delineating coldwater streams include the presence of four or more coldwater macroinvertebrate taxa or a minimum of two coldwater fish in combination with at least two primary coldwater macroinvertebrates. Based on the 2007 sampling of Redhaw Creek and current designation protocols, a CWH Aquatic Life Use is recommended. Three coldwater fish (central mudminnow, redside dace and mottled sculpin) and two primary coldwater macroinvertebrates were collected. This recommendation is buttressed by the inclusion of five coldwater macroinvertebrate taxa in the initial 1998 sample.

Kiser Ditch is a tributary of the Muddy Fork confluent at RM 0.92 that is about 6.0 miles in length and drains an area of 19.4 mi^2. It is within the EOLP ecoregion and is designated as WWH, PCR, AWS, and IWS in the 1978 WQS but the uses had not been verified. The 2007 sampling was the first time that biological sampling was utilized to assess the use classification. The QHEI score for Kiser Ditch at RM 0.38 was 32.5. The stream was essentially a straight, deep channel that offered little in terms of habitat for aquatic communities. Gradient was low and the watershed was predominated by wetlands and flat agricultural fields.

Operation of the Mohicanville Dam on the Lake Fork of the Mohican River for flood control results in periodic inundation of the surrounding area. Assigning of a Modified Warmwater Habitat aquatic life use for Kiser Ditch is recommended based on the combination of limited in-stream habitat and altered flow regime.

Aquatic Life Use Attainment Status

Biological and habitat assessments were conducted at 7 sites in 2007. Aquatic life use attainment status is presented in Table 6a and Figure 6a, representing approximately 22 stream miles in the Muddy Fork Mohican assessment unit. Five sites representing 16 assessed stream miles, fully met the current or recommended aquatic life use. The uppermost site on Muddy Fork was representative of 5 assessed stream miles and partially met the WWH use. The site on Kiser Creek, failed to meet the recommended MWH aquatic life use.

The headwaters of the Muddy Fork of the Mohican River are impounded to form Cinnamon Lake. As a result, it appeared that water released from the reservior was negligible during except following periods of significant rainfall. Downstream fro Cinnamon Lake, Muddy Fork at RM 23.29 offered good habitat but riffles were nearly intermittent when macroinvertebrate sampling was conducted. However, a typical WWH macroinvertebrate assemblage was collected. Partial attainment of the WWH use resulted from a fish assemblage that netted a fair IBI score. A QHEI score of 83.0 reflected overall very good habitat conditions and water quality results indicated acceptable water quality. The stream likely goes intermittent during low flow periods and this, more anything else, likely resulted in the less than goal fish score. Pioneering and tolerant fish such as creek chubs and white suckers predominated at RM 23.29. These species are able to take advantage of environmental situations that are in flux such as when water flow is seasonally interrupted.

The remaining sites on Muddy Fork met WWH expectations, however, fish index scores varied exceptional to marginally good. A large sand bed load was noted in Muddy Fork and recovery from past channelization was still ongoing. This somewhat limited the diversity of macroinvertebrates in Muddy Creek and contributed to the inconsistency of the fish index scores. Additionally, the macroinvertebrate community at RM 18.37 reflected a moderate increase in enrichment, possibly in response to nutrients contributed by the West Salem WWTP. No macroinvertebrate sampling was conducted at RM 4.30 due to impoundment by the Mohicanville Dam.

Biological sampling results from Redhaw Creek easily attained the recommended CWH use. An IBI score of 54 was in the exceptional range at RM 2.00 and the stream supported a variety of relatively pollution sensitive darter and sculpin species. Macroinvertebrate sampling at RM 2.54 yielded a very good assemblage that included 19 sensitive taxa. One possible threat to maintaining the high quality resource condition was loss of beneficial in-stream and riparian habitat features. Recent efforts to remove gravel from the bank full channel had

occurred along the stream, leaving the material that remained unstable and subject to redistribution during high flow events.

Kiser Ditch failed to meet MWH use expectations. Flooding rains that preceded biological sampling of Kiser Ditch were impounded by the Mohicanville Dam and inundated agricultural fields and lowland areas along the stream. Decomposition of vegetative material rendered the water anoxic. This water eventually drained into Kiser Ditch. The stream was flowing with septic black water the first week of September 2007. Fish and macroinvertebrate communities were significantly affected as a result. The fish at RM 0.38 were rated as poor and the macroinvertebrates were in very poor condition. This acute condition likely is repeated when impounded floodwaters are subject to elevated temperature typical of the late summer season.

A single declining fish species was collected in the Muddy Creek assessment unit. Redside dace were present in Redhaw Creek and in Muddy Creek upstream from Redhaw Creek.

Recreation Use Status

The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 36 separate samples collected at 7 sites.

No Class A stream assessments were done in this WAU. Recreation in this area is limited and, in fact, none was observed during the field season. This is probably due to the fact that the Muddy Fork is channelized and low gradient.

Point Source Pollutant Loadings

Facilities regulated by an individual NPDES permit are listed in Tables 6c. No facilities classified as major dischargers exist in this WAU.

<u>West Salem WWTP</u> (permit # 3PB00053)

The Village of West Salem is located in northwestern Wayne County, at the intersections of State Routes 301 & 42 and owns and operates a 204,000 gpd wastewater treatment plant. The original WWTP and sanitary sewer system was constructed in 1964 and discharges to the Muddy Fork Mohican River at RM 20.28 An addition to the sanitary sewer system was made in 1973 to serve the Lea Crest Estates Trailer Park at the south edge of the Village. The sanitary sewer system is a separate sewer system and serves the entire Village.

On June 6, 1986, Draft Director's Final Findings and Orders and a Draft NPDES permit were sent to the Village from the Ohio EPA. The Village was required to submit a General Plan for wastewater treatment plant improvements and eliminate plant bypasses to meet final effluent limitations of the effective NPDES permit (required by January 24, 1987).

On December 16, 1999, the Ohio EPA filed a Consent Order against the Village for operating the wastewater treatment plant and sewer system in such a manner as to result in numerous violations of the discharge limitation and monitoring requirements of their NPDES Permit

Presently, the Village continues to have plant bypasses that are significant in amount and frequency. The Village hired an engineer to conduct a recent study of the collection system to locate potential sources of I&I. This study indicated the Lea Crest Estates Trailer Park to be a major contributor to the I&I problem. As a result, the Village drafted Resolution 05-42A which declared the need to levy a special assessment for the improvement of the sewer system within the trailer park.

The active NPDES permit for the facility, 3PB00053*HD contains a Schedule of Compliance that requires the Village initiate a Bypass Elimination Plan. By July 1, 2009, the Village is required to submit to a bypass elimination plan to either eliminate the causes of the excessive I&I or provide measures to control bypasses at the wastewater treatment plant. By July 1, 2010, the Village is required to eliminate all plant bypasses.

Water Quality Status

Results for select water quality constituents are summarized in Table 3b. Water quality was tested at five sites in the Muddy Fork and found to be in fair condition for the most part. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of limited nutrient enrichment in the samples. Nutrient levels in the Muddy Fork were assessed based on statewide target values for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for nitrate-nitrite. Levels of phosphorus are not a major concern; however nitrate-nitrite levels were slightly elevated. The stream wide average (n=28) for phosphorus was 0.073 mg/L and for nitrate-nitrite was 1.48 mg/L.

Water quality was tested at one sites from Redhaw Creek and found to be in good condition. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is no indication of nutrient enrichment in the samples. Nutrient levels were assessed based on statewide target values for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for nitrate-nitrite. The stream wide average (n=5) for phosphorus was 0.015 mg/L and for nitrate-nitrite was 0.64 mg/L.

Water quality was tested at one sites from Kiser Ditch and found to be in good condition. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There was no indication of nutrient enrichment in the samples. Nutrient levels were assessed based on statewide target values for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for

nitrate-nitrite. The stream wide average (n=5) for phosphorus was 0.081 mg/L and for nitrate-nitrite was 0.84 mg/L.

Sediment Quality Status

Only one sediment sample was collected in this WAU from the Muddy Fork at Funk Road and results indicated good sediment quality.

Sediment sample results were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et al*. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. In addition, the Ohio Sediment Reference Value represents ecoregion background conditions based on data collected at Ohio reference sites.

Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment and accumulate in the food chain.

Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. Sample results indicate that no Sediment Quality Guidelines were exceeded.

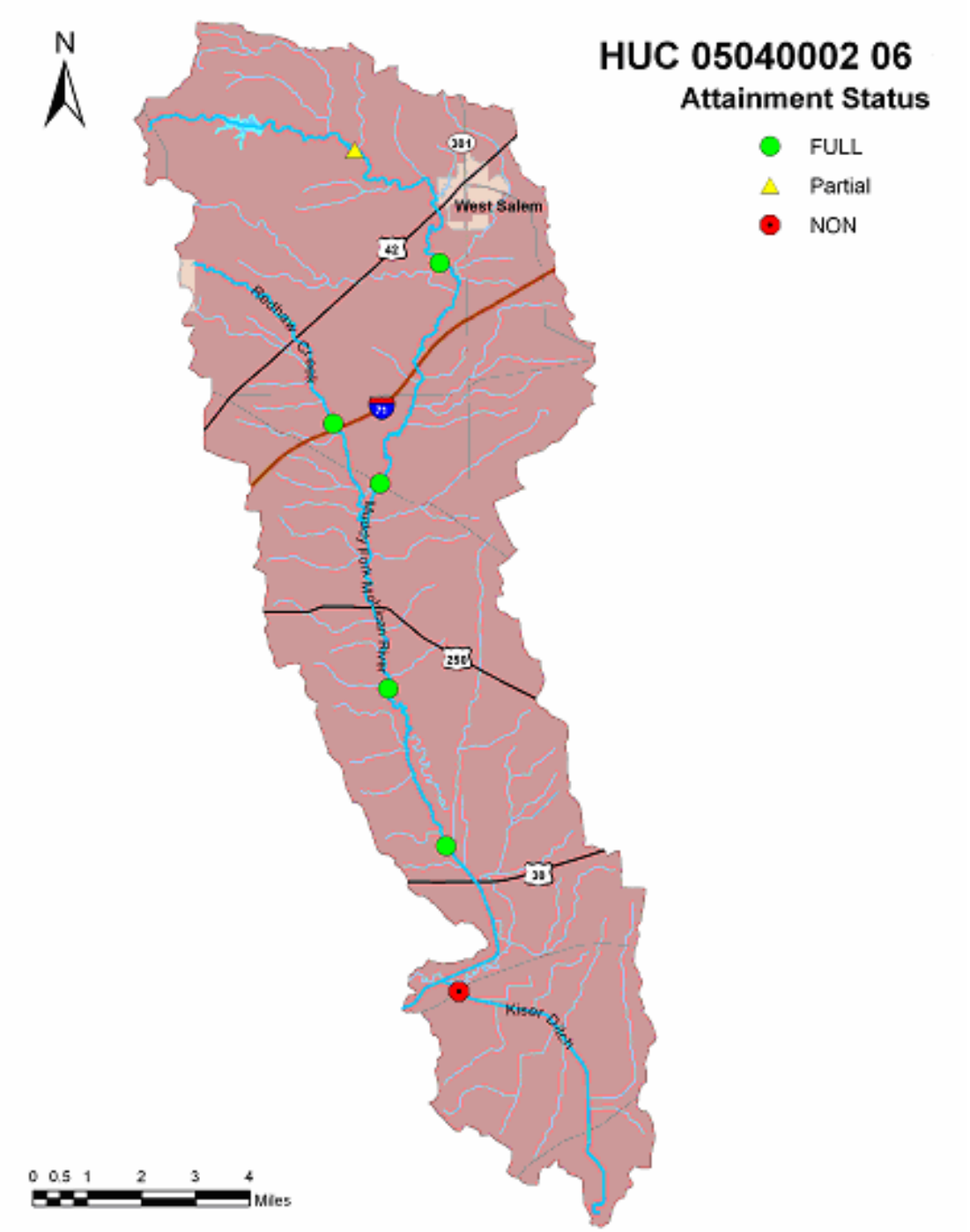

Figure 6a. Sampling Locations and Aquatic Life Use Attainment Status in the Muddy Fork Mohican River WAU (0504000205), June 15 to October 15, 2007.

Table 6a. Aquatic life and recreational use attainment status for sampling locations in the Muddy Fork Mohican River WAU (0504000205). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Muddy Fork Mohican River	23.29	WWH	Partial	34*		G	73.5	Flow alteration	Dam or impoundment
Muddy Fork Mohican River	18.37	WWH	FULL	50		G	73.0		
Muddy Fork Mohican River	13.43	WWH	FULL	38ns	8.6	G	55.0		
Muddy Fork Mohican River	8.20	WWH	FULL	49	10.1	42	70.5		
Muddy Fork Mohican River	4.30	WWH	(FULL)	40	7.7ns		44.0		
Redhaw Creek	2.54	CWH-R	FULL	54		VG	66.5		
Kiser Ditch	0.38	MWH-R	NON	24		VP*	32.5	Sedimentation/Siltation, High flow regime, Dissolved oxygen, Biological Oxygen Demand	Channelization, Dam or Impoundment.

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 6b. Results for select water quality constituents tested in grab samples from the Muddy Fork Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	**River Mile**	**Use**	**Constituent**	**Values**
Muddy Fork WWH, PCR, AWS, IWS wadable stream (105.3 mi^2)	23.29	WWH	t-P (0.10)	**0.109**, 0.081, 0.032, 0.058, **0.180**
			NO_3-NO_2 (mg/L) (1.00)	0.44, 0.37, 0.28, 0.22, 0.50
		PCR	E. coli. (#/100 ml) (298, 126)	100, **2500, 1800, 370, 640**
	18.37	WWH	t-P (0.10)	**0.216, 0.234, 0.168, 0.106, 0.278**
			NO_3-NO_2 (mg/L) (1.00)	**2.39, 2.26, 3.51**, 0.87, **2.41**
		PCR	E. coli. (#/100 ml) (298, 126)	**320, 370, 1500**, 150, **580**
	13.43	WWH	t-P (0.10)	<0.010, <0.010, 0.027, 0.013, 0.012
			NO_3-NO_2 (mg/L) (1.00)	0.65, 0.60, 0.68, 0.62, 0.26
		PCR	E. coli. (#/100 ml) (298, 126)	**500,** 230, **9000, 340, 420**
	8.20	WWH	t-P (0.10)	0.043, 0.052, 0.042, 0.039, 0.044
			NO_3-NO_2 (mg/L) (1.00)	**2.07, 1.78**, 0.84, **1.03, 1.23**
		PCR	E. coli. (#/100 ml) (298, 126)	**1200, 720, 3800,430, 1900**

Table 6b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Muddy Fork WWH, PCR, AWS, IWS wadable stream (105.3 mi^2)	4.30	WWH	t-P (0.10)	0.035, 0.038, 0.029, 0.029, 0.021, 0.035, 0.052, 0.041
			NO_3-NO_2 (mg/L) (1.00)	3.57, 2.86, 2.20, 2.78, 2.78, 1.33, 1,26, 1.51
		PCR	E. coli. (#/100 ml) (298, 126)	**400, 720, 420, 550, 520, 2300**
Redhaw Creek (RM11.78) WWH, PCR, AWS, IWS wadable stream (12.7 mi^2)	2.54	WWH	t-P (0.10)	0.013, <0.010, 0.022, 0.016, 0.015
			NO_3-NO_2 (mg/L) (1.00)	0.90, 0.75, 0.58, 0.57, 0.39
		PCR	E. coli. (#/100 ml) (298, 126)	**1300, 1200, 10600, 960, 1300**
Kiser Ditch WWH, PCR, AWS, IWS wadable stream	0.38	WWH	t-P (0.10)	0.066, 0.041, **0.104**, 0.097, 0.098
			NO_3-NO_2 (mg/L) (1.00)	**1.18, 1.04**, 0.69, 0.91, 0.37
		PCR	E. coli. (#/100 ml) (298, 126)	40, 80, **2000, 4800, 480**

Table 6c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Cinnamon Lake Subdivision	2PR00009	Muddy Fork	25.50	150,000 gpd package plant
Northwest Local Schools	3RT00009	unnamed trib. Muddy Fork (RM 20.35)	----	15000 gpd package plant
West Salem WWTP	3PB00053	Muddy Creek	20.28	0.2 MGD oxidation ditch
American Augers	2PR00172	unnamed trib Wolf Run (RM 2.47)	0.2	7,500 gpd package plant
Hidden Acres MHP/Campground	2PR00239	unnamed trib Wolf Run (RM 2.47)	0.6	15,000 gpd package plant
ODOT Rest Area	3PP00029	unnamed trib Wolf Run (RM 14.67)	1.4	20,000 gpd package plant

Lake Fork Mohican River Watershed Assessment Unit

The Lake Fork Mohican River WAU (0504000207) covers a land area of 79.8 mi^2 and lies within Ashland, Wayne, and Holmes Counties. The boundary encompasses the Lake Fork Mohican River from its origin (RM 14.10) to its confluence with the Mohican River.

This area has not been previously assessed and the impairment status of all uses is listed as unknown in 2006 *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2006).

Aquatic Life Use Designations
All four surveyed streams in the Lake Fork Mohican River WAU were within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. The aquatic life use, however, had not been verified using current protocols involving biological sampling and habitat evaluation. QHEI scores ranged from 44 at RM 3.03 on the Odell Lake Outlet to 87.0 at RM 0.95 on Lake Fork. While habitat quality varied from site to site, biological sampling results demonstrated either actual attainment of, or potential for, meeting the WWH use. One area where the WWH use was not met, Lake Fork upstream from the Mohicanville Dam, was a relatively short reach where impacts other than an irretrievable habitat modifications affected the stream. This reach was also bracketed by areas that fully met the recommended WWH use.

Lake Fork is a tributary of the Mohican River confluent at RM 23.50 that is about 14.1 miles in length and drains an area of 347 mi^2. It originates at the junction of Jerome Fork and Muddy Fork. Significant portions were channelized in the 1930's by the US Army Corps of Engineers and the Corps maintained drainage until sometime in the 1960's. The Mohicanville Dam was constructed by the Corps in 1935 as a flood control structure. It is a dry dam with no permanent pool located at RM 12.04 and it inundates up to 8,800 acres at a spillway elevation of 963 feet above sea level (Figure 7a). A log jam removal project was done on Lake Fork by the Ashland County SWCD in 2007. One of these log jams was located just below State Route 95 (Figure 7b).

The combination of channelization, a high sediment bedload and operation of the Mohicanville Dam produced a monotonous habitat in the reach of the Lake Fork that can be impounded. Modified habitat attributes, particularly related to silt and embeddedness predominated at RM 12.7. Downstream from dam, natural recovery of typical stream habitat attributes was evident. WWH attributes were much more prevalent at RMs 7.43 and 0.95. The increased heterogeneity of the habitat was favorable to wider range of fish and macroinvertebrates.

An Unnamed Tributary of Lake Fork confluent at RM 6.56 is identified as Odell Lake Outlet by the USDA NRCS in its narrative descriptions of 14 digit sub-watersheds. It is about 8.1 miles in length and drains 34.1 mi^2. It is the inlet and

outlet stream of Odell Lake, a 107 acre natural lake located in Holmes County. Upstream from Odell Lake, the stream was channelized with high steep banks. The water was tannin colored, suggested sustained flow from wetlands. The diversity of positive habitat attributes increased downstream from the lake. A QHEI score of 68.5 was recorded at RM 0.59.

Crab Run is a tributary of Odell Lake Outlet confluent at RM 0.92 that is about 5.1 miles in length and drains an area of 10.7 mi^2. The upper reaches have been extensively modified by channelization and removal of riparian vegetation. Several pastures are along its course and many of the livestock have unrestricted watering access (Figure 7c). Habitat at RM 2.17, conversely, included a predominance of favorable habitat features such as gravel/rubble substrates and a wooded riparian corridor.

Plum Run is a tributary of Lake Fork confluent at RM 4.37 that is about 5.2 miles in length and drains an area of 8.6 mi^2. Most of the stream has been channelized; however, at RM 0.13, the stream had maintained or recovered typical form and functions of a WWH stream A QHEI score of 75.5 was recorded and a favorable complex of pool, riffle and run habitats was present.

Aquatic Life Use Attainment Status

Attainment status was determined for seven sites in the Lake Fork Mohican watershed, representing approximately 21 stream miles in the assessment unit. Six sites representing 14 assessed stream miles, fully met the WWH aquatic life use. One site; Lake Fork at RM 14.04, upstream from the Mohicanville Dam; was in non-attainment of the WWH aquatic life use and represented seven assessed miles. Aquatic life use attainment status is presented in Table 7a and Figure 7a.

Above the Mohicanville Dam, both the fish and macroinvertebrate communities reflected an impaired resource condition of Lake Fork. Both the ICI and IBI scores were in the fair range. The MIwb score rated a poor narrative evaluation. In both communities the number and diversity of organisms was depressed. Pollution tolerant common carp comprised over eighty percent of the fish biomass at RM 12.7. Sewage fungus was noted on woody debris and a septic odor was noted by OEPA staff when the macroinvertebrate sampling was conducted at RM 14.04. The macroinvertebrate sampling took place in early September, after flows had receded following a period when the Lake Fork and a significant portion of the watershed had been inundated to control downstream flooding. The historically channelized condition of the stream which trapped sediment, periodic impoundment behind the dam and the subsequent discharge of flood waters that carried a high organic load were principle factors that impaired biological communities within this reach.

Habitat and water quality were substantially improved at RMs 7.43 and 0.95 on Lake Fork compared with upstream from the Mohicanville Dam. Fish and

macroinvertebrate indices exceeded ecoregional expectations at both sites. Thirty six fish species were collected from each site; over twice as many as at RM 12.7. Macroinvertebrate sampling yielded a similar increase in diversity. The number of sensitive macroinvertebrate taxa increased from four at RM 14.04 to 29 at RMs 7.43 and 0.95. River chubs, an increasingly rare fish species in Ohio streams were collected from the Lake Fork at RM 7.43. Sampling at RM 0.95 also yielded river chubs; additionally, three other declining species, streamline chubs, rosyface shiners and mimic shiners, were recorded.

The three sampled tributaries to the Lake Fork met the recommended WWH aquatic life use. Plum Run and Crab Run supported fish assemblages that produced IBI scores in the exceptional range. However both streams were likely somewhat enriched and subject to habitat degradation and organic loading related to livestock production. Pollution tolerant fish comprised over half the number of individuals collected at RM 2.17 on Plum Run and a high predominance of facultative to tolerant macroinvertebrates were noted in Crab Run. The Odell Lake Outlet fish and macroinvertebrate community condition was slightly constrained due to habitat limitations upstream from the lake. Downstream from Odell Lake, fish and macroinvertebrate indices were in the exceptional range. . Two declining fish species were collected from Crab Run, redside dace and southern redbelly dace. Redside dace were present upstream from Odell Lake.

Recreation Use Status

The overall recreation use for this watershed unit is considered impaired. Data used in the evaluation included E. coli counts from 42 separate samples collected at 7 sites.

A seasonal geometric mean was computed at each site and individual results were compared to the PCR single sample maximum criterion of 298 CFU/100 ml to help identify problem areas. Results for the Lake Fork are presented in Figure 7d. Crab Run at Washington TR 473 (RM 2.17) had the highest geometric mean of 3482 CFU/100 ml and 5 of 5 results exceeded the maximum. A pasture is located just upstream from here and the livestock have unrestricted watering access. Plum Run at Holmes CR 22 (RM 0.13) had a geometric mean of 1621 CFU/100 ml and 5 of 5 results exceeded the maximum. No obvious sources were noted at this site. Odell Lake Outlet at State Route 226 (RM 3.03) had a geometric mean of 1533 CFU/100 ml and 5 of 5 results exceeded the maximum. This site is located at the Village of Big Prairie, which does not have central sewage collection and treatment.

Class A stream assessments were done at two sites on the Lake Fork below Mohicanville dam. Recreation on the river is common and both public and private access to the river is provided at several locations. Funk Bottoms Wildlife Area offers 1,422 acres of public hunting and fishing with access along State Route 95. A canoe launch and parking area is provided below the Mohicanville

dam. Lake Fork Canoe Livery is located at State Route 3 and provides canoe and kayak rentals. Camp Toodik also uses this launch area for river trips and operates a 93 acre campground 2.5 miles east of Loudonville on State Route 39/60. A set of five samples collected between 7/5 and 8/2 was used in the calculations. Both sites violated the PCR time weighted geometric mean of 126 CFU/100 ml. At State Route 3 (RM 7.33) the geometric mean count was 1126 CFU/100 ml and at Washington TR 451 (RM 0.95) it was 529 CFU/100 ml. A potential source of contamination at State Route 3 is Idyl Wild Farm; a large dairy operation located about 2.5 miles upstream. Contribution from failed home sewage treatment systems must also be considered.

Point Source Pollutant Loadings

Facilities regulated by either an individual or general NPDES permit are listed in Tables 7c and 7d, respectively. There are no major municipal or industrial facilities in the WAU.

Water Quality Status

Results for select water quality constituents are summarized in Table 7b. The standard (minimum/maximum, average) or target used to evaluate each constituent is included in the table. Results above these levels are considered degraded and highlighted in bold. The seasonal geometric mean computed for E. coli is presented in parenthesis. In general, water quality was good in and very few problems were documented.

Nutrient levels in the Lake Fork were assessed based on statewide target values for small rivers of 0.17 mg/L for phosphorus and 1.50 mg/L for nitrate-nitrite. Levels of phosphorus are not a significant concern. They are above target near the origin, but decline steadily through natural assimilation and are well below target near the mouth. This is a function of natural habitats and an intact floodplain in the lower reaches. Overall only 5 of 18 (28%) samples tested were above the target. Levels of nitrate-nitrite might be more problematic. A total of 17 of 18 (94%) samples tested were above the target and levels remain fairly consistent throughout the river. A major impact is not anticipated since levels are only moderately elevated with an overall average of 2.29 mg/L.

Dissolved oxygen was not identified as a problem in any of the grab samples tested in the Lake Fork. All 15 samples tested were above the 5.0 mg/L OMZA criterion for WWH streams. An automatic meter was deployed at Washington TR 451 (RM 0.95) and programmed to record hourly levels over a 48-hr period. The minimum reading recorded was 7.34 mg/L and the diurnal flux was only 1.27 mg/L.

Four sites on three different tributary streams were sampled in the WAU. Nutrient levels were assessed based on statewide target values for wadeable streams of 0.10 mg/L for phosphorus and 1.00 mg/L for nitrate-nitrite. Levels of phosphorus are not a major concern in the tributary streams either. Overall only

2 of 20 (10%) samples tested were above the target. Again, levels of nitrate-nitrite might be more problematic. A total of 16 of 20 (80%) samples tested were above the target. Levels are only slightly elevated as the overall average concentration was 1.44 mg/L, so not much impact should occur.

Dissolved oxygen was not a problem in the tributary streams. All 20 samples tested were above the 5.0 mg/L OMZA criterion for WWH streams. The only results of note were saturation levels consistently above 100% in Crab Run at Washington TR 473 (RM 2.17). This is likely a function of the lack of a riparian corridor upstream and influence from accelerated photosynthetic activity.

Sediment Quality Status

A sediment sample was collected from the Lake Fork at Washington TR 451 (RM 0.95). Very little in the way of sediment is present, but a small pocket of silt was found in an eddy below the bridge. Samples were tested for metals, PAH, PCB, and organochlorine insecticides. No organic compounds were detected and all metals were below their respective SRV.

Public Water Supply Use Status

There are no facilities in this watershed unit that use surface water as a drinking supply.

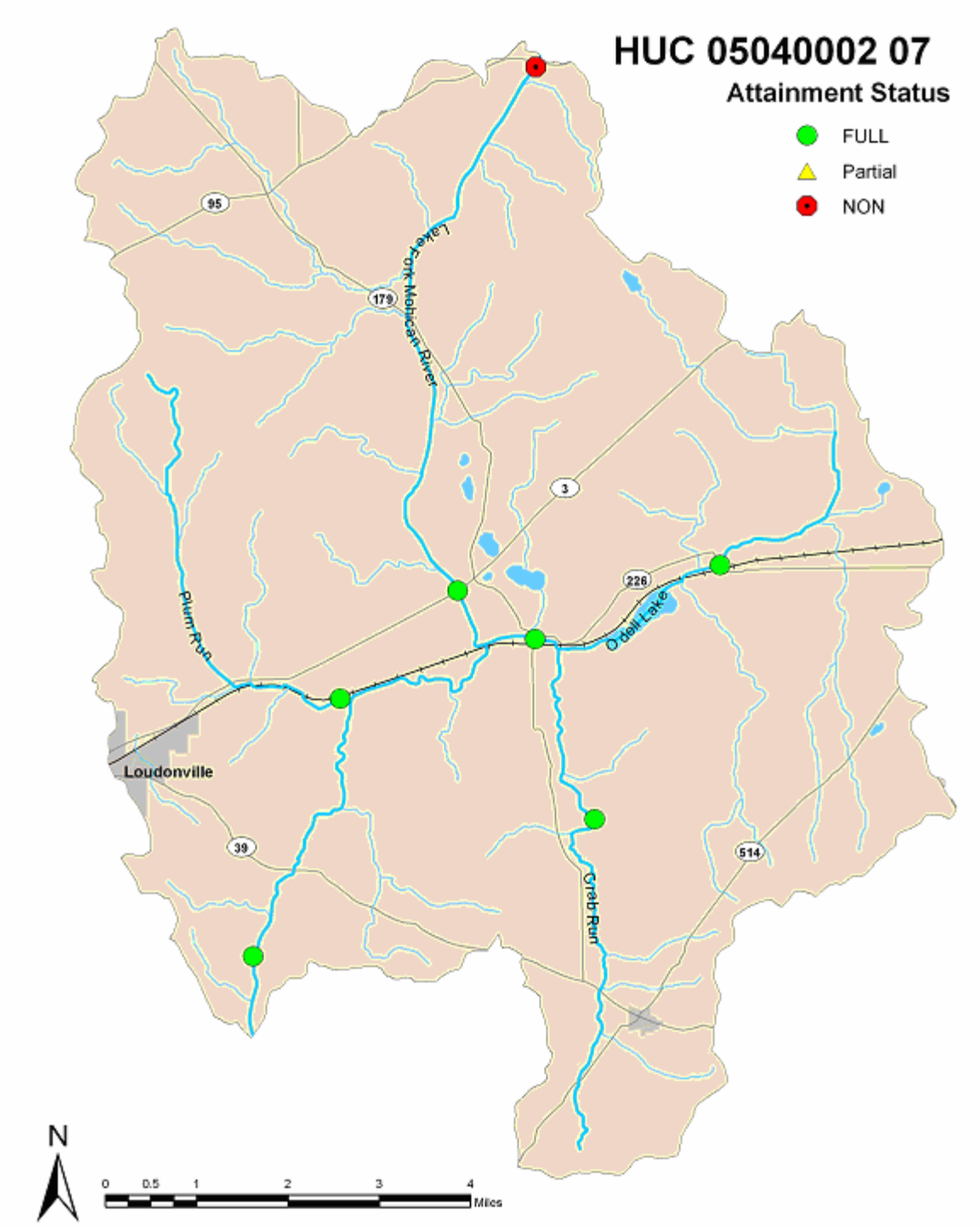

Figure 7a. Sampling Locations and Aquatic Life Use Attainment Status in the Lake Fork Mohican River WAU (0504000207), June 15 to October 15, 2007.

Figure 7b. View of Mohicanville dam on Lake Fork at RM 12.04 taken from the public access area near USGS gage station #0313500.

Figure 7c. View of a log jam on Lake Fork below State Route 95 (RM 14.04) that was subsequently removed by an Ashland County SWCD drainage project.

Figure 7d. View of Crab Run as it passes through a pasture just upstream Washington TR 473 (RM 2.17). Note the cow watering in the stream.

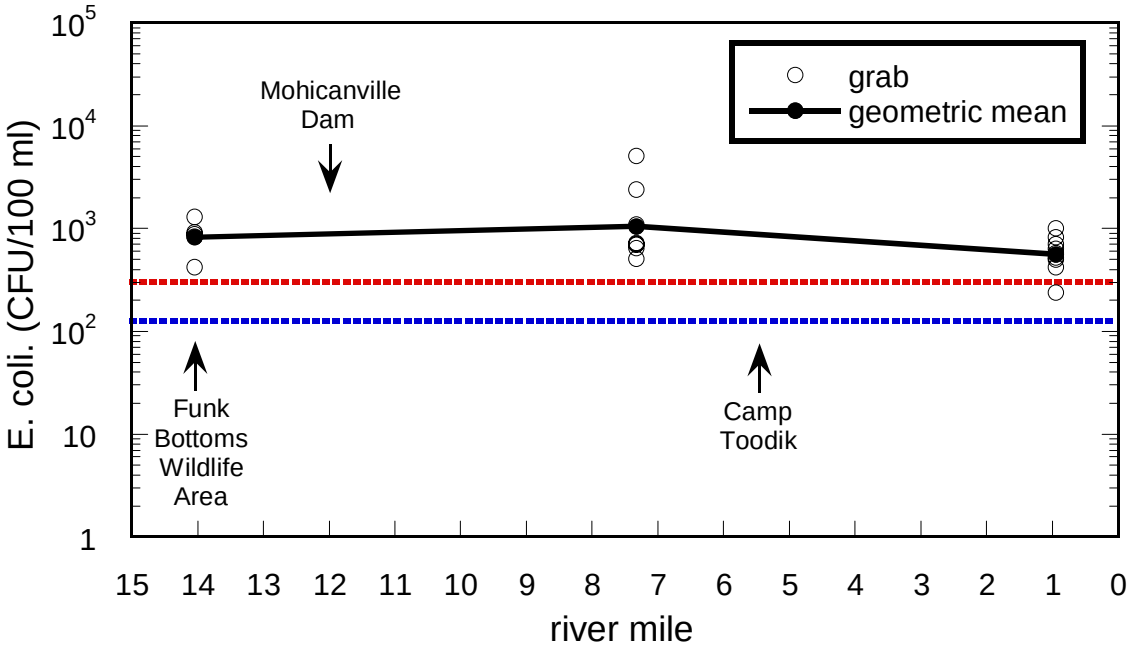

Figure 7e. Bacteria levels in the Lake Fork from all samples collected during the 2007 recreation season (5/1-10/15). The blue line represents the time weighted PCR geometric mean criterion of 126 CFU/100 ml and the red line the maximum criterion of 298 CFU/100 ml.

Table 7a. Aquatic life and recreational use attainment status for sampling locations in the Lake Fork Mohican River WAU (0504000207). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Lake Fork	14.04	WWH-R	NON	30*	5.8*	18*	47.5	Direct habitat alterations; Other flow regime alterations; Dissolved Oxygen; Sedimentation, Nutrient/Eutrophication Biological indicators	Non-irrigated Crop Production, Channelization, Dam or Impoundment.
Lake Fork	7.43	WWH-R	FULL	50	8.9	42	69.0		
Lake Fork	0.95	WWH-R	FULL	51	9.6	50	87.0		
Crab Run	2.17	WWH-R	FULL	52		E	74.5		
Odell Lake Outlet	3.03	WWH-R	FULL	42		G	44.0		
Odell Lake Outlet	0.59	WWH-R	FULL	50	9.0	50	68.5		
Plum Run	0.13	WWH-R	FULL	50		G	75.5		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 7b. Results for select water quality constituents tested in grab samples from the Jerome Fork-Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	**River Mile**	**Use**	**Constituent**	**Values**
Lake Fork WWH, PCR, AWS, IWS small river (347 mi^2)	14.04	WWH	t-P (mg/L) (0.17)	**0.272**, **0.268**, **0.335**, 0.159, **0.202**
			NO_3-NO_2 (mg/L) (1.50)	**2.66**, **2.56**, **3.22**, **2.38**, **1.75**
		PCR	E. coli. (#/100 ml) (298, 126)	**420**, **840**, **1300**, **920**, **880** (**820**)
	7.33	WWH	t-P (mg/L) (0.17)	0.128, 0.141, **0.213**, 0.114, 0.148
			NO_3-NO_2 (mg/L) (1.50)	**2.30**, **2.58**, **2.64**, **1.78**, **1.79**
		PCR	E. coli. (#/100 ml) (298, 126)	**510**, **700**, **5100**, **1100**, **650**, **720**, **690**, **2400** (**1056**)
	0.95	WWH	t-P (mg/L) (0.17)	0.071, 0.093, 0.146, 0.093, 0.163, 0.139, 0.083, 0.121
			NO_3-NO_2 (mg/L) (1.50)	**3.45**, **2.26**, **2.10**, **2.37**, **2.38**, **1.95**, **1.62**, 1.41
		PCR	E. coli. (#/100 ml) (298, 126)	**500**, **420**, **1000**, **520**, **820**, **580**, **700**, 240, **640** (**562**)

Table 7b. Continued

Stream Use Designations	**River Mile**	**Use**	**Constituent**	**Values**
Odell Lake Outlet WWH, PCR, AWS, IWS wadeable stream (34.1 mi^2)	3.03	WWH	t-P (mg/L) (0.10)	**0.969**, 0.069, 0.088, 0.074, 0.080
			NO_3-NO_2 (mg/L) (1.00)	**1.83**, **1.81**, **1.76**, **1.22**, **1.24**
		PCR	E. coli. (#/100 ml) (298, 126)	**2600**, **1300**, **1400**, **560**, **3200** (**1533**)
	0.59	WWH	t-P (mg/L) (0.10)	0.025, 0.028, 0.031, 0.014, 0.033
			NO_3-NO_2 (mg/L) (1.00)	**1.14**, 0.67, 0.55, 0.53, 0.79
		PCR	E. coli. (#/100 ml) (298, 126)	**900**, **1600**, **380**, **310**, **2200** (**821**)
Crab Run WWH, PCR, AWS, IWS headwater stream (10.7 mi^2)	2.17	WWH	t-P (mg/L) (0.08)	0.016, 0.010, 0.012, 0.016, 0.031
			NO_3-NO_2 (mg/L) (1.00)	**1.55**, **1.25**, **1.13**, **1.20**, **1.40**
		PCR	E. coli. (#/100 ml) (298, 126)	**2300**, **2500**, **840**, **5300**, >**20000** (**3482**)
Plum Run WWH, PCR, AWS, IWS headwater stream (8.6 mi^2)	0.13	WWH	t-P (mg/L) (0.08)	0.044, 0.066, 0.080, 0.061, **0.135**
			NO_3-NO_2 (mg/L) (1.00)	**2.54**, **2.26**, **2.12**, **1.92**, **1.87**
		PCR	E. coli. (#/100 ml) (298, 126)	**680**, **1100**, **2400**, **520**, **12000** (**1621**)

Table 7c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Iron Pony Saloon	3PR00158	UT to Lake Fork		0.007 MGD package plant
Round Lake Christian Assembly	2PR00019	Round Lake		0.012 MGD package plant
Long Lake RV Park	2PR00227	UT to Bonnett Lake		0.008 MGD package plant
Lakeville Elementary School	3PT00062	Odell Lake Outlet		0.005 MGD package plant
Woodland Inn	3PR00327	UT to Odell Lake		0.0016 MGD package plant
Prairie House Apart.	3PW00035	Odell Lake		0.003 MDG package plant
Mansfield Plumbing Products	3IQ00103	Odell Lake Outlet		non contact cooling
Whispering Hills Campground	3PR00172	UT to UT to Odell Lake		0.025 MGD package plant
Nashville WTP	3IX00002	UT to Crab Run		
Nashville Elementary School	3PT00063	UT to Crab Run		0.005 MGD package plant
Buckeye Deli	3PR00447	UT to Crab Run		0.0015 MGD package plant
Kaufman MHP		UT to Lake Fork		0.006 MGD package plant

Table 7d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Dometic Corp. Plant 1	3GR00902	Odell Lake Outlet	Industrial Storm Water
Mansfield Plumbing Prod.	3GR00326	Odell Lake Outlet	Industrial Storm Water
Mansfield Plumbing Prod.	3GR00333	Odell Lake Outlet	Industrial Storm Water

Mohican River Watershed Assessment Unit

The Mohican River WAU (0504000208) drains a total of 138.8 mi^2 and lies within Ashland, Richland, Holmes, Knox and Coshocton Counties. The boundary of this assessment unit encompasses the Black Fork Mohican River and tributaries downstream from the Rocky Fork (RM 14.12) along with tributaries to the Mohican River. The Mohican River mainstem has a drainage area in excess of the 500 mi^2 limit used in delineating assessment units with multiple water courses, and is discussed separately from smaller drainages within this report. Included in the lower Black Fork WAU are Honey Creek and Big Run, which are confluent with the Black Fork, and Negro Run, a Mohican River tributary.

Aquatic Life Use Designations
All four surveyed streams in the Mohican River WAU are within the EOLP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 WQS. The aquatic life use, however, had not been verified using current protocols involving biological sampling and habitat evaluation.

Black Fork is a tributary of the Mohican River confluent at RM 27.57 that is about 62.8 miles in length and drains an area of 356 mi^2. It is recognized as a state scenic river downstream of Charles Mill Reservoir (RM 18.47). In-stream and riparian habitats were in very good condition. The QHEI scores for the Black Fork at RMs 6.90 and 2.53 were 83.0 and 80.5, respectively, and easily exceeded the level at which WWH use should be considered.

Honey Creek is a tributary of Black Fork confluent at RM 5.10 that is about 8.2 miles in length and drains an area of 17.3 mi^2. The two sampled locations at RMs 5.91 and 0.11 had sufficient habitat to support a good diversity of fish and macroinvertebrates (QHEI scores of 64.0 and 61.0, respectively). Recently developed methods for delineating coldwater streams include the presence of four or more coldwater macroinvertebrate taxa or a minimum of two coldwater fish in combination with at least two primary coldwater macroinvertebrates. Five coldwater macroinvertebrates and two coldwater fish were recorded at RM 5.10. Coldwater fauna were much reduced at RM 0.11; a single coldwater macroinvertebrate taxon and one coldwater fish (mottled sculpin) were recorded. The stream flows through areas with row crops, pasture and old field. Overhead canopy is limited; consequently, the stream temperature progressively increases as the water flows toward the confluence with the Black Fork Mohican River. Consequently, the CWH use designation is recommended for Honey Creek upstream from the unnamed tributary confluent at RM 4.19. The WWH use is recommended for the remainder of the stream downstream from RM 4.19.

Big Run is a tributary of Black Fork confluent at RM 4.06 that is about 6.0 miles in length and drains an area of 8.50 mi^2. The stream had been historically channelized but natural processes in the intervening years had allowed for significant recovery of natural habitat features. A QHEI score of 57.5 was

recorded at RM 0.19. The WWH aquatic life use is recommended for Big Run. The appropriateness of the use is reinforced by the fish and macroinvertebrate sampling results.

Negro Run is a tributary of Mohican River confluent at RM 11.46 that is about 5.0 miles in length and drains an area of 10.5 mi^2. Habitat condition was very good and was reflected in a QHEI score of 76.0. Based on the 2007 sampling of Negro Run and current designation protocols, a CWH Aquatic Life Use is recommended. Three coldwater fish (southern redbelly dace, redside dace, and mottled sculpin) and four coldwater macroinvertebrates were collected.

Aquatic Life Use Attainment Status

Attainment status was determined for six sites in the Mohican River WAU, representing approximately 21 stream miles in the assessment unit. Four sites representing 8 assessed stream miles, fully met the WWH aquatic life use. Nonattainment documented in the Black Fork as it exited the preceding watershed assessment unit and was continued for an additional six miles in the Mohican River WAU. Biological communities demonstrated partial attainment in the remaining seven miles of stream. Aquatic life use attainment status is presented in Table 8a and Figure 8a.

The Black Fork Mohican River at RMs 6.90 and 2.53 supported fish assemblages that, at least, marginally attained WWH expectations. The macroinvertebrate community, however, was impacted and generated ICI scores in the fair range and the proportion of pollution tolerant organisms on the artificial substrates was high. The Perrysville WWTP may have been contributing additional nutrients to the system; however, decimation of the community due to high stream flow likely had a greater affect on the depressed macroinvertebrate index score. It appeared that elevated flow following summer flooding had redistributed and scoured the substrates. It appeared that reestablishment of a stable macroinvertebrate assemblage was still ongoing when sampling was conducted. The cycle of disruption and recolonization is likely repeated along this reach of the Black Fork following similar high flow events.

Recommended aquatic life uses were met for the three small tributaries in the Mohican River WAU. Big Run appeared to be enriched. A lot of filamentous algae was noted and decayed organic material had settled in the pools. Pollution tolerant white suckers and creek chubs comprised eighty percent of the fish collected. Still, both organism groups were in relatively good condition which indicated that the assimilative capacity of Big Run had not been exceeded. The fish community in Honey Creek was in very good condition at both sampled locations. An exceptional macroinvertebrate community was present at RM 5.19 on Honey Creek. The macroinvertebrates showed a decline in pollution sensitive taxa at RM 0.11; however, this likely was a reflection of the shift from a coldwater to a more typical warmwater community. The CWH use was met on Negro Run.

Both the fish and macroinvertebrates were reflective of an exceptional resource condition.

Redside dace were collected from all three tributaries. Negro Run and Honey Creek supported least brook lampreys. Southern redbelly dace were recorded from Negro Run and rosyface shiners were collected from Honey Creek.

Recreation Use Status
The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 34 separate samples collected at 6 sites.

Class A stream assessments were conducted at two sites on the lower Black Fork. Public and private access to the river is provided at several locations including several private canoe liveries. A set of five samples collected between 7/5 and 8/02 was used in the calculations. Black Fork at State Route 39–Perrysville (RM 7.09) the geometric mean count was 603 CFU/100 ml and at Black Fork at State Route 39–Loudonville (RM 2.50) it was 1302 CFU/100 ml. These results violate the PCR criterion.

Point Source Pollutant Loadings
Facilities regulated by either an individual or general NPDES permit are listed in Tables 3c and 3d, respectively. No facilities classified as a major dischargers exist in the WAU.

Water Quality Status
Results for select water quality constituents are summarized in Table 8b. Water quality was tested at two sites in the Mohican River WAU and found to exhibit good quality for the most part. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of nutrient enrichment in the samples. Nutrient levels in the Black Fork were assessed based on statewide target values for small rivers of 0.17 mg/L for phosphorus and 1.50 mg/L for nitrate-nitrite. Levels of phosphorus and nitrate-nitrite were elevated. The stream wide average (n=14) for phosphorus was 0.249 mg/L and for nitrate-nitrite was 3.28 mg/L.

Water quality was tested at two sites from Honey Creek and found to exhibit good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of elevated nitrate-nitrite concentration in the samples. Nutrient levels in Honey Creek were assessed based on statewide target values for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for nitrate-nitrite. Levels of nitrate-nitrite were slightly elevated. The stream wide average (n=10) for phosphorus was 0.032 mg/L and for nitrate-nitrite was 1.81 mg/L.

Water quality was tested at one site from Big Run and found to exhibit good quality. None of the physical or chemical constituents tested in grab samples

exceeded their respective WQS criteria. There is indication of elevated nitrate-nitrite concentrations in the samples. Nutrient levels in Honey Creek were assessed based on statewide target values for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for nitrate-nitrite. Levels of nitrate-nitrite were elevated. The stream wide average (n=5) for phosphorus was 0.060 mg/L and for nitrate-nitrite was 3.49 mg/L.

Water quality was tested at one site from Negro Run and found to exhibit very good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. Nutrient levels in Negro Run met their respective numerical values based on statewide target levels for wadable streams of 0.10 mg/L for phosphorus and 1.0 mg/L for nitrate-nitrite. The stream wide average (n=5) for phosphorus was 0.016 mg/L and for nitrate-nitrite was 0.62 mg/L.

Sediment Quality Status

Sediment sample results were evaluated using guidelines established in Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A Threshold Effect Concentration (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A Probable Effect Concentration (PEC) indicates a level above which harmful effects are likely to be observed. In addition, the Ohio Sediment Reference Value represents ecoregion background conditions based on data collected at Ohio reference sites.

The chemical sediment quality was assessed at one location within the Mohican River WAU. Several additional sites were not sampled due to the lack of fine grain sediments. Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment and accumulate in the food chain.

Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. Sediments with chemical concentrations reported above the Consensus-Based Probable Effect Concentration (PEC) and/or the Ohio Sediment Reference Value may result in negative environmental impacts and warrant further evaluation. In a sediment sample collected from the Black Fork at State Route 95 (upstream of Perrysville) arsenic was detected at 11.7 mg/kg and nickel at 11.7 25 mg/kg. Both metal concentrations where slightly above the respective TEC value but well below the PEC or SRV value. PCB-1242 was detected at a concentration of 225 µg/kg, which is above the TEC value but below the PEC. All other parameters where below their respective detection limits

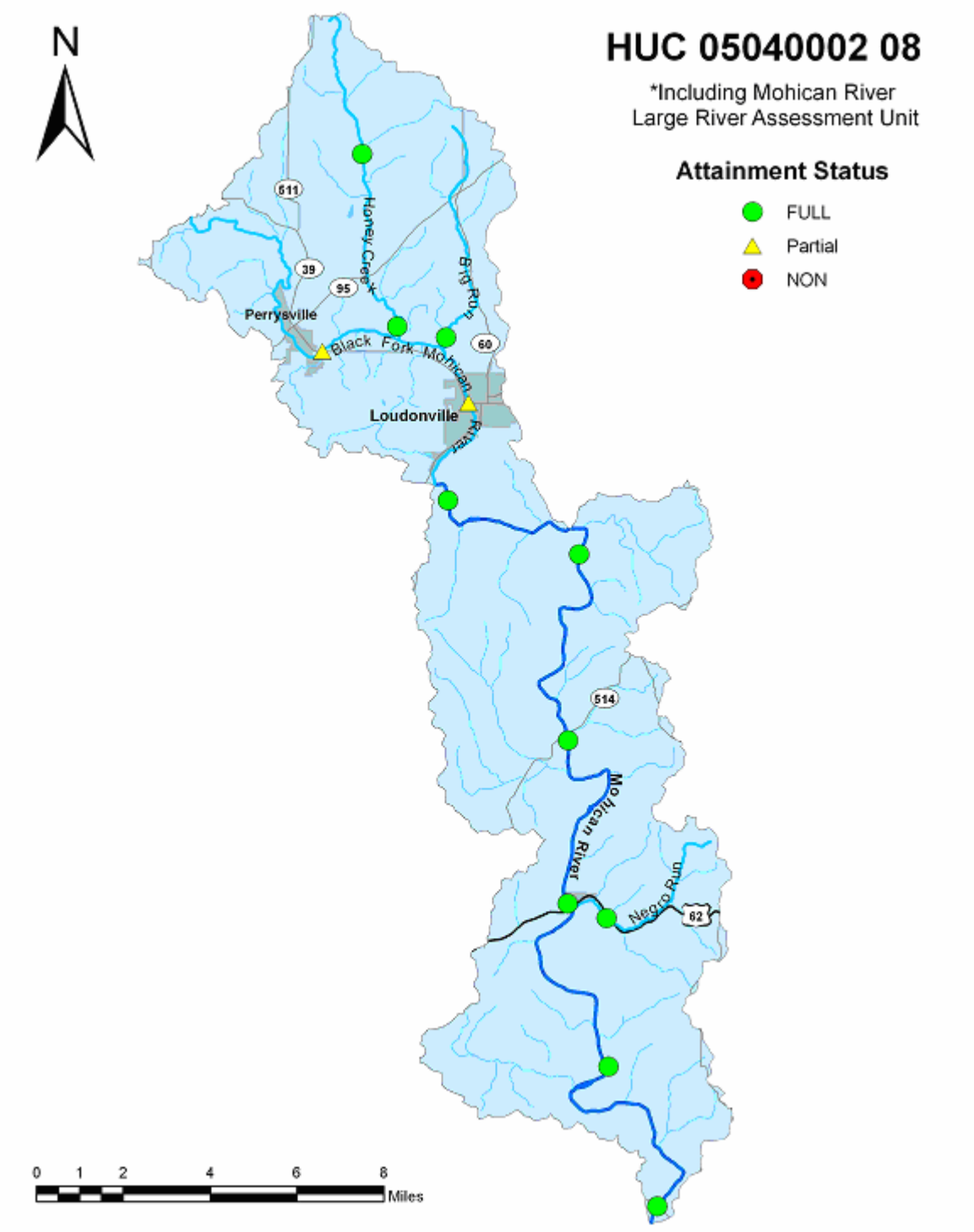

Figure 8a. Sampling Locations and Aquatic Life Use Attainment Status in the Mohican River WAU (0504000208), June 15 to October 15, 2007.

Table 8a. Aquatic life and recreational use attainment status for sampling locations in the Mohican River WAU (0504000208). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Black Fork Mohican River	6.90	WWH -R	Partial	42	8.9	28*	83.0	High flow regime, Direct alterations	Major flooding
Black Fork Mohican River	2.53	WWH -R	Partial	39ns	8.4ns	28*	80.5	High flow regime, Direct alterations	Major flooding
Honey Creek	5.19	CWH-R	FULL	46		E	64.0		
Honey Creek	0.11	WWH-R	FULL	46		G	61.0		
Big Run	0.19	WWH-R	FULL	42		G	57.5		
Negro Run	1.04	CWH-R	FULL	52		E	76.0		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 8b. Results for select water quality constituents tested in grab samples from the Mohican River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	River Mile	Use	Constituent	Values
Black Fork WWH, PCR, AWS, IWS small river (356 mi^2) Perrysville WWTP (2PA00004) (RM 7.53) Loudonville WWTP (2PD00023) (RM 1.75)	7.09	WWH	t-P (mg/L) (0.17)	0.149**, 0.242, 0.495, 0.324, 0.499**
			NO_3-NO_2 (mg/L) (1.50)	**5.16, 1.85, 4.52, 1.82, 4.00**
		PCR	E. coli. (#/100 ml) (298, 126)	240, **330, 1200, 350, 460, 1600**, 260 **(603)**
	2.50	WWH	t-P (mg/L) (0.17)	0.128, **0.275, 0.281, 0.253, 0.332**
			NO_3-NO_2 (mg/L) (1.50)	**5.00, 1.95, 7.74, 1.75, 3.20**
		PCR	E. coli. (#/100 ml) (298, 126)	**370**, 260, **11000, 430, 440, 2000, 900, 4800 (1302)**
Honey Creek (RM 5.10) WWH, PCR, AWS, IWS wadable stream (17.3 mi^2)	5.19	WWH	t-P (mg/L) (0.10)	0.015, 0.032, 0.029, 0.025, 0.055
			NO_3-NO_2 (mg/L) (1.00)	**2.78, 1.76, 1.62, 1.28, 1.01**
		PCR	E. coli. (#/100 ml) (298, 126)	290, **6700, 420, 1000, 2100**
	0.11	WWH	t-P (mg/L) (0.10)	0.22, 0.036, 0.021, 0.025, 0.057
			NO_3-NO_2 (mg/L) (1.00)	**4.44, 1.54, 1.39, 1.02, 1.26**
		PCR	E. coli. (#/100 ml) (298, 126)	**1040, 940, 440, 940, 530**
Big Run WWH, PCR, AWS, IWS wadable stream (8.50 mi^2)	0.19	WWH	t-P (mg/L) (0.10)	0.020, **0.171**, 0.023, 0.031, 0.053
			NO_3-NO_2 (mg/L) (1.00)	**2.12, 4.27, 4.09, 3.67, 3.31**
		PCR	E. coli. (#/100 ml) (298, 126)	**2300, 880, 830, 1500, 600**

Table 8b. Continued

Stream Use Designations	River Mile	Use	Constituent	Values
Negro Run WWH, PCR, AWS, IWS wadable stream (10.5 mi^2)	1.04	WWH	t-P (mg/L) (0.10)	0.032, <0.010, <0.010, <0.010, 0.020
			NO_3-NO_2 (mg/L) (1.00)	0.80, 0.50, 0.65, 0.55, 0.60
		PCR	E. coli. (#/100 ml) (298, 126)	**320, 510**, 160, 220

Table 8c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
S&S Aggregate	2IJ00077	Black Fork	14.02	intermittent overflow from dredge lake
Perrysville WWTP	2PA00004	Black Fork	7.53	0.12 MGD oxidation ditch system
Mansfield Plumbing Products	2IJ00062	Black Fork	6.80	settling pond/neutralization
Loudonville WTP	2IW00122	Black Fork	2.48	filler backwash/lime sludge/lagoon system
Loudonville WWTP	2PD00023	Black Fork	1.75	0.6 MGD conventional activated sludge system
Mohican River Estates	2PY00028	Black Fork	0.60	20,000 gpd package plant

Table 8d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Mar-Zane, Inc.	2GG00175	Black Fork	industrial storm water
Cowen Truck Line	2GG00287	Black Fork	industrial storm water
Cowen Truck Line	2GR00413	Black Fork	industrial storm water
Mansfield Plumbing Products	2GR00183	Black Fork	industrial storm water
Mansfield Plumbing Products	2GR00190	Black Fork	industrial storm water
Conagra Flour Mill	2GG00121	Black Fork	industrial storm water
Ellis Brothers Concrete	2GG00261	Black Fork	industrial storm water
Flexible Corp.	2GR00230	Black Fork	industrial storm water
MCI Service Parts	2GR00495	Black Fork	industrial storm water

Mohican Large River Assessment Unit

The Mohican Large River WAU (05040002-000) drains a total of 998.8 mi2 and lies within Ashland, Richland, Wayne, Holmes, Knox and Coshocton Counties.

Past assessment of the Mohican River LRAU has been limited to 2 sites. Both site indicated full attainment of ecoregional biologic criteria and the WWH aquatic life use.

Aquatic Life Use Designations
The Mohican River is a tributary of the Walhonding River confluent at RM 23.18 that is about 27.58 miles in length and drains an area 998.7 mi^2. It is within the EOLP ecoregion and is designated as WWH, PCR, PWS, AWS, and IWS based on the 1978 Ohio WQS. It is recognized as a state scenic river below Clear Fork to the confluence with the Walhonding River.

The Mohican River was designated by ODNR as a state scenic river in 2006. The river was designated with a WWH aquatic life use in the 1978 WQS. The 2007 survey, however, represents the first time that Ohio EPA systematic sampling was conducted to determine the appropriate use and to evaluate the condition of the habitat and biological communities relative to the aquatic life use. Sampling was conducted at six sites along the Mohican River between its origination at RM 27.57, where the Black Fork and Clear Forks meet, to the confluence with the Kokosing River. Habitat along the entire reach was in excellent condition. QHEI scores ranged from 82.0 at RM 0.47 to 91.0 at RM 11.66. Unimpeded riffle/run/pool development and an intact wooded riparian were major factors benefiting the Mohican River. A variety of cover and current conditions were present. Habitat heterogeneity afforded potential for commensurate high diversity of fish and macroinvertebrates assemblages. A EWH use is recommended based on the conditions encountered.

Aquatic Life Use Attainment Status
Biological and habitat assessments were conducted at 6 sites in 2007. Aquatic life use attainment status is presented in Table 9a and Figure 8a.

Biological index scores from the Mohican River were all in the exceptional range at the six sampled locations. The combination of good water quality and varied habitat with limited substrate embeddedness benefited the fish and macroinvertebrates communities. Diverse assemblages of both organism groups were collected and the river supported a number of declining fish species as well as blue breast darters, a threatened species in Ohio especially sensitive to perturbations in habitat and water quality. Declining fish recorded in the Mohican River included river chubs, big eye chubs, streamline chubs, rosyface shiners and mimic shiners. The occurrence of streamline chubs is noteworthy in that their distribution is confined largely to this reach of river. They have been recorded elsewhere but not to the extent that they were present in the Mohican

River. Similarly, a high diversity of pollution sensitive macroinvertebrate taxa were collected

Recreation Use Status
The overall recreation use is considered impaired. Data used in the evaluation included E. coli counts from 48 separate samples collected at 6 sites.

Class A stream assessments were done on all Mohican River sites. Public and private access to the river is provided at several locations including numerous private canoe liveries and campgrounds. A set of five samples collected between 7/5 and 8/02 was used in the calculations. Results at all sites except the Mohican River at State Route 715 (RM 0.47) violated the PCR criterion. Results are presented in Table 9b.

Point Source Pollutant Loadings
Facilities regulated by an individual NPDES permit are listed in Tables 3c. No facilities classified as a major dischargers exist in the LRAU.

Water Quality Status
Results for select water quality constituents are summarized in Table 9b. Water quality was tested at six sites from the Mohican River and found to exhibit good quality. None of the physical or chemical constituents tested in grab samples exceeded their respective WQS criteria. There is indication of slight nutrient enrichment in the samples. Nutrient levels in the Mohican River were assessed based on statewide target values for small rivers of 0.17 mg/L for phosphorus and 1.50 mg/L for nitrate-nitrite. The stream wide average (n=31) for phosphorus was 0.148 mg/L and for nitrate-nitrite was 1.83 mg/L.

Sediment Quality Status
No sediment samples were collected in the LRAU. In general, the Mohican River contain very little in the way of fine silt and clay sediment deposits.

Table 9a. Aquatic life and recreational use attainment status for sampling locations in the Mohican River LRAU (05040002 000). The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The Mohican River watershed is located in the Erie-Ontario Lake Plain ecoregion and streams are currently designated Warmwater Habitat (WWH) or recommended (R) as a Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH) or Modified Warmwater Habitat (MWH) waterbody. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Stream	Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI[a]	QHEI Habitat	Cause/Source*	
Mohican River	27.00	EWH-R	FULL	49	10.3	48	87.0		
Mohican River	22.54	EWH-R	FULL	57	9.9	50	85.0		
Mohican River	16.40	EWH-R	FULL	55	10.9	E	83.0		
Mohican River	11.66	EWH-R	FULL	57	10.4	50	91.0		
Mohican River	6.53	EWH-R	FULL	58	10.2	52	86.0		
Mohican River	0.47	EWH-R	FULL	58	10.1	54	82.0		

Ecoregion Biocriteria: Erie-Ontario Lake Plain			
INDEX - Site Type	WWH	EWH	MWH
IBI: Headwater+Wading/Boat	40	50/48	24
MIwb: Wading/Boat	7.9/8.7	9.4/9.6	6.2/5.8
ICI	34	46	22

[ns] Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
* Significant departure from biocriterion (>4 IBI or ICI units; >0.5 MIwb units). Poor and very poor results are underlined.
[a] Narrative evaluation used in lieu of ICI (E=Exceptional; VG=Very Good; G=Good; MG=Marginally Good; F=Fair; P=Poor).
* For Recreational Use, the cause of impairment is bacteria and the source is typically livestock or wastewater from HSTS , CSOs, or WWTPs. See the Recreational use section for sources.

Table 9b. Results for select water quality constituents tested in grab samples from the Mohican Large River WAU. The standard (min/max, avg.) or target used to evaluate the constituent is included. Concentrations that exceeded these levels and are considered degraded are highlighted in bold.

Stream Use Designations	**River Mile**	**Use**	**Constituent**	**Values**
Mohican River WWH, PCR, AWS, IWS small river (998.7 mi^2)	27.00	WWH	t-P (mg/L) (0.17)	0.129, **0.177, 0.278, 0.179, 0.246**
			NO_3-NO_2 (mg/L) (1.50)	**4.25**, 1.47, **2.33**, 1.32**, 2.99**
		PCR	E. coli. (#/100 ml) (298, 126)	**360, 14000, 770**, 260, 230, **600, 1200, 580 (506)**
	22.54	WWH	t-P (mg/L) (0.17)	**0.210**, 0.144**, 0.187**, 0.131, **0.193**
			NO_3-NO_2 (mg/L) (1.50)	**3.18, 1.54, 1.92**, 1.35, **2.20**
		PCR	E. coli. (#/100 ml) (298, 126)	**370, 390**, 220, **370,** 200, **650**, 210, **1400 (295)**
	16.92	WWH	t-P (mg/L) (0.17)	0.128, 0.140, 0.**152,** 0.111, 0.141
			NO_3-NO_2 (mg/L) (1.50)	**2.99, 2.02, 1.73, 1.74**, 162
		PCR	E. coli. (#/100 ml) (298, 126)	**790**, 230, 150, 230, 170**, 420, 600, 20000 (272)**
	11.66	WWH	t-P (mg/L) (0.17)	0.126, 0.160, 0.166, 0.123, 0.182
			NO_3-NO_2 (mg/L) (1.50)	**2.52, 1.53, 1.61**, 1.22, 1.19
		PCR	E. coli. (#/100 ml) (298, 126)	250, 240, **360**, 60, 60, 250, 490 **(174)**

Table 9b. Continued

Stream Use Designations	**River Mile**	**Use**	**Constituent**	**Values**
Mohican River WWH, PCR, AWS, IWS small river (998.7 mi^2)	6.53	WWH	t-P (mg/L) (0.17)	0.058, 0.118, 0.114, 0.148
			NO_3-NO_2 (mg/L) (1.50)	**2.31, 1.57**, 1.22, 1.20
		PCR	E. coli. (#/100 ml) (298, 126)	160, 100, 260, **1100**, 50, **300**, 260, **340 (257)**
	0.50	WWH	t-P (mg/L) (0.17)	0.030, 0.107, 0.116, 0.122, 0.161, 0.105, **0.202**
			NO_3-NO_2 (mg/L) (1.50)	1.42, 1.37, **1.89**, 1.40, **1.53**, 1.10, 1.06
		PCR	E. coli. (#/100 ml) (298, 126)	180, 40, 80, **560**, 20, 10, 160, 280, 70 (87)

Table 9c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Judson Hills Baptist Camp	2PR00200	Ball Alley Run (RM 26.26)	0.90	15,000 gpd package plant
Landoll's Mohican Castle	2PR00171	unnamed trib. to Mohican (RM 24.57)	1.6	13,000 gpd package plant
Smith's Pleasant Valley Campground	3PR00271	Mohican River	23.60	5,000 gpd package plant
October Hills Campground	3PG00134	Mohican River	23.00	14,000 gpd package plant

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