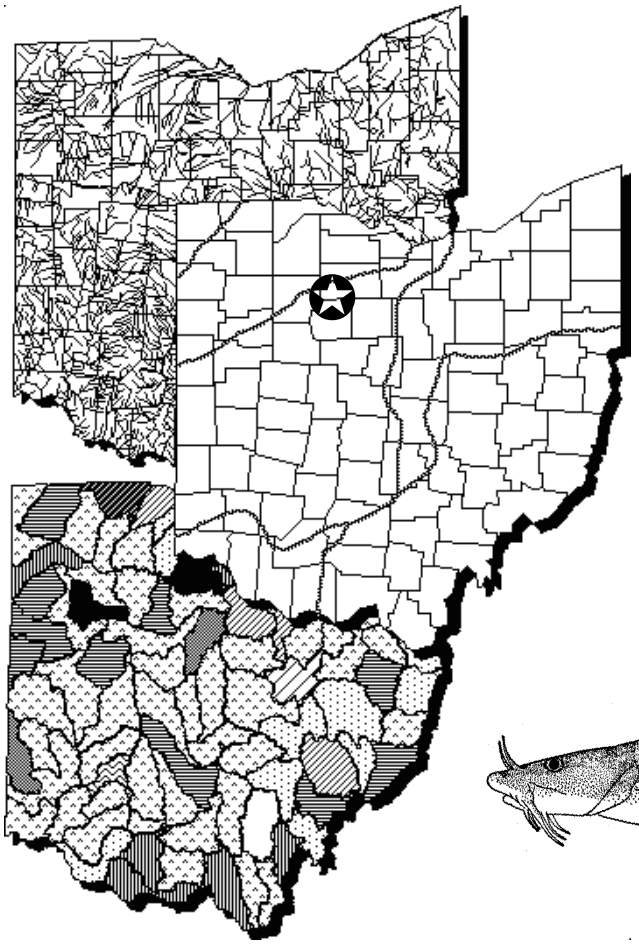
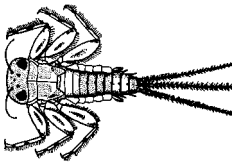
Biological and Water Quality Study of the Sandusky River and Selected Tributaries 2001

Seneca, Wyandot, and Crawford Counties, Ohio





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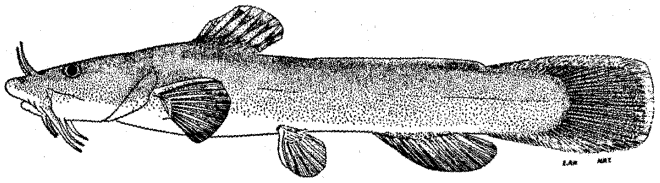

Stonecat Madtom

May 21, 2003

Bob Taft
Governor, State of Ohio
Christopher Jones
Director, Ohio Environmental Protection Agency
P.O. Box 1049, Lazarus Government Center, 122 S. Front St., Columbus, OH 43216-1049

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Seneca, Wyandot, and Crawford Counties, OH

May 21, 2003

OEPA Technical Report EAS/2003-4-6

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
122 South Front St., Columbus OH 43215
Mail to:
P.O. Box 1049, Columbus OH 43216-1049

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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.

Ohio Environmental Protection Agency. 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.

Ohio Environmental Protection Agency. 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.

Ohio Environmental Protection Agency. 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.

Ohio Environmental Protection Agency. 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.

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.

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

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8777

ACKNOWLEDGMENTS

The following Ohio EPA staff are acknowledged for their contribution to this report:

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This evaluation and report were possible only with the assistance of the study team, many full and part time field staff, and the chemistry analyses provided by the Ohio EPA Division of Environmental Services. Property owners who permitted access for sampling are also gratefully acknowledged for their cooperation.

Copies of this report are located on the Ohio EPA internet web page (www.epa.state.oh.us/dsw/document_index/psdindx.html) or may be available on CD from:

Division of Surface Water
Ecological Assessment Unit
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8780

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 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.

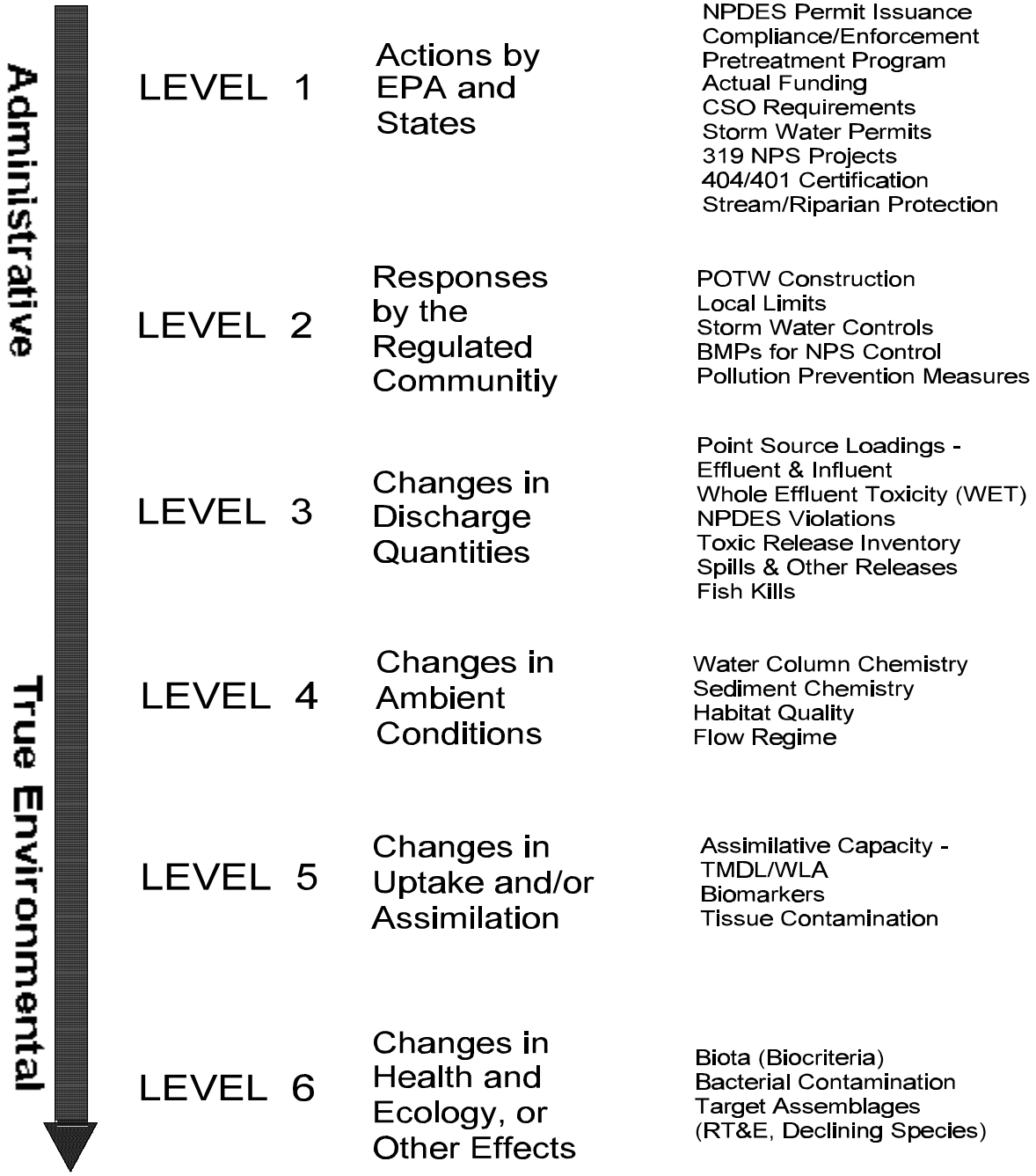
The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State 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 (Figure1). 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 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 Ohio Water Resource Inventory (305[b] 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) *Cold-water Habitat (CWH)* - this use is intended for waters which support assemblages of cold water 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 water quality 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- primary contact recreation) or for partial body contact such as wading (SCR- secondary contact recreation). 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 were encountered during the 2001 study. While the various perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

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 groundwater, 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 trapiziodal 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 reaeration 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 erosional 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 stormwater runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban stormwater is more of a concern if combined sewer overflows are involved. The impact from rural stormwater 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 the National Pollutant Discharge Elimination System (NPDES). 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 criteria 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 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).

Metals

Metals can be toxic to aquatic life and hazardous to human health. Although they are naturally occurring elements many are extensively used in manufacturing and are by-products of human activity. Certain metals like copper and zinc are essential in the human diet, but excessive levels are usually detrimental. Lead and mercury are of particular concern because they often trigger fish consumption advisories. Mercury is used in the production of chlorine gas and caustic soda and in the manufacture of batteries and fluorescent light bulbs. In the environment it forms inorganic salts, but bacteria convert these to methyl-mercury and this organic form builds up in the tissues of fish. Extended exposure can damage the brain, kidneys, and developing fetus. The Ohio Department of

Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under not to eat more than one meal per week of any species of fish from waters of the state because of mercury. Lead is used in batteries, pipes, and paints and is emitted from burning fossil fuels. It affects the central nervous system and damages the kidneys and reproductive system. Copper is mined extensively and used to manufacture wire, sheet metal, and pipes. Ingesting large amounts can cause liver and kidney damage. Zinc is a by-product of mining, steel production, and coal burning and used in alloys such as brass and bronze. Ingesting large amounts can cause stomach cramps, nausea, and vomiting.

Metals criteria are established in the Ohio Water Quality Standards to protect human health, wildlife, and aquatic life. Three levels of aquatic life standards are established (Administrative Code 3745-1-07, Table 7-1) and limits for some elements are based on water hardness (Administrative Code 3745-1-07, Table 7-9). Human health and wildlife standards are linked to either the Lake Erie (Administrative Code 3745-1-33, Table 33-2) or Ohio River (Administrative Code 3745-1-34, Table 34-1) drainage basins. The drainage basins also have limits for additional elements not established elsewhere that are identified as Tier I and Tier II values.

Bacteria

Bacteria levels in streams are a concern because of human health. 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).

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 (1996) 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. Classes are grouped in ranges that are based on the median analytical value (non-elevated) plus 1 (slightly elevated), 2 (elevated), 4 (highly elevated), and 8 (extremely elevated) inter-quartile values. 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 % particle size distribution (sand $60 µ, silt 5-59 µ, clay #4 µ), % solids, and % organic carbon. Due to the dynamics of flowing water, most streams do not contain a lot of sediment and samples often consist mostly of inert sand. This scenario changes if the stream is impounded by a dam or channelized. Chemical attributes included metals, volatile and semi-volatile organic compounds, pesticides, and poly-chlorinated biphenyls (PCBs).

NONPOINT SOURCE POLLUTION IMPACTS AND REMEDIATION PROJECTS

The Sandusky River Watershed Coalition prepared a comprehensive watershed inventory and management plan in 2001 just ahead of the TMDL assessment phase. Chapter 10 in the plan discusses nonpoint sources of pollution, agricultural land use, phosphorus and nitrogen budgets for crop land, and urban nonpoint source issues in the Sandusky River watershed.

It is clear that nonpoint source pollution is related to land use. All land use contributes to nonpoint sources of pollution that impair our watersheds. Since agriculture occupies about 83% of the land area in the Sandusky watershed, agricultural land uses are responsible for much of the nonpoint pollution in area streams, especially for nutrients, sediments and herbicides. Land use also impacts water resources by affecting stream flow and stream habitat. Habitat destruction is a form of nonpoint source pollution. Over the past twenty five years many farmers within the watershed have voluntarily adopted various management practices aimed at reducing nonpoint pollution from agricultural land uses. Heidelberg Water Quality Lab has conducted stream monitoring programs that document how these practices have substantially reduced phosphorus and sediment loading to Lake Erie. (SRWC, 2002)

Nonpoint Pollution and Land Use Impacts on Water Resources in the Sandusky Watershed.

A. Impacts on Drinking Water
- Nitrate concentrations often exceed drinking water standards
- Seasonally elevated herbicide levels
- High concentrations of suspended solids during runoff events.

B. Impacts on Aquatic Life
- Failure to attain aquatic life uses set by Ohio Water Quality Standards
- Fish and wildlife kills due to spills
- Sedimentation impairment to in stream habitat for fish and macro invertebrates

C. Impacts on Recreational Water Use
- Primary and secondary contact recreation limited by high bacteria events
- Fish consumption advisory for all waters of the Sandusky
- Aesthetic impairment from sediment and algal blooms

D. Impacts on Lake Erie through Pollutant Loading
- Phosphorus loading to Sandusky Bay and Lake Erie
- Suspended sediment degradation to Sandusky River, Sandusky Bay, and Lake Erie habitat
- Pesticides, nitrates, and other organic chemical pollutants transported by sediment

E. Impacts from Urban Land Use
- Impervious surfaces cause accelerated runoff volume to the river
- Combined sewer overflow events
- Contaminated storm runoff

Nonpoint Source Pollution Reduction Projects in the Sandusky River Watershed

Section 319 grant to Seneca County Health Department

1997-2001 $263,900

The goal of this grant was to eliminate poorly treated home sewage from contaminating the groundwater. The objectives were to develop an inventory of all home sewage systems in Thompson Twp of Seneca county where the Bellevue- Castalia Karst Plain geologic formation is located. Homeowners applied for 50% cost share to replace or repair 42 failed home sewage systems.

Concurrent with this grant, the Seneca County Commissioners were awarded a DEFA Rural Hardship grant that paid up to 100% costs to replace 19 additional systems. As a result of grant assistance, approximately 5.5 million gallons of sewage is properly treated on-site and no longer discharges to the groundwater in this region. This project took place in the Green Creek (04100007-110) and Sandusky Bay-West (04100007-130) assessment units.

Section 319 "Mini Grant" to Sandusky River Watershed Coalition
1998-2000 $15,000
Test the Guide to Developing a Local Watershed Action Plan. A watershed inventory was produced by this new watershed group. A strong partnership was forged with Heidelberg college, which continues to support the Coalition with technical resources. The need for a full time coordinator was recommended from this project.

Section 319-ODNR grant to Sandusky River Watershed Coalition
2000-2006 $192,000
Watershed Coordinator grant to support building partnerships and supporting the comprehensive watershed planning process throughout all 14 assessment units of the Sandusky River watershed. The coordinator's duties also include support of the TMDL initiative in the upper portion of the watershed which began in 2001. The coordinator has been involved with several implementation grants that have been awarded to partnering organizations in the Coalition.

Section 319 grant to Sandusky River Watershed coalition
2001-02 $32,000
Watershed Coordinator support grant to specifically help raise public awareness about the TMDL assessment in the summer of 2001 and the ongoing public involvement in developing the TMDL plan. Funds were partially used to print the first edition of the Sandusky Watershed Inventory and Management Plan.

Section319 Grant to Seneca County Health Department
2001-04 $120,400
The grant will provide 50% up to $4,500 cost share to 20 volunteer homeowners to replace failed home sewage systems with an experimental Peat bio-filter sewage treatment system. As part of the demonstration of this alternative treatment technology a field day and training will be provided to local home sewage system installers and sanitarians from other health departments. DEFA low interest Linked Deposit Loan Program will also be available to assist with system replacement in the entire county, and will extend beyond the time frame of the grant. The Health Department has written a plan to identify critical water quality areas and carry out a program for inspection, replacement or repair of failed home systems in the Wolf Creek (04100007-100) and Sandusky-Tiffin (0410007-090) assessment units.

Section 319 grant to Akron University, Department of Geology
2001-2003 $99,900

This research project will delineate the southern boundary of the Bellevue-Castalia Karst Plain. This sensitive geologic formation has the potential for direct contamination of the groundwater due to fractured and solutioned limestone formations very close to the land surface. The project area covers several assessment units in the Sandusky, Olentangy and Scioto watersheds of Crawford, Seneca, Sandusky and Erie counties. Specifically the dye tracing and modeling will be conducted in seven of the nine assessment units of the Sandusky TMDL study area, excluding the upper and lower Tymochtee Creek (04100007-050 and 060) assessment units.

Section 319 grant to Ducks Unlimited
2002-05 $160,000
The goal of this project is to restore 100 acres of natural flow-through wetlands to address habitat and siltation impairments in the downstream riparian corridors and coastal zone areas of the Sandusky River watershed. Private landowners will be eligible if they have not been previously assisted, or do not qualify for any of the current land conservation or set-aside programs that benefit water quality such as Conservation Reserve Enhancement Program (CREP), Wetland Reserve Program (WRP), and Conservation Reserve Program (CRP). Ducks Unlimited will restore multiple wetlands with high restoration potential to improve water quality. Partners include, the Sandusky River Watershed Coalition, ODNR-Division of Wildlife, ODNR Coastal Nonpoint Source Program, Winous Point Marsh Conservancy, and the four local SWCD offices from Sandusky, Ottawa, Erie, and Seneca counties. Specifically the project will be implemented in Muddy Creek (04100007-010), Sandusky-Fremont (04100007-120), Green Creek (04100007-110), and Sandusky Bay-West (04100007-130) assessment units of the Sandusky watershed.

Section 319 grant to Seneca SWCD
2002-05 $500,000
The goal of this grant is to implement agricultural best management practices (BMPs) in the Sandusky River watershed to reduce siltation and nutrient runoff into both surface and groundwater. Cost share funds for manure management, livestock exclusion, barn roof runoff, and filter strips will be targeted to landowners who are not eligible for other state and federal cost share programs. Cost sharing will also be provided for purchase of conservation tillage, residue management, and manure application equipment, and stabilization structures adjacent to sinkholes to reduce nutrient inflow into groundwater. Completion of a nutrient/resource management plan is a pre-requisite for 319 funding. These BMPS will benefit water quality in the project area which comprises 11 of the 14 assessment units of the Sandusky River watershed, excluding the most downstream units of Muddy Creek, Sandusky Bay-West and Sandusky Bay-East.

USEPA Grant to Ohio RCAP and Sandusky River Watershed Coalition
2003 $50,000
This grant will support the first year employment of a Karst Coordinator to implement the Unified Source Water Protection Plan for the karst region of the Sandusky watershed. The goals of the grant are to educate the public on the vulnerability of drinking water in the karst, and to work with the public drinking water suppliers to implement protection strategies outlined in the Plan. Local funds from the Ohio RCAP, WSOS and local communities will continue this coordinator position for several more years. The coordinator will initially work in the karst region associated with Green Creek (04100007-110), Sandusky Bay-West (04100007-130), and Honey Creek (04100007-080) assessment units. Public awareness and education efforts will ultimately extend south to the Sandusky-Mexico (04100007-070) and Broken Sword (04100007-030) assessment units.

Biological and Water Quality Study of the Sandusky River 2001

Seneca, Wyandot, and Crawford Counties, OH

State of Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
122 South Front St., Columbus OH 43215

INTRODUCTION

Ambient biological, water column chemical and sediment sampling was conducted in the Sandusky River basin from June to October 2001 as part of the five-year basin approach for monitoring, assessment, and the issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment. This study area included over 91 miles of the Sandusky River beginning in the headwaters(RM 127.8) and extending to CR 38, downstream from Tiffin, Ohio. Subwatersheds within the study area included Paramour Creek, Broken Sword Creek, Tymochtee Creek, Sycamore Creek and Honey Creek. Where possible, tributary streams with at least 4 mi^2 of drainage were sampled.

Specific objectives of this evaluation were to:

1) Monitor and assess the chemical, physical and biological integrity of the streams within the 2001 Sandusky River study area;

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

3) Evaluate the influence of the Crestline, Bucyrus, Upper Sandusky and Tiffin 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 Warmwater Habitat (WWH) and Modified Warmwater Habitat aquatic life uses and other non-aquatic use designations and recommend changes where appropriate.

The findings of this evaluation 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 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]).

SUMMARY

Aquatic Life Use Attainment Status and Trends

The 2001 Sandusky River study area included eight Watershed Assessment Units and a Large River Assessment Unit of the Sandusky River mainstem where the drainage area exceeded 500 mi^2. These were: Sandusky River-Bucyrus (headwaters to Broken Sword Creek); Broken Sword Creek; Sandusky River-Upper Sandusky (downstream Broken Sword Creek to upstream Tymochtee Creek); Upper Tymochtee Creek(headwaters to downstream Warpole Creek); Lower Tymochtee Creek (downstream Warpole Creek to mouth); Sandusky River-Mexico (downstream Tymochtee Creek to upstream Honey Creek), excluding the Sandusky River mainstem; Honey Creek; Sandusky River -Tiffin (downstream Honey Creek to upstream Wolf Creek), excluding the Sandusky River mainstem; and the Sandusky River mainstem from downstream Tymochtee Creek to upstream Wolf Creek. Summary statistics related to aquatic life use and a brief synopsis for each assessment unit are provided in Table 1A. The comments provided for each assessment unit include principal causes and sources of impact on aquatic life and recreational uses and significant contaminants in sediment and fish tissue.

Within the entire study area, aquatic life uses were assessed at 112 sites with drainage areas of less than 50 mi^2 (Table 1B). Of these sites, 38 fully met the designated or recommended use. Fifteen partially met and 59 sites were not attaining. Thirty-five sites representing 156.1 miles of streams draining between 50 mi^2 and 500 mi^2 of watershed were sampled. Designated or recommended aquatic life uses were fully met for 83.4 of the total assessed miles. Partial attainment was recorded for 52.7 miles. Non-attainment of aquatic life uses were demonstrated for 20 miles of the total assessed. An additional 36.0 miles of full attainment were documented in the Sandusky River mainstem between the confluence of Tymochtee Creek and Wolf Creek where the drainage area exceeded 500 mi^2. Seven miles of this reach of the Sandusky River were in non-attainment of the current or recommended aquatic life use.

Table 1A Aquatic life use attainment status for each of eight Watershed Assessment Units and for the Sandusky Large River Unit sampled in 2001. The assessment unit score is an average grade of aquatic life use status. The method of calculation is presented in the 2002 Integrated Water Quality Monitoring and Assessment Report (www.epa.state.oh.us/dsw/tmdl/2002IntReport/2002OhioIntegratedReport.html). An assessment unit score of 80 is used as the benchmark above which a watershed in considered to be in good condition relative to aquatic life uses. A maximum assessment unit score of 100 is possible if all monitored sites meet designated aquatic life uses. The comments provided for each assessment unit include principal causes and sources of impact on aquatic life and recreational uses and significant contaminants in sediment and fish tissue.

Sandusky River - Bucyrus headwaters to ust. Broken Sword Cr. AU# 0400011 020	**Total**	**Aquatic Life Attainment Status**						**Assessment Unit Score**
		Full		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	20	6	30	2	10	12	60	**32**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	22.1	10.4	47	10.3	47	1.4	6	

Comments

Sedimentation and enrichment associated with the predominant agricultural land use were the most common impacts on aquatic life use attainment. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat at some sites. Two distinct areas impacted by organic loadings were the Sandusky River within the City of Bucyrus due to combined sewer overflows (CSOs) and Westerly Creek within the Village of Crestline due to failed septic systems, urban runoff and the wastewater treatment plant (WWTP). The compound of greatest concern regarding enrichment impacts is phosphate (PO_4) because it is often growth limiting. Elevated levels of mercury were documented in sediment tested around the City of Bucyrus. A review of the annual Toxic Release Inventory report indicated that the General Electric Lamp Plant disposed of 49 pounds of mercury into the sewer system in 2000 and 19.8 pounds in 2001. The discharge of mercury via the Bucyrus WWTP and CSOs needs to be corrected. The Ohio Department of Health advises that meals of largemouth bass caught in the Sandusky River be limited to one per month because of mercury levels. The meal advice for carp is one per week and channel catfish one per month because of PCB levels.

Table 1A continued.

Broken Sword Creek AU# (04100011 030)	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	10	4	40	-	-	6	60	**71**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	15.8	13.8	87	2.0	13	-	-	

Comments
Impairment of water quality and fish and macroinvertebrate communities in the Broken Sword hydrologic unit can be largely attributed to agricultural practices within the watershed. Sedimentation and elevated nutrient levels were a concern along with the low water levels encountered during the sampling period. Modification of stream channels and tiling to facilitate drainage have reduced the volume of water present during dry weather periods making drought conditions in the streams a much more frequent occurrence. The upper site on Brandywine Creek (RM 3.3)was in non-attainment of a Limited Resource Water (LRW) aquatic life use. The stream was pooled with a septic layer of black sediment. The probable source was a hog manure spill that was investigated on May 14, 2001 and traced to Liberty Lean Farm located at 3240 Quaintance Rd. Another spill and fish kill associated with this facility was investigated on October 27, 2002.

Table 1A continued.

Sandusky River - Upper Sandusky (dst. Broken Sword Cr. to ust. Tymochtee Cr.) AU# (04100011 040)	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	15	4	27	2	13	9	60	**52**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	29.0	26.0	90	3.0	10	-	-	

Comments

The failure of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed and pollution from poorly treated sewage. Sedimentation, enrichment/low dissolved oxygen and substrate embeddedness were common impacts where aquatic life use attainment was not fully met. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelizing of streams, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. Significant nutrient enrichment and/or organic loading were indicated at sites on the Little Sandusky River resulting from failed on-site septic systems within the Village of Morral.

A mercury value exceeding the level established to protect drinking water supplies and prevent contamination of fish tissue was documented in the Sandusky River at TR 124 (RM 90.27) A couple of spills were investigated in 2001. One incident was at the Qualitec Trucking, Inc. facility located at 16303 TR 124, Harpster, OH. It was determined that 1000 gallons of waste oil was deliberately dumped and subsequently leached into a field tile that led directly to the Sandusky River. The Upper Sandusky WWTP reported a spill to the Sandusky River on June 18, 2001. A lift station pump failed and resulted in the bypass of a large amount of sewage directly into the river.

Table 1A continued.

Upper Tymochtee Creek (headwaters to Warpole Cr.) AU# 04100011 050	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	16	7	44	-	-	9	56	**13**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	19.3	-	-	7.8	40	11.5	60	

Comments

Given that farming will remain the predominant land use, modified warmwater (MWH) or Limited Resource Water (LRW) uses were recommended for a majority of small channelized streams(less than 10 mi^2) where limited habitat conditions made these uses applicable. The failure of a majority of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed, pollution from poorly treated sewage and spills. Sedimentation, enrichment/low dissolved oxygen, ammonia and bacteria were a concern, but the most pervasive impact was simply the low water levels that were encountered during the sampling period. In addition to the widespread impacts associated with agriculture, several distinct areas were impacted by organic loadings from on-site septic systems. These were Tymochtee Creek and Prairie Run immediately downstream from the Village of Meeker, Tymochtee Creek downstream from the Village of Marseilles, Little Tymochtee Creek at Township Road 104 (RM 13.5) and Warpole Creek downstream from the Village of Harpster.

A pollution complaint was investigated on November 9, 2001 at Corey Dairy, located at 18405 Wyandot County Rd. 70. It was determined that land applied manure leached into field tiles and entered a ditch that flows into the Little Tymochtee Creek (upper). The investigating Wildlife Officer stated that there was potential for future incidents because of the size of the operation, heavy clay soils and shallow field tiles. A complaint was investigated on March 7, 2001concerning the Devries Dairy Farm at 15603 State Hwy. 67. It was determined that land applied manure leached into a field tile that entered Tymochtee Creek.

Table 1A continued.

Lower Tymochtee Creek (dst. Warpole Cr. to mouth) AU# 04100011 060	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	9	2	22	1	11	6	67	**27**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	26.7	10.9	41	15.8	59	0	-	

Comments

The failure of a majority of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed, pollution from poorly treated sewage and spills. Sedimentation, enrichment/low dissolved oxygen, ammonia and bacteria were a concern, but the most pervasive impact was simply the low water levels that were encountered during the sampling period.

In addition to agricultural sources discussed above, unrestricted cattle access to the stream was a significant contributor to loss of habitat function and elevated fecal coliform counts on Little Tymochtee Creek (lower) at CR 29. This was the only site in the entire Sandusky River watershed that had two bacteria results with greater than 10,000 colonies/100ml. Another incident of note is a kerosene spill into Little Tymochtee Creek (lower) investigated on April 8, 2001.

The Carey WWTP discharge impacted County Ditch #32. Water quality data indicated impairment by enrichment/low dissolved oxygen and ammonia. This site had the highest measured phosphorus concentrations in the entire Sandusky River study area.

Potential sources of impact on Spring Run include stormwater discharges from the Budd Co., urban runoff and the Carey WWTP via County Ditch #32. Water chemistry results suggested impairments due to elevated nutrient enrichment, ammonia and temperature. In addition, a diesel fuel spill occurred earlier in the summer when a train engine was damaged and fuel seeped into a tile that discharged to the stream.

Redhorse suckers and northern pike were relatively common in this reach of Tymochtee Creek. Improvements in upstream portions of the watershed to lessen sediment load and improve habitat function will help to maintain the pike population and possibly allow for repopulation further upstream. Redhorse suckers, as a group, are sensitive to siltation. Their occurrence was associated with midchannel areas of relatively clean rubble due to the redistribution of fine sediment to stream margins during high flow events.

Table 1A continued.

Sandusky River - Mexico (dst. Tymochtee Cr. to ust. Honey Cr. excluding mainstem) AU# 04100011 070	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	13	6	46	3	23	4	31	**56**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	10	4.1	41	5.9	59	-	-	

Comments

Impediments to full attainment of applicable aquatic life uses within the assessment unit can be largely attributed to agricultural practices within the watershed. Sedimentation and substrate embeddedness were the most common impacts where aquatic life use attainment was not fully met. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelizing of streams, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods. Many of the sampled locations had slow current which keeps eroded sediment trapped within the stream channel. Additionally, the lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream.

Thorn Run appeared to be impaired by enrichment/low dissolved oxygen in addition to reduced habitat quality. A likely source is poorly treated sewage from failed on-lot septic systems in the Village of McCutchenville.

An impact to the macroinvertebrate community in Sycamore Creek at RM 3.8 was noted but a cause was not readily apparent. The stream did not appear to be excessively effected by enrichment, rather, the impact may have been a response to low level chronic toxicity. Possible sources include a lingering impact from the Kirby tire fire, agricultural runoff and degraded water quality from point and/or nonpoint sources in the Village of Sycamore. Additional sampling is needed to determine if the condition has persisted and to identify a cause(s).

Table 1A continued.

Honey Creek AU# 04100011 080	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	19	8	42	4	21	7	39	**62**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	33.2	18.2	55	7.9	24	7.1	21	

Comments
The failure of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to either agricultural practices within the watershed or point source pollution loadings. Sedimentation, enrichment/low dissolved oxygen and substrate embeddedness were the most common impacts where aquatic life use attainment was not fully met. Many of the sampled locations had slow current which keeps eroded sediment trapped within the stream channel. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelizing of streams, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods. Levels of phosphorus increase substantially in Honey Creek through the zone that includes New Washington, Attica and Bloomville. The majority of phosphorus appears to originate from the Attica Wastewater Treatment Plant (WWTP).

Sediment sampling was conducted in Honey Creek at TR 173 (RM 18.05). Results for metals ranged from slightly elevated to extremely elevated and several values were considered above toxic levels. The substrate was almost entirely bedrock and only a very small amount of sediment was found in an isolated eddy. The results were unexpected and difficult to explain, but, because of the small quantity of sediment at the site, it should not have significant ecological impact.

Sandusky River - Tiffin (dst. Honey Cr. to ust. Wolf Cr. excluding mainstem) AU# 04100011 090	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	8	1	13	2	25	5	62	**50**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	-	-	-	-	-	-	-	

Comments
The lack of aquatic life use attainment at all but one site within the assessment unit can be largely attributed to agricultural practices within the watershed. There are no regulated point sources located in the assessment unit. Sedimentation, enrichment/low dissolved oxygen and elevated bacteria levels were a concern along with the low water levels that were encountered during the sampling period. The channelizing of streams, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods.

Table 1A continued.

Sandusky River Mainstem (mainstem exceeding 500mi^2 drainage area) AU# 04100011 001	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Assessed Miles with > 500 mi^2 drainage area	43.0	36.0	83	7.0	17	-	-	Not applicable

Comments

Two impounded areas failed to meet the WWH use. The Ella St. dam (RM 42.0) exists to supply drinking water for the City of Tiffin. The St. Johns dam (RM 50.2) allows for small boat recreation, but severely impairs the attainment of the designated WWH use. Both impounded areas were similarly effected by heavy siltation, limited habitat and a lack of discernible flow. Since the Ella St. dam is necessary and its removal is not a possibility, an impounded Modified Warmwater Habitat use (MWH) is appropriate. Biological communities in the impounded reach met this use. The recreational use provided by the St. Johns dam is not sufficient justification for recommending the MWH use. Biological sampling in the St. Johns dam failed to attain the designated WWH aquatic life use. Currently plans are being made for removal of the dam which would result in significant improvement in aquatic life use attainment. Very few water quality problems were documented in the assessment unit, however, urban stormwater is a concern as a source of recreational impairment. A storm on July 24, 2001 apparently produced enough rain to activate combined sewer overflows (CSOs) in Tiffin and elevated bacteria counts were subsequently documented. The associated ammonia and phosphorus concentrations were also higher. Pesticide scans indicated that insecticides used on crops were a concern in several areas. The compound dieldrin was detected in both the Ella St. and St. Johns dam pools on the Sandusky River. The level at both sites exceeded toxicity guidelines.

Table 1B. Aquatic life use attainment status of the Sandusky River basin, June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Sandusky River						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
127.8/127.8	36[ns]	7.5*	42	82.0	Partial	TR 13, Lower Leesville Rd.
120.8/120.0	37[ns]	7.1*	48	57.0	Partial	CR 55, Locust Grove Rd.
116.2/114.9	40	7.6*	48	60.5	Partial	TR 82, Kiess Rd.
111.2/111.2	24*	6.0*	22*	44.0	**NON**	Ust. Bucyrus WWTP
110.4/110.4	36[ns]	7.2*	18*	75.0	Partial	CR 121, Kerstetter Rd.
105.8/103.7	37[ns]	9.0	VG	74.5	Full	TR 128, Shupp Rd.
98.7/98.7	44	9.0	44	82.5	Full	SR 231
93.8/93.8	32*	8.2[ns]	48	67.0	Partial	TR 128
90.3/90.3	44	9.0	54	66.0	Full	TR 124
83.3/85.0	43	8.2[ns]	46	59.0	Full	CR 55
78.4/77.9	48	8.1[ns]	44	71.5	Full	CR 121
72.0/72.1	52	9.3	52	76.5	Full	TR 40 (Parker Bridge)
65.0/65.1	53	8.5	E	76.0	Full	CR 16
57.4/57.3	48	8.7	48	60.5	Full	CR 9
52.2/52.2	43	7.5*	12*	50.0	**NON**	Walnut Grove Campground
47.7/47.8	54	10.3	54	85.0	Full	CR 90
46.8/46.8	53	9.7	48	84.5	Full	From CR 90
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
43.0/43.0	46	7.3	NA	57.0	Full	US 224
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
41.8/41.9	57	10.1	42	76.0	Full	Ella St.
38.9/38.9	54	10.7	50	87.0	Full	Ust. Tiffin WWTP
36.4/36.5	50	9.9	36	84.5	Full	CR 38
Paramour Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
6.3/6.3	26*	NA	20*	35.0	**NON**	TR 176, Finnegan Rd.
4.8/---	28*	NA	---	30.0	(**NON**)	SR 61

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Paramour Creek (continued.)						
---/2.9	---	---	Fair*	---	(**NON**)	Krichbaum Rd.
1.5/1.5	20*	3.6*	G	53.0	**NON**	TR 48, Nazor Rd.
Paramour Creek tributary @ RM 5.13 (PPG trib.)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
3.7/3.7	36[ns]	NA	30*	39.0	Partial	PPG park, Ust. outfall trib.
0.2/0.2	26*	NA	MG	37.5	**NON**	TR 228, Hook Rd.
Paramour Creek tributary @ RM 2.88 (East Crestline Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	20*	NA	F*	61	**NON**	TR 167, Cayer Rd.
Paramour Creek tributary @ RM 1.92 (Westerly Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.4/2.4	34*	NA	12*	60.0	**NON**	Patterson St.
Allen Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.2/1.2	42	NA	MG[ns]	48.5	Full	CR 35, Crestline (Boyer) Rd.
Loss Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
4.6/4.6	26*	NA	Fair	54.0	**NON**	SR 598
1.0/1.1	38[ns]	NA	G	75	Full	TR 44, Biddle (Dice) Rd.
Loss Creek tributary @ RM 2.98 (South Fork Loss Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	20*	NA	G	61	**NON**	TR 178, Loss Creek Rd.
Sandusky River tributary @ RM 122.09 (East North Robinson Run)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.9/0.8	40	NA	G	64	Full	CR 49, Remlinger Rd.
Sandusky River tributary @ RM 121.19 (West North Robinson Run)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.2/0.2	40	NA	G	55.5	Full	TR 45, Stetzer Rd.
Grass Run						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
10.6/10.6	26	NA	P*	19.5	**NON**	CR 330, Lincoln Highway
8.4/9.1	34	NA	P*	31.5	**NON**	From CR 2

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Grass Run (continued)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
3.4/3.4	46	NA	G	59.5	Full	TR 59
Gray Eye Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.3/1.3	44	NA	G	45	Full	SR 231
Broken Sword Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/32.6	---	---	G	---	(Full)	TR 53, Dickson (Lightsburg)
30.3/30.3	36	NA	G	30.5	Full	TR 20, Beck (Kirkpatrick) Rd.
27.9/27.9	30	---	G	31.5	Full	CR 78, Ridgetown-Annapolis
25.5/25.5	26	6.8	54	20.0	Full	TR 41, Schwemley Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
19.7/16.7	28*	7.4*	30*	52.5	**NON**	Holmes Center Rd./ Bethel Rd.
12.3/12.3	38[ns]	8.8	38	67.0	Full	US 30, Lincoln Highway
10.5/10.5	40	8.1[ns]	42	67.5	Full	TR 10/11, County Line Rd.
4.8/3.9	41	7.6*	48	65.5	Partial	CR 55/ CR 56
0.9/0.6	47	9.1	46	76.0	Full	CR 62
Red Run						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/0.5	---	---	F	---	(Full)	CR 139, Henry Cooper Rd.
Brandywine Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
3.3/3.3	12*	NA	P*	37.5	**NON**	CR 31, Spore-Brandywine Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.6/1.6	24	NA	P*	27.5	**NON**	TR 30, Temple Rd.
Indian Run						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.5/3.5	26	NA	P*	33.0	**NON**	CR 47
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.9/1.0	26*	NA	MG[ns]	44.0	**NON**	TR 137

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Little Sandusky River						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
---/10.4	---	---	P*	---	(**NON**)	
9.4/9.4	24*	NA	VP*	32.0	**NON**	CR 67, Morral-Kirkpatrick Rd.
7.0/8.6	20*	NA	F*	37.0	**NON**	TR 68, Wyandot-Marion Rd.
---/6.5	---	---	F*	---	(**NON**)	
1.3/1.4	26*	5.1*	34[ns]	50.5	**NON**	CR 113
Little Sandusky River Tributary @ RM 8.93						
	Eastern Corn Belt Plains (ECBP) - MWH Use Designation					
---/2.6	20*	NA	---	18.5	**(NON)**	CR 90, Goodnow Rd.
Honey Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
---/2.4	---	---	MG	---	(Full)	TR 128
0.5/0.5	12*	NA	G	43.0	**NON**	CR 126
Rock Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
4.0/4.0	34*	NA	F*	36.0	**NON**	TR 124
0.9/0.9	30*	NA	MG[ns]	57.0	Partial	TR 51
Negro Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
2.9/2.9	44	NA	VG	59.0	Full	CR 128
0.5/0.5	42	NA	G	57.5	Full	CR 124
Spring Branch						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
1.2/1.2	38[ns]	NA	VG	54	Full	TR 136
Sugar Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
0.6/0.6	34*	NA	G	64.0	Partial	SR 67
Layton Ditch						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
0.4/0.3	26*	NA	F	57.0	**NON**	CR 37

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Tymochtee Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/53.2	---	---	F	---	(Full)	CR 88, Pleasant Hill Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
49.3/49.3	22*	NA	VP*	47.0	**NON**	CR 213, Main St.
47.2/46.9	26*	6.0*	34[ns]	45.5	**NON**	CR 30, Osbun Rd.
42.8/43.0	28*	5.7*	44	55.0	**NON**	TR 64, Fail Rd.
40.8/40.8	31*	7.1*	38	68.0	Partial	SR 67
34.0/34.0	31*	7.3*	MG	40.5	Partial	TR 97
26.2/25.8	32*	7.0*	44	56.5	Partial	SR 53
19.6/19.4	33*	7.3*	38	57.0	Partial	TR 49
13.7/15.6	36[ns]	6.6*	40	54.5	Partial	TR 42/ TR 44
8.1/7.8	45	9.1	48	75.0	Full	SR 199
4.7/4.7	40	8.3	VG	61.0	Full	SR 103
Prairie Run						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/4.1	---	---	---	P	(Full)	CR 63, Schreck Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.0/1.0	26	NA	MG	32.0	Full	TR 31, Agosta-Meeker Rd.
Thompson Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation						
1.5/---	32	NA	---	16.5	(Full)	Adj. CR 35,
Enoch Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.6/2.0	28*	NA	F*	36.5	**NON**	CR 29, DeCliff Rd.
Carroll Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation						
1.0/1.0	26	NA	F	16.0	Full	CR 30, Osbun Rd.
Pawpaw Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
8.9/8.9	28*	NA	P*	28.5	**NON**	TR 235
6.0/6.0	22*	NA	F*	61.0	**NON**	CR 255 /18, Marion-Hardin Rd.
0.6/0.6	26*	---	MG[ns]	68.0	**NON**	TR 24, Fail Rd.

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Little Tymochtee Creek (upper)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
13.5/13.5	30	NA	P*	26.0	**NON**	TR 104
10.0/10.0	30	NA	F	---	FULL	TR 24, Rager Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
7.4/7.4	26*	NA	MG[ns]	50.0	**NON**	CR 215, County Line Rd.
4.0/4.1	34*	5.6*	28*	53.5	**NON**	CR 93
Warpole Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.5/1.5	36	NA	MG	33.0	Full	TR 58
Lick Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.3/1.3	32*	NA	MG[ns]	49.5	Partial	CR 97
Little Tymochtee Creek (lower)						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/10.3	---	---	P*	---	(**NON**)	TR 49
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
6.9/6.9	26*	NA	F*	46.5	**NON**	CR 44
0.9/1.0	24*	6.0*	G	41.5	**NON**	CR 29
Spring Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
5.3/5.4	28*	NA	F*	31.5	**NON**	Muncie St.
3.7/3.7	20*	NA	P*	49.0	**NON**	From TR 100 at Quarry Rd.
County Ditch # 32 (05-303)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.2/0.1	26*	NA	P*	33.0	**NON**	SR 199
Poverty Run (05-302)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
---/4.7	---	---	MG	---	(Full)	County Line Rd.
3.0/3.1	42	NA	MG	40.5	Full	TR 11, Poverty Run Rd.
Thorn Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.9/2.9	22*	NA	MG[ns]	29.5	**NON**	CR 5
1.0/0.9	24*	NA	F*	44.0	**NON**	SR 53

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Thorn Run (continued)						
5.3/---	22*	NA	---	42.0	**(NON)**	TR 30
3.7/3.5	24*	NA	MG[ns]	23.5	**NON**	SR 103
2.0/1.9	30*	NA	MG[ns]	52.0	Partial	CR 16
Taylor Run Tributary @ RM 2.49 (West Branch Taylor Run)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/3.3	---	---	MG	---	(FULL)	SR 67
Sycamore Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
22.0/22.0	28	NA	G	38.5	Full	CR 5
18.9/18.9	26	NA	G	46.0	Full	TR 37, Kennedy Rd.
13.0/14.3	38[ns]	7.5	46	56.0	Full	SR 103
9.2/9.1	32*	5.9*	G	55.0	Partial	TR 10/ 11, County Line Rd.
7.3/6.9	40	8.1	G	58.0	Full	SR 231
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
4.9/5.1	40	6.4*	G	65.0	Partial	SR 103/ 231
3.6/3.8	46	9.0	28*	84.0	Partial	SR 67, Kilborn St.
0.4/0.4	44	8.4	48	70.0	Full	CR 37
Sycamore Creek Tributary @ RM 12.92 (Spring Creek 05-075)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
5.7/5.7	40	NA	MG	21.5	Full	CR 27, Carey Rd.
Greasy Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.6/1.6	34*	NA	G	43	Partial	TR 136
Mile Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
3.5/3.5	38[ns]	NA	G	51.5	Full	SR 67
0.3/0.3	32*	NA	G	66.5	Partial	CR 37
3.0/3.1	42	NA	MG	40.5	Full	TR 11, Poverty Run Rd.
Honey Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
41.7/41.7	32*	NA	G	55.5	Partial	TR 73, Waynesburg-Tiro Rd.
38.4/38.4	32*	NA	G	51.0	Partial	TR 67, Young Rd.

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Honey Creek (continued)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
34.1/34.1	28	7.3	32	32.5	Full	TR 85, Bigham Rd.
32.2/30.9	32	6.7	42	27.0	Full	TR 13, County Line Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
25.1/25.1	32*	5.1*	30*	51.0	**NON**	TR 79, Slessman Rd.
18.1/18.2	32*	6.7*	42	58.5	Partial	TR 173, Cemetery Rd.
14.8/14.6	32*	7.6*	VG	62.0	Partial	TR 58, Center Rd.
12.5/12.4	44	9.2	38	74.5	Full	SR 67/ 100
6.6/6.6	46	9.3	E	76.5	Full	TR 58, Center Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
0.2/1.1	45	7.4	G	52.5	Full	CR 19
Honey Creek Tributary @ RM 41.3 (Tiro Creek)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/0.7	---	---	P	---	**(NON)**	TR 190, Hammond Rd.
Honey Creek Tributary @ RM 32.84 (Celery Creek)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/5.6	---	---	P	---	**(NON)**	TR 14, Base Line Rd. (ust. trib.)
---/2.2	---	---	VP	---	**(NON)**	TR 30 (ust. trib.)
Brokenknife Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
5.1/5.1	30	NA	G	25.0	Full	TR 133, McCarthy Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.0/1.0	30*	NA	G	56.5	Partial	TR 13, County Line Rd.
Aicholz Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.9/3.9	28	NA	P*	28.5	**NON**	CR 23, Scipio Siding Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.5/2.4	38[ns]	NA	G	42.5	Full	TR 77, Cooper Rd.
Silver Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/10.6	---	---	VP	---	(**NON**)	SR 4, Columbus-Sandusky Rd.

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Silver Creek (continued)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
7.7/7.7	36[ns]	NA	MG	46.5	Full	CR 58/ 14, County Line Rd.
4.1/4.1	26*	NA	MG	31.5	**NON**	SR 19, Bucyrus Clyde Rd.
Silver Creek Tributary @ RM 0.72 (Slee Ditch 05-213)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	44	NA	G	51.5	Full	At mouth
Buckeye Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.7/2.6	46	NA	MG	58.0	Full	TR 10/ 11, County Line Rd.
0.4/0.8	46	NA	G	84.0	Full	TR 17
Van Meter Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.7/1.7	32	NA	G	47.0	Full	TR 151, Infirmary Rd.
Bells Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.2	22*	NA	F*	54.5	**NON**	SR 53
Gibson Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.3/0.4	32*	NA	MG	46.0	Partial	Sycamore
Rock Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
8.4/ 8.3	32*	NA	F*	49.0	**NON**	CR 16
4.0/ 4.0	38[ns]	8.1[ns]	50	76.0	Full	TR 201, Old Attica Rd.
East Branch Rock Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
---/ 4.2	---	NA	F*	---	(**NON**)	SR 67
0.1/ 0.1	32*	NA	F*	57.5	**NON**	At mouth
Willow Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.0/ 3.0	22*	NA	MG	35	**NON**	TR 15, Morrison Rd.

Table 1B continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Morrison Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/ 11.4	---	---	P*	---	(**NON**)	SR 18
9.4/ 9.4	32	NA	P*	34	Partial	TR 175, Coffman Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.4/ 2.4	34*	NA	MG	55.0	Partial	TR 15, Morrison Rd.1.5/1.5

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	MWH impounded	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	-/30	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	-	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

The figure (Figure 1A) below is a first look at the basin wide condition of streams in the Sandusky basin. A lower drainage area limit of 20 mi^2 was set for the data used since this is the minimum drainage area for a wadeable stream. This size stream also tended to have water in the channel unlike many of the smaller drainage sites. An upper limit of 500 mi^2 excludes the mainstem Sandusky sites downstream from Tymochtee Creek. The horizontal line in each graph is the index score for WWH attainment. The two vertical lines accentuate the principal conclusions made from the data. First, note that the sites with drainage areas of greater than about 225 mi^2 generally met WWH expectations. Secondly, nearly all of the sites between 20 and 50 mi^2 had subpar fish results. Results for both organism groups from sites of between 50 mi^2 and 225mi^2 are mixed.

Overall, the macroinvertebrate community met expectations at a higher frequency than did either fish index at sites of less than 225 mi^2. The macroinvertebrates tend to score better than the fish when water chemistry is acceptable but the macrohabitat is degraded. Additional substantiation of this is that there are a number of poor habitat sites (triangles on the graphs) where the macroinvertebrates met WWH expectations. Conversely, none of the poor habitat sites had IBI or MIwb scores that attained. Few of the IBI scores and none of the MIwb scores for sites between 20 mi^2 and 50 mi^2 attained or exceeded the WWH criterion. Degraded habitat was the most pervasive cause although nutrients certainly negatively effected certain of the sites. The assessment unit summaries provide more site specific appraisals of causes and sources. Even the sites with good habitat were effected due to low flow conditions and sedimentation. The sites between 50 mi^2 and 225 mi^2 were more predictable in terms of habitat condition positively effecting the fish community. This was likely due to increased flow which provided increased pool depths and improved the functioning of various cover types to support a greater diversity of fish species.

The information presented in Figure 1A is instructive as to where restoration activities might best be directed. First, funds do not need to be spent to improve conditions in areas where the drainage area exceeds 225mi^2. These sites are largely already meeting ecoregion expectations for aquatic life and should continue to do so unless new impacts (*i.e.*, additional WWTP loadings, drainage improvements) are introduced. Preservation of existing riparian areas would be beneficial in maintaining healthy biological communities.

A second conclusion is that the efforts to improve habitat in stream segments with drainage areas between 50 mi^2 and 225 mi^2 should result in better fish communities. A benchmark would be to restore the stream habitat so that a QHEI score of at least 60 is achieved. Nutrient sources should also be addressed where it has been noted in the assessment unit summaries to benefit both biological communities and recreational use concerns.

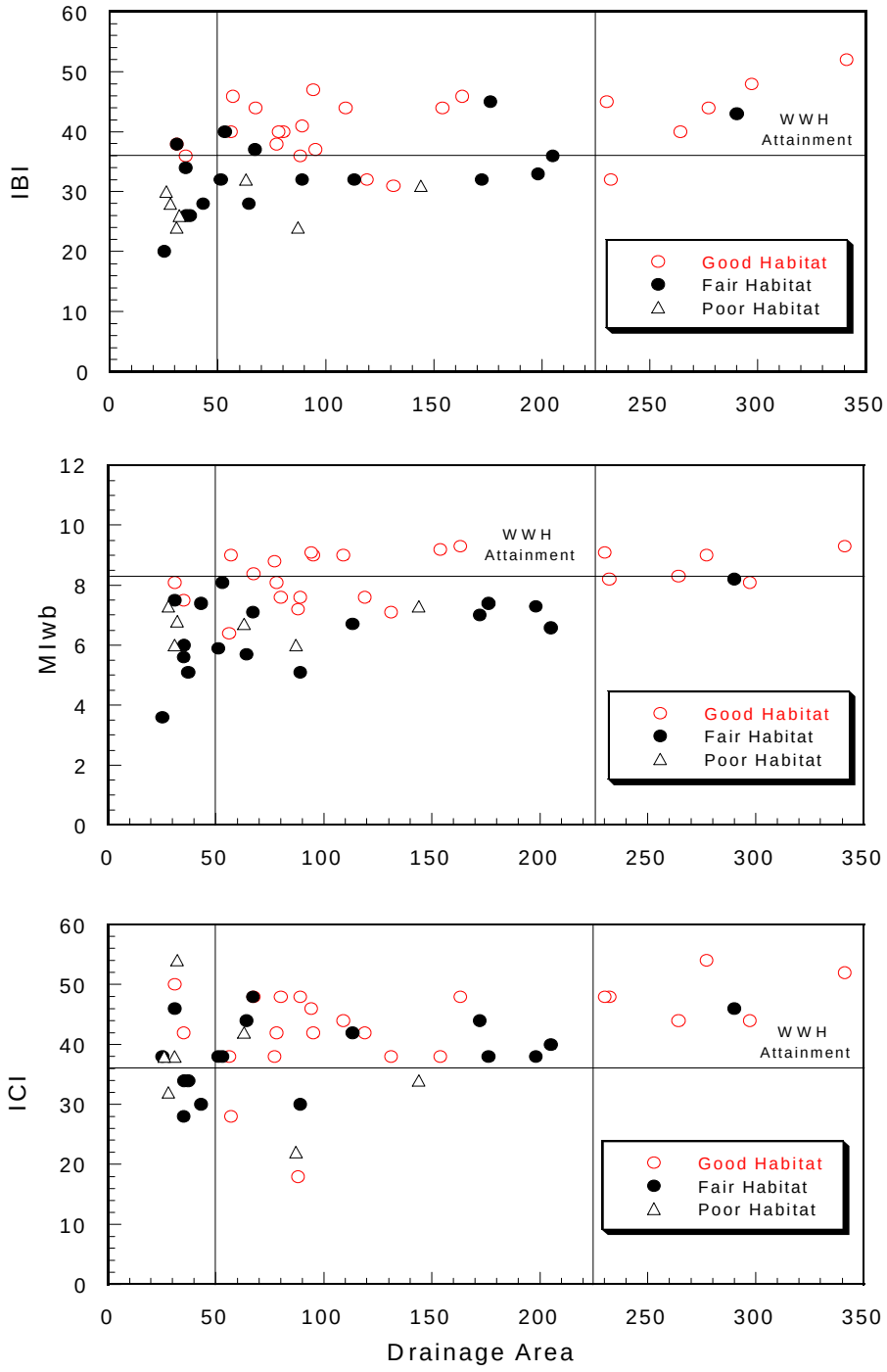


Figure 1A Biological index scores of 20 mi^2 to 500 mi^2 drainage area sites in the 2001 Sandusky River study area as related to habitat quality. Corresponding ICI scores are used where narrative evaluations were made based on qualitative sampling results.

Thirdly, the 20 mi^2 to 50 mi^2 sites were, as a group, severely impacted. Many of these sites were on waterways that are being maintained to facilitate drainage of agricultural fields. As such, Modified Warmwater Habitat or Limited Resource Water aquatic life uses were recommended where warranted for streams in which the 2001 sampling effort was the first occasion for Ohio EPA to evaluate biological communities and habitat conditions. Some improvement in the macroinvertebrate community could be realized by limiting nutrient loadings but fish populations are unlikely to improve much given the alteration of the flow regime that has occurred to facilitate agricultural operations and the effects of sedimentation and substrate embeddedness.

Different imprints of pollution attributable to urban nonpoint source runoff and CSOs on the Sandusky River above the confluence of Tymochtee Creek versus agricultural related to impacts on Tymochtee Creek are apparent in the fish and macroinvertebrate sampling results (Figure 1B). The two stream segments drain similarly sized areas. In the case of the Sandusky River the impact from

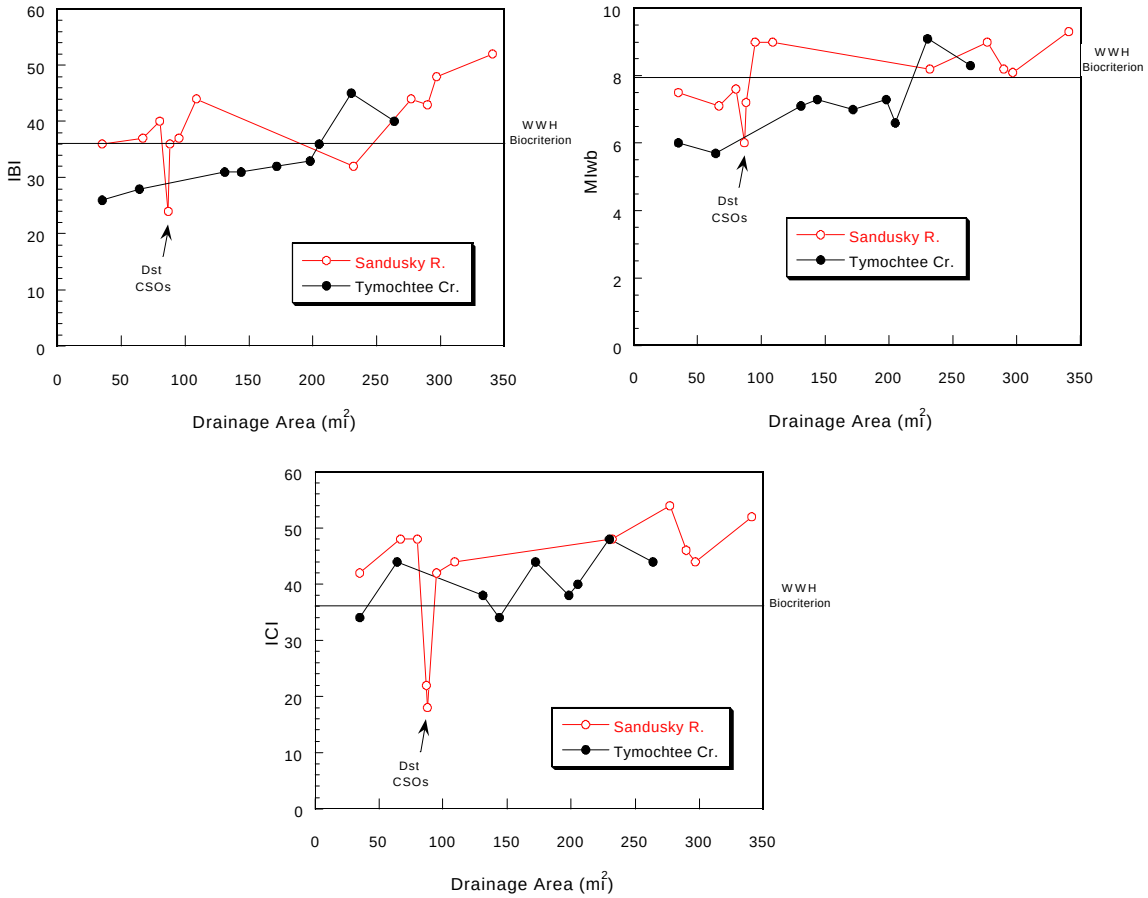


Figure 1B. 2001 Tymochtee Creek and the Sandusky River fish (IBI and MIwb) and macroinvertebrate (ICI) community condition by drainage area.

CSOs was severe but impaired a relatively short reach of the stream. Tymochtee Creek was impacted by sedimentation and habitat degradation associated with agricultural practices throughout the basin. The fish (IBI and MIwb) and macroinvertebrate (ICI) graphs show a similar tendency for the lower performing index scores in Tymochtee Creek compared to the Sandusky River with the exception of the Sandusky River immediately downstream from the CSOs. The impact on Tymochtee was evident in the drainage area range of 16 to 210 mi^2. The lower reaches of both streams recorded similar biological index scores and met the WWH use. This example demonstrates how the three factors used to define degree of impact effecting streams function independently. Magnitude, frequency and duration all contribute to the severity of an impact. The urban impacts in the city of Bucyrus were severe but impaired biological function in much less of the stream downstream. In the case of the agricultural impacts seen on Tymochtee Creek, the effect was not as great in magnitude but was pervasive and relatively constant. Approximately 40 miles of Tymochtee Creek were negatively effected by land use impacts versus less than three miles of the Sandusky River related to CSOs.

There were a limited number of streams in which nutrient enrichment and/or organic loadings were the significant causes of impairment to aquatic life. The Sandusky River was impacted by CSOs within the city of Bucyrus. Westerly Creek received excessive loadings from residential septic systems, urban runoff and the Crestline WWTP. Brandywine Creek was in poor condition due to a hog manure spill from the Liberty Lean Farm. The Little Sandusky River was impacted by individual septic systems within the village of Morral. A grey water discharge and poor macroinvertebrate community condition were noted at RM 13.5 on Little Tymochtee Creek (upper trib.). Insufficiently treated sewage from septic systems within the village of Meeker was a significant contributor to the poor biological results recorded for Tymochtee Creek at RM 49.3. The Carey WWTP was apparently discharging excessive levels of nutrients and/or organic material into County Ditch #32. Spring Run was impacted by several sources including the Carey WWTP (via County Ditch #32), stormwater runoff from the BUDD Co., urban runoff associated with the city of Carey and an oil spill which occurred prior to the 2001 sampling period. Celery Creek and Tiro Creek appeared to be overwhelmed with nutrients and/or organic material due to the intensive row crop agricultural activities in the watershed. The fish community in Silver Creek at RM 4.1 seemed to be recovering from the effects of a release of an unknown acutely toxic or oxygen demanding substance. Excessive nutrient enrichment was indicated in Willow Creek and Morrison Creek.

Previous Ohio EPA surveys of waters within the study area date back to 1974. Initial monitoring relied heavily on water chemistry results and was directed at evaluating municipal WWTP and combined sewer overflow (CSO) impacts. The Sandusky River downstream from Bucyrus, Spring Run downstream from Carey and Paramour Creek downstream from Crestline were found to be severely impacted. While impacts were still evident at all three of these locations, the severity was much reduced in 2001, particularly in terms of bacteriological contamination.

The first comprehensive sampling to evaluate the condition of fish and macroinvertebrate communities in the Sandusky River mainstem from the headwaters to Wolf Creek occurred in 1979

and 1981. In this survey, both organism groups showed significant impact downstream from Bucyrus and to a lessor degree downstream from Paramour Creek and the city of Upper Sandusky. Evidence of degradation related to CSOs and the Bucyrus WWTP extended for approximately twelve miles. No significant impact was associated with the Tiffin WWTP based on sampling conducted in 1981, however, impoundments were identified has negatively affecting stream biota.

The next comprehensive assessment of the mainstem was conducted in 1990. As in past years,. discharges from Bucyrus CSOs were identified by the Ohio EPA as a significant source of organic load to the Sandusky River. Improvement was noted in the macroinvertebrate community as a result of upgrades to the Bucyrus WWTP. A decline in the fish community documented between RMs 92.1 aand 81.3 in 1990 compared with the earlier survey was attributed to sedimentation and embeddedness of the stream bottom. Higher fish community scores were recorded within and downstream from Tiffin compared to 1981. Improvements to the WWTP and reduced CSO discharges were credited with the improvements in the fish community in 1990.

In general, the 2001 Sandusky River survey demonstrated improvement in the quality of both fish and macroinvertebrate communities. For example, an overall increase in the IBI scores between 1979 and 2001 can be seen in the IBI scores recorded during the period (Figure 1C). Bucyrus CSOs continued to affect biological performance, and the fish community at RM 93.8 appeared to be affected by siltation and nutrients. The remaining downstream sampling locations recorded IBI scores that exceeded the WWH criterion, a marked improvement compared to the 1979/1981 scores when only two of eleven sites in this reach met or exceeded the criterion.

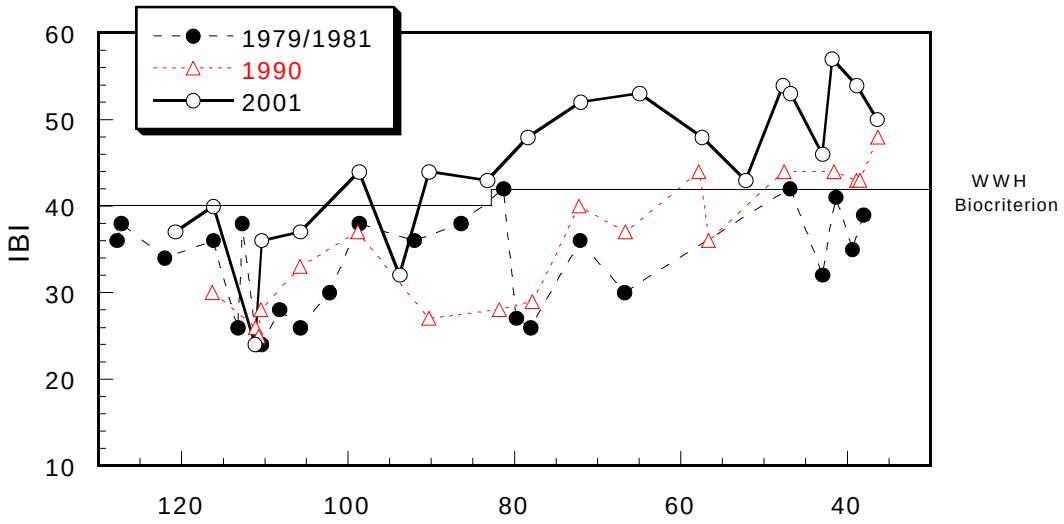


Figure 1C. Longitudinal trend of the Index of Biotic Integrity (IBI) in the Sandusky River between 1979 and 2001.

Recreational Uses

A total of 222 samples were submitted for fecal coliform analysis and most sites had separate samples collected at two-week intervals. A total of 61 (28%) exceeded the average PCR criterion of 1,000/100 ml, 27 (12%) exceeded the maximum PCR criterion of 2,000/100 ml and 13 (6%) exceeded an extremely elevated level of 10,000/100 ml. One site, Little Tymochtee Creek (lower trib.) at County Rd. 29, had extremely elevated counts in both samples. This stream flows through a pasture and the livestock have direct access to the water.

Extremely elevated levels of bacteria were documented in the Sandusky River below the City of Tiffin. The source was overflows from combined sewers that were activated during a rainstorm. The Tiffin City Council approved a phased plan for separating combined sewers in January, 2002. Another problem spot in Tiffin is Honey Creek near its confluence with the Sandusky River. At this location, the Honey Creek Subdivision has about 34 homes that are served by on-lot sewage treatment systems and apparently some have overflows that are connected to a storm sewer tile. The entire length of the Little Sandusky River had elevated bacteria levels and the source is overflows from failed on-lot septic systems in the Village of Morral. Other areas where failed septic systems were a concern are the Village of Meeker in Marion County, the Villages of Harpster and Marseilles in Wyandot County, the Village of Republic in Seneca County and the Villages of Chatfield, Tiro and Sulphur Springs in Crawford County. Westerly Creek in the Village of Crestline was a concern because of a combined sewer overflow and a small part of the municipal area that is not connected to the sanitary sewer system.

Public Water Supplies

There are five communities in the study area that use surface water as a raw source of drinking water. Ohio American Water draws from the Sandusky River at RM 42.12 and supplies the City of Tiffin.

The City of Upper Sandusky uses an impounded reservoir to store water pumped from the Sandusky River at RM 83.15 and also has an intake near the treatment plant at RM 82.90. The city is in the process of constructing a new up-ground reservoir to store river water. The City of Bucyrus draws from the Sandusky River at RM 115.45 and pumps into up-ground reservoirs. The Village of Attica draws from Honey Creek at RM 28.36 and pumps into an upground reservoir. The Village of New Washington draws from Alum Ditch (tributary confluent with Brokenknife Creek at RM 5.50) and pumps into upground reservoirs. Water quality criteria established for a public water supply (Administrative Code 3745-1-33) apply within 500 yards of an intake. The Sandusky River at Ella St. (RM 41.84) was the only site in the study area that met this requirement. Nearly all of the iron and manganese results exceeded Public Water Supply criteria, but since the treatment plant employs a lime softening process to remove hardness before distribution, it should not be an issue.

Sediment Quality

A total of 21 sediment samples were analyzed for various physical and chemical properties. Physical attributes measured included particle size distribution, % solids and % organic carbon. Most locations sampled did not retain a lot of sediment, except those that were channelized or impounded

by dams. Where sediment was found, it consisted mostly of sand (median content was 62.4%). Chemical attributes measured included metals, volatile and semi-volatile organic compounds, pesticides and poly-chlorinated biphenyls (PCBs). 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.

Sample analysis indicated elevated levels of certain metals in urban areas. Although these elements occur naturally, many are extensively used in manufacturing and are the byproducts of human activity. The Sandusky River below the City of Bucyrus is the area of greatest concern. Mercury was documented at levels exceeding toxicity guidelines at three sites spanning more than 5 miles of river. Mercury was even detected in the water column further downstream at levels exceeding the human health criterion. The General Electric Lamp Plant in Bucyrus was identified as a major source of mercury both released into the atmosphere and into the sanitary sewer. Using the sanitary sewer to dispose of waste mercury is a major concern, especially since the Bucyrus collection system is 60% combined and contains 16 combined sewer overflows. General Electric reported in an annual Toxic Release Inventory that 49 pounds of mercury in 2000 and 19.8 pounds in 2001 were discharged into the sewer. Other sources of mercury include burning of coal, manufacture of batteries and production of chlorine gas and caustic soda. Paramour Creek below the Village of Crestline was another area of concern mainly because the elements copper and zinc exceeded toxicity guidelines.

The semi-volatile organic scans identified several compounds classified as polycyclic aromatic hydrocarbons (PAHs). Some of these have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. They are byproducts of fossil fuel combustion and are contained in creosote and coal tar. Levels of PAHs in sediment collected from the Sandusky River below the City of Bucyrus were identified as a problem by the Ohio EPA in 1990 (Biological and Water Quality Study of the Sandusky River and Selected Tributaries, Technical Report EAS/1991-6-2). The 2001 data indicated that conditions have not changed, especially in the river segment where combined sewer overflows discharge. Sycamore Creek below the Village of Sycamore had elevated levels of PAHs due to runoff from the Kirby Tire fire that erupted on August 21, 1999. Spring Run below the Village of Carey was impaired by a diesel fuel spill that occurred on June 20, 2001 when a Wheeling and Lake Erie Railway engine was damaged and lost 2500 gallons of fuel.

Water Column Pesticide and Organic Compound Concentrations

Pesticide scans indicated that discontinued but environmentally persistent insecticides formerly used on crops were a problem in several areas. The compound dieldrin was detected in both the Ella St. and St. Johns dam pools on the Sandusky River. The level at both sites exceeded toxicity guidelines. The compound heptachlor epoxide is a break down product of the insecticide heptachlor and it was reported at two sites sampled in Wyandot County.

Little was detected in the volatile organic compound or PCB scans. The PCB test checks for seven Arochlor mixtures and all were below reporting limits, but this does not mean that low levels are not present. The Ohio Department of Health (ODH) issued an advisory in 1997 for the Sandusky River limiting consumption of carp to one meal per week and channel catfish to one meal per month because of PCB in tissue samples. The only volatile organic compound detected was a small amount of toluene below the City of Tiffin. Toluene is used to enhance octane in gasoline and is commonly detected in urban stormwater.

Fish Tissue

The Ohio Department of Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under to eat not more than one meal per week of any species of fish from waters of the state because of mercury concerns. For the Sandusky River the advisory was extended to all individuals limiting Largemouth Bass at one meal per month. The meal advice for carp is one per week and channel catfish one per month because of PCB levels.

Spills

At least 13 spills were reported in 2001 that contributed to impacts on biological communities and water quality of streams within the study area. It is likely that other pollutant releases went unreported during this time. The spills primarily involved the loss of petroleum products or manure. Additionally, a large sewage bypass from the Upper Sandusky WWTP occurred when a lift station pump failed. Causes included accident, equipment failure, deliberate dumping and the land application of manure during or immediately prior to rain events. Spill investigations resulting from land applied manure that leached into field tiles in the Tymochtee Creek basin occured on March 7 at Devries Dairy, on November 9 at Corey Dairy and at Buckeye Egg on November 19. In the Little Sandusky River basin, a spill was reported by Macon Bacon on December 12. In the Broken Sword Creek basin, spills were investigated at Liberty Lean Farm on May 14 and at Rossman Farms on November 11.

RECOMMENDATIONS

Current and recommended aquatic life, water supply and recreational uses are presented in Table 1C. A number of the tributary streams evaluated in this study were originally designated for aquatic life use in the 1978 and 1985 Ohio WQS; others were previously undesignated. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. Several subbasin streams have been evaluated for the first time using a standardized biological approach as part of this study. Ohio EPA is obligated by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations. Thus, some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

The WWH aquatic life use designation for the Sandusky River should be maintained with the exception of the area influenced by the Ella Street dam in Tiffin. A modified warmwater (MWH) aquatic life use is recommended for the reach impounded by the Ella St. dam since it serves an important public drinking water supply function. Use attainability analysis based on the 2001 biological and habitat results confirmed the appropriateness of the current aquatic life use. Only two areas of the Sandusky River mainstem did not meet the designated or recommended aquatic life uses. The first was downstream from combined sewer overflows (CSOs) in the city of Bucyrus. The second non-attaining segment was the seven miles of river impounded by the St. Johns dam. The dam is scheduled for removal which will restore the natural flow regime to this reach of the Sandusky River and permit reestablishment of warmwater lotic fish and macroinvertebrate communities.

Use attainability analyses of small water courses resulted in the recommended designation of Modified Warmwater Habitat (MWH) and Limited Resource Water (LRW) segments where poor habitat quality was unlikely to improve in the foreseeable future. These streams were channelized and maintained to facilitate agricultural activities and offered very limited habitat. It is not realistic to expect typical WWH aquatic communities under these conditions. This survey is the first time these habitat limited segments has been evaluated using biological and habitat data and does not represent a downgrading of the previous WWH use which was based on unverified designations in the 1978 and 1985 water quality standards. Other small streams were impacted by habitat modification but retained the WWH use where recovery of natural habitat features such as a wooded riparian and multiple cover types was evident. Additional habitat improvement is possible through the application of management practices to limit soil loss and restore wooded riparian areas.

Table 1C. Waterbody use designations for the Sandusky River basin. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. Designated uses based on results other than Ohio EPA biological data are marked with an circle (o). A delta ( )) indicates a new recommendation based on the findings of this report.

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Sandusky river - at RMs 18.05, 42.12, 82.9, 83.15 and 115.45		+						o	+	+		+	
- RM 42.0 to RM 19.0	+	+							+	+		+	
- RM 45.0 to RM 42.0 (Ella St. dam)	+			[a]+					+	+		+	
- RM 47.8 (upstream from Tiffin) to RM 45.0	+	+							+	+		+	
- U.S. 30 N (RM 82.1) in Upper Sandusky to RM	*	+							+	+		+	
- Beechgrove rd. (RM 115.43) to U.S. rte. 30 N		+							+	+		+	
- all other segments		*							*	*		*	
Morrison creek - headwaters to RM 7.9 (CR 43)				[a]+					*+	*+			*+
- all other segments		*+							*+	*+		*+	
Willow creek				[a]+					*+	*+		*+	
Unnamed tributary (Willow creek RM 0.88)							o						o
Rock creek		*+							*+	*+		*+	
East branch		*+							*+	*+		*+	
Armstrong & Beighly ditch		*							*	*		*	
Carpenter ditch		*							*	*		*	
Gibson creek		*+							*+	*+		*+	
Bells run		*+							*+	*+		*+	
Honey creek - at RM 28.35								o					
- RM 37.3 (Scott Rd) to RM 28.3 (SR4)				[a]+					*+	*+		*+	
- RM 1.2 (CR 19) to RM 0.0				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	

Table 1C (continued.)

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Van Meter creek				[a]+					*+	*+		*+	
Buckeye creek		*+							*+	*+		*+	
Silver creek - headwaters to RM 8.7 (Brillhart Rd.)							[a]+		*+	*+			[a]+
- all other segments		*+							*+	*+		*+	
Slee Ditch (Silver Creek RM 0.72)		*+							*+	*+		*+	
Aicholtz ditch - headwaters to RM 2.8 (CR 12)				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	
Kagy ditch		*							*	*		*	
Bolinger ditch		*							*	*		*	
Hedden ditch		*							*	*		*	
Hooper ditch		*							*	*		*	
Schaaf ditch		*							*	*		*	
Brokenknife creek - headwaters to RM 3.2 (Seneca/Crawford countyline)				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	
Kibler ditch (Brokenknife creek RM 5.27)							+		*	*			+
Alum ditch (Brokenknife creek RM 5.50)								o					
Celery creek (Honey creek RM 32.84)				[a]+					*+	*+		[a]+	
Tiro creek (Honey creek RM 41.3)				[a]+					*+	*+		[a]+	
Mile run		*+							*+	*+		*+	
Sycamore creek - headwaters to RM 17.8 (SR 19)				[a]+					*+	*+		*+	
- all other segments		+							+	+		+	
Greasy run		*+							*+	*+		*+	
Spring Creek (Sycamore creek RM 12.92)		+							+	+		+	
Taylor run		*+							*+	*+		*+	
West Branch Taylor run (Taylor run RM 2.49)				[a]+					*+	*+			[a]+
Thorn run		*+							*+	*+		*+	

Table 1C (continued.)

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Tymochtee creek - headwaters to RM 51.8 (Cramer Rd.)							[a]+		+	+			[a]+
- all other segments		+							+	+		+	
Spring run		*+							*+	*+		*+	
Poverty run		*+							*+	*+		*+	
No. 32 ditch		*+							*+	*+		*+	
Little Tymochtee creek - headwaters to RM 9.1 (CR 108)							[a]+		*+	*+			[a]+
- all other segments		*+							*+	*+		*+	
Hart ditch		*							*	*		*	
Browns run		*							*	*		*	
Veith ditch		*							*	*		*	
Lick run		*+							*+	*+		*+	
Baughman run		*							*	*		*	
Blake ditch		*							*	*		*	
Perkins run		*							*	*		*	
Oak run		*							*	*		*	
Sugar run		*							*	*		*	
Warpole creek				[a]+					*+	*+		*+	
St. James run		*							*	*		*	
Unnamed tributary (Tymochtee creek RM 40.30)				+					+	+			+
Little Tymochtee creek - headwaters to RM 9.0 (CR 205)				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	
Reevhorn run		*							*	*		*	
Pawpaw run		*							*	*		*	
Pawpaw run		+							+	+		+	
Unnamed tributary (Pawpaw run RM 4.17)				+					+	+			+
Carroll ditch				+					+	+			+

Table 1C (continued.)

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Enoch creek		+							+	+		+	
Blood run		+							+	+		+	
Prairie run		+							+	+		+	
Thompson ditch				+					+	+			+
Layton ditch		*+							*+	*+		*+	
Sugar run		*+							*+	*+		*+	
Negro run		+							+	+		+	
Spring branch		*+							*+	*+		*+	
Kiser run		*							*	*		*	
Porcupine creek		*							*	*		*	
Cranberry run		*							*	*		*	
Rock run		+							+	+		+	
Little Sandusky river		+							+	+		+	
Honey run		*+							*+	*+		*+	
Unnamed tributary (little Sandusky river RM 8.93)				+					+	+			+
Broken Sword creek - headwaters to RM 21.4 (Eaton Rd.)				[a]+					+	+		+	
- all other segments		+							+	+		+	
Indian run - headwaters to RM 1.7 (SR 231))				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	
Brandywine creek - headwaters to RM 1.6 (Temple Rd.)							[a]+		*+	*+			[a]+
- all other segments				[a]+					*+	*+		*+	
Red run							[a]+		*+	*+			[a]+
Grass run -.headwaters to RM 6.0 (Marion Melmore Rd.)				[a]+					*+	*+		*+	
- all other segments		*+							*+	*+		*+	
Gray Eye run		*+							*+	*+		*+	
West North Robinson Run (Sandusky river at RM 121.19)		*+							*+	*+		*+	
East North Robinson Run (Sandusky river at RM 122.09)		*+							*+	*+		*+	

Table 1C (continued.)

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Loss creek		*+							*+	*+		*+	
South Fork Loss Creek		*+							*+	*+		*+	
Paramour creek		+							*+	*+		+	
Crestline STP tributary (Westerly creek / Paramour creek.RM 1.92))		*+							*+	*+		*+	
Crestline tributary (West Crestline tributary / Paramour creek RM 2.88)		*+							*+	*+		*+	
PPG tributary (Paramour creek RM 5.13)		*+							*+	*+		*+	
Allen 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.

WATERSHED ASSESSMENT UNIT REPORTS

Sandusky-Bucyrus Assessment Unit

The Sandusky-Bucyrus assessment unit (04100011-020) encompasses the drainage area beginning with the headwaters of Paramour Creek to the Sandusky River upstream from Broken Sword Creek (RM 94.48). Biological and habitat assessments were conducted at 27 sites in 2001 and their attainment status is presented in Table 2A. Surface water physical/chemical assessments were conducted at 17 sites. Each site had five sets of grab samples collected at two-week intervals. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters including metals, nutrients and oxygen demand. Four sites had extra samples collected to test for the presence of volatile and semi-volatile organic compounds and two sites were tested for levels of herbicides. Sediment analysis was conducted at five sites. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 2B.

Six of 21 sites with drainage areas <50 mi^2 met the existing or recommended aquatic life use. Two sites partially met and 13 sampled locations were in non-attainment of the designated or recommended use (Table 2B). Six sites with drainage areas >50 mi^2 represented 22.1 miles of the Sandusky River. Full attainment of the designated Warmwater Habitat (WWH) use was met for 10.4 miles of the stream, 10.3 miles partially met and non-attainment was ascribed to 1.4 miles of stream.

The failure of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed and pollution from point sources. Point source facilities regulated in the assessment unit are listed in Table 2C. Sedimentation and enrichment were the most common impacts where aquatic life use attainment was not fully met. Two distinct areas impacted by organic loadings were the Sandusky River within the City of Bucyrus due to combined sewer overflows (CSOs) and Westerly Creek within the Village of Crestline due to failed septic systems, urban runoff and the Wastewater Treatment Plant (WWTP). The compound of greatest concern regarding enrichment impacts is phosphate (PO_4) because it is often growth limiting.

Flow data collected by the US Geological Survey on the Sandusky River at Kerstetter Rd. is displayed in Figure 2A. About 38 years of data were used to calculate the flow characteristics. The seven days, 10 years low flow value for May-November is 1.1 cubic feet per second (cfs) and the 80% duration value (flow equaled or exceeded) is 3.5 cfs. Flows were generally near 6 cfs during most of the study, indicating that even under drought conditions, the Sandusky River maintained fairly normal flows for that time of year. The effects of low water were apparent in the smaller tributary streams. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat at some sites. The channelization, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. The lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration potential.

The Sandusky River, Paramour Creek and the PPG Tributary are designated as WWH streams based on previous biological surveys. The 2001 survey is the first time that aquatic life uses have been evaluated using biological and habitat information for the remaining sampled streams within the Sandusky-Bucyrus assessment unit. The upper portion of Grass Run was the only one of the streams that was channelized with little likelihood for recovery and offered minimal instream habitat. It is not realistic to expect typical WWH aquatic communities under these conditions so a Modified Warmwater Habitat (MWH) Aquatic Life Use is recommended. The recommended segment is from the headwaters to Marion-Melmore Rd. (RM 6.0). The presence of a wooded riparian and a natural or recovering stream channel were primary considerations for recommending the WWH use for the remaining tributaries. Many of these sites had at least moderate amounts of instream cover and sinuosity. Sedimentation and substrate embeddedness were the most commonly encountered negative habitat attributes of these streams. A significant loss in habitat function in Loss Creek and the South Fork of Loss Creek occurred due to minimal sustained flow that limited pool depths and availability of riffle habitat.

Allen Run, West North Robinson Run, East North Robinson Run and Grey Eye Creek met the recommended WWH Aquatic Life Use based on fish and macroinvertebrate sampling results.

The PPG Tributary partially met the use at RM 3.7 with marginally good fish condition and a fair macroinvertebrate community. The IBI index score at RM 0.2 was in the poor range. The fish communities were similar but the larger drainage area (4 mi^2) should have supported a more diverse assemblage. Additionally, the occurrence of DELT anomalies occurred at a higher frequency than was observed upstream. These results indicateded that the fish community was negatively effected by the discharges from the PPG facility. Conversely, the macroinvertebrate community was in marginally good condition and apparently benefited from increased flow volume. Water quality data indicated impairment from metals, enrichment, elevated bacteria counts and warmer than normal temperatures. The PPG Industries Glass Division generates process and sanitary wastewater and collects stormwater during rain events. Process water enters a flow equalization basin and is treated with an oil skimmer and sand filter. The basin is equipped with a bypass for emergency purposes. Filter backwash is treated in a sludge thickening tank and de-watered using a filter press. Some treated process water is recycled to use as cooling water and any excess is discharged. Sanitary water is treated by two parallel package plants with chlorine disinfection and dechlorination. An onsite electrical transformer is contained in an emergency spill holding tank and rain water that collects is discharged to the storm sewer system. All flows combine and are discharged through a tile under Horning Rd.

Both organism groups failed to meet WWH expectations in East Crestline Creek (Paramour Creek Tributary at RM 2.88). It appeared that water quality rather than habitat degradation was impacting the biology. Urban stormwater is probably the source of most pollution, especially considering the presence of a rail transfer yard and Moyer's Auto Junkyard within the drainage area.

Westerly Creek was in non-attainment upstream and downstream from the Crestline WWTP. This facility treats sewage to a secondary level by counter current aeration and is designed to handle 0.95 million gallons per day (MGD). Flows in excess of this only receive primary treatment and disinfection up to 2.2 MGD. The collection system consists of 60% separate and 40% combined sewers with two lift stations and one CSO just west of Park Ave. About 1% of the service area is not connected to the collection system and these homes are served by on-lot units. This neighborhood is adjacent to the site sampled at Patterson St. (RM 2.41) and the impact was apparent. Water quality evaluated was impaired by enrichment/low dissolved oxygen and elevated bacteria counts. The pollution source is poorly treated sewage from failed on-lot septic systems. The extension of sanitary sewers to serve this area should be investigated. Downstream from the Crestline WWTP at Oldfield Rd. (RM 0.13), the discharge provided increased flow and suspended organic material that benefited filter feeding caddisflies and midges. Subsequently the ICI marginally met WWH expectations at RM 0.1. The fish community declined compared to the upstream site and was predominated by pollution tolerant species resulting in a poor IBI score. Water quality evaluated at this location was impaired by enrichment and elevated bacteria counts. The greatest concern involves phosphorus with a median concentration of 0.81 mg/l, considerably higher than the level recommended in wadeable streams of 0.10 mg/l. Annual loadings (kg/day) from the WWTP over the last 20 years were tracked using the Liquid Effluents Analysis Processing (LEAP) system. This is an Ohio EPA database that stores monthly selfmonitoring data. Results for phosphorus plotted against volume discharged are displayed in Figure 2B. Loadings declined considerably after the facility was upgraded in 1994, but further consideration should be made regarding advanced treatment to remove phosphorus and sewer separation to eliminate hydraulic overloading. The source of the elevated bacteria counts was probably a combination of the failed septic systems located upstream and overflows from the combined sewer system. A fish kill was investigated in Westerly Creek on April 5, 2001. It was determined that a blockage in the sewage collection system was causing a bypass.

Grass Run was in non-attainment of the recommended MWH use for the reach between Lincoln Hwy. (RM 10.6) and Bucyrus-Nevada Rd. (RM 8.4). Macroinvertebrate condition was poor at both locations. The fish community was in poor condition at RM 10.6 but met the use at RM 8.4. Stresses to the aquatic community likely included reduced dry weather flow, siltation, excessive nutrients and low dissolved oxygen levels resulting from agricultural practices within the drainage area. The Wynford Local School WWTP discharges to Grass Run upstream from Lincoln Hwy., but it should not have much of an impact because it is a new unit and discharges seasonally. Water quality evaluated at Bucyrus-Nevada Rd. verified that there was impairment from low dissolved oxygen. Enrichment was still indicated in the aquatic community at TR 59 (RM 3.4), but improved habitat and gradient benefited both the macroinvertebrate and fish communities. Full attainment of the WWH aquatic life use was documented, however, the reach is subjected to excessive nutrients from agricultural runoff and home septic systems. Water quality sampling indicated low dissolved oxygen was still a problem. The median phosphorus concentration was 0.11 mg/l, slightly higher than the level recommended in headwater streams of 0.08 mg/l.

None of the Paramour Creek sites attained the designated WWH use. A lack of sustained flow exacerbated the effects of nutrient enrichment and limited habitat related to channelization and prevented the establishment of warmwater fish and macroinvertebrate faunas from the headwaters to RM 2.9. The macroinvertebrate community was significantly improved at RM 1.5 compared with upstream, but the fish community indices scored in the poor range. It was apparent that despite moderate improvements in the habitat condition, sedimentation and absence of typical pool/riffle/run development due to past channelization limited diversity in the fish community. Individuals of only seven fish species were collected and the majority were pollution tolerant. Water quality data in Paramour Creek indicated impairment was caused by enrichment/low dissolved oxygen, elevated ammonia, elevated bacteria and warmer than normal temperatures. The poorest quality was documented at the headwater site at Finnegan Rd. (RM 6.31). Results were typical of streams polluted by sources such as failed septic systems or livestock manure. Conditions improved downstream, but enrichment is much more of a concern at Nazor Rd. (RM 1.50) below the confluence of Westerly Creek. A herbicide test performed at this location quantified the presence of atrazine and metolachlor at 0.79 and 0.21µg/l, respectively. Not much information is available on what effect low levels of these compounds have on aquatic life. Atrazine is a concern in drinking water supplies and has a maximum contaminant level of 3.0µg/l.

South Fork Loss Creek and the headwaters of Loss Creek had adequate habitat but the streams were very shallow which reduced the functionality of the available cover to support warmwater fish and macroinvertebrate assemblages. Additionally, elevated nutrients were indicated at RM 4.6 on Loss Creek in the predominance of white suckers and the low diversity of macroinvertebrates collected. Agricultural runoff and residential septic systems were likely sources of enrichment. The biocriteria scores for Loss Creek at RM 4.6 did not meet WWH expectations and the South Fork Loss Creek partially attained the use. Attainment of WWH expectations was documented at RM 1.0 on Loss Creek and represented significant improvement in the fish community. However, the wide shallow condition of the stream was still probably hampering the development of a more robust fish community. Water quality sampling at this site revealed conditions impaired mainly by low dissolved oxygen.

The Bucyrus WWTP treats sewage to a secondary level by activated sludge aeration and is designed to handle 3.4 MGD. Flows in excess of the design capacity only receive primary treatment and disinfection up to 6.0 MGD. Flows above the hydraulic capacity activate CSOs and, on occasion, a raw bypass at the head of the plant. The collection system consists of 40% separate sewers and 60% combined sewers with 16 CSOs. Bucyrus submitted a CSO Operational Plan to the Ohio EPA in 1998 and has been trying to identify problem areas in the collection system with cameras. The city does not have an Ohio EPA approved pre-treatment program. This should be immediately addressed, especially considering the discovery that large amounts of mercury were disposed into the sewer from the General Electric Lamp Plant. This facility reported in an annual Toxic Release Inventory of the disposal of 49 pounds in 2000 and 19.8 pounds in 2001. An Indirect Discharger Permit may be appropriate for this facility.

The Bucyrus CSOs were identified by the Ohio EPA as a significant source of organic load to the Sandusky River in 1990 (Biological and Water Quality Study of the Sandusky River and Selected Tributaries, Technical Report EAS/1991-6-2). The 2001 sampling demonstrated that little has changed. The WWH use was partially met at sites sampled upstream from Bucyrus. The MIwb score was negatively effected by the presence of large carp. IBI scores at least marginally met WWH expectations. ICI scores were in the exceptional range indicating that water quality was relatively good. Water quality data indicated that impairment was caused by enrichment/low dissolved oxygen and warmer than normal temperatures. Enrichment was greatly effected by point sources in Crestline, but nonpoint sources should not be over looked. A herbicide test at Locust Grove Rd. (RM 127.70) quantified the presence of atrazine and metolachlor at 0.95 and 0.28 µg/l, respectively. Not many dissolved oxygen readings measured by grab sample exceeded the criterion, but continuous monitors revealed that oxygen levels were very poor when evaluated over a diel period. These units record hourly measurements for 48 hours. Results obtained from grab samples are displayed in Figure 2C along with the average criteria that apply (temperature criterion valid June 16-September 15). The continuous monitors were deployed on July 24, 2001 and their results are displayed in Figure 2D. Phosphorus concentrations were mostly above the target value for small rivers and the results are displayed in Figure 2E. Along the reach where the CSOs are located, the Sandusky River was also negatively effected by siltation and embeddedness. Fish and macroinvertebrate indices fell into the fair to poor range at RM 111.2. Black septic sediment and sewage fungus were observed along the margins of the stream. The degree that the fish and macroinvertebrates communities were depressed compared with ecoregional expectations and conditions documented upstream was beyond what is attributable to a limited habitat. The number of mayfly and caddisfly taxa (relatively pollution sensitive groups) collected from the natural substrates declined from 16 at Kiess Rd. (RM 116.2) to 6 at RM 111.2 and fewer than half as many fish species were recorded at RM 111.2 compared to RM 116.2.

No further impact from the Bucyrus WWTP was expressed in the fish or macroinvertebrate results downstream from the plant at Kerstetter Rd. (RM 110.43). Partial attainment of the WWH use was documented since IBI marginally met WWH expectations and the ICI and MIwb were in the fair range. Full attainment was documented for 10.4 miles of the Sandusky River upstream from the confluence of Broken Sword Creek, the terminus of this assessment unit. Water quality data indicated that impairment was caused by the same conditions (enrichment/low dissolved oxygen and warm temperatures) but also by elevated bacteria levels. A continuous monitor deployed at Kerstetter Rd. on July 24, 2001 is displayed in Figure 2F and it revealed that oxygen levels were depressed below the average WWH criterion for nearly the entire period of record. The level of phosphorus spikes downstream from the WWTP because its concentration is high in the effluent. Annual phosphorus loadings (kg/day) from the WWTP over the last 20 years were tracked using the LEAP database. Results plotted against volume discharged are displayed in Figure 2G. Sites bracketing the WWTP discharge were also tested for the presence of volatile and semi-volatile organic compounds and none were detected. Significant upgrades made to the treatment plant in recent years have greatly improved effluent quality. However, major rehabilitation of the collection system to separate sewers and eliminate CSOs will be required to achieve attainment in the river.

Sediment quality was evaluated at four sites on the Sandusky River and one on Paramour Creek. Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCB). Results for metals varied widely and are presented in Table 2D. No volatile, pesticide, or PCB compounds were detected in any of the samples. Several semi-volatile compounds were detected and most were classified as polycyclic aromatic hydrocarbons (PAH), except for low levels of bis (2-ethylhexyl) phthalate in four samples. Phthalates are added to plastics to make them softer and are a common contaminant in the environment. PAH compounds are a concern because several have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. They are commonly the byproducts of fossil fuel combustion and are contained in substances such as creosote and coal tar.

PAHs were identified as a problem in the Sandusky River around the Bucyrus area in 1990. Fortunately, large areas of deep sediment deposits are not common in the Sandusky River. Most deposits were in isolated pockets of deeper pools or in eddies along the river bank. This should minimize any ecological impacts from elevated contaminant levels since they are not common and can be avoided by aquatic life. Background conditions in 2001 were established at Kiess Rd. The sample consisted of 75.1% sand, 24.9% silt and clay, 1.7% organic carbon and 67.9% solids. Most metals were ranked as non-elevated or were below the reporting limit. Although a few tentatively identified compounds were reported in the semi-volatile organic scan, no priority pollutants were detected. Tentative compounds are matched by a computer library system and the concentrations are considered estimated. The impact from CSOs was evaluated just upstream from the Bucyrus WWTP outfall. The sample consisted of 84.3% sand, 15.7% silt and clay, 2.4% organic carbon and 64.9% solids. Most metals were ranked as non-elevated or were below the reporting limit, except mercury was detected at 0.238 mg/kg. This exceeded the TEC of 0.18 mg/kg. The source of this mercury is likely the General Electric facility mentioned above. The total PAH concentration was 16.5 mg/kg at this location in 1990 and increased to 24.05 mg/kg in 2001. This exceeded both the TEC of 1.61 mg/kg and the PEC of 22.8 mg/kg. The impact from wastewater effluent was evaluated at Kerstetter Rd. (RM 110.43). The sample consisted of 62.4% sand, 37.6% silt and clay, 3.8% organic carbon and 45.7% solids. Several metals were considered elevated or highly elevated and the results for copper, lead, zinc and mercury all exceeded respective TEC levels. This sample had the highest mercury concentration documented at 0.701 mg/kg. The total PAH concentration was 21.46 mg/kg. Recovery was evaluated at Shupp Rd. (RM 105.76). The sample consisted of 57.9% sand, 42.1% silt and clay, 3.0% organic carbon and 49.1% solids. Mercury continued to be a concern at a concentration of 0.223 mg/kg. The total PAH concentration dropped to 2.57 mg/kg. A significant source of PAHs in this area is probably stormwater discharged from CSOs, especially where rail yards are present because of the use of creosote to preserve timbers. Automobile fluids and residue from incomplete combustion of gasoline are other common sources of PAHs. The disposal of mercury into the Bucyrus sewer system needs to be discontinued. The Ohio Department of Health advises that meals of largemouth bass caught in the Sandusky River be limited to one per month because of mercury levels. The meal advice for carp is one per week and channel catfish one per month because of PCB levels. This is especially a concern due to the popularity of sport fishing

in the area.

The Paramour Creek site at Nazor Rd. (RM 1.50) was sampled to evaluate wastewater impacts from both the Crestline WWTP and PPG Industries as well as urban and rural runoff. The sample consisted of 58.6% sand, 41.4% silt and clay, 2.3% organic carbon and 53.6% solids. No PCBs, pesticides, or volatile compounds were detected. Several metals were considered elevated or highly elevated and the results for chromium, copper and zinc all exceeded respective TEC levels. Three PAHs were detected at a total concentration of 2.91 mg/kg, a level which exceeded the TEC.

Table 2A. Aquatic life use attainment status of the Sandusky-Bucyrus assessment unit (headwaters to upstream Broken Sword Creek), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Sandusky River						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
127.8/127.8	36[ns]	7.5*	42	82.0	Partial	TR 13, Lower Leesville Rd.
120.8/120.0	37[ns]	7.1*	48	57.0	Partial	CR 55, Locust Grove Rd.
116.2/114.9	40	7.6*	48	60.5	Partial	TR 82, Kiess Rd.
111.2/111.2	24*	6.0*	22*	44.0	**NON**	Ust. Bucyrus WWTP
110.4/110.4	36[ns]	7.2*	18*	75.0	Partial	CR 121, Kerstetter Rd.
105.8/103.7	37[ns]	9.0	VG	74.5	Full	TR 128, Shupp Rd.
98.7/98.7	44	9.0	44	82.5	Full	SR 231
Paramour Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
6.3/6.3	26*	NA	20*	35.0	**NON**	TR 176, Finnegan Rd.
4.8/---	28*	NA	---	30.0	(**NON**)	SR 61
---/2.9	---	---	Fair*	---	(**NON**)	Krichbaum Rd.
1.5/1.5	20*	3.6*	G	53.0	**NON**	TR 48, Nazor Rd.
Paramour Creek tributary @ RM 5.13 (PPG trib.)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
3.7/3.7	36[ns]	NA	30*	39.0	Partial	PPG park, Ust. outfall trib.
0.2/0.2	26*	NA	MG	37.5	**NON**	TR 228, Hook Rd.
Paramour Creek tributary @ RM 2.88 (East Crestline Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	20*	NA	F*	61	**NON**	TR 167, Cayer Rd.
Paramour Creek tributary @ RM 1.92 (Westerly Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.4/2.4	34*	NA	12*	60.0	**NON**	Patterson St.
0.2/0.1	26*	NA	32[ns]	66.5	**NON**	Oldfield Rd.

Table 2A. Continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Allen Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.2/1.2	42	NA	MG[ns]	48.5	Full	CR 35, Crestline (Boyer) Rd.
Loss Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
4.6/4.6	26*	NA	Fair	54.0	**NON**	SR 598
1.0/1.1	38[ns]	NA	G	75	Full	TR 44, Biddle (Dice) Rd.
Loss Creek tributary @ RM 2.98 (South Fork Loss Creek)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	20*	NA	G	61	**NON**	TR 178, Loss Creek Rd.
Sandusky River tributary @ RM 122.09 (East North Robinson Run)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.9/0.8	40	NA	G	64	Full	CR 49, Remlinger Rd.
Sandusky River tributary @ RM 121.19 (West North Robinson Run)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.2/0.2	40	NA	G	55.5	Full	TR 45, Stetzer Rd.
Grass Run						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
10.6/10.6	26	NA	P*	19.5	**NON**	CR 330, Lincoln Highway
8.4/9.1	34	NA	P*	31.5	**NON**	From CR 2
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
3.4/3.4	46	NA	G	59.5	Full	TR 59
Gray Eye Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.3/1.3	44	NA	G	45	Full	SR 231

Table 2B. Values obtained from surface water grab samples collected in the Sandusky-Bucyrus Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO) and ammonia (NH_3-N), °Celsius for temperature (T), colonies/100 ml for fecal coliform (FC)and µg/l for copper (Cu) and iron (Fe). Strontium is not included because 72 of 89 values (80.9%) exceeded Tier II limits.

Mile	*Parameter (value)*
Sandusky River (WWH, PCR, AWS)	
127.80	T (23.4 †)
120.82	T (23.2 †); DO (4.2 †)
116.18	T (22.7 †); DO (4.2 †); FC (1200 ‡)
111.20	T (22.5 †); DO (3.9 ††, 1.5 ††)
110.43	T (22.4 †); DO (4.0 †, 3.5 ††, 4.1 †); FC (1100 ‡)
105.76	DO (4.3 †); FC (1200 ‡)
98.69	T (22.4 †); FC (1200 ‡)
Grass Run (WWH, PCR, AWS)	
8.36	DO (4.3 †, 3.7 ††)
3.42	DO (3.7 ††, 4.8 †); FC (1200 ‡)
Loss Creek (WWH, PCR, AWS)	
0.96	T (22.8 †); DO (3.0 ††, 3.4 ††)
Paramour Creek (WWH, PCR, AWS)	
6.31	T (23.6 †); DO (4.6 †, 3.0 ††); NH_3-N (1.71 †); FC (>10000 ‡‡)
4.78	T (28.3 ††, 27.9 †); FC (1300 ‡)
1.50	T (24.3 †)
Westerly Creek (WWH, PCR, AWS)	
2.41	T (23.0 †); DO (4.7 †, 3.3 ††); FC (>10000 ‡‡)
0.13	T (23.8 †); FC (1200 ‡, 1800 ‡)
PPG Tributary (WWH, SCR, AWS)	
3.80	T (29.5 ††); Cu (13 ††); FC (>10000 ‡)
0.18	T (23.7 †); Fe (5970 aws); FC (7900 ‡)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR), secondary contact (SCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡), agriculture outside mixing zone average (aws)

Table 2C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Sandusky-Bucyrus Assessment Unit.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
Crestline Water Treatment Plant	2IY00092-001	Unnamed Trib Paramour Creek Sandusky River	129.89	softener backwash treated by a sand filter
PPG Ind., Glass Division	2IE00004-001	"PPG" Tributary Paramour Creek	5.13	combined flows from 601, 602, 603and stormwater
PPG Ind., Glass Division	2IE00004-601			process cooling water treated by an oil-water separator and sand filter
PPG Ind., Glass Division	2IE00004-602			sanitary sewage treated by a package plant
PPG Ind., Glass Division	2IE00004-603			electrical substation spill containment sump
Crestline Wastewater Treatment Plant	2PC00006-001	Westerly Creek Paramour Creek	0.50 1.92	sanitary sewage treated by a counter current aeration system
Crestline Wastewater Treatment Plant	2PC00006-009	Westerly Creek		combined sewer overflow
Crawford County Landfill	2IN00127-001	Unnamed Trib Sandusky River	121.19	stormwater treated by a settling pond
Crawford County Landfill	2IN00127-002	Unnamed Trib Sandusky River	121.19	stormwater treated by a settling pond
Crawford County Landfill	2IN00127-003	Unnamed Trib Sandusky River	121.19	stormwater treated by a settling pond
Ranchwood Mobile Home Park	2PY00029-001	Unnamed Trib Sandusky River	121.19	sanitary sewage treated by a package plant
Linlare Village	2PG00089-001	Unnamed Trib Sandusky River	117.87	sanitary sewage treated by a package plant

Table 2C continued.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
Timken Co.	2IC00046-001	Unnamed Trib Sandusky River (Bucyrus Reservoir #2)	1.55 116.32	process cooling water treated by an oil-water separator, sand filter and settling ponds
Bucyrus WTP	2IW00020-001	Sandusky River	113.40	lime sludge treated by settling lagoons
BP Oil, Bucyrus Bulk Plant	2IN00172-001	Sandusky River (via storm tile)		stormwater treated by an oil-water separator and settling pond
Bucyrus Wastewater Treatment Plant	2PD00021-001	Sandusky River	111.00	sanitary sewage treated by an activated sludge aeration system
Bucyrus Wastewater Treatment Plant	2PD00021-002	Sandusky River	111.00	raw bypass
Bucyrus Wastewater Treatment Plant	2PD00021-003, 007-009, 015-026	Sandusky River		combined sewer overflow
Bucyrus Wastewater Treatment Plant	2PD00021-027	Unnamed Trib Sandusky River		combined sewer overflow
Swift-Eckrich, Inc.	2IH00088-001	Sandusky River (via storm tile)	98.70	sanitary sewage treated by a package plant
Wynford Local School	2PT00028-001	Grass Run Sandusky River	96.61	sanitary sewage treated by a package plant

Table 2D. Metal concentrations in sediment collected from the Sandusky-Bucyrus Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Those preceded by a (†) exceeded the threshold effect concentration described by MacDonald et al (2000). Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated]

Sandusky River at RM 116.18- Kiess Rd.

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
14800 [b]	85.2 [a]	9410	<16	8.8 [a]	13400 [a]	<21	4090	267 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<21	3660	<2630	57	58.1 [a]	<0.031	5.45 [a]	0.244 [a]	<1.05

Sandusky River at RM 111.20- Upstream Bucyrus WWTP

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
7610 [a]	59.2 [a]	14000	<15	18.7 [a]	9650 [a]	32 [a]	4830	107 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<20	2100	<2520	64	90.5 [a]	† 0.238	4.30 [a]	0.408 [a]	<1.01

Sandusky River at RM 110.43- Kerstetter Rd.

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
23900 [d]	163 [c]	25200	31 [c]	† 48.2 [d]	21100 [a]	† 44 [a]	8020	254 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<30	6730	<3710	121	† 177 [c]	† 0.701	9.15 [a]	0.673 [b]	<1.48

Sandusky River at RM 105.76- Shupp Rd.

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
21500 [c]	124 [b]	18600	22 [b]	18.5 [a]	17600 [a]	<29	6960	449 [b]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<29	5660	<3640	102	104 [b]	† 0.223	7.42 [a]	0.477 [a]	<1.45

Paramour Creek at RM 1.50- Nazor Rd.

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
24800 [d]	133 [b]	10200	† 49 [d]	† 37.7 [c]	18400 [a]	<27	4660	266 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<27	5650	<3390	77	† 292 [d]	0.096	8.05 [a]	0.669 [b]	<1.36

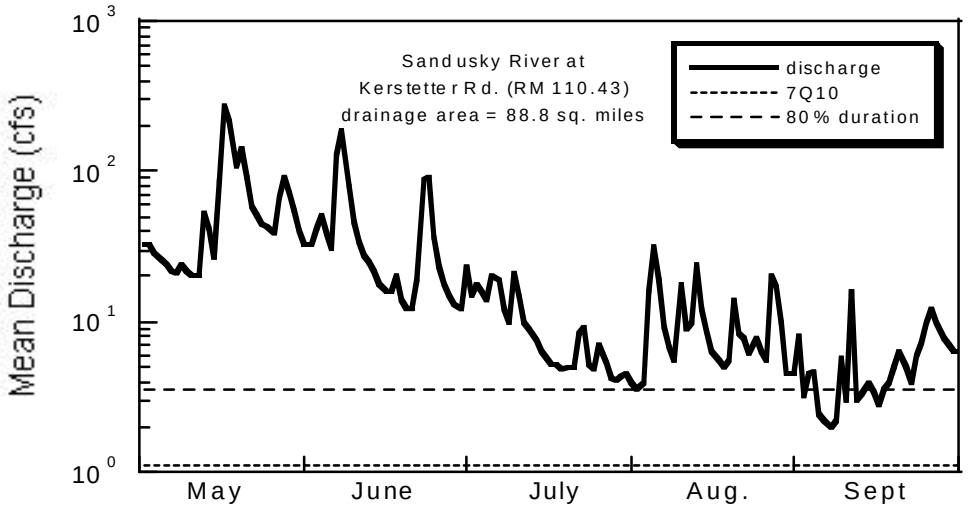


Figure 2A. Flow data collected by the US Geological Survey on the Sandusky River at Kerstetter Rd., May 1 to September 30, 2001.

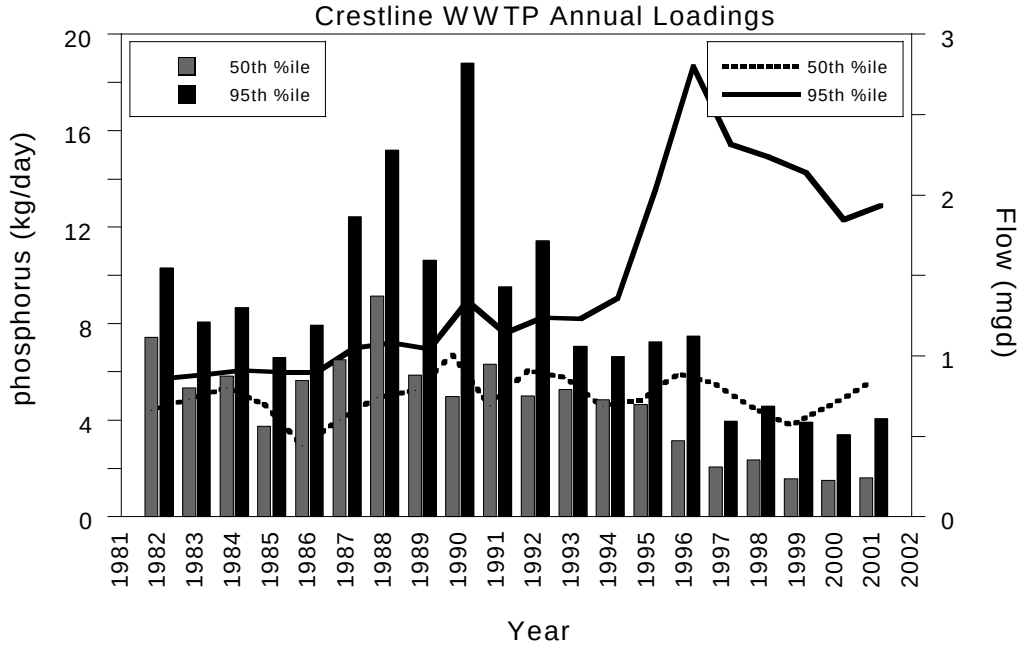


Figure 2B. Annual phosphorus loadings (kg/day) and flow from the Crestline WWTP, 1982-2001.

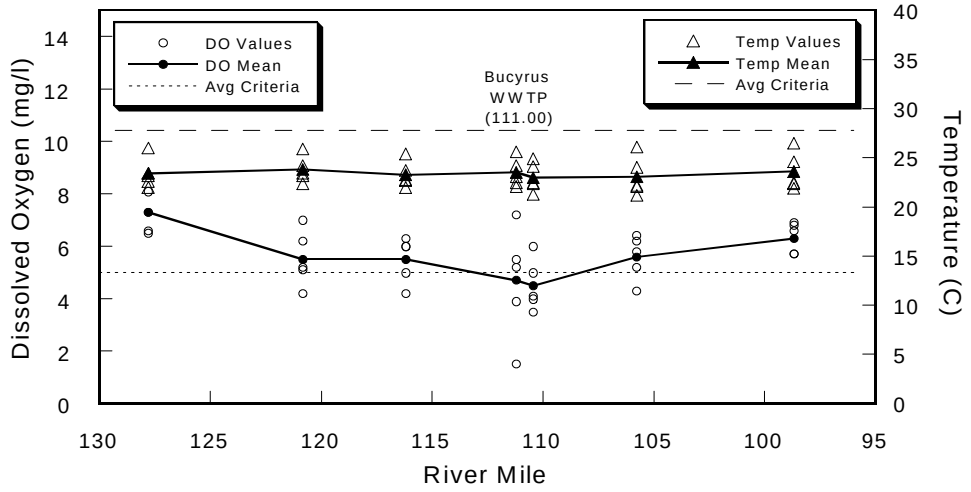


Figure 2C. Sandusky River dissolved oxygen and temperature results within the Sandusky-Bucyrus assessment unit (04100011-020), June - October, 2001. Temperature criterion valid June 16-September 15.

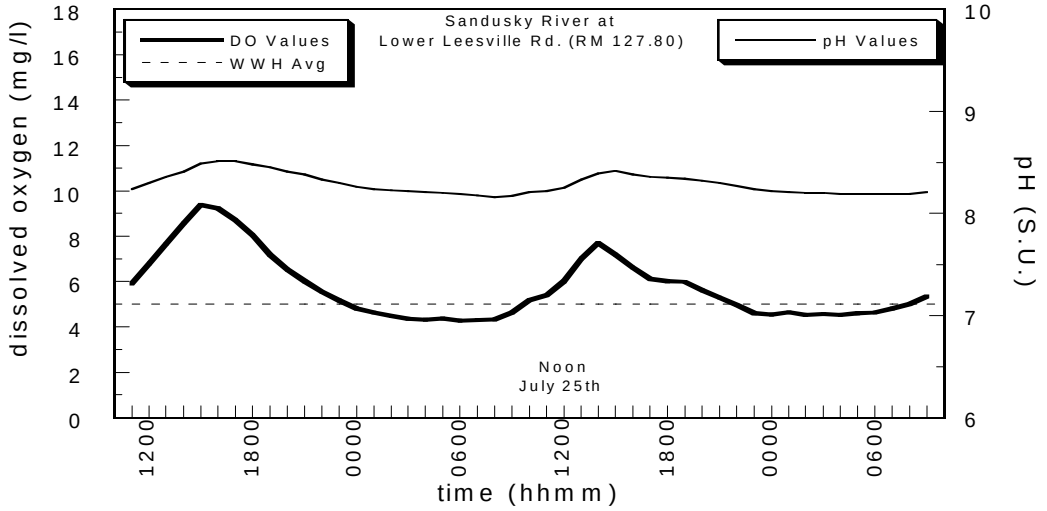


Figure 2D. Dissolved oxygen and pH values from the Sandusky River at Lower Leesville Rd. (RM 127.8) recorded using continuous monitors, July 24-26, 2001.

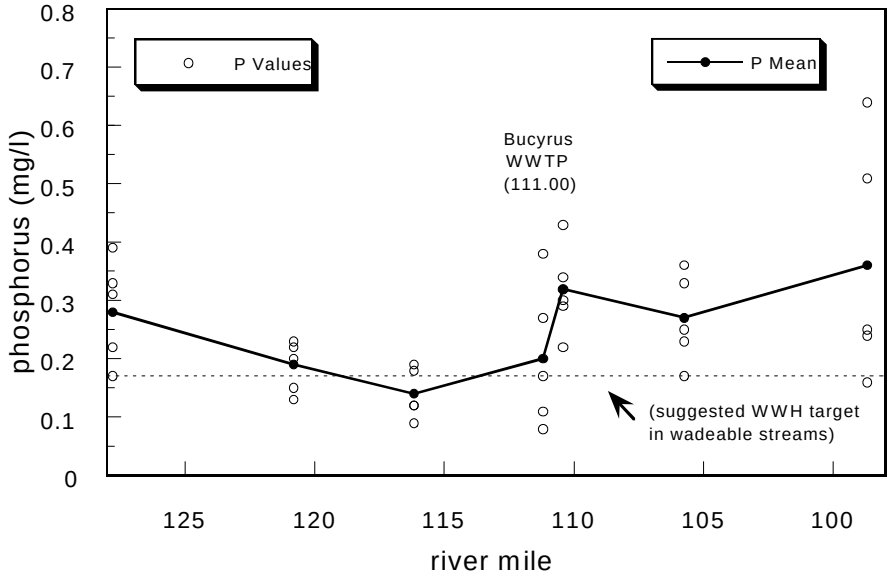


Figure 2F. Phosphorus values from grab samples collected from the Sandusky River in the Sandusky-Bucyrus assessment unit, June-October, 2001.

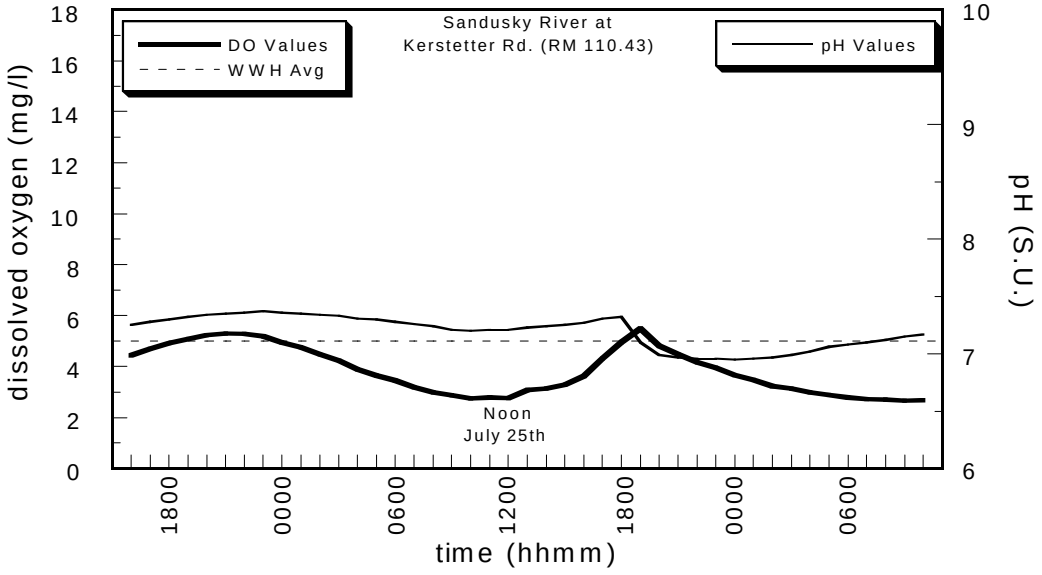


Figure 2F. Dissolved oxygen and pH values from the Sandusky River at Kerstetter Rd. (RM 110.4) recorded using continuous monitors, July 24-26, 2001.

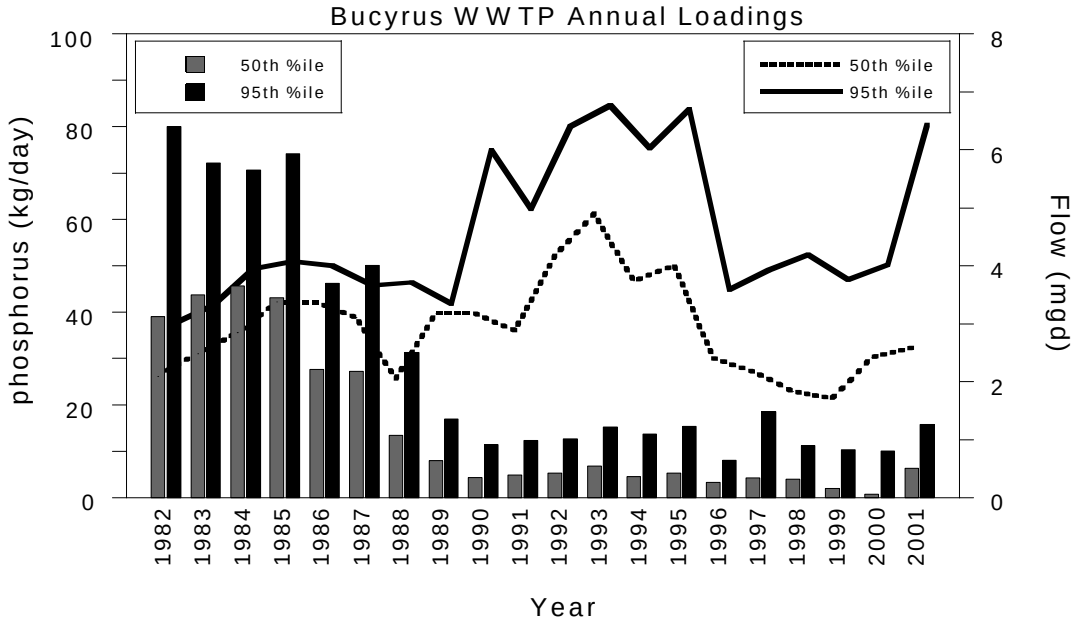


Figure 2G. Annual phosphorus loadings (kg/day) and flow from the Bucyrus WWTP, 1982-2001.

Broken Sword Creek Assessment Unit

The Broken Sword Creek assessment unit (04100011-030) encompasses the Broken Sword Creek mainstem and tributaries. Biological and habitat assessments were conducted at 14 sites in 2001. Aquatic life use attainment status for streams in the assessment unit is presented in Table 3A. Surface water physical/chemical assessments were conducted at 11 sites. The majority had five sets of grab samples collected at two-week intervals. Sites with fewer sets collected were dry or intermittent. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. One site had an extra sample collected to test for the presence of volatile and semi-volatile organic compounds and another site was tested for levels of herbicides. Sediment analysis was conducted at one site Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 3B.

Four of ten sites with drainage areas of <50 mi^2 met the designated or recommended aquatic life use; six were in non-attainment. Four sites on the Broken Sword Creek mainstem had drainage areas >50 mi^2. Biological condition of the four sites reflected 13.8 miles of full attainment and 2.0 miles of partial attainment of the Warmwater Habitat (WWH) aquatic life use. A Limited Resource Water (LRW) aquatic life use is recommended for the extent of Red Run and for Brandywine Creek from the headwaters to upstream from Temple Rd. (RM 1.6). Recommended Modified Warmwater Habitat (MWH) stream segments include Broken Sword Creek from the headwaters to RM 21.4

(Eaton Rd.), Indian Run from the headwaters to RM 1.6 (SR 231)and Brandywine Creek from Temple Rd. (RM 1.6) to the mouth. The WWH use should be retained for Broken Sword Creek from Eaton Rd. to the confluence with the Sandusky River.

Impairment of water quality and fish and macroinvertebrate communities in the Broken Sword assessment unit can be largely attributed to agricultural practices within the watershed. Sedimentation and elevated nutrient levels were a concern along with the low water levels that were encountered during the sampling period. Reduced tree canopy impacts streams because an important macroinvertebrate food source (leaves) is removed and higher water temperatures and evaporation rates result. Modification of stream channels and tiling to facilitate drainage have reduced the volume of water present during dry weather periods making drought conditions in the streams a much more frequent occurrence.

A total of 16 sites was originally selected within the subbasin for biological sampling. Two sites were either dry or had only widely disconnected pools when biological sampling was attempted. Little was to be gained in sampling those areas where a puddle of water was present. The absence of significant flow in these streams was apparently a consequence of channel modification, tiling of agricultural fields to facilitate drainage and drought. These streams were unnamed tributaries confluent with Broken Sword Creek at RM 28.04 and RM 12.75. Assignment of an aquatic life use is not appropriate given the inability of the sites to develop any semblance of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat guidelines which are currently being drafted by Ohio EPA. Therefore, it is recommended that these watercourses remain undesignated until the Primary Headwater Habitat designations are promulgated.

Seven sampled sites on four streams had drainage areas <10 mi^2. Indian Run at RM 0.9 was the only one of these streams that possessed sufficient physical habitat characteristics to warrant the WWH aquatic life use. The Qualitative Habitat Evaluation Index (QHEI) at this site was 44 which alone is not generally considered sufficient for designating a stream as WWH. The presence of a formerly altered but recovered stream channel and multiple instream cover types, however, indicated that the habitat could be improved enough to meet goals of the WWH use. Red Run at RM 0.5 was a small channelized watercourse overgrown with vegetation. Fish sampling was not conducted due to insufficient water in the stream. Brandywine Creek at CR 31 was a headwater stream consisting of intermittent pools. These conditions precluded the establishment of even MWH communities and, as such, both streams are candidates for the LRW use. The remaining sites with <10 mi^2 drainage area are candidates for the MWH aquatic life use. Broken Sword Creek at RM 32.6 and RM 30.3, Indian Run at RM 3.5 and Brandywine Creek at RM 1.6 were channelized with little likelihood for recovery and offered minimal instream habitat.

Three sites on Broken Sword Creek between RM 27.9 and 19.7 had drainage areas in the range of 10 mi^2 to 50 mi^2. Of the three, only the furthest downstream (RM 19.7) possessed attributes such as a natural stream channel and sufficient instream cover to retain the WWH aquatic life use

designation. The other two sites were channelized with no recovery evident. It is not realistic to expect typical WWH aquatic communities under these conditions so the MWH use is recommended.

All of the Broken Sword Creek sites with >50 mi^2 drainage had sufficient warmwater habitat attributes to warrant the WWH aquatic life use. QHEI scores ranged from 65.0 to 76.0. Scores of greater than 60 are a good indication of the appropriateness of the WWH use.

Macroinvertebrate sampling of Red Run produced 28 taxa and the community was rated as fair at Henry Cooper Rd.(RM 0.5). The stream was ditched and likely effected by tiling of agricultural fields but the recommended LRW use was met since no severe toxic impact was indicated.

Fish and macroinvertebrate communities were in poor condition at the upper site on Brandywine Creek (RM 3.3) which translates to non-attainment of the LRW aquatic life use. Sampling yielded no fish and only 18 macroinvertebrate taxa. The stream was pooled with a septic layer of black sediment. The probable source of this degradation is a hog manure spill that was investigated on May 14, 2001 and traced to Liberty Lean Farm located at 3240 Quaintance Rd. Another spill and fish kill associated with this facility was investigated on October 27, 2002. Conditions were marginally better at RM 1.6 (Temple Rd.). The fish were in fair condition but the macroinvertebrate community continued to be in poor condition. The stream was predominated by pollution tolerant snails, beetles and leeches which suggested continued high nutrients and low dissolved oxygen levels. The median phosphorus concentration at this location was 0.20 mg/l, considerably higher than the level recommended to meet attainment goals. The net result was non-attainment of the proposed MWH aquatic life use.

Both sites on Indian Run were in non-attainment of recommended aquatic life uses. The macroinvertebrate community condition was poor at RM 3.5 and marginally good at RM 1.0. The fish community sampling yielded IBI scores in the fair range. Sedimentation was evident and likely exacerbated by the low water levels. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat. Additionally, the lack of water movement exacerbated impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. The degraded condition of biological communities in Indian Run was attributable to agricultural practices within the basin. Water quality in Indian Run was monitored at T.R. 137 (RM 0.94) and results were good, but recreation uses are impaired because of elevated bacteria counts.

Fish and macroinvertebrate communities were sampled at four sites upstream from RM 21.4 in Broken Sword Creek. This reach is recommended for the MWH use. The macroinvertebrate results were reflective of relatively good water quality and at RM 25.5 yielded an ICI score in the exceptional range. This site was the only site of the four sampled with sufficient depth and flow characteristics to permit sampling using artificial substrates from which ICI scores are generated. Fish results within this reach also met expectations given the limitations inherent in the modified habitat condition. Water quality was evaluated at three sites in the upper reach of Broken Sword Creek. The leading causes of impairment were elevated temperature and low dissolved oxygen, with

stream channel modifications being the primary source. Results for these parameters obtained from five sets of grab samples are displayed in Figure 3A. The average temperature criterion indicated on the graph is valid June 16-September 15. Temperature exceedences were documented at all three sites and while dissolved oxygen measured during the daytime met standards, problems were indicated during low light periods associated with plant respiration. Results from a continuous monitor deployed at Schwemley Rd. (RM 25.50) are presented in Figure 3B. Oxygen levels remain below the criterion for extended periods of time on a daily basis. This site was also tested for the presence of herbicides and atrazine was detected at 0.72 µg/l. Spills are a cause of impairment in this reach as well. One spill investigated involved the release of hog manure near Schwemley Rd. on November 11, 2001. It was determined that Rossman Farms located at 3933 Hieber Rd. over-applied the liquid to a field and it leached into a tile.

Fish and macroinvertebrate communities were sampled at five sites in the lower 21.4 miles of Broken Sword Creek recommended for the WWH use. Neither fish nor macroinvertebrate communities met expectations for this use at the uppermost site within this reach. Causes of impairment included a lack of flow and heavy siltation largely related to natural low gradient and erosion from upstream agricultural areas. Sediment from upstream is effectively trapped within the stream channel. Elevated nutrients and/or low dissolved oxygen were also a likely factor. The assemblages of fish and macroinvertebrates did not have taxa present that would be expected had habitat been the only determinant of diversity within the two groups. Macroinvertebrate taxa such as burrowing mayflies and slack water caddisflies should have been present given the available habitat. Similarly, the fish community included a high percentage of tolerant species and no pollution intolerant taxa were collected.

Higher stream gradient at downstream sites offered a more varied habitat. This was reflected in the ICI and IBI indices which depend in large part on taxa diversity to achieve good scores. ICI scores ranged from 38 to 48 and IBI scores were between 38 and 47at the lower four Broken Sword Creek sites. The MIwb index which is a measure of how evenly biomass is distributed among the fish species only marginally attained WWH expectations at RM 10.5 and was not attaining at RM 4.8. The lower than expected MIwb scores was an indication that the fish community was impacted. Potential stressors at RM 4.8 included the Nevada WWTP, road construction on US Rt. 30and effects from a dam immediately upstream from the sampled reach. Dams can be a source of algae which is then fed upon by carp in the downstream area. The MIwb is negatively effected when comparatively few carp make up a large portion of the biomass at a site. Biological condition of the lower four Broken Sword Creek sites which had >50 mi^2 drainage area reflected 13.8 miles of full attainment of the WWH aquatic life use and 2.0 miles of partial attainment.

Water quality was evaluated at five sites in the lower reach of Broken Sword Creek. The assessment included testing for the presence of volatile and semi-volatile organic compounds at CR 62 (RM 0.87); none were detected. The leading cause of impairment was enrichment/low dissolved oxygen. Low dissolved oxygen exceeding the statewide average criterion was measured at Lemert Rd. (RM 19.13) and C.R. 62 (RM 0.87). Results obtained from the five sets of grab samples are displayed in

Figure 3C. Phosphorus is the nutrient that generates the most concern because it often limits growth and its presence can stimulate the development of nuisance algae and weeds. These growths cause aesthetic problems because the floating mats are unsightly and odorous when they decay. In turn, daily fluctuations in levels of dissolved oxygen and pH occur as a result of plant photosynthesis and respiration. Bacteria that perform the decay process consume oxygen and further decrease levels in the water column. The median phosphorus concentration in this reach was 0.13 mg/l.

Likely sources of phosphorus in this reach are crop fertilizer, failed on-lot septic systems and point sources. Regulated point sources are listed in Table 3C. Of these, the Nevada WWTP is certainly a concern, but the village does not have phosphorus limits or monitoring requirements. As a result, there was no loading data available to evaluate. These requirements are mainly a policy for large volume facilities. A package plant that serves the Foxfire Campground discharges to Broken Sword Creek at RM 10.55, but this facility has yet to be issued a permit. Failed on-lot septic systems are a concern because poorly treated sewage will eventually enter a stream. Food, human waste and especially synthetic detergents all contain phosphorus and contribute to the amount in domestic wastewater. Normal concentrations range from 10-12 mg/l. The Village of Oceola is in this reach and does not provide municipal sewage collection and treatment. Handling of sewage at the Sunset Springs Campground is also a concern according to the Crawford County Health Dept. The impact from cropland varies depending on the amount of erosion and presence or absence of buffer zones. Some phosphorus enters streams through field tile drainage, but at a much lesser amount because it binds so tightly to soil particles.

There is also a concern for water quality impairment resulting from spills in this reach. One spill investigated involved the release of diesel fuel at S.R. 4 (RM 23.2) on March 27, 2001. The spill was caused by a truck accident. Another spill released a small amount of hydraulic oil at a construction site near C.R. 56 (RM 3.8) on September 13, 2001.

The tributary confluent with Broken Sword Creek at RM 28.04 drains the Village of Sulphur Springs. This community is served by on-lot septic systems and the Crawford County Health Dept. has indicated that many are failed. While there was little flow in this stream, it was possible to sample water from a pool at Ridgeton-Annapolis Rd. (RM 0.77). Results for bacteria and nutrient tests did not show an impact at this location.

Sediment was collected from Broken Sword Creek at C.R. 62 near the Sandusky River confluence. The substrate at this location is mostly rock and only a small deposit of sediment was found, so the ecological impact of its quality should be minimal. Analysis determined that the sample contained 64.1% sand, 35.9% silt and clay and 3.8% organic carbon. Results for metals are displayed in Table 3D, but, based on toxicity studies presented in literature, they are not a concern. The only concern was for an elevated level of heptachlor epoxide, which is an oxidation product of the insecticide heptachlor. The value exceeded the probable effect concentration (PEC) described by MacDonald et al (2000). This is a level above which harmful effects are likely to be observed in aquatic life.

Table 3A. Aquatic life use attainment status of the Broken Sword Creek assessment unit , June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

RM Fish/Invert.	IBI	MIwb	ICI	QHEI	Attainment Status	Location
Broken Sword Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/32.6	---	---	G	---	(Full)	TR 53, Dickson (Lightsburg)
30.3/30.3	36	NA	G	30.5	Full	TR 20, Beck (Kirkpatrick) Rd.
27.9/27.9	30	---	G	31.5	Full	CR 78, Ridgetown-Annapolis
25.5/25.5	26	6.8	54	20.0	Full	TR 41, Schwemley Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
19.7/16.7	28*	7.4*	30*	52.5	**NON**	Holmes Center Rd./ Bethel Rd.
12.3/12.3	38^{ns}	8.8	38	67.0	Full	US 30, Lincoln Highway
10.5/10.5	40	8.1^{ns}	42	67.5	Full	TR 10/11, County Line Rd.
4.8/3.9	41	7.6*	48	65.5	Partial	CR 55/ CR 56
0.9/0.6	47	9.1	46	76.0	Full	CR 62
Red Run						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/0.5	---	---	F	---	(Full)	CR 139, Henry Cooper Rd.
Brandywine Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
3.3/3.3	12*	NA	P*	37.5	**NON**	CR 31, Spore-Brandywine Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.6/1.6	24	NA	P*	27.5	**NON**	TR 30, Temple Rd.
Indian Run						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.5/3.5	26	NA	P*	33.0	**NON**	CR 47
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.9/1.0	26*	NA	MG^{ns}	44.0	**NON**	TR 137

Table 3B. Values obtained from surface water grab samples collected in the Broken Sword Creek Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Criteria identified for warmwater habitat apply to water bodies not assigned use designations. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36)[3] apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), °Celsius for temperature (T), colonies/100 ml for fecal coliform (FC)and µg/l for barium (Ba). Results for strontium are not included because 45 of 54 values (83.3%) exceeded the Tier II limit.

Mile	*Parameter (value)*
Broken Sword Creek (WWH, PCR, AWS)	
30.31	T (23.2 †); Ba (232 ˙, 248 ˙); FC (1700 ‡)
27.96	T (24.5 ††, 28.2 †)
25.48	T (24.7 ††, 30.1 ††)
19.13	T (23.3 †); DO (4.9 †)
12.41	none
10.53	none
5.14	none
0.87	DO (4.6 †)
Indian Run (WWH, PCR, AWS)	
0.94	FC (1500 ‡, 1200 ‡)
Brandywine Creek (WWH, PCR, AWS) n ' 4 of 5	
1.60	T (22.8 †)
Broken Sword Creek Tributary at RM 28.04	
0.77	Ba (238 ˙, 480 ˙, 614 ˙, 618 ˙)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

[3] Tier II aquatic life outside mixing zone average (˙)

Table 3C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Broken Sword Creek Assessment Unit.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
National Lime and Stone, Bucyrus Plant	2IJ00020001	Broken Sword Ck	15.42	groundwater and stormwater treated by a settling pond
National Lime and Stone, Bucyrus Plant	2IJ00020003	Broken Sword Ck	14.48	groundwater and stormwater treated by a settling pond
Nevada Water Treatment Plant	2IY00060001	Unnamed Trib Broken Sword Ck	0.82 5.63	softener backwash treated by a sand filter
Nevada Wastewater Treatment Plant	2PA00070001	Rhine Ditch Broken Sword Ck	0.35 5.23	sanitary sewage treated by a modified activated sludge extended aeration system

Table 3D. Metal concentrations in sediment collected from the Broken Sword Creek Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated]

Broken Sword Creek at RM 0.87- Wyandot County Rd. 62

Al	**Ba**	**Ca**	**Cr**	**Cu**	**Fe**	**Pb**	**Mg**	**Mn**
26800 [d]	144 [c]	26700	33 [c]	15.4 [a]	19100 [a]	<32	6340	<3940
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<32	6340	<3940	243	87.6 [a]	<0.043	6.82 [a]	0.434 [a]	<1.58

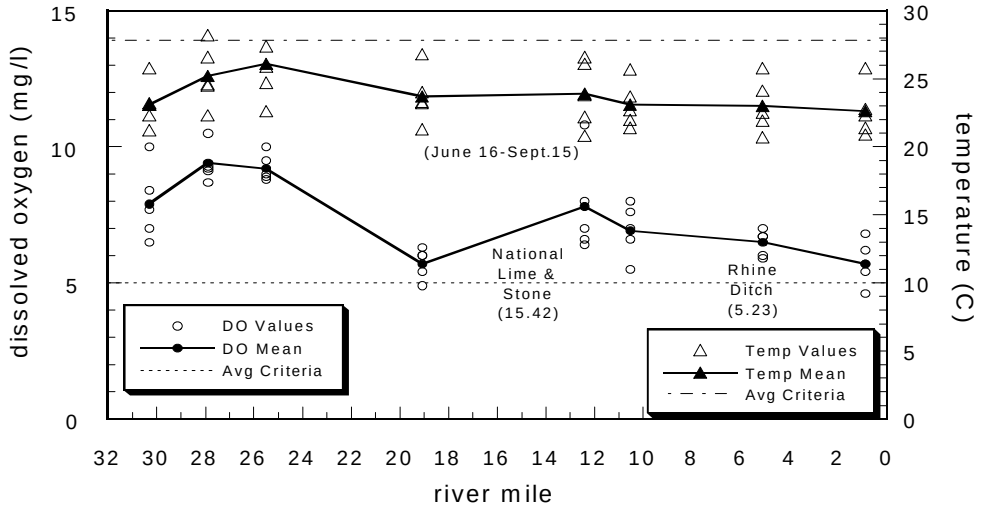


Figure 3A. Dissolved oxygen and temperature readings collected from Broken Sword Creek, June to October, 2001. Temperature criterion valid June 16 to September 15.

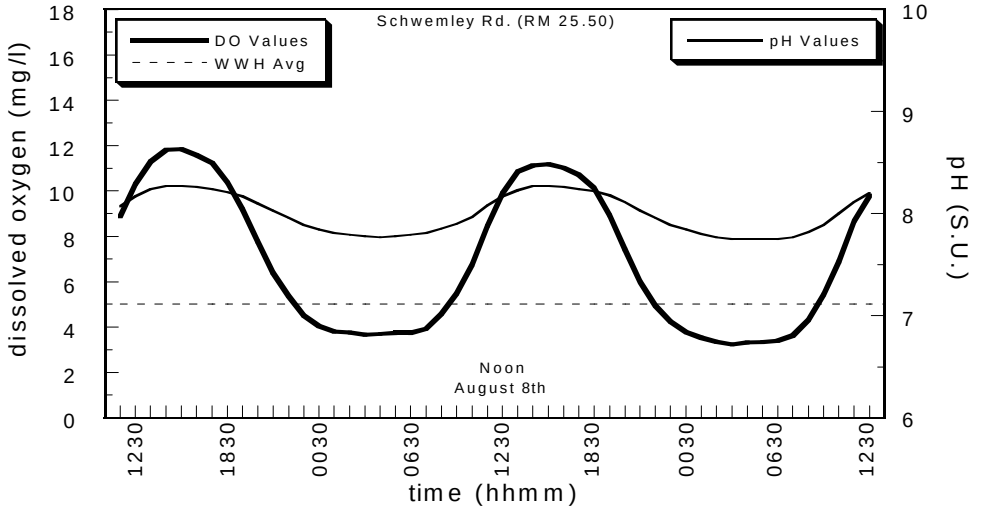


Figure 3B. Dissolved oxygen and pH values from Broken Sword Creek at Schwemley Rd. (RM 25.5) recorded using continuous monitors, August 17-19, 2001.

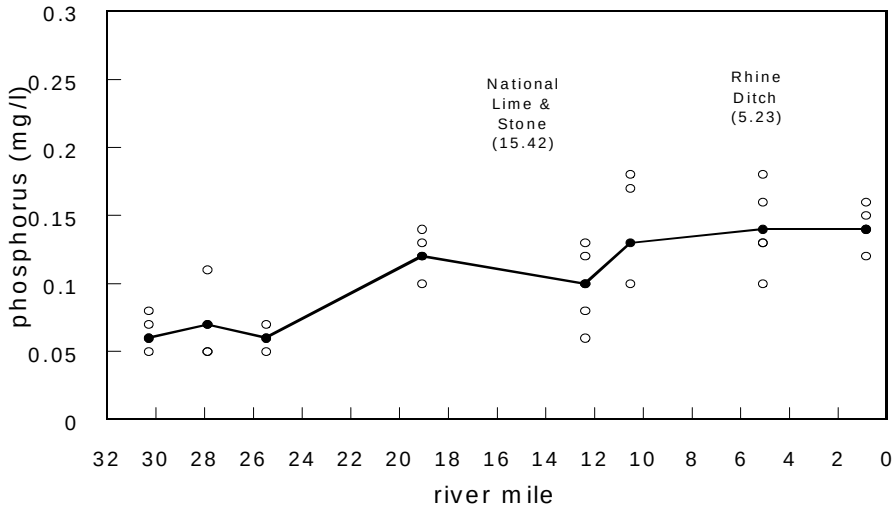


Figure 3C. Phosphorus values collected from grab samples from Broken Sword Creek, June-October, 2001.

Sandusky-Upper Sandusky Assessment Unit

The Sandusky-Upper Sandusky assessment unit (04100011-040) encompasses the area from downstream Broken Sword Creek (RM 94.48) to upstream Tymochtee Creek (RM 65.73). Biological and habitat assessments were conducted at 20 sites in 2001 on nine streams. Biological attainment status is presented in Table 4A. Surface water physical/chemical assessments were conducted at 12 sites. All the sites except one had five sets of grab samples collected at two-week intervals. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. Two sites had an extra sample collected to test for the presence of volatile and semi-volatile organic compounds and one site was tested for levels of herbicides. Sediment analysis was conducted at two sites. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 4B.

The City of Upper Sandusky is within this assessment unit and the Wastewater Treatment Plant (WWTP) is the single largest discharge. There are several other point sources regulated in the assessment unit and they are listed in Table 4C. In addition to the mainstem, five smaller watersheds were sampled (Little Sandusky River, Rock Run, Negro Run, Sugar Run and Layton Ditch). Four of fifteen sites with drainage areas <50 mi^2 met the designated or recommended aquatic life use. Nine were in non-attainment and two partially met of the designated or recommended use. Five sites on the Sandusky River mainstem had drainage areas between 232 mi^2 and 341 mi^2. Biological assessment of the five sites reflected 26.0 miles of full attainment of the Warmwater Habitat (WWH) aquatic life use and 3.0 miles of partial attainment.

The failure of streams with drainage areas <50 mi^2 within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed and pollution from poorly treated sewage. Sedimentation, enrichment/low dissolved oxygen and substrate embeddedness were common impacts where aquatic life use attainment was not fully met. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelizing of streams, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. Flow data collected by the US Geological Survey on the Sandusky River at CR 121 (RM 78.09) is displayed in Figure 4A. About 44 years of data were used to calculate the flow characteristics. The 7 day, 10 year low flow value for May-November was 1.7 cubic foot per second (cfs) and the 80% duration value (flow equaled or exceeded) was 9.5 cfs. Flows were generally near 13 cfs during most of the study, indicating that, even with drought conditions, the river maintained fairly normal flows for that time of year. Many of the sampled locations had slow current velocities which keep eroded sediment trapped within the stream channels. Additionally, the lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. The benefits of flow contributed by groundwater to small streams was evident in Negro Run and Spring Branch. Significant nutrient enrichment and/or organic loading was indicated at sites on the Little Sandusky River and attributed to failed on-site septic systems within the Village of Morral.

Phosphate (PO_4) is the compound of greatest concern regarding enrichment impacts because it is often growth limiting.

The Sandusky River, Rock Run and Little Sandusky River are designated as WWH streams based on previous biological surveys. The unnamed tributary to the Little Sandusky River(RM 8.93) was designated as a Modified Warmwater Habitat (MWH). The 2001 survey is the first time that aquatic life use has been evaluated using biological and habitat information for the other sampled streams within the assessment unit. The remaining streams possessed sufficient physical habitat characteristics to warrant the WWH aquatic life use. The Qualitative Habitat Evaluation Index (QHEI) scores at sites in these streams (Negro Run, Sugar Run and Layton Ditch) ranged from 43.0 to 64.0. The presence of a wooded riparian and/or recovering stream channel were primary considerations for recommending the WWH use. Further recovery where habitat modification had occurred is possible through the application of management practices to limit soil loss and stream bank erosion.

Insufficiently treated waste from on-site septic systems within the Village of Morral were severely impacting the Little Sandusky River at RMs 10.4 and 9.4. Masses of aquatic worms which feed on sewage were observed at RM 10.4. Poor to very poor fish and macroinvertebrate assemblages were present. In addition to the obvious organic degradation, the entire stream was effected by heavy siltation and habitat alteration. As a result, none of the sampled locations met the WWH aquatic life use. Improvement in biological condition could be gained by correcting the obvious sewage problem in Morral. The effects of channelization and habitat function due to siltation is one that will be difficult to address. The sampled locations had a low gradient which tends to keep eroded sediment within the stream channel. Additionally, the resultant lack of current likely worsened the impact from organic loading and nutrient enrichment by limiting reaeration of the stream. Water quality at Morral-Kirkpatrick Rd. (RM 9.44) was the most severely impaired of the three sites evaluated. Conditions were impaired by enrichment/low dissolved oxygen and elevated bacteria counts. Elevated bacteria counts generate a concern for human health and may result in non-attainment of the designated Primary Contact Recreation use.

Six fish species were collected and the community was rated as poor at RM 2.6 on the Little Sandusky River Tributary (RM 8.93). No macroinvertebrates were collected because the stream was dry on the date that sampling was attempted. The designated MWH use was not met based on these results. The aquatic life use was based on sampling conducted at RM 0.9 in 1995. Upstream, at RM 2.6, the stream functioned as a conveyance for agricultural drainage but had little to offer in the way of habitat for aquatic life. The application of a Primary Headwater Habitat use should be considered at this site (RM 2.6) if it becomes an option in the future.

The upstream site on Honey Run (RM 2.4) is provisionally listed as fully attaining the WWH use based on a marginally good macroinvertebrate assemblage; however, no fish sampling was conducted. The stream failed to meet the use at RM 0.5 due to a very poor fish index score (IBI = 12). Only eight individuals were collected despite relatively good habitat. Conversely, the

macroinvertebrate community was in good condition. The reason for these divergent results was not readily apparent and will need additional sampling to determine if a water quality problems exists. Water quality evaluated at CR 126 (RM 0.52) was good except for an elevated bacteria count. A possible source is Maken Bacon Farms, Inc. located at 2594 CR 74. This facility is a large hog operation that has a 1.2-1.4 million gallon holding pond for storing liquid manure. The operator reported a spill to Honey Run on December 12, 2001 after manure applied to soy bean stubble leached into field tiles. The tile main enters Honey Run at Township Rd. (TR) 72 just east of TR 135.

Spring Branch and Negro Run demonstrated attainment of the WWH aquatic life use. The available habitat varied between sites. One important attribute both streams had in common was that groundwater contributed flow and enhanced water quality. This was reflected in collection of 12 to 15 EPT taxa and good numbers of mottled sculpins at each site. Water quality was evaluated in Negro Run at CR 124 (RM 0.52) and CR 128 (RM 2.91). The only water quality problem documented was elevated bacteria levels. A possible source is failed on-lot septic systems in the unincorporated Village of Seal.

A total of four sites were sampled on Rock Run, Sugar Run and Layton Ditch. These were sites with <10 mi^2 of drainage. None of the sites fully met the recommended WWH use. The failure of streams to meet the WWH aquatic life use can be largely attributed to conditions resulting from the predominant agricultural land use. Impacts included a combination of enrichment, siltation and minimal flow. The sampled locations had slow current velocities which keep eroded sediment trapped within the stream channels. Additionally, the lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. An additional source of degradation on Rock Run was discharge of insufficiently treated sewage from adjacent residences at RM 0.9. Water quality data evaluated in Rock Run at TR 51 (RM 0.80) documented an elevated bacteria count, so the likely source is the failed on-lot septic systems mentioned above.

Five locations were sampled by Ohio EPA staff on the Sandusky River mainstem between the confluences of Broken Sword Creek and Tymochtee Creek. The only site where fish and macroinvertebrate results did not at least marginally meet expectations for the WWH aquatic life use was a RM 93.8. At this location, the IBI score was in the fair range. The fish community at this site appeared to be more effected by siltation and nutrients than other mainstem sites within the assessment unit. As a result, the proportion of simple lithophilic species was depressed while tolerant and omnivores fishes were present in higher than expected numbers. IBI and MIwb scores were in the marginally good to very good range at the remaining locations. The macroinvertebrate community was consistently in the exceptional range which indicated overall good water quality at the sampled locations.

Water quality evaluated in the Sandusky River mainstem was good except for several warmer than

normal water temperatures. These alone should not have a major effect on aquatic life. Although less oxygen is soluble in warm water, there were no dissolved oxygen criterion exceedences in the grab samples. Results obtained from grab samples are displayed in Figure 4B along with the average criterion that apply (temperature criterion valid June 16-September 15). Several continuous monitors were deployed on July 24, 2001 and verified that good oxygen levels were maintained over a diel period. These instruments record hourly measurements for 48 hours. There were only brief periods during the evening that levels dipped below the average WWH criterion of 5.0 mg/l. Results for units deployed at CR 128 (RM 93.76) and TR 40 (RM 72.09) are displayed in Figure 4C. A mercury value of 0.30 µg/l was documented at TR 124 (RM 90.27) and this exceeded the human health and wildlife limits established to protect drinking water supplies and prevent contamination of fish tissue. Elevated levels of mercury were documented in sediment tested around the City of Bucyrus and it was discovered that the General Electric Lamp Plant in town disposed of mercury into the sewer system. An annual Toxic Release Inventory indicated that 49 pounds were disposed in 2000 and 19.8 pounds in 2001. Some other sources of mercury include burning of coal, manufacture of batteries and production of chlorine gas and caustic soda. The sites at CR 55 (RM 83.47) and CR 121 (RM 78.09) were selected to bracket the Upper Sandusky WWTP and had additional testing conducted for the presence of volatile and semi-volatile organic compounds. No compounds were detected in either sample.

Pollution spills can have a major impact on attainment of designated beneficial uses. One incident was investigated at the Qualitec Trucking, Inc. facility located at 16303 TR 124, Harpster, OH. It was determined that 1000 gallons of waste oil was deliberately dumped from an above ground storage tank into an adjacent field. The oil leached into a field tile that leads directly to the Sandusky River. The Upper Sandusky WWTP reported a spill to the Sandusky River on June 18, 2001. A lift station pump failed and resulted in the bypass of a large amount of sewage directly into the river. The collection system contains three combined sewer overflows (CSOs) that discharge during wet weather and the main plant has a bypass that activates when the plant exceeds hydraulic capacity. The WWTP is designed to treat 2.0 million gallons per day (MGD) at a secondary level with ultraviolet radiation as disinfection. Flows above design capacity receive primary treatment and disinfection up to the hydraulic capacity of 3.0 MGD. The city is considering construction of a one million gallon equalization basin to reduce the frequency of bypasses.

Sludge deposits noted in the Sandusky River downstream from the WWTP raised some concern. Annual loadings (kg/day) of suspended solids over the last 20 years were evaluated using the Liquid Effluents Analysis Processing (LEAP) system, an Ohio EPA database that stores monthly selfmonitoring data and are displayed in Figure 4D. The facility is allowed to discharge a daily maximum of 204.4 kg/day and a monthly average of 136.3 kg/day.

Additional sampling conducted by the consulting firm, Hull and Associates, showed a decline in the fish community downstream from the Upper Sandusky WWTP (Table 4D). The sampling was conducted on October 3, 2001 and was observed by Ohio EPA staff. Both fish indices declined from, at least, marginally good upstream from the plant to the fair range downstream. Personal

communication with the EPA observer indicated sludge deposits were extensive in the river channel, both along the margins and covering an entire pool area. It should be noted that this was a single sampling event. Normal EPA protocol requires two sampling passes be conducted in this size stream to determine aquatic life use attainment. Nevertheless, it appeared that proper plant operations were disrupted at some point prior to the sampling and that the stream was impacted. Further investigation is needed too more conclusively identify the frequency and magnitude with which these events occur.

Sediment quality was evaluated at two sites in the assessment unit. Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCBs). Results for metals varied widely and are presented in Table 4E. No volatile, semi-volatile, or PCB compounds were detected.

Sediment collected at County Rd. 55 (RM 83.47) consisted of 68.5% sand, 42.1% silt and clay, 1.6% organic carbon and 63.8% solids. This segment of the river has a fairly slow current velocity and a large amount of deep sediment is deposited. Most metals were either ranked as non-elevated or were below the reporting limit. The compound heptachlor epoxide was detected at 19.1 µg/kg. This exceeded both the TEC of 2.47 µg/kg and PEC of 16.0 µg/kg. Sediment collected at County Rd. 121 (RM 78.09) consisted of 57.0% sand, 43.0% silt and clay, 3.2% organic carbon and 45.1% solids. This segment of the river is predominately bedrock and very little sediment is present. Most metals were either ranked as non-elevated or were below the reporting limit.

Table 4A. Aquatic life use attainment status of the Sandusky-Upper Sandusky assessment unit (04100011-040), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Sandusky River						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
93.8/93.8	32*	8.2[ns]	48	67.0	Partial	TR 128
90.3/90.3	44	9.0	54	66.0	Full	TR 124
83.3/85.0	43	8.2[ns]	46	59.0	Full	CR 55
78.4/77.9	48	8.1[ns]	44	71.5	Full	CR 121
72.0/72.1	52	9.3	52	76.5	Full	TR 40 (Parker Bridge)
Little Sandusky River						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
---/10.4	---	---	P*	---	(**NON**)	
9.4/9.4	24*	NA	VP*	32.0	**NON**	CR 67, Morral-Kirkpatrick Rd.
7.0/8.6	20*	1.4*	F*	37.0	**NON**	TR 68, Wyandot-Marion Rd.
---/6.5	---	---	F*	---	(**NON**)	
1.3/1.4	26*	5.1*	34[ns]	50.5	**NON**	CR 113
Little Sandusky River Tributary @ RM 8.93						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation						
2.6/	20*	NA	---	18.5	**(NON)**	CR 90, Goodnow Rd.
Honey Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
---/2.4	---	---	MG	---	(Full)	TR 128
0.5/0.5	12*	NA	G	43.0	**NON**	CR 126
Rock Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
4.0/4.0	34*	NA	F*	36.0	**NON**	TR 124
0.9/0.9	30*	NA	MG[ns]	57.0	Partial	TR 51

Table 4A. Continued

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Negro Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
2.9/2.9	44	NA	VG	59.0	Full	CR 128
0.5/0.5	42	NA	G	57.5	Full	CR 124
Spring Branch						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
1.2/1.2	38[ns]	NA	VG	54	Full	TR 136
Sugar Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
0.6/0.6	34*	NA	G	64.0	Partial	SR 67
Layton Ditch						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
0.4/0.3	26*	NA	F	57.0	**NON**	CR 37

Table 4B. Values obtained from surface water grab samples collected in the Sandusky-Upper Sandusky Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33)[3] and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), °Celsius for temperature (T), colonies/100 ml for fecal coliform (FC)and µg/l for mercury (Hg). Strontium is not included because 59 of 59 values (100%) exceeded Tier II limits.

Mile	*Parameter (value)*
Sandusky River (WWH, PCR, AWS)	
93.76	T (25.4 ††)
90.27	T (24.5 ††); Hg (0.30 ^{hhw})
83.47	T (25.3 ††)
78.09	T (27.2 ††, 27.9 †); FC (1600 ‡)
72.09	T (26.7 ††, 28.5 †, 28.6 †)
Negro Run (WWH, PCR, AWS)	
2.91	T (24.1 †); FC (8000 ‡‡)
0.52	T (25.7 ††); FC (>10000 ‡‡, 1300 ‡)
Rock Run (WWH, PCR, AWS)	
0.80	FC (5700 ‡‡)
Little Sandusky River (WWH, PCR, AWS)	
9.44	T (23.7 †); DO (4.5 †, 3.5 ††, 3.6 ††, 3.5 ††, 2.7 ††); FC (>10000 ‡‡)
6.52	T (23.1 †); FC (>10000 ‡‡, 2800 ‡‡)
1.45	FC (7300 ‡‡)
Honey Run (WWH, PCR, AWS)	
0.52	FC (>10000 ‡‡) [n ' 4]

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

[3] human health and wildlife outside mixing zone average (^{hhw})

Table 4C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Sandusky-Upper Sandusky Assessment Unit.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
The Olen Corporation, Plant #6	2IJ00067-001	Sandusky River	86.98	un-treated groundwater and stormwater
Ligui-Box Corp.	2IQ00009-002	Unnamed Trib Sandusky River (Upper Sandusky Reservoir)	83.14	sanitary sewage treated by a package plant
Upper Sandusky Water Treatment Plant	2IW00270-001	Sandusky River	83.00	lime sludge treated by a settling pond
BP Oil, Upper Sandusky Bulk Plant	2IN00169-001	Sandusky River (via storm tile)		stormwater treated by an oil-water separator and settling pond
Upper Sandusky Wastewater Treatment Plant	2PD00039-001	Sandusky River	80.02	sanitary sewage treated by an activated sludge aeration system
Upper Sandusky Wastewater Treatment Plant	2PD00039-051	Sandusky River	80.02	raw bypass
Upper Sandusky Wastewater Treatment Plant	2PD00039-003, 008-009	Sandusky River		combined sewer overflow

Table 4D. Fish index scores upstream and downstream from the Upper Sandusky River WWTP conducted by Hull and associates, October 3, 2001.

RM	IBI	MIwb	Location
83.3[a]	38[ns]	7.8[ns]	CR 55
80.2[b]	38[ns]	8.3	Immediately downstream Upper Sandusky WWTP
79.9[b]	28*	6.8*	Downstream WWTP (sludge deposits noted)

[a] Boat sampling method
[b] Wading sampling method.
* Significant departure from ecoregion biocriterion.
[ns] Nonsignificant departure from biocriterion (≤4 IBI or ≤0.5 MIwb units).

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	WWH	EWH
IBI Headwater - Wading/ Boat	40/ 42	50
MIwb Wading/ Boat	8.3/ 8.5	9.4/ 9.6

Table 4E. Metal concentrations in sediment collected from the Sandusky-Upper Sandusky Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated]

Sandusky River at RM 83.47- Wyandot County Rd. 55

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
17600 [c]	79.7 [a]	21900	16 [a]	10.7 [a]	13800 [a]	<21	7500	271 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<21	4120	<2660	148	65.2 [a]	<0.033	5.07 [a]	0.266 [a]	<1.06

Sandusky River at RM 78.09- Wyandot County Rd. 121

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
14500 [b]	82.6 [a]	27000	<22	18.0 [a]	15500 [a]	<30	8980	266 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<30	4140	<3700	218	102 [b]	0.052	6.02 [a]	0.400 [a]	<1.48

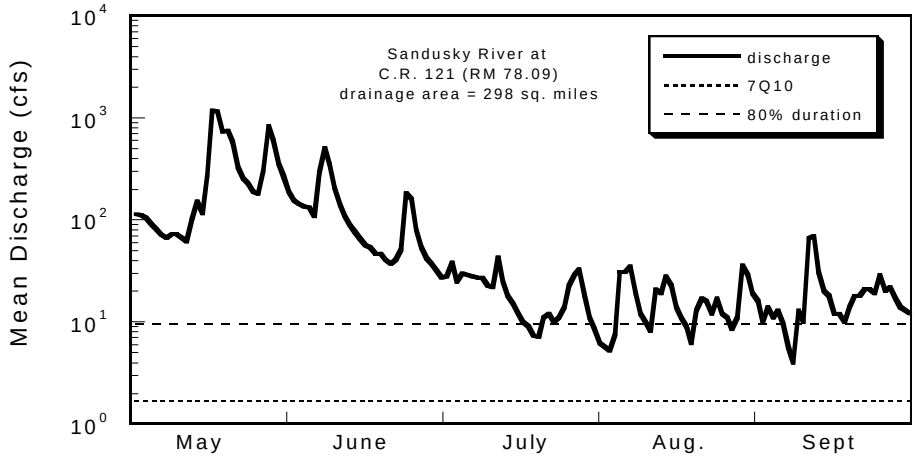


Figure 4A. Flow data collected by the US Geological Survey on the Sandusky River at C.R. 121 (RM 78.1), May1 to September 30, 2001.

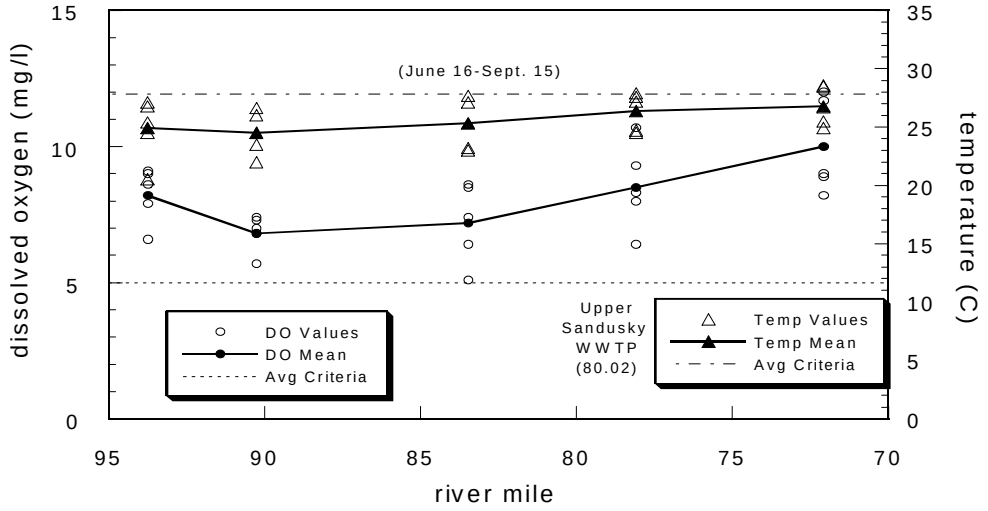


Figure 4B. Sandusky River dissolved oxygen and temperature results for the Sandusky-Upper Sandusky assessment unit (04100011-040), collected June - October, 2001. Temperature criterion valid June 16 -September 15.

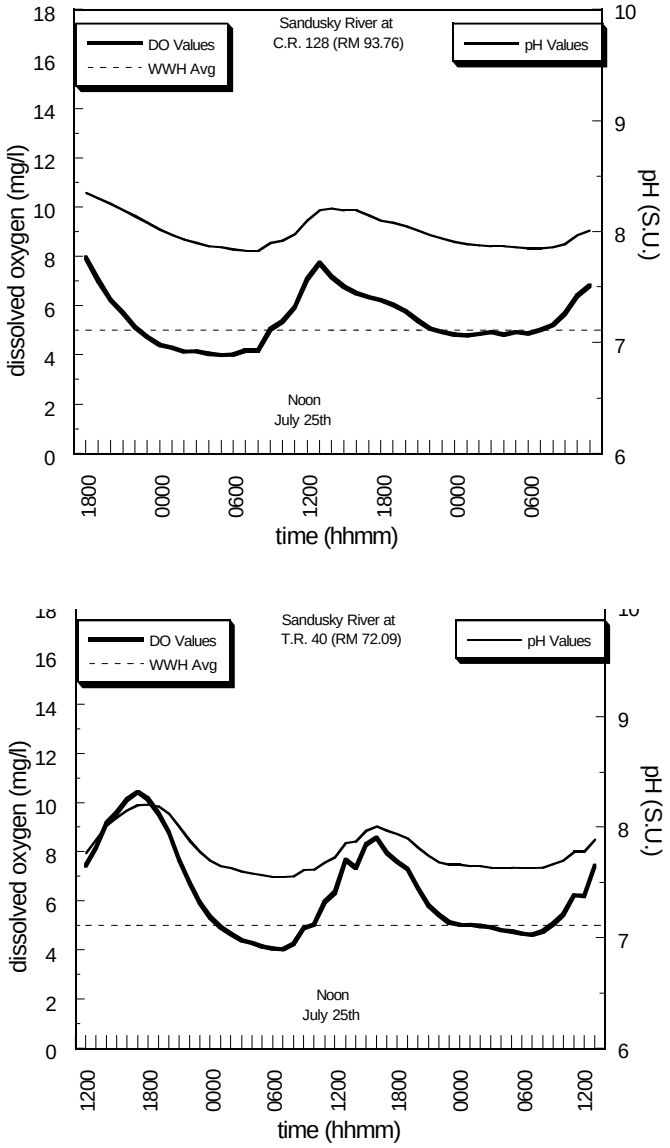


Figure 4C. Dissolved oxygen and pH values from the Sandusky River at CR 128 (RM 93.76) and TR 40 (RM 72.09) recorded using continuous monitors deployed July 24-26, 2001.

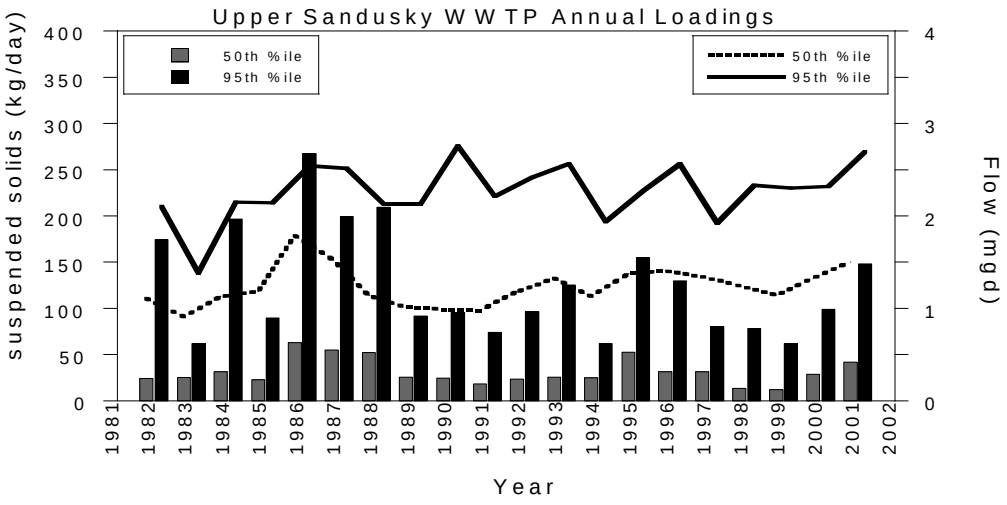


Figure 4D. Annual suspended solids loadings (kg/day) and flow from the Upper Sandusky WWTP, 1982 to 2001.

Upper Tymochtee Assessment Unit

The upper Tymochtee assessment unit (04100011-050) encompasses the drainage area beginning with the headwaters of Tymochtee Creek downstream to and including Warpole Creek. Biological and habitat assessments were conducted at 18 sites in 2001. Attainment status for streams in the assessment unit are presented in Table 5A. Surface water physical/chemical assessments were conducted at 16 sites. The majority had five sets of grab samples collected at two-week intervals. Sites with fewer sets collected were dry or intermittent. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. Two sites had an extra sample collected to test for levels of herbicides. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 5B.

Given that farming will remain the predominant land use, Modified Warmwater Habitat (MWH) or Limited Resource Water (LRW) aquatic life uses were recommended for a majority of the small channelized streams(<10 mi^2) where limited habitat conditions made these uses applicable. Sites >10 mi^2 were considered of sufficient habitat quality to warrant a Warmwater Habitat (WWH) aquatic life use. Six of 15 sites with drainage areas of 50 mi^2 or less met the recommended aquatic life use. The remaining nine sampled locations were in non-attainment of the designated or recommended use. Three sites on Tymochtee Creek with drainage areas >50 mi^2 represented 19.3 miles of stream. None of these miles were in full attainment of the designated WWH use. The use was partially met for 7.8 miles with non-attainment ascribed to 11.5 miles.

The failure of a majority of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed, pollution from poorly treated sewage and spills. Sedimentation, enrichment/low dissolved oxygen, ammonia and bacteria were a concern, but the most pervasive impact was simply the low water levels that were encountered during the sampling period. In addition to the widespread impacts associated with agriculture, several distinct areas were impacted by organic loadings from on-site septic systems. These were Tymochtee Creek and Prairie Run immediately downstream from the Village of Meeker, Tymochtee Creek (upper) downstream from the Village of Marseilles, Little Tymochtee Creek at Township Road 104 (RM 13.5) and Warpole Creek downstream from the Village of Harpster.

The modification of stream channels and tiling to facilitate drainage have reduced the volume of water present during dry weather periods making drought conditions in the streams a much more frequent occurrence.

A total of 26 sites were originally selected within the subbasin for biological sampling. Eight of seventeen sites with drainage areas of <10 mi^2 were either dry or had only widely disconnected pools when biological sampling was attempted. Little was to be gained in sampling those areas where a puddle of water was present. These streams included Blood Run, Prairie Run at RM 4.1, Carroll Ditch Tributary at RM 0.35 (West Branch Carroll Ditch), Reevhorn Run (two sites), Ramage Run,

Warpole Creek at RM 2.5 and St. James Run. Assignment of an aquatic life use is not appropriate given the inability of the sites to develop any semblance of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat guidelines which are currently being drafted by Ohio EPA. Therefore, it is recommended that these watercourses remain undesignated until the Primary Headwater Habitat designations are promulgated.

Three sets of surface water samples were collected from Reevhorn Run at Wyandot County Rd. 76 (RM 2.26) before it dried. An abnormal amount of algae was present and the dissolved oxygen and pH values were highly elevated because of it. This indicated the presence of a nutrient source, but its location was not pinpointed.

Nine sampled sites on seven streams had drainage areas of <10 mi^2. Enoch Creek and Pawpaw Run were the only streams with >10 mi^2 drainage that possessed sufficient physical habitat characteristics to warrant the WWH aquatic life use. The presence of a wooded riparian corridor and a natural or recovering stream channel were primary considerations for recommending the WWH use. The most upstream Tymochtee Creek site (RM 53.2) was channelized and intermittent. The wetted channel was extremely shallow and covered with emergent aquatic vegetation. These conditions precluded the establishment of even the MWH fish community and, as such, is a candidate for the LRW use. The remaining <10 mi^2 sites were channelized with little likelihood for recovery and offered minimal instream habitat. It is not realistic to expect typical WWH aquatic communities under these conditions, so the MWH aquatic life use is recommended for Little Tymochtee Creek (upper) upstream from County Road 205 (~RM 9.0), Prairie Run and Warpole Creek. Thompson Ditch and Carroll Ditch have existing MWH designations that should be retained.

All of the sites with >10 mi^2 drainage had sufficient attributes to warrant the WWH aquatic life use. Qualitative Habitat Evaluation Index (QHEI) scores ranged from 33 to 68. Scores of greater than 60 are a good indication of the appropriateness of the WWH use. Tymochtee Creek at RM 40.8 and Pawpaw Run at RM 0.6 both received QHEI values of 68. The remaining sites on Tymochtee Creek and Little Tymochtee Creek (upper) were still considered candidates for the WWH use despite lower QHEI scores. Recovery where channelization had occurred was ongoing and habitat improvement is possible by reducing sedimentation through the application of management practices to limit soil loss and stream bank erosion. Sites on Tymochtee Creek had moderate amounts of instream cover and sinuosity, but low current velocities along with sedimentation limited functionality in supporting warmwater fish and macroinvertebrate assemblages. A significant loss in habitat function in Little Tymochtee Creek (upper) can be attributed to drainage manipulation of the surrounding area to facilitate row crop agriculture. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat.

Prairie Run, Thompson Ditch, Warpole Creek and Carroll Ditch met the MWH aquatic life use based on fish and macroinvertebrate sampling results. Water quality at some of these sites indicated some problems. Prairie Run at Agosta Meeker Rd. (RM 1.02) was impacted by enrichment/low dissolved

oxygen and elevated bacteria. Phosphorus is the likely stimulus for enrichment since the median concentration at this location was 0.26 mg/l. Failed on-lot septic systems in the Village of Meeker are probably a contributing source. Warpole Creek at Mifflin Township Rd. 108 (RM 2.53) was impacted by enrichment/low dissolved oxygen, ammonia and elevated bacteria. Failed on-lot septic systems in the Village of Harpster (population 230) are the probable source.

Carroll Ditch at Osbun Rd. (RM 0.66) met applicable water quality criteria except for an elevated temperature reading. A concern in this area involves spills originating at the Buckeye Egg facility on Morral Kirkpatrick Rd. This company has a poor history of compliance and the Ohio EPA decided to revoke its NPDES permits on May 23, 2002. The company then hired Compliance Consulting Associates LLC to manage operations through December 2003 and is in pursuit of a buyer for its three mega-farms located in the state. One incident was reported on November 9, 2001 after land applied manure entered a ditch that flows into Carroll Ditch at RM 0.35. The spill occurred because the manure was applied during a rain event.

Little Tymochtee Creek (upper) failed to attain the MWH use at RM 13.5 but fully met the biocriteria at RM 10.0. The IBI scores were in the expected range for MWH at both sites. It is noteworthy, however, that only three and four taxa were collected at RMs 13.5 and 10.0, respectively. Low taxa diversity and predominance of blackstriped topminnows at both sites were a result of the nearly intermittent flow conditions. The non-attainment at RM 13.5 was determined based on poor macroinvertebrate community condition. A predominance of pollution tolerant snails and limited diversity were indicative of significant pollution impacts in addition to limitations that channelization imparted on the biota. A gray water discharge was noted at the site and it appeared that nutrient and organic inputs were overwhelming the assimilative capacity to the stream. Additionally, water quality in Little Tymochtee Creek (upper) at Rager Rd. (RM 9.77) was impscted by elevated temperature and bacteria. All of the temperatures measured exceeded the criterion on the date they were collected. This site lacked shade normally provided by a riparian corridor. The elevated bacteria probably results from the gray water discharge noted at Pleasant Township Rd. 104 (RM 13.5).

Pawpaw Run was in non-attainment of the WWH use at all three sites sampled (RMs 8.9, 6.0 and 0.6). Macroinvertebrate condition progressed from poor at RM 8.9 to marginally good at the most downstream site (RM 0.6). The fish community was depressed at all three locations. IBI scores were in the fair to poor range and creek chubs were the most commonly collected fish. Stresses to the aquatic community likely included reduced dry weather flow, siltation and impacts from agricultural practices within the drainage area. Water quality was good at Fail Rd. (FM 0.57), but impaired from enrichment/low dissolved oxygen at Marion-Hardin Rd. (RM 6.13). Runoff from adjacent pasture land probably contributed to this impact.

Enoch Creek was in non-attainment of the WWH use at DeCliff Rd. (RM 1.59) based on fair quality fish and macroinvertebrate communities. Water quality was impacted by enrichment/low dissolved oxygen and elevated ammonia. These results suggested a source of either poorly treated sewage or

manure runoff.

Neither of the remaining Little Tymochtee Creek (upper) sites (RMs 7.4 and 4.0) attained the designated WWH use. A lack of sustained flow was a primary limitation to the establishment of warmwater fish at both locations. Habitat attributes such as varied substrate types and well defined pool/riffle areas were of limited function due to the nearly intermittent conditions encountered. As a result, an IBI score in the poor range and a predominance of tolerant individuals were recorded at RM 7.4. The macroinvertebrate community at RM 7.4 was in marginally good condition and indicated that nutrient concentrations were not excessive. Water quality at Wyandot/Hardin Line Rd. (RM 7.41) was good except for a low dissolved oxygen recorded during one of the sampling events.

The lack of flow led to low diversity and very low numbers of fish collected at RM 4.0. An IBI in the fair range and the MIWB in the poor range were the result. Nutrient and/or organic enrichment appeared elevated at RM 4.1 and the macroinvertebrates were in only fair condition. Water quality results at Wyandot County Rd. 93 (RM 4.00) support this observation as the median phosphorus concentration was 0.13 mg/l. This site was also tested for the presence of herbicides and atrazine was detected at 1.28 µg/l.

The sediment at RM 4.1 gave off a manure odor when disturbed and a scum layer was noted on the day macroinvertebrate sampling was conducted. This is probably related to a pollution complaint investigated on November 9, 2001 at Corey Dairy, which is located at 18405 Wyandot County Rd. 70. This facility has a capacity for 675 animals and stores manure in a two million gallon holding lagoon. It was determined that land applied manure leached into field tiles and entered a ditch that flows into Little Tymochtee Creek (upper) at RM 5.50. The investigating Wildlife Officer stated that there was potential for future incidents because of the size of the operation, heavy clay soils and shallow field tiles. Once again, the lack of water movement was a factor due to limited reaeration. The situation in Little Tymochtee was one that was repeated elsewhere in the subbasin with the tiling of agricultural fields to facilitate drainage.

Six sites were sampled in Tymochtee Creek between RMs 53.2 and 34.0. Fish sampling was not conducted at the uppermost site for reasons described above. Twenty-three macroinvertebrate taxa were collected and the community was rated as poor at RM 53.2. Siltation, rather than any water quality impact, was the reason for this result. The recommended LRW use designation attained in this reach since no severe toxic impact was indicated. Significant organic loading was evidenced in a very poor macroinvertebrate community at RM 49.3. Pollution tolerant taxa predominated and no mayflies or caddisflies were collected. This site is adjacent to the Village of Meeker and was apparently receiving insufficiently treated sewage from on-site home septic systems. Fish sampling at RM 49.3 yielded low numbers of four species, three of which were pollution tolerant white suckers, creek chubs and green sunfish. The resulting IBI score was in the poor range. Moderate amounts of in-stream cover of differing type should have supported a greater variety of fish species; however, the lack of flow limited the functionality of the habitat and exacerbated the impact of organic loading to the stream.

The macroinvertebrate community demonstrated improvement in sites downstream from the Village of Meeker beginning at RM 47.2. Marginally good to very good assemblages were collected and included eight to fifteen mayfly and caddisfly taxa. It is noteworthy that the site with the best macroinvertebrate community health was one with the least amount of siltation (RM 42.8). Siltation was particularly severe at RM 40.8 where removal of riparian trees was ongoing. The fish community continued to be depressed at the four sites on Tymochtee Creek. IBI and MIwb scores were fair to poor at RMs 47.2 and 42.8, reflecting nonattainment of the WWH aquatic life use. Fish index scores were in the fair range at RMs 40.8 and 34.0 which, in combination with at least marginally good macroinvertebrate community health, netted partial attainment of the WWH aquatic life use at these locations. Low flow conditions and siltation were the primary cause for depressed conditions at these sites because the limited available habitat could not support WWH fish communities.

Water quality was evaluated at five sites in this reach of Tymochtee Creek. Impacts from enrichment/low dissolved oxygen, ammonia and bacteria were documented. Poor dissolved oxygen levels were recorded and results are displayed in Figure 5A. Phosphorus levels were consistently above the recommended ecoregional targets (Figure 5B). Problems begin at Marion County Rd. 213-A (RM 49.44) and are caused by failed on-lot septic systems in the Village of Meeker. Physical evidence such as gray water and septic odors were noted and chemical evidence included elevated levels of ammonia (two values exceeded the WQS criterion) and a median phosphorus concentration of 0.32 mg/l. Results at Osbun Rd. (RM 47.16) indicated that much of the pollutant load was assimilated, but dissolved oxygen continues to be low. Improvement is slowed by the modified channel and low gradient due to limited reaeration potential. A continuous monitor deployed at this location revealed that oxygen levels remain below the WQS criterion for extended periods of time (Figure 5C). This site was also tested for the presence of herbicides and atrazine was detected at 1.19 µg/l and metolachlor was detected at 0.53 µg/l. No WQS criteria were exceeded at Fail Rd. (RM 42.83), but phosphorus was still elevated with a median concentration of 0.13 mg/l.

Tymochtee Creek at State Hwy. 67 (RM 40.76) was impacted by failed on-lot septic systems in the Village of Marseilles (population 130). One area where sewage was identified was just upstream from the bridge where a storm tile drains Broadway St. Another potential source of pollution at this location is the Devries Dairy Farm at 15603 State Hwy. 67. A complaint was investigated on March 7, 2001 and it was determined that land applied manure leached into a field tile that entered Tymochtee Creek around RM 41.4. The stream continued to suffer from pollution sources at Mifflin Township Rd. 97 (RM 33.99). The principal impacts continued to be enrichment/low dissolved oxygen and elevated bacteria.

Table 5A. Aquatic life use attainment status of the upper Tymochtee Creek assessment unit, June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Tymochtee Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/53.2	---	---	F	---	(Full)	CR 88, Pleasant Hill Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
49.3/49.3	22*	NA	VP*	47.0	**NON**	CR 213, Main St.
47.2/46.9	26*	6.0*	34[ns]	45.5	**NON**	CR 30, Osbun Rd.
42.8/43.0	28*	5.7*	44	55.0	**NON**	TR 64, Fail Rd.
40.8/40.8	31*	7.1*	38	68.0	Partial	SR 67
34.0/34.0	31*	7.3*	MG	40.5	Partial	TR 97
Prairie Run						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/4.1	---	---	---	P	(Full)	CR 63, Schreck Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.0/1.0	26	NA	MG	32.0	Full	TR 31, Agosta-Meeker Rd.
Thompson Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation						
1.5/---	32	NA	---	16.5	(Full)	Adj. CR 35,
Enoch Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.6/2.0	28*	NA	F*	36.5	**NON**	CR 29, DeCliff Rd.
Carroll Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation						
1.0/1.0	26	NA	F	16.0	Full	CR 30, Osbun Rd.
Pawpaw Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
8.9/8.9	28*	NA	P*	28.5	**NON**	TR 235
6.0/6.0	22*	NA	F*	61.0	**NON**	CR 255 /18, Marion-Hardin
0.6/0.6	26*	NA	MG[ns]	68.0	**NON**	TR 24, Fail Rd.

Table 5A continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Comments
Little Tymochtee Creek (upper)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
13.5/13.5	30	NA	P*	26.0	**NON**	TR 104
10.0/10.0	30	NA	F	---	FULL	TR 24, Rager Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
7.4/7.4	26*	NA	MG[ns]	50.0	**NON**	CR 215, County Line Rd.
4.0/4.1	34*	5.6*	28*	53.5	**NON**	CR 93
1.5/	36	NA	MG	33.0	Full	TR 58
Warpole Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.5/1.5	36	NA	MG	33.0	Full	TR 58

Table 5B. Values obtained from surface water grab samples collected in the upper Tymochtee Creek Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO) and ammonia (NH_3-N), °Celsius for temperature (T)and colonies/100 ml for fecal coliform (FC). Strontium is not included because 73 of 78 values (93.6%) exceeded Tier II limits.

Mile	*Parameter (value)*
Tymochtee Creek (WWH, PCR, AWS)	
49.44	DO (2.9 ††, 2.5 ††, 1.9 ††); NH_3-N (3.21 †, 1.88 †); FC (1400 ‡, 4400 ‡‡)
47.16	DO (4.0 †, 3.3 ††)
42.83	none
40.76	T (22.3 †); FC (3400 ‡‡)
33.99	DO (3.8 ††, 3.6 ††); FC (2400 ‡‡)
Warpole Creek (WWH, PCR, AWS)	
2.53	DO (4.7 †, 3.6 ††); NH_3-N (2.01 †); FC (1200 ‡, 1300 ‡)
1.52	none
Little Tymochtee Creek (upper) (WWH, PCR, AWS)	
9.77	T (27.8 ††, 28.1 †, 31.4 ††, 32.1 ††, 34.7 ††); FC (2000 ‡)
7.41	DO (4.5 †)
4.00	T (22.8 †)
Reevhorn Run (WWH, PCR, AWS) n ' 3 of 5	
2.26	none
Pawpaw Run (WWH, PCR, AWS)	
6.13	T (24.2 †); DO (3.3 ††, 4.0 †)
0.57	none
Carroll Ditch (MWH, SCR, AWS)	
0.66	T (22.3 †)
Enoch Creek (WWH, PCR, AWS)	
1.59	DO (3.8 ††, 3.6 ††); NH_3-N (3.22 †)
Prairie Run (WWH, PCR, AWS)	
1.02	DO (4.2 †); FC (2500 ‡‡, 2000 ‡)

[1] Aquatic Life Habitat: warmwater (WWH), modified warmwater (MWH); Recreation: primary contact (PCR), secondary contact (SCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

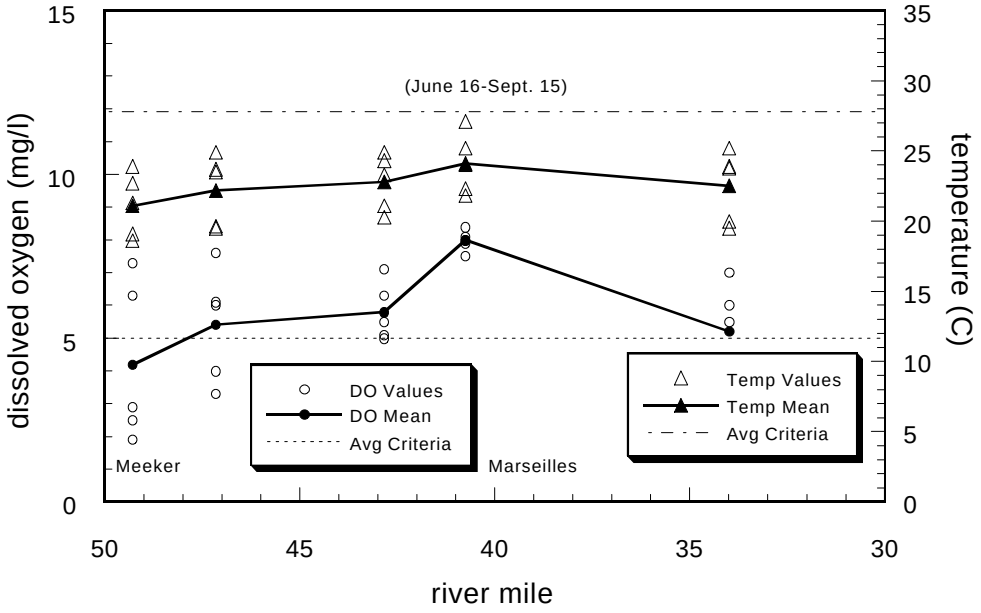


Figure 5A. Tymochtee Creek dissolved oxygen and temperature results for the Upper Tymochtee assessment unit (04100011-050), collected June- October, 2001. Temperature criterion valid June 16- September 15.

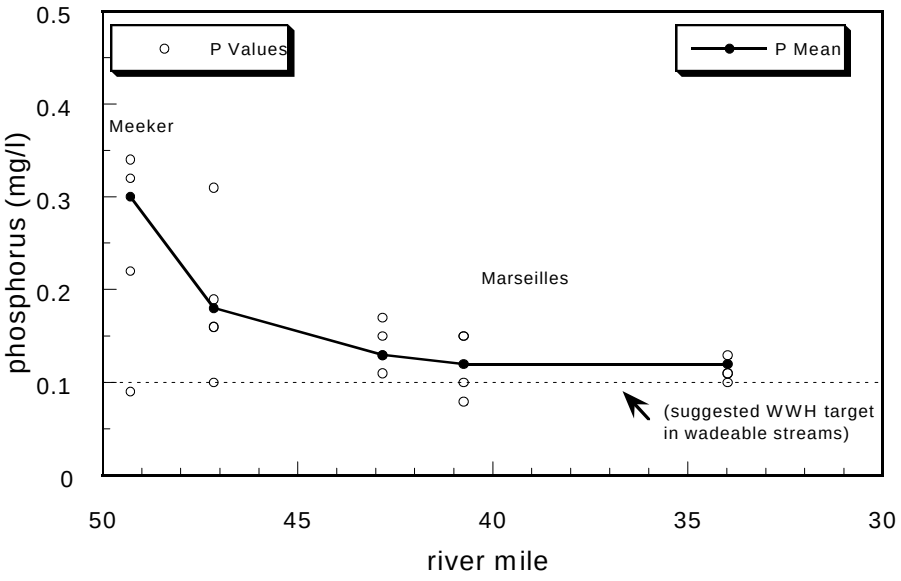


Figure 5B. Phosphorus values from Tymochtee Creek grab samples in the upper Tymochtee Creek assessment unit, collected June-October, 2001.

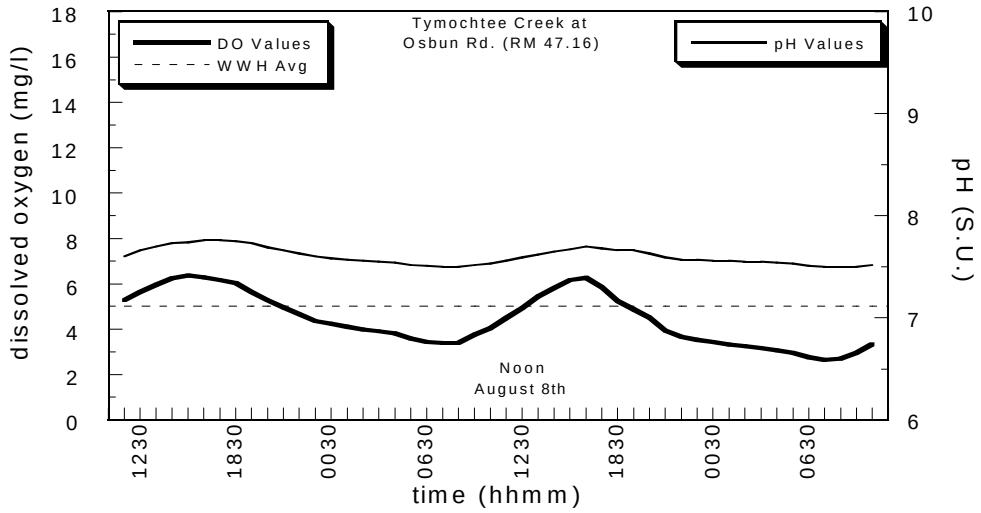


Figure 5C Dissolved oxygen and pH values from Tymochtee Creek at Osbun Rd. (RM 47.2) recorded using continuous monitors, August 17- 19, 2001.

Lower Tymochtee Assessment Unit

The Lower Tymochtee assessment unit (04100011-060) encompasses the Tymochtee Creek drainage area downstream from Warpole Creek (RM 26.7) to the confluence with the Sandusky River. Biological and habitat assessments were conducted at 14 sites in 2001. Aquatic Life Use attainment status for streams in the assessment unit are presented in Table 6A. Surface water physical/chemical assessments were conducted at 16 sites. The majority had five sets of grab samples collected at two-week intervals. Sites with fewer sets collected were dry or intermittent. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. Two sites had an extra sample collected to test for the presence of volatile and semi-volatile organic compounds and one was tested for levels of herbicides. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 6B. Sediment analysis was conducted at three sites.

Two of nine sites with drainage areas of <50 mi^2 met the recommended aquatic life use. Six sites were not attaining and one partially met of the designated or recommended use. Five sites on the Tymochtee Creek mainstem had drainage areas >50 mi^2. Biological condition of the five sites reflected to 10.9 miles of full attainment of the Warmwater Habitat (WWH) aquatic life use and 15.8 miles of partial attainment.

The failure of a majority of streams within the assessment unit to attain applicable aquatic life uses and water quality criteria can be largely attributed to agricultural practices within the watershed, pollution from poorly treated sewage, and spills. Point source facilities regulated in the assessment unit are listed in Table 6C. Sedimentation, enrichment/low dissolved oxygen, ammonia and bacteria were a concern, but the most pervasive impact was simply the low water levels that were encountered during the sampling period.

The modification of stream channels and tiling to facilitate drainage have reduced the volume of water present during dry weather periods making drought conditions in the streams a much more frequent occurrence. The water is carried away quickly from the surrounding watershed at high volume immediately following a rain event rather than filtering through the soil and reaching the stream at a lower volume and more sustained rate. Reduced tree canopy impacts streams because an important macroinvertebrate food source (leaves) is removed and water temperatures and evaporation rates are increased. Consequently, intermittent or nearly intermittent conditions resulted during dry weather encountered during the summer 2001 sampling period. Minimal sustained flow during the summer months limits pool depths and availability of riffle habitat. Additionally, the lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream.

A total of 24 sites was originally selected within the subbasin for biological sampling. Seven sites were either dry or had only widely disconnected pools when biological sampling was attempted. Little was to be gained in sampling those areas where only puddles of water were present. The absence of significant flow in these streams was apparently a consequence of the tiling of agricultural

fields to facilitate drainage. These streams included Oak Run (three sites), Perkins Run, Blake Ditch, Baughman Run and County Ditch #32 at CR 97. Stream dessication was most evident in Oak Run near the mouth which was severely intermittent even though the watershed encompassed an area of more than 16 mi^2. The assignment of an aquatic life use for these streams is not appropriate given the lack of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat guidelines which are currently being drafted by Ohio EPA. Therefore, it is recommended that these watercourses remain undesignated until the Primary Headwater Habitat designations are promulgated.

It was possible to collect three sets of surface water samples from County Ditch # 32 at CR 97 (RM 1.83) before it dried. No WQS criteria were exceeded in any of the samples. Water quality monitoring was performed in Oak Run at two sites, but, on July 23, 2001, it was noted that the stream was dry downstream from TR 54 (RM 0.29). This certainly contributed to the low dissolved oxygen problems that were documented. A pollution complaint was investigated in Oak Run when land applied manure leached into a field tile that outlets to the headwaters at TR 64. It was determined that Corey Dairy located at 18405 CR 70 was responsible. This facility has a capacity for 675 animals and stores manure in a two million gallon holding lagoon. The investigating Wildlife Officer stated that there was potential for future incidents because of the size of the operation, heavy clay soils and shallow field tiles.

The most upstream Little Tymochtee Creek (lower) site (RM 10.3) was channelized and nearly intermittent. The channel was extremely shallow and had a soft silty substrate. These conditions precluded the establishment of even a Modified Warmwater Habitat (MWH) fish community and, as such, is a candidate for a Limited Resource Water (LRW) use. All of the other sampled streams within the lower Tymochtee assessment unit possessed sufficient physical habitat characteristics to warrant the WWH aquatic life use. The average Qualitative Habitat Evaluation Index (QHEI) score of five sites on Tymochtee Creek was 60.6. Scores of greater than 60 are a good indication of the appropriateness of the WWH use. The QHEI scores for the remaining sites ranged from 31.5 to 49.5. Though scores reflected less than optimal habitat condition, these streams were still considered candidates for the WWH use. The presence of a wooded riparian and/or recovering stream channel were primary considerations for recommending the WWH use. Further recovery where channelization had occurred is possible through the application of management practices to limit soil loss and stream bank erosion. A significant loss in habitat function in Lick Run can be attributed to drainage manipulation of the surrounding area to facilitate row crop agriculture. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat. Unrestricted cattle access to the stream was a significant contributor to loss of habitat function on Little Tymochtee Creek (lower) at CR 29. Impacts from point sources on Spring Run and County Ditch #32, which are discussed below, override limitations that habitat may be having on stream biota. The WWH use is recommended for Spring Run and County Ditch #32 at least until the streams are reevaluated once the point source issues have been addressed.

Lick Run was sampled at CR 97 (RM 0.83); the results indicated a fair fish community condition

and a marginally good macroinvertebrate community. This corresponds with partial attainment of the WWH use. Significant amounts of woody debris were present but minimal flow decreased the functionality of the cover to support more diverse biological assemblages. Water quality was impaired by low dissolved oxygen and elevated dissolved solids. The minimal flow certainly contributed to these problems. It is common for dissolved solids to be elevated under these conditions, especially if intermittent pools are present, because evaporation concentrates salts such as sodium, calcium, chloride and sulfate. This is a concern because it reduces egg survival in fish and disrupts mechanisms that control ions in blood plasma (osmoregulation).

Thirty-one macroinvertebrate taxa were collected and the community was rated as poor at the most upstream site on Little Tymochtee Creek (lower) (RM 10.3). Nutrients and siltation were having a significant impact but the recommended LRW use was met since no severe toxic impact was indicated. Water quality was impaired by enrichment/low dissolved oxygen, ammonia and temperature. Flow conditions and the modified stream channel contributed to temperature and dissolved oxygen problems, but the origin of ammonia and phosphorus loadings was not identified. The only point source under permit near here is General Clay Products. This facility operates a brick manufacturing facility that de-waters a clay mine and discharges treated process water into Veith Ditch, a tributary of Lower Little Tymochtee confluent at RM 12.19. However, it is doubtful that this type of facility would be the source of these pollutants. An incident of note in this area was a diesel fuel spill investigated on December 29, 2001 that resulted from a CSX train derailment. Some of the fuel entered Veith Ditch after it migrated through the railroad ballast into a field tile.

Neither of the Little Tymochtee Creek (lower) sites at CR 44 (RM 6.9) or CR 29 (RM 0.9) attained the designated WWH use. Limited flow, heavy siltation and the absence of riffle habitat precluded the establishment of typical warmwater fish and macroinvertebrate faunas at RM 6.9. The macroinvertebrate community, which included only two mayfly and caddisfly taxa, was in fair condition. The fish community was rated poor and predominated by tolerant species such as creek chubs, brown bullheads and green sunfish. No WQS criteria were exceeded at this site. An IBI in the poor range and the MIwb in the fair range were recorded at RM 0.9. Unconfined cattle access to the stream at this site had led to heavy siltation and extensive embeddedness of the stream bottom. Commensurate macroinvertebrate sampling at RM 1.0 yielded a total of ten mayfly and caddisfly taxa and suggested that, while somewhat enriched, water quality of the stream was acceptable. These sampling results indicated that significant improvement in fish community of Little Tymochtee Creek (lower) could be realized if the habitat was rehabilitated. Water quality at CR 29 was impacted by elevated fecal coliform counts. Cattle were probably the source, but failed on-lot septic systems in the Village of Lovell might also have contributed. Another potential source was a package sewage treatment plant operated by Schmidt Machine, however, this effluent was chlorinated and should not be a problem if the system was maintained properly. A pollution complaint was investigated in Lovell on August 16, 2001, and it was determined that a sewage-like material was entering the stream from a field tile. The investigating officer suspected that it originated from residential septic systems. The Wyandot County Health Department was planning to conduct a dye test to confirm this. This was the only site in the entire Sandusky River watershed

that had two bacteria results that exceeded 10,000 colonies/100ml. Another incident of note effecting the Little Tymochtee Creek (lower) was a kerosene spill investigated on April 8, 2001. It was determined that the release occurred because an above ground storage tank at Schmidt Machine was over filled and product migrated into a field tile. This site was also tested for the presence of herbicides and atrazine was detected at 2.35 µg/l and metolachlor was detected at 0.47 µg/l.

Biological sampling of County Ditch #32 was conducted downstream from the Carey WWTP, which contributed the majority of the flow in the stream. Pollution tolerant taxa predominated both the fish and macroinvertebrate assemblages. The impaired condition of the biota was indicative of a very high nutrient and/or organic load originating from the Carey WWTP. Water quality data supported this conclusion which indicated impacts due to enrichment/low dissolved oxygen and ammonia. This site had the highest phosphorus concentrations in the entire Sandusky River watershed, including a median value of 3.50 mg/l and maximum of 6.54 mg/l. The Carey WWTP only has monitoring requirements for phosphorus and does not have concentration limits. The maximum summer limit for ammonia of 3.0 mg/l has apparently been violated on occasion based on the stream results. This is a secondary treatment plant that operates by an activated sludge aeration system. Upgrades to the plant to improve nitrification and phosphorus removal may be necessary.

Spring Run was sampled at Muncie St. (RM 5.3) downstream from the Budd Co. and at TR 100A (RM 3.7), downstream from County Ditch #32. Both sites were in non-attainment of the WWH aquatic life use. Biological communities were in fair condition at Muncie St. A predominance of facultative and tolerant macroinvertebrate taxa and pioneering fish species were reflective of degraded conditions. Potential sources of impact included stormwater discharges from the Budd Co. and urban runoff from the surrounding area. Water quality indicated fairly good conditions, although one dissolved oxygen result exceeded the WQS criterion. Further decline was documented in the fish and macroinvertebrate communities downstream from County Ditch #32. Both assemblages were in poor condition. Water quality was impaired by nutrient enrichment, ammonia and temperature. Extensive beds of aquatic weeds were present and resulted in abnormally highly dissolved oxygen readings. In addition to impacts noted upstream and pollutant loadings contributed by the Carey WWTP discharge, this area had been subjected to a diesel fuel spill earlier in the summer. Oil was observed during sampling and likely contributed to the degraded condition of the stream. The spill occurred on June 20, 2001 (Ohio EPA Emergency Response spill number 0106-88-2207) when a Wheeling and Lake Erie Railway engine was damaged and lost 2500 gallons of fuel. Most of the product was contained by an earth dam, but some seeped into a National Lime and Stone tile that discharges to Spring Run. I.T. Corporation was hired to clean up the spill and deployed containment boom and absorbent material at several locations in Spring Run. Free product was recovered by vacuum truck. Response by the Ohio DNR, Division of Wildlife confirmed that the spill caused some mortality to various fish, crayfish and mammals. The containment booms and absorbent material were removed on July 5, 2001.

Poverty Run was the only tributary to Tymochtee Creek within the assessment unit that fully met the WWH aquatic life use. Macroinvertebrate sampling was conducted at Countyline Road (RM 4.7)

and produced a marginally good assemblage of organisms. No fish sampling was conducted at the site due to severe intermittent conditions in the stream when the sampling was attempted in mid-August. The presence of a marginally good macroinvertebrate community is enough to provisionally designate full attainment. Both fish and macroinvertebrates were sampled at Poverty Run Rd. (RM 3.0). The macroinvertebrates were again in marginally good condition and fish sampling produced an IBI score in the good range. The fish community included mottled sculpins, the presence of which was a good indication ground water was sustaining the flow in the creek. Water quality indicated good conditions, although one of the bacteria results exceeded the WQS criterion for PCR. This stream closely resembled other similarly sized streams in the Lower Tymochtee assessment unit and the wider Sandusky River study area in terms of the available habitat. The results provided evidence that historically channelized streams with impairment associated with nearly intermittent conditions could meet the WWH use if the flow regime were improved.

Five sites were sampled in the lower 26.7 miles of Tymochtee Creek. The macroinvertebrate scores were in the good to very good range at all five sites. Both the IBI and MIwb indices were in the fair range at RMs 26.2 and 19.6, which in combination with good to very good macroinvertebrate index scores, resulted in partial attainment of the WWH aquatic life use at these locations. At RM 13.7 the IBI score marginally met WWH use expectations but the MIwb remained only in the fair range. Cases like this point to habitat degradation rather than water quality as the primary limitation to overall resource health. Full attainment of the WWH use was documented at RM 8.1 (SR199) and RM 4.7 (SR103). Also of note, the area of best habitat quality as expressed by the QHEI (RM 8.1) recorded the highest fish and macroinvertebrate index scores. Biological condition of the five sites taken together totaled 10.9 miles of full attainment of the WWH aquatic life use and 15.8 miles of partial attainment.

Redhorse suckers and northern pike were relatively common in this reach of Tymochtee Creek. The northern pike were historically much more common in similar low gradient streams in the Lake Erie basin. Their frequency of occurrence in Tymochtee Creek was one of the highest recorded by Ohio EPA. Improvements in upstream portions of the watershed to lessen sediment load and improve habitat function will help to maintain the pike population and possibly allow for repopulation further upstream. Redhorse suckers, as a group, are sensitive of siltation. Their occurrence was associated with midchannel areas of relatively clean rubble. These areas remain relatively silt free due to the redistribution of fine sediment to stream margins during high flow events. Similar flow regimes in the Tiffin and St. Joseph Rivers also support redhorse suckers.

Water quality in this reach of Tymochtee Creek indicated good conditions. Essentially no WQS issues were documented in the sample results. Temperature and dissolved oxygen readings maintained levels consistent with the WWH aquatic life use (Figure 6A), likely due to the benefit obtained from a wooded riparian corridor and meandering channel. The improvement in habitat is also reflected in levels of phosphorus (Figure 6B). Most data points were below the target value of 0.10 mg/l for wadeable streams. The assessment included testing for the presence of volatile and semi-volatile organic compounds at SR 199 (RM 8.06); none were detected.

Sediment quality was also evaluated in the lower Tymochtee Creek assessment unit. Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCBs). Results for metals are presented in Table 6D. No organic compound results are presented because very few were detected. Most were either phthalate or polycyclic aromatic hydrocarbons (PAHs), both common contaminants in urban areas. Phthalate compounds are added to plastics to make them more flexible. PAH compounds are the byproducts of fossil fuel combustion and are contained in substances such as creosote and coal tar. Some have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. No PCB compounds were detected in any of the samples.

Tymochtee Creek at State Hwy. 103 (RM 4.64) was sampled to assess background conditions. The sediment consisted of 100% silt/clay, 1.4% organic carbon and 66.2% solids. No organic compounds were detected and metals did not appear to be a concern. Aluminum was the only element ranked higher than non-elevated.

Spring Run at Township Rd. 100A (RM 3.68) was sampled to evaluate impacts from the Carey WWTP and the diesel fuel spill. Remnants of the spill were evident when sediment was collected on September 13, 2001. A strong fuel odor and sheen resulted when the bottom was disturbed. The sediment consisted of 70.5% sand, 29.5% silt/clay, 4.9% organic carbon and 44.8% solids. The volatile organic scan detected 17 estimated or tentatively identified compounds. These compounds are identified by a best fit with the computer library and their concentrations are considered approximate. The semi-volatile organic scan detected four PAH compounds and one phthalate. An additional 18 tentatively identified compounds were detected. The total PAH concentration of 13.46 mg/kg is a concern because it exceeded the TEC. The metals scan indicated some concern regarding zinc because the 244 mg/kg concentration is considered highly elevated and exceeded the TEC. Zinc is very common which made it difficult to pinpoint the source; wastewater effluent, mining, urban runoff and the diesel spill probably all contributed. There is also some concern with copper because the 28.6 mg/kg concentration was considered elevated.

Little Tymochtee Creek (lower) at County Rd. 29 (RM 0.90) was sampled to evaluate impacts from the Wyandot County Environmental Landfill. Portions of the landfill operated prior to current solid waste regulations, so the disposal areas did not have impermeable liners. This old section of the landfill is being excavated and placed in new cells that meet design criteria. The facility also has stormwater ponds that discharge to the creek. Other sources that may effect sediment quality include General Clay Products, Schmidt Machine, Advanced Organics, Wyandot County Airport, Ohio DOT US Hwy. 23 South Rest Area, several abandoned oil and gas wells and kerosene and diesel spills that were reported in 2001. The sediment consisted of 67.3% sand, 32.7% silt/clay, 1.7% organic carbon and 77.1% solids. No priority organic compounds were detected, but a few tentatively identified compounds were reported. The metals scan indicated little cause for concern except for arsenic which exceeded the TEC level.

Table 6A Aquatic life use attainment status of the Lower Tymochtee Creek assessment unit (04100011-020), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Tymochtee Creek						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
26.2/25.8	32*	7.0*	44	56.5	Partial	SR 53
19.6/19.4	33*	7.3*	38	57.0	Partial	TR 49
13.7/15.6	36[ns]	6.6*	40	54.5	Partial	TR 42/ TR 44
8.1/7.8	45	9.1	48	75.0	Full	SR 199
4.7/4.7	40	8.3	VG	61.0	Full	SR 103
Lick Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
1.3/1.3	32*	NA	MG[ns]	49.5	Partial	CR 97
Little Tymochtee Creek (lower)						
	Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)					
---/10.3	---	---	P*	---	(**NON**)	TR 49
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
6.9/6.9	26*	NA	F*	46.5	**NON**	CR 44
0.9/1.0	24*	6.0*	G	41.5	**NON**	CR 29
Spring Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
5.3/5.4	28*	NA	F*	31.5	**NON**	Muncie St.
3.7/3.7	20*	NA	P*	49.0	**NON**	From TR 100 at Quarry Rd.
County Ditch # 32 (05-303)						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
0.2/0.1	26*	NA	P*	33.0	**NON**	SR 199
Poverty Run (05-302)						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
---/4.7	---	---	MG	---	(Full)	County Line Rd.
3.0/3.1	42	NA	MG	40.5	Full	TR 11, Poverty Run Rd.

Table 6B. Values obtained from surface water grab samples collected in the Lower Tymochtee Creek Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), ammonia (NH_3-N)and dissolved solids (TDS), °Celsius for temperature (T)and colonies/100 ml for fecal coliform (FC). Strontium is not included because 70 of 78 values (89.7%) exceeded Tier II limits.

Mile	*Parameter (value)*
Tymochtee Creek (WWH, PCR, AWS)	
26.28	none
19.45	FC (1300 ‡)
13.73	none
8.06	T (28.0 †)
4.64	none
Spring Run (WWH, PCR, AWS)	
5.29	DO (4.7 †)
3.68	T (28.1 †, 28.7 †, 28.3 †); NH_3-N (0.57 †)
Poverty Run (WWH, PCR, AWS)	
2.99	FC (>10000 ‡‡)
Wyandot County Ditch #32 (WWH, PCR, AWS) n ' 3 at RM 1.83	
1.83	none
0.05	DO (4.7 †, 4.0 †, 4.1 †); NH_3-N (2.34 †, 2.25 †, 8.14 †, 5.04 †)
Lower L. Tymochtee Creek (WWH, PCR, AWS)	
10.32	T (29.3 ††); DO (4.3 †, 4.8 †); NH_3-N (1.73 †)
6.87	none
0.90	FC (>10000 ‡‡, >10000 ‡‡)
Lick Run (WWH, PCR, AWS)	
0.83	DO (4.8 †, 4.5 †); TDS (1660 †)
Oak Run (WWH, PCR, AWS)	
4.70	DO (4.8 †)
0.29	T (23.1 †); DO (4.0 †, 3.1 ††)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

Table 6C. Values obtained from surface water grab samples collected in the Lower Tymochtee

Creek Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), ammonia (NH_3-N), and dissolved solids (TDS), °Celsius for temperature (T), and colonies/100 ml for fecal coliform (FC). Strontium is not included because 70 of 78 values (89.7%) exceeded Tier II limits.

Mile	*Parameter (value)*
Tymochtee Creek (WWH, PCR, AWS)	
26.28	none
19.45	FC (1300 ‡)
13.73	none
8.06	T (28.0 †)
4.64	none
Spring Run (WWH, PCR, AWS)	
5.29	DO (4.7 †)
3.68	T (28.1 †, 28.7 †, 28.3 †); NH_3-N (0.57 †)
Poverty Run (WWH, PCR, AWS)	
2.99	FC (>10000 ‡‡)
Wyandot County Ditch #32 (WWH, PCR, AWS) n ' 3 of 5 at mile 1.83	
1.83	none
0.05	DO (4.7 †, 4.0 †, 4.1 †); NH_3-N (2.34 †, 2.25 †, 8.14 †, 5.04 †)
Lower L. Tymochtee Creek (WWH, PCR, AWS)	
10.32	T (29.3 ††); DO (4.3 †, 4.8 †); NH_3-N (1.73 †)
6.87	none
0.90	FC (>10000 ‡‡, >10000 ‡‡)
Lick Run (WWH, PCR, AWS)	
0.83	DO (4.8 †, 4.5 †); TDS (1660 †)
Oak Run (WWH, PCR, AWS)	
4.70	DO (4.8 †)
0.29	T (23.1 †); DO (4.0 †, 3.1 ††)

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[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

Table 6D. Metal concentrations in sediment collected from the Lower Tymochtee Creek Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Those preceded by a (†) exceeded the threshold effect concentration described by Macdonald et al (2000). Relative concentrations are ranked based on a system developed by Ohio EPA. [A non-elevated; b slightly elevated; c elevated; d highly elevated; e extremely elevated]

Tymochtee Creek at RM 4.64- State Route 103

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
22700 d	71.7 a	6980	20 a	13.5 a	16200 a	<22	5660	255 a
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<22	4980	<2750	112	65.9 a	<0.028	5.99 a	0.233 a	<1.10

Little Tymochtee Creek (lower) at RM 0.90- Wyandot County Rd. 29

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
23500 d	106 b	42200	24 b	17.1 a	21100 a	<19	14400	288 a
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
22 a	7670	<2360	107	78.2 a	<0.021	† 10.8 b	0.224 a	<0.94

Spring Run at RM 3.68- Crawford Township Rd. 100-A

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
25600 d	183 c	38400	26 b	28.6 c	15800 a	<33	15900	212 a
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<33	6840	<4130	513	† 244 d	0.059	4.59 a	0.465 a	<1.65

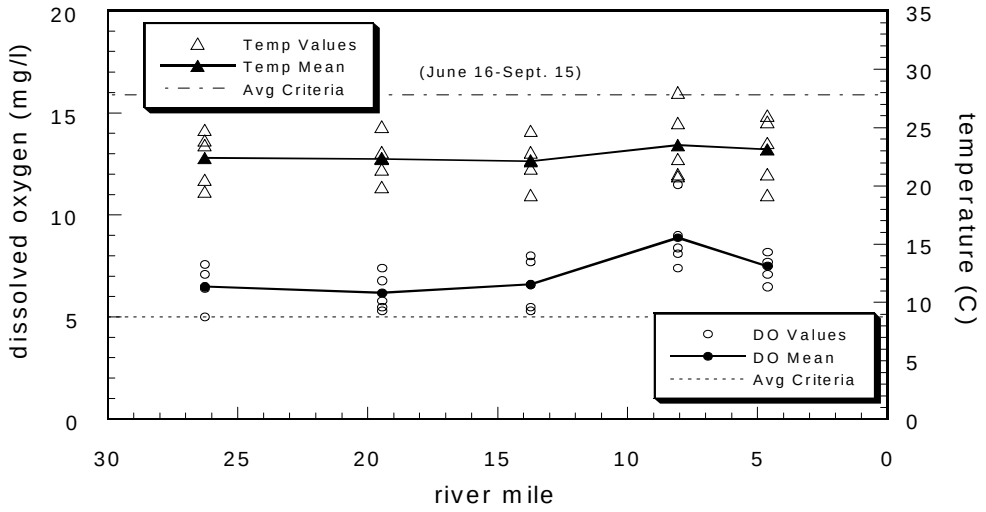

Figure 6A. Dissolved oxygen and temperature results Tymochtee Creek, June- October, 2001. Temperature criterion valid June 16-September 15.

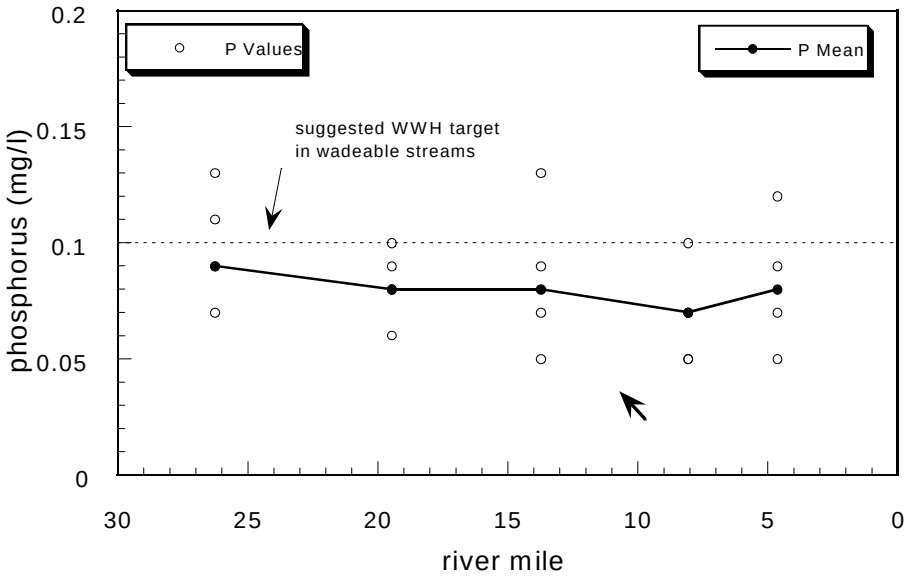

Figure 6B. Phosphorus values from grab samples collected from Tymochtee Creek, June-October, 2001.

Sandusky-Mexico Assessment Unit

The Sandusky-Mexico assessment unit (04100011-070) encompasses the drainage area downstream from the confluence of Tymochtee Creek (RM 65.73) to upstream from the confluence of Honey Creek (RM 43.70), excluding the mainstem. The Sandusky River mainstem sites which exceeded 500 mi^2 are discussed elsewhere in keeping with current reporting protocol for addressing aquatic life use and attainment status. Biological and habitat assessments were conducted at 18 sites in 2001 on seven streams; their Aquatic Life Use attainment status is presented in Table 7A. Surface water physical/chemical assessments were conducted at 14 sites. The majority had five sets of grab samples collected at two-week intervals. One site was added after sampling was initiated and two were dry or intermittent for portions of the study. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. Five sites had an extra sample collected to test for the presence of volatile and semi-volatile organic compounds and one site was tested for levels of herbicides. Sediment analysis was conducted at five sites. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 7B.

Four smaller watersheds were sampled within this area; Thorn Run, Taylor Run, Sycamore Creek and Mile Run. Six of 13 sites with drainage areas <50 mi^2 met the recommended aquatic life use. Four sites were not attaining and three partially met the designated or recommended use. Five sites on the lower 10 miles of the Sycamore Creek mainstem had drainage areas >50$mi.^2$. Biological condition of the five sites reflected 4.1 miles of full attainment of the Warmwater Habitat (WWH) aquatic life use and 5.9 miles of partial attainment.

Impediments to full attainment of applicable aquatic life uses within the assessment unit can be largely attributed to agricultural practices within the watershed. There are only a few point source facilities regulated in the assessment unit and they are listed in Table 7C. The impact from these pollution loadings appeared to be minimal. Sedimentation and substrate embeddedness were the most common impacts where aquatic life use attainment was not fully met. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelization, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. The water is carried away quickly from the surrounding watershed at high volume immediately following a rain event rather than filtering through the soil and reaching the stream at a lower volume and more sustained rate. Reduced tree canopy impacts streams because an important macroinvertebrate food source (leaves) is removed and higher water temperatures and evaporation rates result. Many of the sampled locations had slow current velocities which keep eroded sediment trapped within the stream channels. Additionally, the lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream.

Thirteen sampled sites on seven streams had drainage areas of <50 mi^2. Spring Creek was

channelized but supported biological communities consistent with the WWH use. Sites on Thorn Run, Mile Run, Greasy Run and Sycamore Creek Tributary at RM 13.0 were either recovering from past channelization or in relatively undisturbed condition. Further habitat improvement where channelization had occurred is possible through the application of management practices to limit soil loss and restore wooded riparian areas. The majority of Taylor Run had not been previously modified. One exception was a small reach of recent channelization by a land owner at RM 3.7 which correspondingly had only a 23.5 Qualitative Habitat Evaluation Index (QHEI) score. Isolated areas of habitat modification are not sufficient to discard the WWH use on a stream with acceptable conditions elsewhere. The WWH aquatic life use is recommended for the above mentioned streams.

Conversely, the West Branch of Taylor Run and Sycamore Creek at RM 22.0 and 18.9 were channelized with little likelihood for recovery and offered minimal instream habitat. It is not realistic to expect typical WWH aquatic communities in the foreseeable future under these conditions so a Modified Warmwater Habitat (MWH) aquatic life use is recommended. The recommended MWH stream segments are the West Branch of Taylor Run and the headwaters of Sycamore Creek downstream to RM 17.8 (SR 19).

The remainder of Sycamore Creek where drainage areas exceeded 50 mi^2 had adequate habitat to support the WWH use. Five sampled sites had relatively natural channel morphology and course substrates. QHEI scores at the sites documented the appropriateness of the WWH use and ranged from 55.0 to 84.0.

Mile Run benefited from having flow due to the contribution of groundwater. The stream supported relatively good fish and macroinvertebrate communities at RM 3.5. Enrichment was indicated by the increased predominance of tolerant fish species and blackflies at RM 0.3. While the macroinvertebrate condition was still considered good, the fish community declined to the fair range. Partial attainment of the WWH use was the result. Water quality data indicated good conditions except for a somewhat elevated bacteria count. It is possible that the source is wastewater from the Mohawk High School sewage plant.

Spring Creek at RM 5.7 was channelized and became intermittent as the summer progressed. Nevertheless, biological sampling demonstrated full attainment of the WWH use. The presence of mottled sculpins indicated that the stream was receiving groundwater. Collection of a large number of stoneroller minnows and a marginally good macroinvertebrate assemblage were consistent with enrichment originating from the surrounding agricultural fields.

The headwaters of Sycamore Creek supported fish and macroinvertebrate communities that met expectations for the recommended MWH use. The macroinvertebrate community was in marginally good to good condition at the sampled locations and indicated that water quality was acceptable. The fish results, while consistent with the MWH use, were somewhat depressed in comparison to the macroinvertebrates which was expected given habitat was the major limiting factor. Water quality data from this segment indicated good conditions except for warmer than normal

temperatures.

The presence of a marginally good macroinvertebrate community in the West Branch of Taylor Run was enough to provisionally designate full attainment of the recommended MWH use. This stream had an oil spill reported on December 11, 2001. The spill was caused by a leak in an above ground tank used to store crude oil located at 667 CR 39. The oil collected on an adjacent field and leached into a field tile. This rig is operated by the Columbus Oilfield Exploration Co. A contractor was hired to clean up the spill by removing product and contaminated vegetation from the water, excavating soil and cleaning the drainage tiles.

The impact of agricultural practices on stream habitat was manifested in the fish community health of Taylor Run, Thorn Run and Greasy Run. Impacts included the addition of sediment and alteration of the natural flow regime. A significant loss in habitat function can be attributed to drainage manipulation of the surrounding area to facilitate row crop agriculture. The sampled locations were intermittent or nearly intermittent which limited pool depths and availability of riffle habitat and retained eroded sediment within the stream channel. Additionally, the lack of water movement exacerbated impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. Sites on Taylor Run at RM 5.3 and RM 3.7 and both locations on Thorn Run yielded IBI scores in the poor range and failed to attain the WWH use. The addition of some groundwater was indicated in the occurrence of mottled sculpins at RM 2.0 on Taylor Run and Greasy Run at RM 1.6 which benefited the fish community to the extent that partial WWH attainment resulted. Regardless of the degree to which the stream channel was modified, macroinvertebrate sampling yielded marginally good results at five of six sampling locations. Water quality data evaluated in Taylor Run indicated good conditions except for one elevated copper result. The overflow from a private pond located adjacent to this site could be the source if copper sulfate was used to control algae blooms. The site on Thorn Run at RM 0.9 was the only location where the macroinvertebrate community did not at least marginally meet WWH expectations. It was among the most impacted by habitat degradation of any sampled. Water quality data evaluated at this location indicated impacts due to enrichment/low dissolved oxygen. A likely source of this condition was poorly treated sewage from failed on-lot septic systems in the Village of McCutchenville.

The five sites on Sycamore Creek with a drainage area >50 mi^2 were effected to varying degrees by low water levels. The macroinvertebrate community was in the range of good to exceptional condition at all but RM 3.8. It is worth noting, however, the slow current velocity over the artificial substrates negated the direct application of the ICI score in determining attainment at three of the five sampling locations. Again this was due to the lack of sustained flow which was most likely due to alteration of the base flow condition with tiling of agricultural fields. The site at RM 9.1/9.2 was particularly susceptible to the low water levels encountered in 2001. The site was predominantly shallow bed rock which limited the diversity of fish species. The absence of deeper water excluded adult predators and species such as common shiners that use pool habitats. Only eleven species were recorded at RM 9.2. Sites upstream and downstream supported significantly higher diversity. The fish captured at RM 4.9 included of an inordinate number of small individuals which was reflected

in a fair MIwb score. Once again, very shallow riffle habitat and the lack of pools deeper than 0.4 meters appeared to be the limiting factors. The reason for the fair ICI result at RM 3.8 was not readily apparent. The macroinvertebrate community did not appear to be excessively effected by enrichment. The reduced diversity and density of organisms present at this site may be a response to low level chronic toxicity. Possible sources included a lingering impact from the Kirby tire fire, agricultural runoff and degraded water quality from point and/or nonpoint sources in the Village of Sycamore. Additional sampling is needed to determine if the condition has persisted and to identify a cause(s).

The reach of Sycamore Creek between RM 9.2 and the mouth was sampled in 2000 in order evaluate recovery from the Kirby tire fire. Overall fish index scores were slightly higher in 2000 than in 2001 and were attributed to habitat differences of sampled locations between the two years. The 2000 ICI scores indicated a decline similar to 2001 results in macroinvertebrate community health downstream from the Village of Sycamore.

Very few water quality problems were documented in this segment of Sycamore Creek. High water temperatures were measured, but this alone should not have had a major effect on aquatic life. Although less oxygen is soluble in warm water, there were no dissolved oxygen criterion exceedences in the grab samples. Results obtained from grab samples are displayed in Figure 7A along with the average criterion that applies (temperature criterion valid June 16-September 15). A continuous monitor deployed near the mouth on August 7, 2001, verified that good oxygen levels were maintained over a diel period. These instruments record hourly measurements for 48 hours.

Evaluation of water quality in the Sycamore Creek watershed included testing for organic compounds. The presence of volatile and semi-volatile compounds was tested at five sites around the Kirby Tire facility. All the verified results for priority pollutants were below reporting limits. A herbicide test was performed at SR 103/231 (RM 5.10) and the compounds atrazine and metolachlor were detected at 2.41 and 0.76 µg/l, respectively. These chemicals are usually applied to corn and soy beans and are commonly used in the Lake Erie basin. Not much information is available on what effect low levels have on aquatic life. Atrazine is a concern in drinking water supplies and has a maximum contaminant level of 3.0 µg/l.

Sediment quality was evaluated at five sites in the assessment unit, all in the Sycamore Creek watershed. These samples were mainly collected to evaluate lingering effects from the fire that erupted at the Kirby Tire facility on August 21, 1999. Conditions immediately after the incident are documented in the Biological and Water Quality Study of Sycamore Creek and the Sandusky River (Ohio EPA 1999, Technical Report EAS/2000-6-3). Air emissions from open tire fires have been shown to contain a number of pollutants including PAHs and metals such as arsenic, cadmium, nickel, zinc, mercury, chromium and vanadium. This information is contained in a document titled Air Emissions From Scrap Tire Combustion (Reisman, 1997). Although much of the substrate in Sycamore Creek consists of rock, a few sediment deposits were identified in isolated areas.

Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCBs). Results for metals varied widely and are presented in Table 7D. No volatile, pesticide, or PCB compounds were detected. Most semi-volatile compounds were classified as polycyclic aromatic hydrocarbons (PAHs), except for bis (2-ethylhexyl) phthalate in one sample. Phthalates are added to plastics to make them softer and are a common contaminant in the environment. PAH compounds are a concern because several have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. They are commonly the byproducts of fossil fuel combustion and are contained in substances such as creosote and coal tar.

The first four samples discussed were collected from Sycamore Creek. Sediment collected at County Line Rd. (RM 9.14) consisted of 60.0% sand, 40.0% silt and clay, 2.2% organic carbon and 49.3% solids. A fairly large sediment deposit was found at this location in an area protected from the main current. Some of the metals were ranked in elevated or highly elevated categories, but only arsenic surpassed toxicity guidelines. The value of 11.8 mg/kg exceeded the TEC of 9.79 mg/kg, but not the PEC of 33.0 mg/kg. Five PAH class compounds were detected for a total concentration of 5.43 mg/kg. This exceeded the TEC of 1.61 mg/kg, but not the PEC of 22.8 mg/kg. A likely source of these contaminants was deposition of particulates contained in the tire fire smoke plume, but stormwater runoff from the township road and leaching from old treated bridge timbers might also have contributed.

Sediment collected at State Rt. 231 (RM 7.34) consisted of 100% silt and clay, 1.7% organic carbon and 51.2% solids. This site had very little material present with only a small deposit found in a pool upstream from the bridge. This area is downstream from effluent discharged by the unit installed to treat runoff from the Kirby Tire site. No PAH compounds were detected, but some of the metals were ranked in elevated to extremely elevated categories and arsenic continued to exceed the TEC at 16.6 mg/kg. The amount of zinc increased to 123 mg/kg, which exceeded the TEC of 121 mg/kg, but not the PEC of 459 mg/kg.

Sediment collected at State Rt. 103/231 (RM 5.10) consisted of 60.4% sand, 39.6% silt and clay, 2.3% organic carbon and 43.3% solids. There was considerably more material present, but most was from bank erosion and isolated from the main channel. No PAH compounds were detected, but some of the metals were ranked as elevated and arsenic continued to exceed the TEC at 13.2 mg/kg.

Sediment collected at State Rt. 67 (RM 3.47) consisted of 100% silt and clay, 5.8% organic carbon and 48.4% solids. The sediment at this location consisted of a very thin layer of fine material covering the rock bottom and probably was flushed out the next rain event. Nine PAHs were detected for a total concentration of 26.93 mg/kg, a value that exceeded the PEC. Some metals were ranked as elevated and zinc again exceeded the TEC at 176 mg/kg. The amount of copper increased to 33.0 mg/kg, which exceeded the TEC of 31.6 mg/kg, but not the PEC of 149 mg/kg. While the

tire fire may have contributed to this result, it was also possible that the Sycamore water and wastewater treatment plants and urban runoff are sources.

Sediment collected from the Kirby Tire Tributary at State Rt. 231 (RM 0.36) consisted of 67.9% sand, 32.1% silt and clay, 4.4% organic carbon and 41.1% solids. No PAH compounds were detected, but some of the metals were ranked as elevated to highly elevated and arsenic exceeded the TEC at 27.2 mg/kg.

Table 7A. Aquatic life use attainment status of the Sandusky-Mexico assessment unit, June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Thorn Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.9/2.9	22*	NA	MG[ns]	29.5	**NON**	CR 5
1.0/0.9	24*	NA	F*	44.0	**NON**	SR 53
Taylor Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
5.3/---	22*	NA	---	42.0	**(NON)**	TR 30
3.7/3.5	24*	NA	MG[ns]	23.5	**NON**	SR 103
2.0/1.9	30*	NA	MG[ns]	52.0	Partial	CR 16
Taylor Run Tributary @ RM 2.49 (West Branch Taylor Run)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/3.3	---	---	MG	---	(FULL)	SR 67
Sycamore Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
22.0/22.0	28	NA	G	38.5	Full	CR 5
18.9/18.9	26	NA	G	46.0	Full	TR 37, Kennedy Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
13.0/14.3	38[ns]	7.5	46	56.0	Full	SR 103
9.2/9.1	32*	5.9*	G	55.0	Partial	TR 10/ 11, County Line Rd.
7.3/6.9	40	8.1	G	58.0	Full	SR 231
4.9/5.1	40	6.4*	G	65.0	Partial	SR 103/ 231
3.6/3.8	46	9.0	28*	84.0	Partial	SR 67, Kilborn St.
0.4/0.4	44	8.4	48	70.0	Full	CR 37

Table 7A. Continued.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Sycamore Creek Tributary @ RM 12.92 (Spring Creek 05-075)						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
5.7/5.7	40	NA	MG	21.5	Full	CR 27, Carey Rd.
Greasy Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
1.6/1.6	34*	NA	G	43	Partial	TR 136
Mile Run						
	Eastern Corn Belt Plains (ECBP) - WWH Use Designation					
3.5/3.5	38[ns]	NA	G	51.5	Full	SR 67
0.3/0.3	32*	NA	G	66.5	Partial	CR 37

Table 7B. Values obtained from surface water grab samples collected in the Sandusky-Mexico Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Criteria identified for warmwater habitat apply to water bodies not assigned use designations. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), °Celsius for temperature (T), colonies/100 ml for fecal coliform (FC), and µg/l for copper (Cu). Strontium is not included because 47 of 65 values (72.3%) exceeded Tier II limits.

Mile	*Parameter (value)*
Mile Run (WWH, PCR, AWS)	
0.30	FC (1100 ‡)
Sycamore Creek (WWH, PCR, AWS)	
22.02	T (25.3 †)
18.92	T (25.3 ††, 28.6 †, 30.2 ††)
14.26	T (24.2 †, 29.5 ††)
9.14	T (24.3 †, 29.0 †)
7.34	T (23.3 †) [n ' 4]
5.10	T (22.8 †)
3.47	FC (1200 ‡) [n ' 3]
0.41	none
Sycamore Creek Tributary at RM 6.49	
0.36	none
Sycamore Creek Tributary at RM 12.92	
1.88	T (22.5 †) [n ' 3]
Taylor Run (WWH, PCR, AWS)	
3.62	Cu (51 †)
1.88	none
Thorn Run (WWH, PCR, AWS)	
0.70	DO (4.4 †, 3.6 ††)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

Table 7C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Sandusky-Mexico Assessment Unit.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
Kirby Tire	2IN00197-001	Sycamore Creek Sandusky River	7.35 57.71	ground and stormwater treated by an oil-water separator and an activated carbon system
Sycamore Water Treatment Plant	2IV00102-001	Sycamore Creek	3.52	sand filter and softener backwash treated by a settling pond
Sycamore Wastewater Treatment Plant	2PB00000-001	Sycamore Creek	3.45	sanitary sewage treated by a package plant
Mohawk High School	2PT00014-001	Mile Run Sandusky River	1.5 56.03	sanitary sewage treated by a package plant

Table 7D Metal concentrations in sediment collected from the Sandusky-Mexico Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Those preceded by a (†) exceeded the threshold effect concentration described by MacDonald et al (2000). Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated]

Sycamore Creek at RM 9.14- Sycamore Township Rd. 10

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
26500 [d]	154 [c]	34100	29 [c]	17.6 [a]	22000 [b]	<28	12300	409 [b]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<28	7740	<3500	81	79.3 [a]	0.040	† 11.8 [b]	0.433 [a]	<1.40

Sycamore Creek at RM 7.34- State Route 231

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
45200 [e]	211 [d]	26200	40 [d]	20.2 [b]	28300 [b]	<30	10800	614 [c]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
33 [b]	13000	<3680	118	† 123 [b]	<0.033	† 16.6 [c]	0.276 [a]	<1.47

Sycamore Creek at RM 5.10- State Route 103/231

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
34800 [d]	160 [c]	54800	29 [c]	15.4 [a]	22200 [b]	<32	32000	580 [c]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<32	8690	<4050	150	87.6 [a]	<0.053	† 13.2 [b]	0.303 [a]	<1.62

Sycamore Creek at RM 3.47- State Route 67

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
12500 [b]	117 [b]	65000	<20	† 33.0 [c]	12600 [a]	35 [a]	26200	212 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<27	3700	<3390	502	† 176 [c]	0.078	6.09 [a]	0.679 [b]	<1.35

Sycamore Creek Tributary (6.49) at RM 0.36- State Route 231

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
26300 [d]	151 [c]	18900	<27	19.0 [a]	38400 [c]	<35	6410	493 [c]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<35	6490	<4420	139	91.7 [a]	<0.056	† 27.2 [d]	0.456 [a]	<1.77

Honey Creek Assessment Unit

The Honey Creek assessment unit (04100011-080) encompasses the entire drainage area including tributary streams. Biological and habitat assessments were conducted at 27 sites in 2001 and their Aquatic Life Use attainment status is presented in Table 8A. Surface water physical/chemical assessments were conducted at 18 sites. The majority had five sets of grab samples collected at two-week intervals. Sites with fewer sets collected were dry or intermittent. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters such as metals, nutrients and oxygen demand. Three sites had an extra sample collected to test for the presence of volatile and semi-volatile organic compounds and one site was tested for levels of herbicides. Sediment analysis was conducted at two sites. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 8B.

Modified Warmwater Habitat (MWH) or Limited Resource Water (LRW) aquatic life uses were recommended for seven small channelized stream segments with drainage areas <10 mi^2 and for 1.1 miles of lower Honey Creek where limited habitat conditions made these uses applicable. Nine of 19 sites with drainage areas of <50 mi^2 met the recommended aquatic life use and three sites partially met. The remaining seven sampled locations were in non-attainment of the designated or recommended use. Eight Honey Creek sites with drainage areas >50 mi^2 covered 33.2 miles of stream. Full attainment of the designated Warmwater Habitat (WWH) use was documented for 18.2 of these miles and the use was partially met for 7.9 miles. Non-attainment was ascribed to 7.1 miles of Honey Creek where the drainage area was >50$mi.^2$.

The failure of streams within the assessment unit to attain the applicable aquatic life uses and meet water quality criteria can be largely attributed to either agricultural practices within the watershed or point source pollution loadings. Point sources regulated in the assessment unit are listed in Table 8C. Sedimentation, enrichment/low dissolved oxygen and substrate embeddedness were the most common impacts where aquatic life use attainment was not fully met. Many of the sampled locations had slow current velocities which keep eroded sediment trapped within the stream channels. Minimal sustained flow during the summer months also limited pool depths and availability of riffle habitat at some sites. The channelization, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. The water is carried away quickly from the surrounding watershed at high volume immediately following a rain event rather than filtering through the soil and reaching the stream at a lower volume and more sustained rate. Reduced tree canopy impacts the stream because an important macroinvertebrate food source (leaves) is removed and higher water temperatures and evaporation rates result. The lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream.

Significant nutrient enrichment and/or organic loading was indicated at sites on Tiro Creek, Celery Creek, Silver Creek and Gibson Creek. Evidence of excessive enrichment included a high

occurrence of pollution tolerant fish and macroinvertebrate taxa and the presence of excessive algal material in the streams. The compound of greatest concern regarding enrichment impacts is phosphate (PO_4) because it is often growth limiting.

Two sources of phosphorus include domestic wastewater and agricultural fertilizers. Most domestic waste in rural areas is treated by on-lot septic systems, but these systems often fail and cause water quality problems. The Village of Tiro is an area to investigate for failed systems and should be considered a candidate for the construction of a sewage collection and treatment system. In municipal areas, wastewater discharged by treatment plants can contain a high amount of phosphorus because it requires special attention to remove and substantially increases operation costs. Phosphate contained in inorganic crop fertilizer binds tightly to soil particles and primarily enters streams as a result of erosion. Tile drainage may also contain some phosphorus. Erosion is especially a problem for streams without any riparian buffer zone to trap runoff. The impact is worse in channelized streams because they no longer have a functioning flood plain that can accept the phosphate laden sediment as would naturally occur during flooding.

Fourteen sites sampled on 11 streams had drainage areas of <10 mi^2. Honey Creek at RM 41.7, Silver Creek at RM 7.7, Slee Ditch, Buckeye Creek, Bells Run and Gibson Creek possessed sufficient physical habitat characteristics to warrant the WWH Aquatic Life Use. Qualitative Habitat Evaluation Index (QHEI) scores ranged from 46.0 to 84.0. Recovery from past channelization was largely complete except that fine sediment remained trapped within the stream channel at many sites. The most upstream Silver Creek site (RM 10.6) was channelized and intermittent. The wetted channel was extremely shallow and covered with grass. These conditions precluded the establishment of even the MWH community and, as such, is a candidate for the LRW use. The remaining <10 mi^2 sites were channelized with little likelihood for recovery and offered minimal instream habitat. It is not realistic to expect typical WWH aquatic communities under these conditions so the MWH aquatic life use is recommended.

Five sites with between 10 mi^2 and 50 mi^2 drainage area were sampled. Honey Creek at RM 34.1 was channelized and offered limited habitat that was altered to such an extent that a MWH use is applicable. The remaining sites either met the WWH use or were sufficiently recovered from past channelization the warrant the WWH designation.

Seven sites on Honey Creek had drainage areas >50 mi^2. The site at RM 32.2 was in a modified reach. A second reach where the MWH use is recommended was between RM 1.2 and the mouth of Honey Creek which was impounded by a dam on the Sandusky River. QHEI scores at the remaining sites which documented the appropriateness of the WWH use for Honey Creek, ranged from 51.0 to 76.5.

The potential MWH stream segments include Tiro Creek, Celery Creek, Van Meter Creek, Brokenknife Creek from the headwaters to Seneca/ Crawford County Line (RM 3.2), Aicholz Ditch from headwaters to County Road 12 (RM 2.8)and two reaches of Honey Creek between Scott Road

(RM 37.3) and State Route 4 (RM 28.3) and from RM 1.2 to RM 0.0.

The pervasive impacts from siltation and embeddedness were demonstrated in the fish community health of the seven sites on Honey Creek from RM 41.7 to RM 14.8. Regardless of the degree to which the stream channel was modified, IBI scores were consistently only in the fair range and MIwb scores were between fair and poor. Macroinvertebrate condition largely met expectations throughout this reach at all sites except for RM 25.1 and indicated that nutrients were not severely impacting. As with many tributary streams discussed below, siltation and embeddedness were limiting the functionality of the available habitat to support reasonably diverse fish assemblages. The problem was present even in reaches with more natural morphology due to the low gradient which does not provide the energy to keep larger substrates clear of sand and silt.

Water quality in this segment was impaired mainly by enrichment/low dissolved oxygen and warm temperatures. Channel maintenance resulting in the loss of tree shade and current turbulence contributed to these problems. Results obtained from grab samples are displayed in Figure 8A along with the average criteria that apply (temperature criterion valid June 16-September 15). The impact from habitat limitations was made worse by enrichment from point sources. Results for phosphorus are displayed in Figure 8B, along with the target value for wadeable streams. Levels of phosphorus increased substantially through the zone that includes New Washington, Attica and Bloomville. Effluent from the lagoon system in New Washington is controlled to discharge only during periods of high stream flow in the spring and fall, so there should have been little or no impact most of the year. The majority of phosphorus appeared to originate from the Attica Wastewater Treatment Plant (WWTP). Annual loadings (kg/day) over the last 20 years were tracked using the Liquid Effluents Analysis Processing (LEAP) system. This is an Ohio EPA database that stores monthly selfmonitoring data. Results for phosphorus plotted against volume discharged are displayed in Figure 8C. The median load rate over the last 10 years has been fairly stable around 1 kg/day.

The benefit of higher gradient and subsequent improved habitat quality was evident at Honey Creek RMs 12.5 and 6.6. These sites fully attained the WWH aquatic life use. The most downstream fish and macroinvertebrate sampling locations were in an impounded reach recommended fo the MWH use. The MWH use was met and no significant enrichment impact was evident. The only water quality impacts in this segment were a few high temperatures and one very elevated fecal coliform result. The bacteria source was failed on-lot septic systems located in the Honey Creek Subdivision.

The water quality assessment of Honey Creek included testing for the presence of volatile and semi-volatile organic compounds at Slessman Rd. (RM 25.03), Cemetery Rd. (RM 18.05)and SR 67/100 (RM 12.30); none were detected. The library match for tentatively identified compounds determined that the herbicides atrazine and metolachlor were present. These pesticides are often applied to corn and soy beans and are commonly used in the Lake Erie basin. A herbicide specific test was performed at Bigham Rd. (RM 34.14) and atrazine and metolachlor were quantified at 0.95 and 0.28 µg/l, respectively. Not much information is available on what effect low levels of these compounds have on aquatic life. Atrazine is a concern in drinking water supplies and has a maximum

contaminant level of 3.0 µg/l.

The non-attainment of sites in Celery Creek and Tiro Creek was determined based on poor macroinvertebrate community condition. No fish sampling was conducted due to the muck bottom that limited the ability of field crews to sample effectively. Poor to very poor macroinvertebrate assemblages were indicative of significant pollution impacts in addition to limitations that channelization and soft substrate imparted on the biota. It appeared that nutrient and/or organic inputs were overwhelming the assimilative capacity of these streams and resulting in low dissolved oxygen levels. Water quality monitoring in Celery Creek at Section Line Rd. (RM 2.20) indicated impacts from enrichment and warm temperature. The stream channel was modified and there are no trees on the banks. This area is extensively farmed for vegetable crops because of the muck soils that are present. A small diesel fuel spill was reported at this location on July 14, 2001. It was determined that a water pump operated by Burma Farms was overfilled with fuel. Water quality was not monitored in Tiro Creek, but the Crawford County Health Dept. has expressed some concern due to the likelihood of failed on lot septic systems in the Village of Tiro. A pollution complaint was investigated in Tiro on May 15, 2001, when it was reported that a resident pumped a septic tank into the street and rain washed the sewage into a storm sewer.

Slee Ditch and Buckeye Creek demonstrated attainment of the WWH aquatic life use. The available habitat varied between sites with the downstream site on Buckeye Creek being one of the highest quality of all small streams sampled. The biological communities apparently benefited from groundwater inputs to maintain flow and water quality. In addition, relatively high numbers of orange throat darters were collected which until the 2001 sampling had not been recorded by Ohio EPA in the Sandusky basin. Orange throat darters were collected elsewhere in the Honey Creek basin but were not as common. Water quality monitoring in Buckeye Creek indicated good conditions, except for one bacteria result that exceeded the Primary Contact Recreation criterion. A fish kill was investigated at this location on December 14, 2001, but the officer was not able to determine a definite cause. There was some suspicion that manure leaching from application fields used by Pope Jersey Farms contributed because the event occurred during a rain storm.

Bells Run was in non-attainment of the WWH use and Gibson Creek partially met. Stresses to the aquatic community in Gibson Creek likely included substrate embeddedness and elevated nutrients originating from the surrounding residential area. Siltation and minimal flow impacted the available habitat and, consequently, limited the establishment of typical warmwater fish and macroinvertebrate communities in Bells Run.

Aicholz Ditch was in non-attainment of the recommended MWH use at RM 3.7 due to a poor macroinvertebrate community. The IBI score was in the fair range but acceptable for the MWH use. The stream bottom was layered with soft clay which limited the diversity of macroinvertebrate taxa. Fish and macroinvertebrate sampling results met expectations for the WWH use at RM 2.5 but were somewhat depressed by low water and substrate embeddedness. The improvement compared to the upstream site can be credited to better habitat conditions. Although the QHEI of 42.5 at RM 2.5 was

still reflective of a modified habitat, it was indicative of significantly more favorable habitat attributes compared with the 28.5 score recorded at RM 3.9. Water quality monitoring in Aicholz Ditch indicated impacts from enrichment/low dissolved oxygen, warm temperatures and elevated bacteria levels. The low water conditions eventually became severe enough that the site at Cooper Rd. (RM 2.46) was dry on August 9, 2001. A small diesel fuel spill happened on February 9, 2001 because of a semi-trailer accident on State Hwy. 4.

A very poor macroinvertebrate community at RM 10.6 on Silver Creek was evidence of severely degraded water quality and non-attainment of even the reduced expectation of the recommended LRW use. Both fish and macroinvertebrates marginally attained expectations for the WWH use at RM 7.7, but an IBI in the poor range at RM 4.1 resulted in non-attainment at RM 4.1. The low IBI score was in large part determined by the large number of pollution tolerant carp, white suckers and green sunfish. A number of wetland associated species were also present such as grass pickerel and golden shiners. This type of assemblage reflected the low flow and sedimentation that has resulted from the modification of the natural stream channel and significant enrichment and/or organic degradation. The collection of over 100 small carp and 355 green sunfish may have been the result of an acutely toxic or with a high oxygen demand substance having been released into the stream from which the community was recovering. Water quality monitoring in Silver Creek indicated impacts from mainly low dissolved oxygen. The low flow conditions certainly contributed to these problems. Hydrological conditions eventually became severe enough that both sites were dry on August 9, 2001.

Fish and macroinvertebrate sampling in Brokenknife Creek yielded results that typified conditions in numerous other small tributaries within the entire Sandusky watershed. While the fish community met expectations for the recommended MWH use at RM 5.1 with an IBI score of 30, the same score did not meet the higher standard for WWH at RM 1.0. The macroinvertebrate community was in good condition which suggested reasonably good water quality at both sampled locations. Common to both sites was the filling of interstitial spaces between larger rocks by sand and silt. As a result, the community was dominated by tolerant and pioneering fish species. Water quality monitoring in Brokenknife Creek indicated impacts due to elevated bacteria levels, but no obvious source was identified. Although the New Washington WWTP discharges to a tributary confluent at RM 5.50, it was probably not a source because it has a controlled discharge.

Sediment quality was evaluated at two sites in the Honey Creek assessment unit. Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCB). No organic compounds were detected at either site. Results for metals varied widely and are presented in Table 8D.

Sediment from Honey Creek at TR 79 (RM 25.03) was sampled to evaluate impacts from the Village of Attica. A large volume of sediment was accumulated at this location and quite a bit of litter including old appliances, bed springs and other trash was present. The sediment consisted of 61.2%

sand, 38.8% silt/clay, 2.3% organic carbon and 50.9% solids. Results for metals ranged from non-elevated to highly elevated, but none were at toxic levels. Honey Creek at TR 173 (RM 18.05) was sampled to evaluate impacts from the Village of Bloomville. The substrate was almost entirely bedrock and only a very small amount of sediment was found in an isolated eddy. It consisted of 100% silt/clay, 3.1% organic carbon and 31.3% solids. Results for metals ranged from slightly elevated to extremely elevated and several were measured at toxic levels. These results were unexpected and difficult to explain, but since sediment was nearly absent at this location and probably did not have a significant ecological impact.

Table 8A. Aquatic life use attainment status of the Honey Creek assessment unit (04100011-080), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Honey Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
41.7/41.7	32*	NA	G	55.5	Partial	TR 73, Waynesburg-Tiro Rd.
38.4/38.4	32*	NA	G	51.0	Partial	TR 67, Young Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
34.1/34.1	28	7.3	32	32.5	Full	TR 85, Bigham Rd.
32.2/30.9	32	6.7	42	27.0	Full	TR 13, County Line Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
25.1/25.1	32*	5.1*	30*	51.0	**NON**	TR 79, Slessman Rd.
18.1/18.2	32*	6.7*	42	58.5	Partial	TR 173, Cemetery Rd.
14.8/14.6	32*	7.6*	VG	62.0	Partial	TR 58, Center Rd.
12.5/12.4	44	9.2	38	74.5	Full	SR 67/ 100
6.6/6.6	46	9.3	E	76.5	Full	TR 58, Center Rd.
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
0.2/1.1	45	7.4	G	52.5	Full	CR 19
Honey Creek Tributary @ RM 41.3 (Tiro Creek)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/0.7	---	---	P	---	**(NON)**	TR 190, Hammond Rd.
Honey Creek Tributary @ RM 32.84 (Celery Creek)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/5.6	---	---	P	---	**(NON)**	TR 14, Base Line Rd. (ust.
---/2.2	---	---	VP	---	**(NON)**	TR 30 (ust. trib.)
Brokenknife Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
5.1/5.1	30	NA	G	25.0	Full	TR 133, McCarthy Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
1.0/1.0	30*	NA	G	56.5	Partial	TR 13, County Line Rd.

Table 8A. Continued

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Aicholz Ditch						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.9/3.9	28	NA	P*	28.5	**NON**	CR 23, Scipio Siding Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.5/2.4	38[ns]	NA	G	42.5	Full	TR 77, Cooper Rd.
Silver Creek						
Eastern Corn Belt Plains (ECBP) - LRW Use Designation (Recommended)						
---/10.6	---	---	VP	---	(**NON**)	SR 4, Columbus-Sandusky Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
7.7/7.7	36[ns]	NA	MG	46.5	Full	CR 58/ 14, County Line Rd.
4.1/4.1	26*	NA	MG	31.5	**NON**	SR 19, Bucyrus Clyde Rd.
Silver Creek Tributary @ RM 0.72 (Slee Ditch 05-213)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.1	44	NA	G	51.5	Full	At mouth
Buckeye Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.7/2.6	46	NA	MG	58.0	Full	TR 10/ 11, County Line Rd.
0.4/0.8	46	NA	G	84.0	Full	TR 17
Van Meter Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
1.7/1.7	32	NA	G	47.0	Full	TR 151, Infirmary Rd.
Bells Run						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.1/0.2	22*	NA	F*	54.5	**NON**	SR 53
Gibson Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
0.3/0.4	32*	NA	MG	46.0	Partial	Sycamore

Table 8B. Values obtained from surface water grab samples collected in the Honey Creek Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Criteria identified for warmwater habitat apply to water bodies not assigned use designations. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), °Celsius for temperature (T)and colonies/100 ml for fecal coliform (FC). Strontium is not included because 45 of 87 values (51.7%) exceeded Tier II limits.

Mile	*Parameter (value)*
Honey Creek (WWH, PCR, AWS)	
41.66	FC (2500 ‡‡)
38.34	T (23.5 †); DO (4.8 †)
34.14	T (25.0 ††, 28.1 †)
32.23	T (26.9 ††, 30.2 ††); DO (4.7 †); FC (1200 ‡)
25.03	T (24.3 †); DO (4.7 †)
18.05	T (23.9 †, 30.6 ††)
14.80	T (23.6 †, 28.9 †); FC (1200 ‡)
12.30	T (25.0 ††)
6.68	T (26.3 ††)
1.10	T (25.5 ††); FC (>10000 ‡‡)
Buckeye Creek (WWH, PCR, AWS)	
0.73	T (24.5 ††); FC (1100 ‡)
Silver Creek (WWH, PCR, AWS)	
7.75	FC (1800 ‡) [n ' 4]
4.08	DO (4.4 †, 4.6 †) [n ' 4]
Aicholz Ditch (WWH, PCR, AWS)	
3.72	T (24.8 ††)
2.46	T (23.1 †); D.O. (4.9 †); FC (1900 ‡) [n ' 4]
Brokenknife Creek (WWH, PCR, AWS)	
5.08	T (25.2 ††); FC (4000 ‡‡)
3.19	T (25.5 ††); FC (1400 ‡)
Honey Creek Tributary at RM 32.84 (a.k.a. Celery Creek)	
2.20	T (27.6 ††, 29.8 ††)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

Table 8C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Honey Creek Assessment Unit.

Facility Name	Ohio EPA Permit Number	Receiving Stream	River Mile	Description
Honey Creek Subdivision	2PR00107-001	Honey Creek	1.10	sanitary sewage treated by a package plant
Aqua Tech Environmental Laboratories	2PR00177-001	Honey Creek	12.30	sanitary sewage treated by a package plant
Clay Distribution	2IN00188-001	Honey Creek	28.32	stormwater treated by an oil-water separator
Attica Water Treatment Plant	(not final)	Honey Creek	28.36	untreated filter backwash
Bloomville Wastewater Treatment Plant	2PB00053-001	Griffin Ditch Honey Creek	0.40 18.19	sanitary sewage treated by a single cell aerated lagoon
Hanson Aggregates Quarry	2IJ00016-001	Aicholtz Ditch Honey Creek	1.95 19.95	groundwater and stormwater treated by a settling pond
Attica Wastewater Treatment Plant	2PB00001-001	Work Ditch Honey Creek	0.95 27.88	sanitary sewage treated by an oxidation ditch system
New Washing-ton Wastewater Treatment Plant	2PB00060-001	Alum Ditch Brokenknife Ck Honey Creek	0.3 5.50 32.55	sanitary sewage treated by two aerated lagoons in series and a polishing pond
New Washing-ton Water Treatment Plant	2IW00200-001	Alum Ditch	2.0	filter backwash and sludge treated by settling lagoons

Table 8D. Metal concentrations in sediment collected from the Honey Creek assessment unit in 2001. Values preceded by a < were below the reporting limit. Those preceded by a (†) exceeded the threshold effect concentration described by MacDonald et al (2000). Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated]

Honey Creek at RM 25.03- Venice Township Rd. 79

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
26700 [d]	159 [c]	4870	32 [c]	16.4 [a]	23600 [b]	<27	4720	640 [c]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<27	6220	<3390	57	95.5 [a]	0.066	9.65 [b]	0.506 [a]	<1.35

Honey Creek at RM 18.05- Bloom Township Rd. 173

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
51800 [e]	295 [d]	19200	† 50 [d]	20.7 [b]	33400 [c]	<47	10500	1220 [d]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<47	12900	<5920	96	† 144 [c]	0.083	† 12.6 [b]	0.704 [b]	<2.37

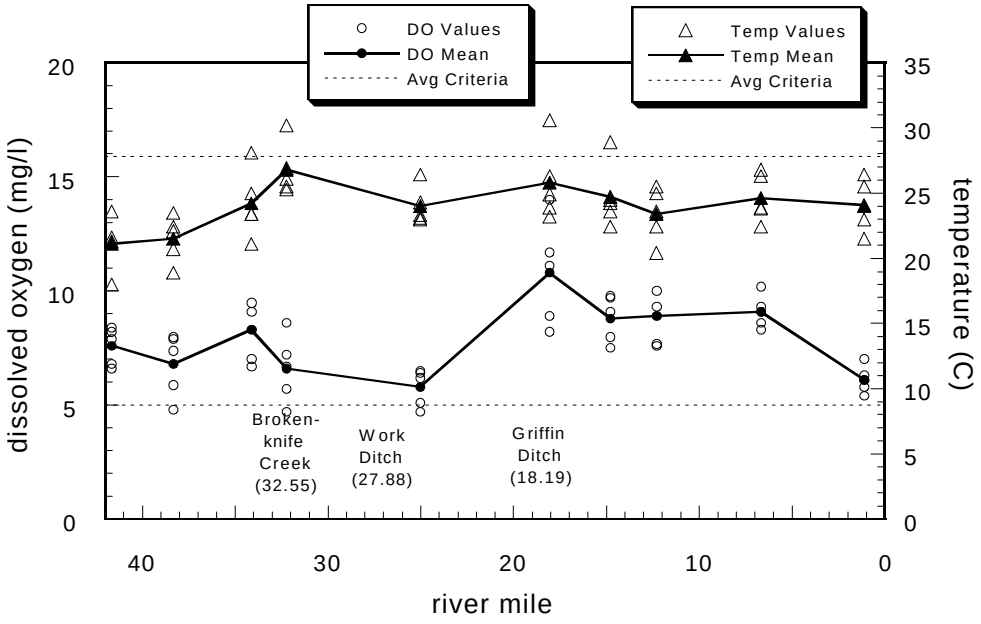

Figure 8A. Dissolved oxygen and temperature results for Honey Creek , June-October, 2001. Temperature criterion valid June 16- September 15.

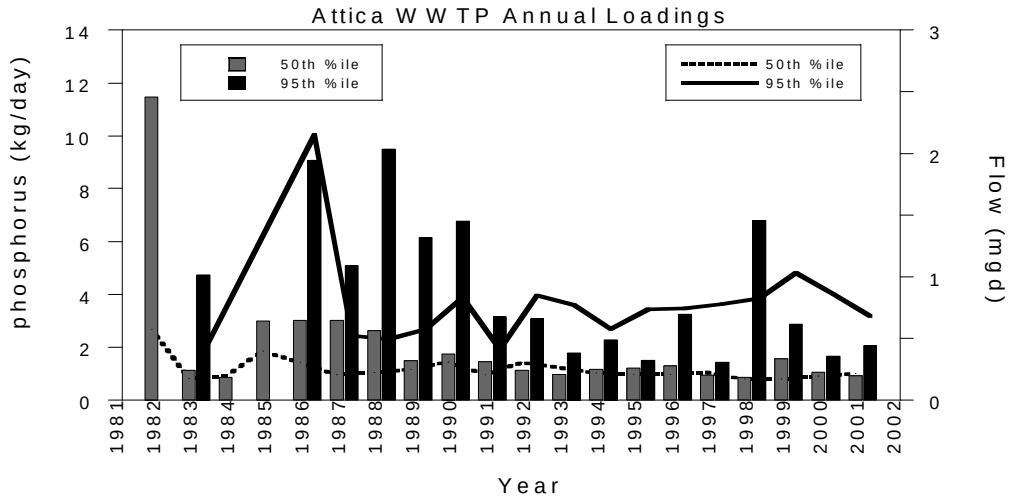

Figure 8C. Annual phosphorus loadings (kg/day) and flow from the Attica WWTP, 1982-2001.

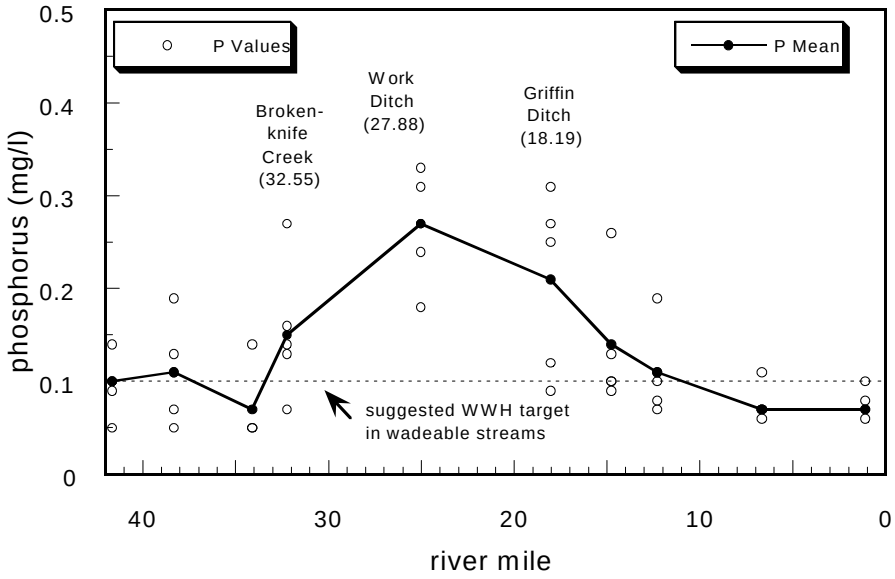

Figure 8B. Phosphorus values from grab samples collected from the Honey Creek, June-October, 2001.

Sandusky-Tiffin Assessment Unit

The Sandusky-Tiffin assessment unit (04100011-090) encompasses the drainage area downstream from the confluence of Honey Creek (RM 43.70) to upstream from the confluence of Wolf Creek (RM 22.73), excluding the mainstem. The Sandusky River mainstem sites which exceeded 500 mi^2 are discussed elsewhere in keeping with current reporting protocol for addressing aquatic life use and attainment status. Biological and habitat assessments were conducted at eight sites in 2001 and their Aquatic Life Use attainment status is presented in Table 9A. Surface water physical/chemical assessments were conducted at six sites. The majority had five sets of grab samples collected at two-week intervals. Sites with fewer sets collected were dry or intermittent. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters including metals, nutrients and oxygen demand. One site included an extra sample collected to test was for levels of herbicides. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 9B. Within this area three smaller watersheds with drainage areas <50 mi^2 were sampled including Rock Creek, Willow Creek and Morrison Creek. One of the eight sites met the recommended aquatic life use; five were in non-attainment and two partially met the designated or recommended use.

A total of 10 sites were originally selected within the subbasin for biological sampling. Two sites on Armstrong and Beighley Ditch were either dry or had only widely disconnected pools when biological sampling was attempted. Little was to be gained in sampling those areas where a puddle of water was present. This stream is actually the headwater of Rock Creek, but it was channelized under a ditch petition. The site selected for surface water sampling at Cooper Rd. (RM 16.66) only had two sets collected before it was deemed dry on July 12, 2001. The absence of significant flow in this stream was apparently a consequence of stream channelizing and tiling of agricultural fields to facilitate drainage. Assignment of an aquatic life use is not appropriate given the inability of the sites to develop any semblance of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat guidelines which are currently being drafted by Ohio EPA. Therefore, it is recommended that these watercourses remain undesignated until the Primary Headwater Habitat designations are promulgated.

Willow Creek at RM 3.0 and Morrison Creek at RM 11.4 and RM 9.4 were channelized with no recovery evident. Few, if any, typical Warmwater Habitat (WWH) attributes were identified at these sites. It is not realistic to expect typical WWH aquatic communities in the foreseeable future under these conditions so a Modified Warmwater Habitat (MWH) aquatic life use is recommended. The recommended MWH stream segments are the entirety of Willow Creek and the Morrison Creek headwaters downstream to RM 7.9 (CR 43).

All of the remaining streams within the assessment unit possessed sufficient physical habitat characteristics to warrant the WWH Aquatic Life Use. The Qualitative Habitat Evaluation Index (QHEI) scores ranged from 49.0 to 76.0. A natural or recovering stream channel and the presence

of a wooded riparian were primary considerations for recommending the WWH use. However, a significant loss in habitat function was encountered at most sites. Minimal sustained flow during the summer months limited pool depths and availability of riffle habitat.

The lack of aquatic life use attainment at all but one site within the assessment unit can be largely attributed to agricultural practices within the watershed. There are no regulated point sources located in the assessment unit. Sedimentation, enrichment/low dissolved oxygen and elevated bacteria levels were a concern along with the low water levels that were encountered during the sampling period. The channelization, removal of riparian trees and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods, making drought conditions in the streams a much more frequent occurrence. The water is carried away quickly from the surrounding watershed at high volume immediately following a rain event rather than filtering through the soil and reaching the stream at a lower volume and more sustained rate. Reduced tree canopy impacts streams because an important macroinvertebrate food source (leaves) is removed and higher water temperatures and evaporation rates result. Consequently, intermittent or nearly intermittent conditions occurred during dry weather and were encountered even though the sites drained areas up to 17.7 mi^2. The lack of water movement can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream.

All four of the streams sampled were affected by siltation and intermittent or nearly intermittent flow conditions. Fine sediment covered and embedded much of the larger substrates and the lack of flow was an impediment to the establishment of typical warmwater aquatic communities. Water quality in these streams was impaired by enrichment/low dissolved oxygen, warm temperatures and elevated bacteria counts. Agricultural practices were the source of these problems, compounded by dry weather during the study period. The conditions eventually degraded to the point that the East Branch Rock Creek at County Rd. 16 (RM 0.47) was dry on August 9, 2001. Only Rock Creek at RM 4.0 had sufficient flow to support a marginally good fish community.

Phosphate (PO_4) is the compound of greatest concern regarding enrichment impacts because it is often growth limiting. The median total phosphorus concentration in Morrison Creek at Morrison Rd. (RM 2.36) was 0.16 mg/l. Evidence of excessive nutrient load included a high occurrence of pollution tolerant fish and macroinvertebrate taxa and the presence of excessive algal material in the streams.

Sources of phosphorus included domestic waste and agricultural fertilizers. Most domestic waste in rural areas originates from failed on-lot septic systems. The Village of Republic is an area to investigate for failed systems and should be considered a candidate for the construction of a sewage collection and treatment system. Phosphorus contained in inorganic crop fertilizer binds tightly to soil particles, so most enters streams from erosion, although some comes from tile drainage. Erosion is especially a problem for 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 therefore cannot expel the phosphate laden sediment that would naturally occur during flooding.

The effect that low water, siltation and embedded substrates were having on small streams within this assessment unit was even apparent at the one site that fully met expectations for the WWH use. Both the IBI and MIwb indices for RM 4.0 on Rock Creek scored in the marginally good range. The Invertebrate Community Index score of 50 was in the exceptional range. Since artificial substrates are used in sampling of macroinvertebrates, habitat impacts do not lower the ICI score to the degree that the fish indexes are depressed. Cases like this point to habitat degradation rather than water quality as the primary limitation to overall stream health. It is also of note that this area had the best habitat quality as expressed by the QHEI and recorded the highest fish and macroinvertebrate index scores of the sampled streams within this assessment unit.

Rock Creek at Old Attica Rd. (RM 3.96) was selected for analysis of herbicide levels. The compounds atrazine and metolachlor were quantified at 2.97 and 1.15 µg/l, respectively. Not much information is available on what effect low levels of these compounds have on aquatic life. Atrazine is a concern in drinking water supplies and has a maximum contaminant level of 3.0 µg/l.

Table 9A. Aquatic life use attainment status of the Sandusky-Tiffin assessment unit (04100011-090), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Rock Creek						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
8.4/ 8.3	32*	NA	F*	49.0	**NON**	CR 16
4.0/ 4.0	38[ns]	8.1[ns]	50	76.0	Full	TR 201, Old Attica Rd.
East Branch Rock Creek (05-015)						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
---/ 4.2	---	NA	F*	---	(**NON**)	SR 67
0.1/ 0.1	32*	NA	F*	57.5	**NON**	At mouth
Willow Creek						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
3.0/ 3.0	22*	NA	MG	35	**NON**	TR 15, Morrison Rd.
Morrison Creek (05-012)						
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
---/ 11.4	---	---	P*	---	(**NON**)	SR 18
9.4/ 9.4	32	NA	P*	34	Partial	TR 175, Coffman Rd.
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
2.4/ 2.4	34*	NA	MG	55.0	Partial	TR 15, Morrison Rd.

Table 9B. Values obtained from surface water grab samples collected in the Sandusky-Tiffin Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are mg/l for dissolved oxygen (DO), °Celsius for temperature (T)and colonies/100 ml for fecal coliform (FC). Strontium is not included because 24 of 26 values (92.3%) exceeded Tier II limits.

Mile	*Parameter (value)*
Morrison Creek (WWH, PCR, AWS)	
9.34	T (24.6 ††); DO (3.6 ††, 3.6 ††); FC (1100 ‡)
2.36	DO (4.6 †, 2.9 ††); FC (6000 ‡‡, 1400 ‡)
Rock Creek (WWH, PCR, AWS)	
8.31	T (23.1 †); DO (3.5 ††, 3.8 ††, 2.3 ††, 4.2 †); FC (1900 ‡)
3.96	T (22.9 †); FC (1100 ‡)
Rock Creek (a.k.a. Armstrong-Beighly Ditch) (WWH, PCR, AWS)	
16.66	T (28.6 ††); DO (3.1 ††) [n ' 2]
E. Br. Rock Creek (WWH, PCR, AWS)	
0.47	T (23.2 †); DO (4.7 †, 4.2 †, 4.1 †, 1.5 ††); FC (3800 ‡‡) [n ' 4]

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡)

Sandusky River-Mainstem Assessment Unit

The Sandusky River mainstem assessment unit (04100011-001) included in the study area encompasses the mainstem from downstream Tymochtee Creek (RM 65.73) to upstream Wolf Creek (RM 22.73). The mainstem has a drainage area in excess of the 500 mi^2 limit used in delineating assessment units with multiple water courses. Consequently, this portion of the mainstem is classified as a large river and is considered separately from smaller drainages within the basin when reporting on attainment status. Biological and habitat assessments were conducted at nine sites in 2001 and aquatic life use attainment status is presented in Table 10A. Surface water assessments were conducted at the same nine sites. The majority had five sets of grab samples collected at two-week intervals. Each sample had physical measurements recorded in the field and was tested in the lab for inorganic parameters including metals, nutrients and oxygen demand. Four sites included an extra sample collected to test for the presence of volatile and semi-volatile organic compounds. Sediment analysis was conducted at three sites. Surface water results that exceeded State of Ohio Water Quality Standards criteria are presented in Table 10B.

Two impounded areas failed to meet the WWH use. The Ella St. dam (RM 42.0) is in place to supply drinking water for the City of Tiffin. The St. John's dam (RM 50.2) allows for small boat recreation, but severely impairs the attainment of the designated WWH use. Both impounded areas were similarly affected by heavy siltation, limited habitat and a lack of discernible flow. Since the Ella St. dam is necessary and its removal is not a possibility, an impounded Modified Warmwater Habitat (MWH) use is appropriate. The recommended segment of MWH is from RM 45.0 to RM 42.0. Biological sampling within the dam pool yielded results that met this use. The recreational use provided by the St. Johns dam is not sufficient justification for recommending the MWH aquatic life use. The impounded portion of the Sandusky River extended seven miles upstream from the dam. The sampling location upstream from the St. Johns dam failed to attain the designated WWH aquatic life use. Work toward removal of the dam by the Ohio Department of Natural Resources is ongoing. The removal is scheduled to begin as early as March of 2003 and should result in significant improvement in aquatic life use attainment. The remaining 36 miles of the mainstem upstream from Wolf Creek fully met aquatic life use expectations.

Very few water quality problems were documented in the assessment unit. High water temperatures were measured, but this alone should not have a major effect on aquatic life. Alterations in habitat and flow in impounded areas caused the problem because the river is wider and more exposed to sunlight for a longer period of time. Although less oxygen is soluble in warm water, there were no dissolved oxygen criterion exceedences in the grab samples. Results from these field readings are displayed in Figure 10A along with the average criteria that apply (temperature criterion valid June 16-September 15). Several continuous monitors were deployed along this segment of the river on July 24, 2001 and verified that good oxygen levels were maintained over a diel period. These instruments record hourly measurements for 48 hours. Aesthetics were negatively affected in the impounded areas, especially in the St. Johns dam pool. The water was stagnant and floating scum and algae were often present. These conditions should improve greatly when the dam removal

project is completed.

There are only two point sources regulated in the assessment unit and they are described in Table 10C. The treated effluent from these facilities did not significantly affect water quality. However, urban stormwater was determined to be a significant source of impact. A storm on July 24, 2001 apparently produced enough rain to activate combined sewer overflows (CSOs) in Tiffin and elevated bacteria counts were subsequently documented. The associated ammonia and phosphorus concentrations were also higher. The Tiffin Wastewater Treatment Plant (WWTP) treats sewage to a secondary level by activated sludge aeration and is designed to handle four million gallons per day (MGD) with chlorine as disinfection. Advanced treatment is completed with addition of ferric chloride in the aeration tanks to remove phosphorus. Flows above design receive primary treatment and disinfection up to the hydraulic capacity of 12 MGD. The head of the plant is equipped with a raw bypass, but it has not been used since the plant was expanded in 1988. The collection system consists of 49% separate sewers and 51% combined sewers with 39 CSOs. In January 2002 the Tiffin City Council approved a phased plan for separating combined sewers. This should result in a major improvement when implemented.

The Sandusky River at Ella St. is designated with the Public Water Supply use because of the raw water intake at RM 42.10. Most of the iron and manganese results exceeded WQS criteria. Ohio American Water employs a lime softening process to remove hardness before distribution and uses settling lagoons to treat the sludge that is produced.

Testing for the presence of volatile and semi-volatile organic compounds was conducted in two segments of the river. One had two sites selected to bracket the closed Tiffin landfill and determine if surface runoff or leachate was an issue. The other had two sites selected to bracket the Tiffin WWTP discharge and evaluate effluent quality. All the results for priority pollutants were below the reporting limit. The library match for tentatively identified compounds indicated that the herbicide atrazine was present at all four sites, but the concentrations were considered estimated. This chemical is most often applied to corn and soy beans and is commonly used in the Lake Erie basin. Not much information is available on what effect low levels have on aquatic life. It is a concern in drinking water supplies and has a maximum contaminant level of 3.0 µg/l.

Sediment quality was evaluated at three sites. Physical attributes that were measured included percent particle size distribution, solids and organic carbon. Chemical attributes that were measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCB). Results for metals varied widely and are presented in Table 10D. No semi-volatile or PCB compounds were detected in any of the samples. The only pesticide detected was the insecticide dieldrin in the Ella St. and St. Johns dam pools. Some portion of the dieldrin detected may be due to the break down of aldrin. Pesticides are a concern because some have been demonstrated to cause cancer in lab animals and have a severe effect on the central nervous system in humans. Most are persistent in the environment, bind strongly to soil and sediment and accumulate in the food chain. The only volatile compound detected was toluene downstream from

Tiffin. Toluene is used to enhance octane in gasoline and has been an issue in the Sandusky River before. A massive spill (200,000 gallons) occurred in a Sugar Creek tributary on February 17, 1988 when a Sun Refining and Marketing Company pipeline ruptured. The main concern for toluene is ingestion; there is a drinking water maximum contaminant level of 1.0 mg/l and a limit in surface water of 5600 µg/l.

Sediment collected in the St. Johns dam pool consisted of 84% sand, 16% silt and clay, 2.3% organic carbon and 71.4% solids. The sediment layer was shallow and covered with detritus. Most metals were either ranked as non-elevated or were below the reporting limit. The insecticide dieldrin was detected at 8.5 µg/kg. This level was above the TEC of 1.90 µg/kg, but not the PEC of 61.8 µg/kg. Sediment collected in the Ella St. dam pool consisted of 75.1% sand, 24.9% silt and clay, 2.4% organic carbon and 62.3% solids. The bottom of the river in this segment is mostly exposed bedrock, especially in the middle of the channel. Most metals were either ranked as non-elevated or were below the reporting limit. The insecticide dieldrin was still detected above the TEC at 10.7 µg/kg. Sediment collected at CR 38 (RM 36.50) consisted of 78.3% sand, 21.7% silt and clay, 3.8% organic carbon and 61.6% solids. This segment of the river is mostly bedrock and very little sediment was present. Most metals were either ranked as non-elevated or were below the reporting limit. The compound toluene was detected in the volatile organic scan. The concentration reported of 0.506 mg/kg was qualified as estimated and at this level was not a significant concern.

Table 10A. Aquatic life use attainment status of the Sandusky-Mainstem assessment unit (04100011-020), June-October, 2001. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb)and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Invertebrate/Fish	IBI	MIwb	ICI[a]	QHEI	Attainment Status[b]	Location
Sandusky River						
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
65.0/65.1	53	8.5	E	76.0	Full	CR 16
57.4/57.3	48	8.7	48	60.5	Full	CR 9
52.2/52.2	43	7.5*	12*	50.0	**NON**	St. Johns dam pool
47.7/47.8	54	10.3	54	85.0	Full	CR 90
46.8/46.8	53	9.7	48	84.5	Full	From CR 90
Eastern Corn Belt Plains (ECBP) - MWH Use Designation (Recommended)						
43.0/43.0	46	7.3	NA	57.0	Full	US 224
Eastern Corn Belt Plains (ECBP) - WWH Use Designation						
41.8/41.9	57	10.1	42	76.0	Full	Ella St.
38.9/38.9	54	10.7	50	87.0	Full	Ust. Tiffin WWTP
36.4/36.5	50	9.9	36	84.5	Full	CR 38

Table 10B. Values obtained from surface water grab samples collected in the Sandusky River Assessment Unit in 2001 that exceeded State of Ohio Water Quality Standards criteria (Chapter 3745-1 of the Administrative Code). Each site had five sets of samples collected at two-week intervals unless indicated otherwise. Assigned stream use designations (3745-1-12)[1] that are linked to statewide water quality criteria (3745-1-07)[2] are listed. Lake Erie Basin Human Health and Wildlife Criteria (3745-1-33) and Tier I and Tier II Limits (3745-1-36) apply to all waters in the study area. Units are °Celsius for temperature (T), colonies/100 ml for fecal coliform (FC)and µg/l for iron (Fe) and manganese (Mn). Strontium is not included because 39 of 39 values (100%) exceeded Tier II limits.

Mile	*Parameter (value)*
Sandusky River (WWH, PCR, AWS)	
65.01	T (25.6 ††)
57.34	T (25.9 ††, 28.3 †, 28.6 †)
52.58	T (26.0 ††, 28.2 †)
47.75	T (26.5 ††)
46.75	none [n ' 1]
42.92	T (28.6 †) [n ' 3]
41.84	T (27.9 ††, 29.3 †); Fe (906 ^{pws}, 615 ^{pws}, 872 ^{pws}, 697 ^{pws}, 469 ^{pws}); Mn (77 ^{pws}, 71 ^{pws}, 215 ^{pws}, 141 ^{pws})
38.90	T (27.5 ††, 28.4 †, 30.1 ††); FC (>10000 ‡‡)
36.50	T (23.2 †); FC (>10000 ‡‡)

[1] Aquatic Life Habitat: warmwater (WWH); Recreation: primary contact (PCR); Water Supply: agricultural (AWS)

[2] aquatic life outside mixing zone maximum (††), aquatic life outside mixing zone average (†), recreation outside mixing zone maximum (‡‡), recreation outside mixing zone average (‡), public water supply outside mixing zone average (^{pws})

Table 10C. Facilities regulated by the National Pollutant Discharge Elimination System located in the Sandusky Large River Assessment Unit.

Facility Name	**Ohio EPA Permit Number**	**Receiving Stream**	**River Mile**	**Description**
Ohio American Water	2IW00235-001	Sandusky River	41.95	lime sludge treated by settling lagoons
Tiffin Wastewater Treatment Plant	2PD00025-001	Sandusky River	38.77	sanitary sewage treated by an activated sludge aeration system
Tiffin Wastewater Treatment Plant	2PD00025-002	Sandusky River		raw bypass
Tiffin Wastewater Treatment Plant	2PD00025-003	Sandusky River		primary bypass
Tiffin Wastewater Treatment Plant	2PD00025-004, 005, 007-023, 028-034, 036-037	Sandusky River		combined sewer overflow
Tiffin Wastewater Treatment Plant	2PD00025-024, 025-027, 039	Rock Creek		combined sewer overflow
Tiffin Wastewater Treatment Plant	2PD00025-035, 040-044	Gibson Run		combined sewer overflow

Table 10D. Metal concentrations in sediment collected from the Sandusky Large River Assessment Unit in 2001. Values preceded by a < were below the reporting limit. Relative concentrations are ranked based on a system developed by Ohio EPA. [[a] non-elevated; [b] slightly elevated; [c] elevated; [d] highly elevated; [e] extremely elevated].

Sandusky River at RM 52.58- Walnut Grove Campground (St. John's Dam Pool)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
16200 [c]	86.1 [a]	22700	17 [a]	9.8 [a]	13100 [a]	<20	8090	229 [a]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<20	4910	<2460	125	52.6 [a]	0.032	6.75 [a]	0.235 [a]	<0.98

Sandusky River at RM 42.92- U.S. 224 (Ella St. Dam Pool)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
14500 [b]	67.3 [a]	26100	<17	11.7 [a]	16400 [a]	<23	10200	268 [b]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<23	3580	<2870	157	57.4 [a]	0.030	8.67 [a]	0.252 [a]	<1.15

Sandusky River at RM 36.50- Seneca County Rd. 38

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
8220 [a]	68.5 [a]	64500	<17	8.6 [a]	9320 [a]	<23	9310	362 [b]
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<23	2370	<2900	713	49.9 [a]	<0.034	5.22 [a]	0.146 [a]	<1.16

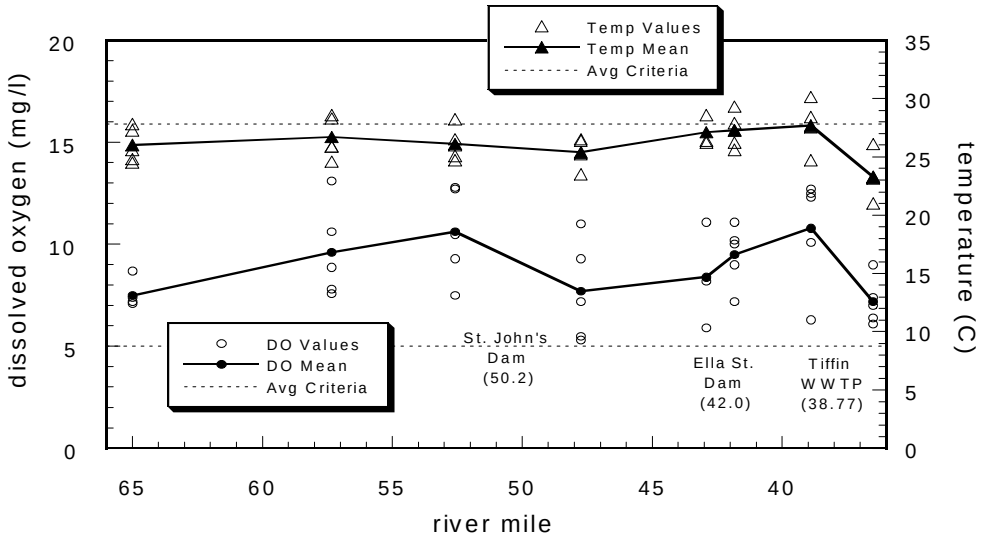

Figure 10A. Dissolved oxygen and temperature results for the Sandusky Large River assessment unit (04100011-001), collected June-October, 2001. Temperature criterion valid June 16- September 15.

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