State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of Crab Creek

Mahoning County, Ohio

October 31, 2008

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study

Crab Creek

2008

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SUMMARY

One mile of Crab Creek was biologically assessed by the Ohio EPA during 2008. Based on the performance of the biological communities, 0.8 mile of Crab Creek was in full attainment of the Warmwater Habitat (WWH) aquatic life use, and 0.2 mile was partially attaining the use (Table 1). The upstream background site and the sites adjacent to the Youngstown Building Material and Aeroquip properties were fully meeting the WWH aquatic life use. The most downstream site was in partial attainment, and this was associated with poor habitat conditions in the stream, along with the urbanized condition of Crab Creek within the study segment (urban runoff and combined sewer overflows). The Youngstown Building Materials and Aeroquip properties are not contributing to impairment of biological and water resources in Crab Creek.

RECOMMENDATIONS

The Crab Creek aquatic life use designation of Warmwater Habitat was originally reported in the Ohio EPA water quality standards from 1978. This designation was not determined using standardized biological and physical habitat sampling techniques. The 2008 sampling of Crab Creek was the first biological study of this stream conducted by Ohio EPA. The study segment of Crab Creek should remain WWH based on biological sampling results. However, a more extensive study should be conducted in the lower mile of Crab Creek to determine the appropriate aquatic life use. This section of Crab Creek has been extensively modified, including portions converted to a concrete trapezoidal channel.

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 (Figure 1). The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes 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

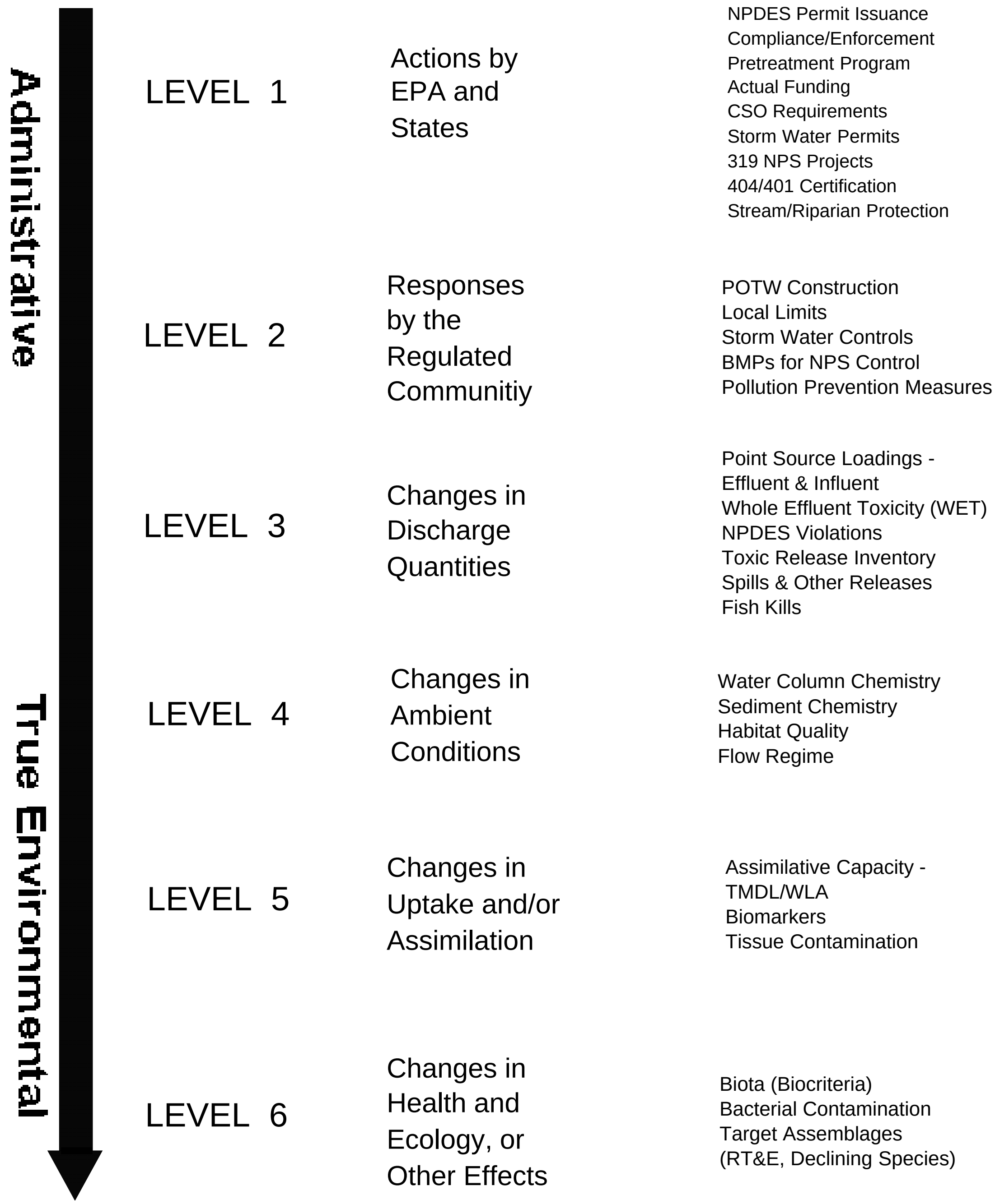

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

declining species or bacterial levels which serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]), the Ohio Nonpoint Source Assessment, and other technical bulletins.

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

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

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

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of 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 AWS and 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.

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Report preparation and analysis: David Altfater, Mike Gray
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INTRODUCTION

A one mile section of Crab Creek was assessed during 2008, evaluating biological, sediment, and surface water resources. This study was undertaken to assess water resource conditions in Crab Creek upstream, adjacent, and downstream from two abandoned properties: former Youngstown Building Materials (YBM) and Aeroquip. This water resource project is part of a Targeted Brownfield Assessment (TBA).

Specific objectives of the evaluation were to:

- Establish biological conditions in Crab Creek by evaluating fish and macroinvertebrate communities,
- Evaluate surficial sediment and surface water chemical quality at four stations in Crab Creek,
- Determine the aquatic life use attainment status of Crab Creek with regard to the Warmwater Habitat (WWH) aquatic life use designations codified in the Ohio Water Quality Standards, and
- Perform the work to satisfy the requirements of VAP rule OAC 3745-300-09.

Crab Creek is located in the Erie Ontario Lake Plain (EOLP) ecoregion. Crab Creek is currently assigned the Warmwater Habitat (WWH) aquatic life use designation for its entire length.

Aquatic life use attainment conditions are presented in Table 1, and sampling locations are detailed in Table 2 and graphically presented in Figure 2.

Table 1. Aquatic life use attainment status for sampling locations in Crab Creek, 2008. The Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biological community. Stream sites are located in the Erie Ontario Lake Plain (EOLP) ecoregion. In the Ohio Water Quality Standards, Crab Creek is designated Warmwater Habitat (WWH). If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted.

Sample Site River Mile	Attainment Status	IBI	ICI	QHEI	Location	Cause	Source
2.1	FULL	40	Good[a]	48.5	Hubbard Ave.		
1.9	FULL	40	44	49.0	Adj. YBM		
1.7	FULL	36[ns]	30[ns]	49.0	Adj. Aeroquip		
1.3	PARTIAL	29*	30[ns]	38.0	McGuffey Ave.	Habitat/ Urban pollutants	Impounded/ CSOs

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP) (OAC 3745-1-07, Table 7-15)		
INDEX - Site Type	MWH	WWH
IBI: Headwater	24	40
ICI	22	34

* 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 The narrative evaluation using the qualitative sample is based on best professional judgement utilizing sample attributes such as taxa richness, EPT taxa richness, and community composition and is used in lieu of the ICI when artificial substrates are lost or deemed not useable.

Table 2. Sampling locations in Crab Creek, 2008. Type of sampling included fish community (F), macroinvertebrate community (M), surface water (W), and sediment (S).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark
2.1	F,M,W,S	41.1229	80.6352	Upstream Hubbard Ave.
1.9	F,M,W,S	41.1203	80.6356	Adjacent Youngstown Building Materials property
1.7	F,M,W,S	41.1181	80.6356	Adjacent Aeroquip property
1.3	F,M,W,S	41.1113	80.6357	Upstream McGuffey Ave.

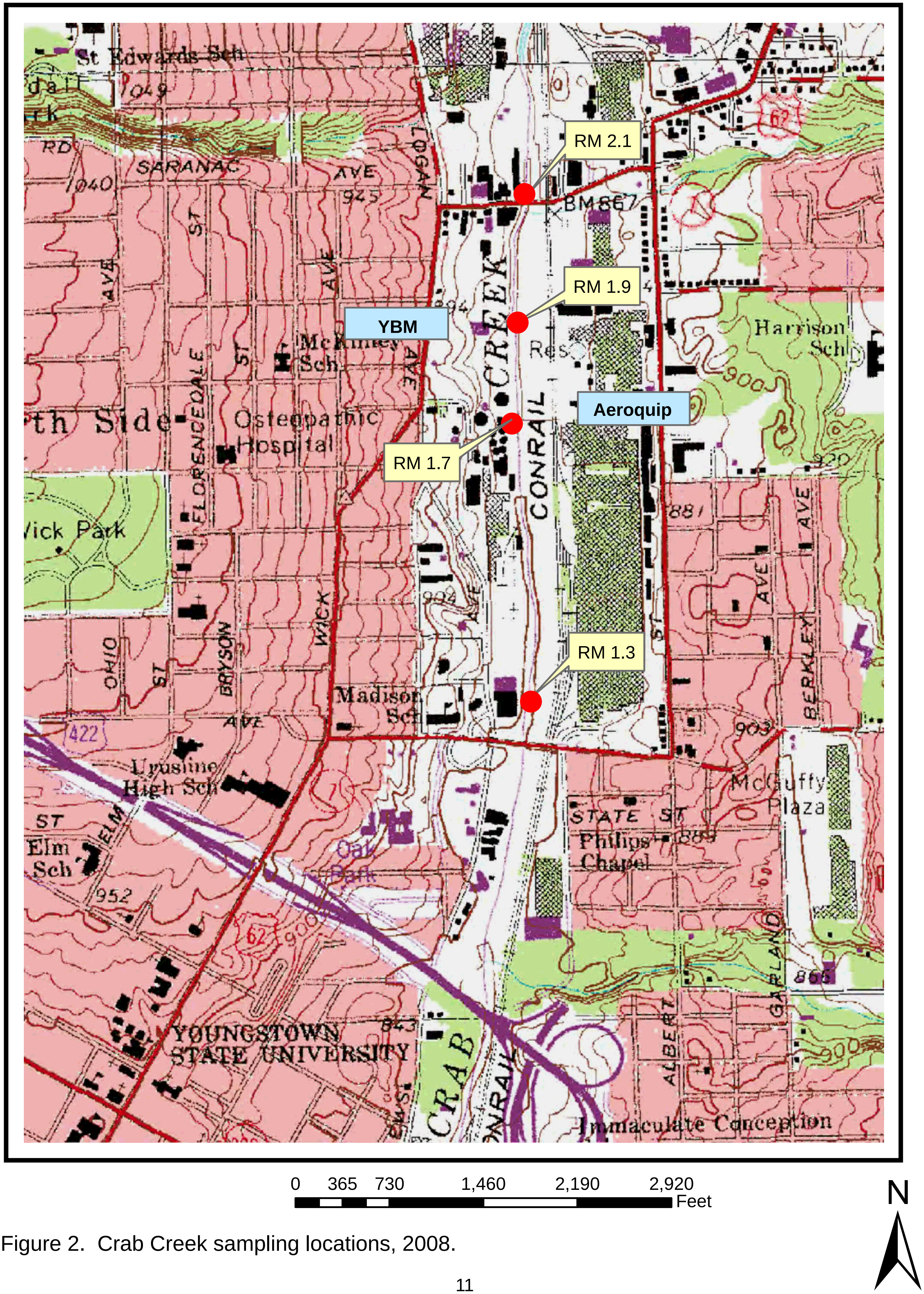

Figure 2. Crab Creek sampling locations, 2008.

METHODS

All chemical, physical, and biological field, EPA laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 2006b), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b, 2008a, 2008b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989), Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (Ohio EPA 2006a), and Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001).

Determining Use Attainment

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

Stream Habitat Evaluation

Physical habitat is evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995; Ohio EPA 2006a). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75 often typify habitat conditions which have the ability to support exceptional faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected multi-incrementally in the upper four inches of bottom material at each biological location using decontaminated stainless steel scoops. At each location, between 9 and 25 scoops of fine grained material over a 150 meter section of stream were collected. Sediment incremental samples were mixed in stainless steel pans (VOC sample jars were filled prior to mixing), transferred into glass jars with teflon lined lids, placed on ice (to maintain $4^{o}C$) in a cooler, and shipped to an Ohio EPA contract lab. Sediment data are reported on a dry weight basis. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Surface water samples were collected directly into appropriate containers, preserved and delivered to an Ohio EPA contract lab. Surface water samples were collected once (twice for metals and cyanide) from each location from the upper 12 inches of water. Collected water was preserved using appropriate methods, as outlined in Parts II and III of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2006b). Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000), along with a comparison of metals results to Ohio Sediment Reference Values (Ohio EPA 2003b).

Macroinvertebrate Community Assessment

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

Fish Community Assessment

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

Field Instrument Calibration

Field instruments are calibrated using manufacturer recommended procedures along with procedures noted in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (2006d) and Biological Criteria for the Protection of Aquatic Life, Volume III (1989b). Laser rangefinders, used to measure sampling distance, were calibrated once at the Groveport Field Facility prior to summer field sampling activities.

Causal Associations

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

RESULTS

Surface Water Quality

Chemical analyses were conducted on surface water samples collected on June 16 and July 28, 2008 from four locations in Crab Creek (Table 3, Appendix Table 1). Surface water samples were analyzed for total analyte list inorganics (metals), PCBs, volatile organic compounds, semivolatile organic compounds, and total cyanide. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 3.

Concentrations of PCBs and semivolatile organic compounds tested in stream waters at all four locations were reported as not detected. Eleven volatile organic compounds were detected in surface water samples from Crab Creek. All of these were below applicable Ohio WQS criteria, or the detectable levels were very low (some parameters do not have water quality criteria developed). The three volatile organic chemicals with the highest instream concentrations (1,2-dichloroethane, cis-1,2-dichloroethene, and trichloroethene) were elevated both upstream and adjacent to the TBA properties.

Table 3. Exceedences of Ohio Water Quality Standards criteria (OAC3745-1) for chemical/physical parameters measured in Crab Creek, 2008.

River Mile	Parameter (value – ug/l)
RM 2.1	None
RM 1.9	None
RM 1.7	None
RM 1.3	None

All metals concentrations were generally very low, with most of the tested parameters less than lab detection limits. All of the metal parameters were below applicable Ohio WQS aquatic life and human health criteria.

Nutrients, ammonia-N, dissolved oxygen and bacteriological parameters were not tested as part of this evaluation. Excluding the typical wastewater chemical parameters noted above, good chemical water quality was evident in all stream samples.

Sediment Quality

Surficial sediment samples were collected at four locations in Crab Creek by the Ohio EPA on June 16, 2008. Sampling locations were co-located with biological sampling sites. Samples were analyzed for total analyte list inorganics (metals), volatile organic compounds, semivolatile organic compounds, PCBs, cyanide, and total petroleum hydrocarbons. Specific chemical parameters tested and results are listed in Appendix Table 2. Sediment data were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000), and *Ecological Screening Levels (ESLs)* (USEPA 2003). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. ESL values, considered protective benchmarks, were derived by USEPA, Region 5 using a variety of sources and methods.

Sediment samples were conservatively sampled by focusing on depositional areas of fine grain material (silts and clays). These areas typically are represented by higher contaminant levels, compared to coarse sands and gravels. Fine grained depositional areas were very sparse at all sites in this high gradient stream.

Chemical parameters measured above ecological screening guidelines are presented in Table 4. All four sampling locations in Crab Creek exhibited some degree of elevated sediment chemical levels. Several PAH compounds were reported above PEC levels, which would suggest some impairment to biological communities. However, good biological integrity was documented at three of the four locations where elevated PAHs were noted. The sparse deposits of fine grained material at each sampling site contributed to low exposure levels of sediment contaminants to biological communities. Based on the sampling results of this survey, the Youngstown Building Materials and Aeroquip properties were not contributing contaminants to the sediments of Crab Creek.

Table 4. Chemical parameters measured above screening levels in sediment samples collected by Ohio EPA from surficial sediments in Crab Creek, June, 2008. Contamination levels were determined for parameters using consensus-based sediment quality guidelines (MacDonald, et.al. 2000) and ecological screening levels (USEPA 2003). Shaded numbers indicate values above the following: Threshold Effect Concentration –TEC (yellow), Probable Effect Concentration – PEC (red) and Ecological Screening Levels (orange). Sampling locations are indicated by river mile (RM).

Parameter	RM 2.1	RM 1.9	RM 1.7	RM 1.3
Total PAHs (ug/kg)	12,530	8,956	11,997	13,320
Acenaphthene (ug/kg)	761 U	773 U	779 J	1310 J
Benz(a)anthracene (ug/kg)	1170 J	856 J	890 J	1110 J
Benzo(a)pyrene (ug/kg)	1100 J	842 J	999 J	1230 J
Benzo(k)fluoranthene (ug/kg)	1290 J	949 J	1100 J	1440 J
Chrysene (ug/kg)	1440 J	898 J	1120 J	1370 J
Fluoranthene (ug/kg)	2950	2430	2460	2890
Phenanthrene (ug/kg)	1280 J	1070 J	1120 J	1660 J
Pyrene (ug/kg)	2220	1820	1910	2310
Aroclor 1260 (PCB) (ug/kg)	76.0	43.1	95.4	133
1,1-Dichloroethane (ug/kg)	17.5	1.57 U	1.43 U	2.03 U
Arsenic (mg/kg)	5.91	12.4	12.2	7.01
Lead (mg/kg)	45.3	52	128	69.2
Zinc (mg/kg)	98.3	106	62.8	163

U – Not detected at or above the method detection limit; J – estimated value, below the reporting limit.

Stream Physical Habitat
Physical habitat was evaluated in Crab Creek at each fish sampling location. Physical habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI); scores are detailed in Table 5.

Physical habitat in Crab Creek within the one mile study area consisted largely of a modified channel, gravel, cobble, and artificial substrates, and stream banks filled in with manmade material. The extensive physical modifications were reflected in the QHEI scores, which ranged from 49.0 to 38.0. All four sites had substrates moderately to extensively embedded with silts and sands. Moderately high stream gradients were noted at the upper three sampling sites; the most downstream site (RM 1.3) was impounded by a riprap barrier underneath the McGuffey Avenue bridge. The three upper sites had extensive riffle areas, while the downstream site was pool and glide habitat. The QHEI at the downstream site (RM 1.3) was 38.0, indicative of poor conditions. The other three sampling locations with riffle and pool habitats (RMs 2.1 – 1.7) had QHEI scores of 48.5 – 49.0, and were indicative of fair conditions.

Table 5. Qualitative Habitat Evaluation Index (QHEI) scores and physical attributes for fish sampling sites in Crab Creek, 2008.

			WWH Attributes											**MWH Attributes**																				
Key QHEI Components														*High Influence*						*Moderate Influence*														
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD,HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attributes**	**(MWH H.I.+1)/ (WWH+1) Ratio**	**(MWH M.I.+1)/ (WWH+1) Ratio**
Crab Creek Year: 2008																																		
2.1	**48.5**	20.41		■		■		■	■		■	■	6			◆	◆		2	●	●			●					●	●		5	0.43	1.14
1.9	**49.0**	20.41		■		■		■	■	■		■	6			◆	◆	◆	3	●	●			●					●	●		5	0.57	1.29
1.7	**49.0**	14.93		■		■			■		■		4			◆	◆		2	●	●			●					●	●		5	0.60	1.60
1.3	**38.0**	14.93		■							■		2	◆		◆	◆		3	●	●			●				●	●		●	6	1.33	3.33

Fish Community

A total of 6,660 fish representing 14 species were collected from Crab Creek between June and July, 2008. Relative numbers and species collected per location are presented in Appendix Table 3 and IBI metrics are presented in Appendix Table 4. Sampling locations were evaluated using Warmwater Habitat biocriteria.

The upstream background site, and two sites adjacent to the YBM and Aeroquip properties, were fully achieving the WWH biocriteria. Although QHEI scores documented less than optimal physical habitat at these three sites, good groundwater flows and high stream gradient provided adequate conditions for meeting warmwater biological integrity. The IBI scores, 36 to 40, were within the marginally good to good range of environmental quality (Table 6).

Reduced habitat quality occurred in Crab Creek at river mile 1.3. This section of stream was impounded by a riprap dam located underneath the McGuffey Avenue bridge. Riffles were not present at RM 1.3, contributing to much lower darter numbers compared with the free-flowing upstream sites. Darters are sensitive to environmental contaminants. The IBI score at RM 1.3 was 29, which did not achieve the WWH biocriterion. Results were reflective of fair environmental quality. Impairment of the fish community at RM 1.3 appears largely a result of poor habitat quality, along with some contributions from urban runoff and combined sewer overflows.

Table 6. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in Crab Creek from June and July, 2008. Relative numbers are per 0.3 km. The applicable aquatic life use designation is WWH.

Stream River Mile	Sampling Method	Species (Mean)	Species (Total)	Relative Number	QHEI	Index of Biotic Integrity	Narrative Evaluation
Crab Creek							
2.1	Wading	8.0	9	2419	48.5	40	Good
1.9	Wading	8.5	10	1657	49.0	40	Good
1.7	Wading	8.5	10	1976	49.0	36[ns]	Marginally Good
1.3	Wading	10.0	11	640	38.0	29*	Fair

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP)		
INDEX - Site Type	MWH[a]	WWH
IBI: Headwater	24	40

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
[ns] Non-significant departure from ecoregion biocriterion ($\leq$4 IBI units)..
[a] Biocriteria scores for channel modified sites.

Macroinvertebrate Community

The macroinvertebrate communities at four Crab Creek sites were sampled in 2008 using qualitative (multi-habitat composite) and quantitative (artificial substrate) sampling protocols. Results are summarized in Table 7. The ICI metrics with the associated scores, and the raw data are attached as Appendix Tables 5 and 6.

The artificial substrate sampler from the upstream site (RM 2.1) was lost; the site evaluation was based on the qualitative sample results. The RM 2.1 site was evaluated as good and fully achieved WWH expectations. The RM 1.9 site, with an ICI of 44, was in attainment of the WWH biocriterion with an evaluation of very good. The RMs 1.7 and 1.3 sites were marginally good; the ICI score of 30 at each site was a non-significant departure from attainment of the WWH biocriterion. The macroinvertebrate communities did not appear to be impacted by the YBM and Aeroquip properties. Impacts from urban runoff, lack of tree canopy, embedded substrates and extensive algal growth were the predominant stressors. The contribution of groundwater flow to Crab Creek was indicated by the presence of several coldwater macroinvertebrate taxa.

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in Crab Creek, 2008.

Stream/ River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
Crab Creek							
2.1	-	-	-	28	13	-	Good
1.9	1230	46	42	21	9	44	Very Good
1.7	424	42	33	26	9	30[ns]	Marginally Good
1.3	597	44	31	26	8	30[ns]	Marginally Good

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP) (Ohio Administrative Code 3745-1-07, Table 7-15)		
INDEX	MWH	WWH
ICI	22	34

[a] EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

[ns] Nonsignificant departure from biocriterion ($\leq$4 ICI units).

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 1987), 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., Ecol. Assess. Sect., 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.

Ohio Environmental Protection Agency. 2008a. 2008 updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2008b. 2008 updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2006a. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, 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.

In addition to the preceding guidance documents, the following publications by the Ohio EPA should also be consulted as they present supplemental information and analyses used by the Ohio EPA to implement the biological criteria.

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

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

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

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

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

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

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

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8786

or

www.epa.state.oh.us/dsw/formspubs.html

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Ohio Environmental Protection Agency. 2006b. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.

Ohio Environmental Protection Agency. 2003. Ecological risk assessment guidance manual. Feb. 2003. Division of Emergency and Remedial Response, Columbus, Ohio.

Ohio Environmental Protection Agency. 2001. Sediment sampling guide and methodologies, 2nd edition. Nov. 2001. Division of Surface Water, Columbus, Ohio.

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Yoder, C. O. 1991**.** Answering some concerns about biological criteria based on experiences in Ohio, *in* G. H. Flock (ed.) Water quality standards for the 21st century. Proceedings of a National Conference, U. S. EPA, Office of Water, Washington, D.C.

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APPENDICES – CRAB CREEK, 2008

Appendix Table 1. Results of chemical surface water sampling conducted by Ohio EPA in Crab Creek, June 16 and July 28, 2008.

Stream	Crab Creek	Crab Creek	Crab Creek	Crab Creek
River Mile	2.1	1.9	1.7	1.3
Date Sampled	6/16/2008	6/16/2008	6/16/2008	6/16/2008
TAL Metals + Cyanide (ug/l)				
Mercury	0.1 U	0.1 U	0.1 U	0.1 U
Aluminum	50.0 U	140	102	138
Antimony	0.349 J	0.387 J	0.441 J	0.313 J
Arsenic	5.05 J	5.0 U	5.0 U	5.0 U
Barium	42.6	45.4	43.3	43.1
Beryllium	0.5 U	0.5 U	0.5 U	0.5 U
Cadmium	2.5 U	2.5 U	2.5 U	2.5 U
Calcium	64,400	65,500	64,600	63,700
Chromium	2.5 U	2.5 U	2.5 U	2.5 U
Cobalt	2.5 U	2.5 U	2.5 U	2.5 U
Copper	5.0 U	5.0 U	5.0 U	5.0 U
Iron	230	426	398	564
Lead	2.5 U	2.5 U	2.5 U	2.5 U
Magnesium	13,200	13,600	13,500	14,000
Manganese	55.1	99.3	71.1	79.5
Nickel	5.0 U	5.0 U	5.0 U	5.0 U
Potassium	3220	3410	3410	3400
Selenium	5.0 U	5.0 U	5.0 U	5.0 U
Silver	5.0 U	5.0 U	5.0 U	5.0 U
Sodium	44,200	45,400	45,200	45,300
Thallium	0.0583 J	0.0623 J	0.05 U	0.0665 J
Vanadium	5.0 U	5.0 U	5.0 U	5.0 U
Zinc	5.0 U	5.0 U	5.0 U	5.0 U
Cyanide	5.0 U	5.0 U	5.0 U	5.0 U
Volatile Organic Analytes (ug/l)				
Acetone	2.5 U	2.5 U	2.83	4.21 J
Benzene	0.125 U	0.125 U	0.125 U	1.17
Bromobenzene	0.125 U	0.125 U	0.125 U	0.125 U
Bromochloromethane	0.20 U	0.20 U	0.20 U	0.20 U
Bromodichloromethane	0.25 U	0.25 U	0.25 U	0.25 U
Bromoform	0.50 U	0.50 U	0.50 U	0.50 U
Bromomethane	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone	2.50 U	2.50 U	2.50 U	2.50 U
n-Butylbenzene	0.25 U	0.25 U	0.25 U	0.25 U
sec-Butylbenzene	0.25 U	0.25 U	0.25 U	0.25 U
tert-Butylbenzene	0.25 U	0.25 U	0.25 U	0.25 U
Carbon disulfide	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	0.25 U	0.25 U	0.25 U	0.25 U
Chlorobenzene	0.125 U	0.125 U	0.125 U	0.125 U
Chlorodibromomethane	0.25 U	0.25 U	0.25 U	0.25 U
Chloroethane	0.50 U	0.50 U	0.50 U	0.50 U
2-Chloroethyl vinyl ether	5.0 U	5.0 U	5.0 U	5.0 U

Appendix Table 1. Continued.

Stream	**Crab Creek**	**Crab Creek**	**Crab Creek**	**Crab Creek**
River Mile	**2.1**	**1.9**	**1.7**	**1.3**
Date Sampled	6/16/2008	6/16/2008	6/16/2008	6/16/2008
Volatile Organic Analytes (ug/l)				
Chloroform	0.125 U	0.125 U	0.125 U	0.125 U
Chloromethane	0.25 U	0.25 U	0.25 U	0.25 U
2-Chlorotoluene	0.125 U	0.125 U	0.125 U	0.125 U
4-Chlorotoluene	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dibromo-3-chloropropane	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromomethane	0.25 U	0.25 U	0.25 U	0.25 U
Dibromomethane	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dichlorobenzene	0.125 U	0.125 U	0.125 U	0.125 U
1,3-Dichlorobenzene	0.25 U	0.25 U	0.25 U	0.25 U
1,4-Dichlorobenzene	0.125 U	0.125 U	0.125 U	0.125 U
Dichlorodifluoromethane	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloroethane	0.125 U	0.125 U	0.204 J	0.496 J
1,2-Dichloroethane	12.8	10.9	11.9	3.71
1,1-Dichloroethene	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene	1.79	5.16	5.31	2.64
trans-1,2-Dichloroethene	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dichloropropane	0.125 U	0.125 U	0.125 U	0.125 U
1,3-Dichloropropane	0.20 U	0.20 U	0.20 U	0.20 U
2,2-Dichloropropane	0.25 U	0.25 U	0.25 U	0.25 U
cis-1,3-Dichloropropene	0.25 U	0.25 U	0.25 U	0.25 U
trans-1,3-Dichloropropene	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloropropene	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	0.25 U	0.25 U	0.25 U	0.747 J
n-Hexane	1.0 U	1.0 U	1.0 U	1.0 U
2-Hexanone	2.5 U	2.5 U	2.5 U	2.5 U
Hexachlorobutadiene	0.25 U	0.25 U	0.25 U	0.25 U
Isopropylbenzene	0.25 U	0.25 U	0.25 U	0.25 U
p-Isopropyltoluene	0.25 U	0.25 U	0.25 U	0.25 U
4-Methyl-2-pentanone	2.5 U	2.5 U	2.5 U	2.5 U
Methylene chloride	0.25 U	0.25 U	0.25 U	0.25 U
Naphthalene	0.20 U	0.20 U	0.20 U	6.96
n-Propylbenzene	0.125 U	0.125 U	0.125 U	0.125 U
Styrene	0.125 U	0.125 U	0.125 U	0.125 U
1,1,1,2-Tetrachloroethane	0.25 U	0.25 U	0.25 U	0.25 U
1,1,2,2-Tetrachloroethane	0.125 U	0.125 U	0.125 U	0.125 U
Tetrachloroethene	0.25 U	0.25 U	0.25 U	0.25 U
Toluene	0.25 U	0.25 U	0.25 U	0.25 U
1,2,3-Trichlorobenzene	0.15 U	0.15 U	0.15 U	0.15 U
1,2,4-Trichlorobenzene	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1-Trichloroethane	0.25 U	0.25 U	0.25 U	0.25 U
1,1,2-Trichloroethane	0.25 U	0.25 U	0.25 U	0.25 U
Trichloroethene	2.99	2.34	2.74	0.982 J
Trichlorofluoromethane	0.25 U	0.25 U	0.25 U	0.25 U
1,2,3-Trichloropropane	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trimethylbenzene	0.25 U	0.25 U	0.25 U	0.25 U
1,3,5-Trimethylbenzene	0.25 U	0.25 U	0.25 U	0.25 U

Appendix Table 1. Continued.

Stream River Mile Date Sampled	**Crab Creek** **2.1** 6/16/2008	**Crab Creek** **1.9** 6/16/2008	**Crab Creek** **1.7** 6/16/2008	**Crab Creek** **1.3** 6/16/2008
Volatile Organic Analytes (ug/l)				
Vinyl acetate	2.5 U	2.5 U	2.5 U	2.5 U
Vinyl chloride	0.25 U	0.503 J	0.267 J	0.25 U
o-Xylene	0.25 U	0.25 U	0.25 U	0.314 J
m-,p-Xylene	0.50 U	0.50 U	0.50 U	0.655 J
Semi-volatile Organic Analytes (ug/l)				
Phenol	2.69 U	2.50 U	2.50 U	2.50 U
bis-(2-Chloroethyl) ether	2.69 U	2.50 U	2.50 U	2.50 U
2-Chlorophenol	2.69 U	2.50 U	2.50 U	2.50 U
1,3-Dichlorobenzene	2.69 U	2.50 U	2.50 U	2.50 U
1,4-Dichlorobenzene	2.69 U	2.50 U	2.50 U	2.50 U
Benzyl alcohol	2.69 U	2.50 U	2.50 U	2.50 U
1,2-Dichlorobenzene	2.69 U	2.50 U	2.50 U	2.50 U
2-Methylphenol	2.69 U	2.50 U	2.50 U	2.50 U
3-,4-Methylphenol	2.69 U	2.50 U	2.50 U	2.50 U
bis(2-Chloroisopropyl) ether	2.69 U	2.50 U	2.50 U	2.50 U
N-Nitrosodipropylamine	2.69 U	2.50 U	2.50 U	2.50 U
Hexachloroethane	2.69 U	2.50 U	2.50 U	2.50 U
Nitrobenzene	2.69 U	2.50 U	2.50 U	2.50 U
Isophorone	2.69 U	2.50 U	2.50 U	2.50 U
2-Nitrophenol	2.69 U	2.50 U	2.50 U	2.50 U
2,4-Dimethylphenol	2.69 U	2.50 U	2.50 U	2.50 U
Benzoic acid	13.4 U	12.5 U	12.5 U	12.5 U
bis(2-Chloroethoxy)methane	2.69 U	2.50 U	2.50 U	2.50 U
2,4-Dichlorophenol	2.69 U	2.50 U	2.50 U	2.50 U
1,2,4-Trichlorobenzene	2.69 U	2.50 U	2.50 U	2.50 U
Naphthalene	2.69 U	2.50 U	2.50 U	2.50 U
4-Chloroaniline	2.69 U	2.50 U	2.50 U	2.50 U
Hexachlorobutadiene	2.69 U	2.50 U	2.50 U	2.50 U
4-Chloro-3-methylphenol	2.69 U	2.50 U	2.50 U	2.50 U
2-Methylnaphthalene	2.69 U	2.50 U	2.50 U	2.50 U
Hexachlorocyclopentadiene	2.69 U	2.50 U	2.50 U	2.50 U
2,4,6-Trichlorophenol	2.69 U	2.50 U	2.50 U	2.50 U
2,4,5-Trichlorophenol	2.69 U	2.50 U	2.50 U	2.50 U
2-Chloronaphthalene	2.69 U	2.50 U	2.50 U	2.50 U
2-Nitroaniline	13.4 U	12.5 U	12.5 U	12.5 U
Dimethylphthalate	2.69 U	2.50 U	2.50 U	2.50 U
Acenaphthylene	2.69 U	2.50 U	2.50 U	2.50 U
2,6-Dinitrotoluene	2.69 U	2.50 U	2.50 U	2.50 U
3-Nitroaniline	13.4 U	12.5 U	12.5 U	12.5 U
Acenaphthene	2.69 U	2.50 U	2.50 U	2.50 U
2,4-Dinitrophenol	13.4 U	12.5 U	12.5 U	12.5 U
4-Nitrophenol	13.4 U	12.5 U	12.5 U	12.5 U
Dibenzofuran	2.69 U	2.50 U	2.50 U	2.50 U
2,4-Dinitrotoluene	2.69 U	2.50 U	2.50 U	2.50 U
Diethylphthalate	2.69 U	2.50 U	2.50 U	2.50 U
4-Chlorophenyl-phenyl ether	2.69 U	2.50 U	2.50 U	2.50 U

Appendix Table 1. Continued.

Stream River Mile Date Sampled	**Crab Creek** **2.1** 6/16/2008	**Crab Creek** **1.9** 6/16/2008	**Crab Creek** **1.7** 6/16/2008	**Crab Creek** **1.3** 6/16/2008
Semi-volatile Organic Analytes (ug/l)				
Fluorene	2.69 U	2.50 U	2.50 U	2.50 U
4-Nitroaniline	13.4 U	12.5 U	12.5 U	12.5 U
4,6-Dinitro-2-methylphenol	13.4 U	12.5 U	12.5 U	12.5 U
N-Nitrosodiphenylamine	2.69 U	2.50 U	2.50 U	2.50 U
4-Bromophenyl-phenylether	2.69 U	2.50 U	2.50 U	2.50 U
Hexachlorobenzene	2.69 U	2.50 U	2.50 U	2.50 U
Pentachlorophenol	13.4 U	12.5 U	12.5 U	12.5 U
Phenanthrene	2.69 U	2.50 U	2.50 U	2.50 U
Anthracene	2.69 U	2.50 U	2.50 U	2.50 U
Di-N-butylphthalate	2.69 U	2.50 U	2.50 U	2.50 U
Fluoranthene	2.69 U	2.50 U	2.50 U	2.50 U
Pyrene	2.69 U	2.50 U	2.50 U	2.50 U
Butylbenzylphthalate	2.69 U	2.50 U	2.50 U	2.50 U
3,3'-Dichlorobenzidine	2.69 U	2.50 U	2.50 U	2.50 U
Benzo(a)anthracene	2.69 U	2.50 U	2.50 U	2.50 U
Chrysene	2.69 U	2.50 U	2.50 U	2.50 U
bis(2-Ethylhexyl) phthalate	3.23 U	3.00 U	3.00 U	3.00 U
Di-n-octylphthalate	2.69 U	2.50 U	2.50 U	2.50 U
Benzo(b)fluoranthene	2.69 U	2.50 U	2.50 U	2.50 U
Benzo(k)fluoranthene	2.69 U	2.50 U	2.50 U	2.50 U
Benzo(a)pyrene	2.69 U	2.50 U	2.50 U	2.50 U
Indeno(1,2,3-cd)pyrene	2.69 U	2.50 U	2.50 U	2.50 U
Dibenzo(a,h)anthracene	2.69 U	2.50 U	2.50 U	2.50 U
Benzo(g,h,i)perylene	2.69 U	2.50 U	2.50 U	2.50 U
PCBs (ug/l)				
Aroclor 1016	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1221	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1232	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1242	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1248	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1254	0.269 U	0.269 U	0.25 U	0.25 U
Aroclor 1260	0.269 U	0.269 U	0.25 U	0.25 U

J - The analyte was positively identified, but the quantitation was below the reporting limit.

U - Not detected at or above the method detection limit (MDL value reported with the U symbol).

Appendix Table 1. Continued.

Stream	**Crab Creek**	**Crab Creek**	**Crab Creek**	**Crab Creek**
River Mile	**2.1**	**1.9**	**1.7**	**1.3**
Date Sampled	7/28/2008	7/28/2008	7/28/2008	7/28/2008
TAL Metals + Cyanide (ug/l)				
Mercury	<0.50	<0.50	<0.50	<0.50
Aluminum	164	105	111	58.5
Antimony	<4.00	<4.00	<4.00	<4.00
Arsenic	<15.0	<15.0	<15.0	<15.0
Barium	40.4	36.1	35.2	41.8
Beryllium	<5.00	<5.00	<5.00	<5.00
Cadmium	<10.0	<10.0	<10.0	<10.0
Calcium	56,400	55,200	54,600	67,400
Chromium	<10.0	<10.0	<10.0	<10.0
Cobalt	<3.00	<3.00	<3.00	<3.00
Copper	3.02 J	2.43 J	<10.0	<10.0
Iron	482	332	359	450
Lead	<10.0	<10.0	<10.0	<10.0
Magnesium	10,800	11,200	10,900	12,300
Manganese	103	81.3	73.2	80.5
Nickel	<10.0	<10.0	<10.0	<10.0
Potassium	3390	3630	3600	3480
Selenium	<5.00	<5.00	<5.00	<5.00
Silver	<10.0	<10.0	<10.0	<10.0
Sodium	39,000	41,800	40,800	42,300
Vanadium	<10.0	<10.0	<10.0	<10.0
Zinc	7.57 J	5.24 J	4.87 J	7.41 J
Cyanide	<10.0	<10.0	<10.0	<10.0

J - The analyte was positively identified, but the quantitation was below the Practical Quantitation Limit.

< - Not detected at or above the practical quantitation limit (PQL value reported with the less than symbol).

Appendix Table 2. Results of sediment sampling conducted by Ohio EPA in Crab Creek, June 16, 2008.

Stream River Mile Date Sampled	**Crab Creek** **2.1** 6/16/2008	**Crab Creek** **1.9** 6/16/2008	**Crab Creek** **1.7** 6/16/2008	**Crab Creek** **1.3** 6/16/2008
TAL Metals + Cyanide (mg/kg)				
Mercury	0.124 J	0.0515 J	0.0213 J	0.0742 J
Aluminum	3970	4630	2690	6140
Antimony	0.397 U	0.460 J	0.352 U	0.498 U
Arsenic	5.91	12.4	12.2	7.01
Barium	49.1	60.0	31.4	74.9
Beryllium	0.389 J	0.402 J	0.288 J	0.485 J
Cadmium	0.655	0.719	0.443 J	0.874
Calcium	12700	16400	12300	19100
Chromium	17	22.6	11.1	20
Cobalt	2.61	3.08	1.94	3.66
Copper	21.7	29.0	25.7	29.3
Iron	16100	17200	14600	21400
Lead	45.3	52	128	69.2
Magnesium	1910	2310	1510	2800
Manganese	282	449	261	363
Nickel	9	9.71	6.58	12.5
Potassium	376	477	295	720
Selenium	4.05	3.85	1.95	4.58
Silver	0.559 J	0.559 J	0.565 J	0.747 J
Sodium	124	130	95.7	198
Thallium	0.0949 J	0.0828 U	0.0705 U	0.160 J
Vanadium	8.47	10.1	7.23	13.8
Zinc	98.3	106	62.8	163
Cyanide	1.5	0.414 U	1.84	2.47
Volatile Organic Analytes (ug/kg)				
Acetone	60.0 J	40.6 J	42.3 J	71.2 J
Benzene	0.787 U	0.785 U	0.716 U	1.02 U
Bromobenzene	0.787 U	0.785 U	0.716 U	1.02 U
Bromochloromethane	0.787 U	0.785 U	0.716 U	1.02 U
Bromodichloromethane	0.787 U	0.785 U	0.716 U	1.02 U
Bromoform	0.787 U	0.785 U	0.716 U	1.02 U
Bromomethane	1.57 U	1.57 U	1.43 U	2.03 U
2-Butanone	13.1 J	7.64 J	9.58 J	17.3 J
n-Butylbenzene	0.787 U	0.785 U	0.716 U	2.86 J
sec-Butylbenzene	0.787 U	0.785 U	0.716 U	1.02 U
tert-Butylbenzene	0.787 U	0.785 U	0.716 U	1.02 U
Carbon disulfide	0.787 U	0.785 U	0.716 U	1.02 U
Carbon tetrachloride	0.787 U	0.785 U	0.716 U	1.02 U
Chlorobenzene	0.787 U	0.785 U	0.716 U	1.02 U
Chlorodibromomethane	0.787 U	0.785 U	0.716 U	1.02 U
Chloroethane	1.57 U	1.57 U	1.43 U	2.03 U
2-Chloroethyl vinyl ether	0.787 U	0.785 U	0.716 U	1.02 U

Appendix Table 1. Continued.

Stream	**Crab Creek**	**Crab Creek**	**Crab Creek**	**Crab Creek**
River Mile	**2.1**	**1.9**	**1.7**	**1.3**
Date Sampled	6/16/2008	6/16/2008	6/16/2008	6/16/2008
Volatile Organic Analytes (ug/kg)				
Chloroform	0.787 U	0.785 U	0.716 U	1.02 U
Chloromethane	3.15 U	3.14 U	2.86 U	4.06 U
2-Chlorotoluene	0.787 U	0.785 U	0.716 U	1.02 U
4-Chlorotoluene	0.787 U	0.785 U	0.716 U	1.02 U
1,2-Dibromo-3-chloropropane	1.57 U	1.57 U	1.43 U	2.03 U
1,2-Dibromomethane	0.787 U	0.785 U	0.716 U	1.02 U
Dibromomethane	0.787 U	0.785 U	0.716 U	1.02 U
1,2-Dichlorobenzene	0.787 U	0.785 U	0.716 U	1.02 U
1,3-Dichlorobenzene	0.787 U	0.785 U	0.716 U	1.02 U
1,4-Dichlorobenzene	0.787 U	0.785 U	0.716 U	1.74 J
Dichlorodifluoromethane	1.57 U	1.57 U	1.43 U	2.03 U
1,1-Dichloroethane	17.5	1.57 U	1.43 U	2.03 U
1,2-Dichloroethane	5.54 J	2.06 J	1.39 J	1.02 U
1,1-Dichloroethene	0.787 U	0.785 U	0.716 U	1.02 U
cis-1,2-Dichloroethene	105	3.10 J	1.74 J	1.45 J
trans-1,2-Dichloroethene	5.27 J	0.785 U	0.716 U	1.02 U
1,2-Dichloropropane	0.787 U	0.785 U	0.716 U	1.02 U
1,3-Dichloropropane	0.787 U	0.785 U	0.716 U	1.02 U
2,2-Dichloropropane	0.787 U	0.785 U	0.716 U	1.02 U
cis-1,3-Dichloropropene	0.787 U	0.785 U	0.716 U	1.02 U
trans-1,3-Dichloropropene	0.787 U	0.785 U	0.716 U	1.02 U
1,1-Dichloropropene	0.787 U	0.785 U	0.716 U	1.02 U
Ethylbenzene	0.787 U	0.785 U	0.716 U	24.3
n-Hexane	0.787 U	0.785 U	0.716 U	1.02 U
2-Hexanone	3.94 U	3.92 U	3.58 U	5.08 U
Hexachlorobutadiene	0.787 U	0.785 U	0.716 U	1.02 U
Isopropylbenzene	0.787 U	0.785 U	0.716 U	7.54 J
p-Isopropyltoluene	0.787 U	0.785 U	0.716 U	7.48 J
4-Methyl-2-pentanone	3.94 U	3.92 U	3.58 U	5.08 U
Methylene chloride	1.57 U	1.57 U	1.43 U	2.03 U
Naphthalene	0.787 U	0.785 U	282	3420
n-Propylbenzene	0.787 U	0.785 U	0.716 U	4.68 J
Styrene	0.787 U	0.785 U	0.716 U	1.02 U
1,1,1,2-Tetrachloroethane	0.787 U	0.785 U	0.716 U	1.02 U
1,1,2,2-Tetrachloroethane	0.787 U	0.785 U	0.716 U	1.02 U
Tetrachloroethene	1.54 J	0.785 U	0.716 U	1.02 U
Toluene	0.787 U	0.785 U	0.716 U	2.39 J
1,2,3-Trichlorobenzene	0.787 U	0.785 U	0.716 U	1.02 U
1,2,4-Trichlorobenzene	0.787 U	0.785 U	0.716 U	1.02 U
1,1,1-Trichloroethane	0.787 U	0.785 U	0.716 U	1.02 U
1,1,2-Trichloroethane	0.787 U	0.785 U	0.716 U	1.02 U
Trichloroethene	1.90 J	0.785 U	0.716 U	1.02 U
Trichlorofluoromethane	1.57 U	1.57 U	1.43 U	2.03 U
1,2,3-Trichloropropane	1.01 U	1.00 U	0.917 U	1.30 U
1,2,4-Trimethylbenzene	0.787 U	0.785 U	0.716 U	35.7
1,3,5-Trimethylbenzene	0.787 U	0.785 U	0.716 U	21.1

Appendix Table 1. Continued.

Stream	Crab Creek	Crab Creek	Crab Creek	Crab Creek
River Mile	2.1	1.9	1.7	1.3
Date Sampled	6/16/2008	6/16/2008	6/16/2008	6/16/2008
Volatile Organic Analytes (ug/kg)				
Vinyl acetate	1.57 U	1.57 U	1.43 U	2.03 U
Vinyl chloride	87.3	1.57 U	1.43 U	2.03 U
o-Xylene	0.787 U	0.785 U	0.716 U	8.11 J
m-,p-Xylene	0.787 U	0.785 U	0.716 U	6.06 J
Semi-volatile Organic Analytes (ug/kg)				
1,2,4-Trichlorobenzene	761 U	773 U	656 U	961 U
1,2-Dichlorobenzene	761 U	773 U	656 U	961 U
1,3-Dichlorobenzene	761 U	773 U	656 U	961 U
1,4-Dichlorobenzene	761 U	773 U	656 U	961 U
2,4,5-Trichlorophenol	761 U	773 U	656 U	961 U
2,4,6-Trichlorophenol	761 U	773 U	656 U	961 U
2,4-Dichlorophenol	761 U	773 U	656 U	961 U
2,4-Dimethylphenol	761 U	773 U	656 U	961 U
2,4-Dinitrophenol	3050 U	3090 U	2620 U	3850 U
2,4-Dinitrotoluene	761 U	773 U	656 U	961 U
2,6-Dinitrotoluene	761 U	773 U	656 U	961 U
2-Chloronaphthalene	761 U	773 U	656 U	961 U
2-Chlorophenol	761 U	773 U	656 U	961 U
2-Methylnaphthalene	761 U	773 U	656 U	961 U
2-Methylphenol	761 U	773 U	656 U	961 U
2-Nitroaniline	3050 U	3090 U	2620 U	3850 U
2-Nitrophenol	761 U	773 U	656 U	961 U
3,3'-Dichlorobenzidine	1520 U	1550 U	1310 U	1920 U
3-,4-Methylphenol	761 U	773 U	656 U	961 U
3-Nitroaniline	3050 U	3090 U	2620 U	3850 U
4,6-Dinitro-2-methylphenol	3050 U	3090 U	2620 U	3850 U
4-Bromophenyl-phenylether	761 U	773 U	656 U	961 U
4-Chloro-3-methylphenol	761 U	773 U	656 U	961 U
4-Chloroaniline	761 U	773 U	656 U	961 U
4-Chlorophenyl-phenyl ether	761 U	773 U	656 U	961 U
4-Nitroaniline	3050 U	3090 U	2620 U	3850 U
4-Nitrophenol	3050 U	3090 U	2620 U	3850 U
Acenaphthene	761 U	773 U	779 J	1310 J
Acenaphthylene	761 U	773 U	656 U	961 U
Anthracene	761 U	773 U	656 U	961 U
Benzo(a)anthracene	1170 J	856 J	890 J	1110 J
Benzo(a)pyrene	1100 J	842 J	999 J	1230 J
Benzo(b)fluoranthene	1080 J	773 U	775 J	961 U
Benzo(g,h,i)perylene	761 U	773 U	656 U	961 U
Benzo(k)fluoranthene	1290 J	949 J	1100 J	1440 J
Benzoic acid	11500 U	11700 U	9940 U	14600 U
Benzyl alcohol	761 U	773 U	656 U	961 U
bis(2-Chloroethoxy)methane	761 U	773 U	656 U	961 U
bis-(2-Chloroethyl) ether	761 U	773 U	656 U	961 U
bis(2-Chloroisopropyl) ether	761 U	773 U	656 U	961 U

Appendix Table 1. Continued.

Stream River Mile Date Sampled	**Crab Creek** **2.1** 6/16/2008	**Crab Creek** **1.9** 6/16/2008	**Crab Creek** **1.7** 6/16/2008	**Crab Creek** **1.3** 6/16/2008
Semi-volatile Organic Analytes (ug/kg)				
bis(2-Ethylhexyl) phthalate	761 U	773 U	656 U	961 U
Butylbenzylphthalate	761 U	773 U	656 U	961 U
Chrysene	1440 J	989 J	1120 J	1370 J
Di-N-butylphthalate	3460 U	3510 U	2980 U	4370 U
Di-n-octylphthalate	761 U	773 U	656 U	961 U
Dibenzo(a,h)anthracene	761 U	773 U	656 U	961 U
Dibenzofuran	761 U	773 U	656 U	961 U
Diethylphthalate	761 U	773 U	656 U	961 U
Dimethylphthalate	761 U	773 U	656 U	961 U
Fluoranthene	2950	2430	2460	2890
Fluorene	761 U	773 U	656 U	961 U
Hexachlorobenzene	761 U	773 U	656 U	961 U
Hexachlorobutadiene	761 U	773 U	656 U	961 U
Hexachlorocyclopentadiene	3460 U	3510 U	2980 U	4370 U
Hexachloroethane	761 U	773 U	656 U	961 U
Indeno(1,2,3-cd)pyrene	761 U	773 U	656 U	961 U
Isophorone	761 U	773 U	656 U	961 U
N-Nitrosodiphenylamine	3460 U	3510 U	2980 U	4370 U
N-Nitrosodipropylamine	761 U	773 U	656 U	961 U
Naphthalene	761 U	773 U	844 J	961 U
Nitrobenzene	761 U	773 U	656 U	961 U
Pentachlorophenol	3050 U	3090 U	2620 U	3850 U
Phenanthrene	1280 J	1070 J	1120 J	1660 J
Phenol	761 U	773 U	656 U	961 U
Pyrene	2220	1820	1910	2310
PCBs (ug/kg)				
Aroclor 1016	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1221	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1232	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1242	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1248	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1254	15.6 U	16.6 U	13.9 U	20.7 U
Aroclor 1260	76.0	43.1	95.4	133
Other Parameters				
Diesel Range Organics (C10-C28) - mg/kg	141	138	133	158
Gasoline Range Organics - mg/kg	0.0767 U	0.0834 U	0.0673 U	0.284
Percent Solids	62.6	59.3	71.0	47.5

J - The analyte was positively identified, but the quantitation was below the reporting limit.

U - Not detected at or above the method detection limit (MDL value reported with the U symbol).

Appendix Table 3. Ohio EPA fish results from Crab Creek, 2008.

River Code: **18-011**	Stream: **Crab Creek**	Sample Date: **2008**
River Mile: **2.10**	Location: upst. Hubbard Rd.	Date Range: 06/16/2008
Time Fished: 3697 sec	Drainage: 12.9 sq mi	Thru: 07/28/2008
Dist Fished: 0.30 km	Basin: Mahoning River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Western Blacknose Dace	N	G	S	T	622	622.00	26.06			
Creek Chub	N	G	N	T	37	37.00	1.55			
Fathead Minnow	N	O	C	T	6	6.00	0.25			
Bluntnose Minnow	N	O	C	T	122	122.00	5.11			
Central Stoneroller	N	H	N		859	859.00	35.99			
Largemouth Bass	F	C	C		3	3.00	0.13			
Johnny Darter	D	I	C		45	45.00	1.89			
Rainbow Darter	D	I	S	M	683	683.00	28.61			
Fantail Darter	D	I	C		10	10.00	0.42			
Mile Total					2,387	2,387.00				
Number of Species					9					
Number of Hybrids					0					

Species List

River Code: **18-011**	Stream: **Crab Creek**	Sample Date: **2008**
River Mile: **1.90**	Location: adj. YBM	Date Range: 06/16/2008
Time Fished: 3627 sec	Drainage: 15.4 sq mi	Thru: 07/28/2008
Dist Fished: 0.30 km	Basin: Mahoning River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
White Sucker	W	O	S	T	1	1.00	0.06			
Western Blacknose Dace	N	G	S	T	504	504.00	30.42			
Creek Chub	N	G	N	T	43	43.00	2.60			
Common Shiner	N	I	S		1	1.00	0.06			
Fathead Minnow	N	O	C	T	5	5.00	0.30			
Bluntnose Minnow	N	O	C	T	126	126.00	7.60			
Central Stoneroller	N	H	N		229	229.00	13.82			
Johnny Darter	D	I	C		33	33.00	1.99			
Rainbow Darter	D	I	S	M	697	697.00	42.06			
Fantail Darter	D	I	C		18	18.00	1.09			
Mile Total					1,657	1,657.00				
Number of Species					10					
Number of Hybrids					0					

Species List

River Code: **18-011**	Stream: **Crab Creek**	Sample Date: **2008**
River Mile: **1.70**	Location: adj. Aeroquip property	Date Range: 06/16/2008
Time Fished: 3729 sec	Drainage: 15.7 sq mi	Thru: 07/28/2008
Dist Fished: 0.30 km	Basin: Mahoning River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
White Sucker	W	O	S	T	3	3.00	0.15			
Western Blacknose Dace	N	G	S	T	706	706.00	35.73			
Creek Chub	N	G	N	T	65	65.00	3.29			
Fathead Minnow	N	O	C	T	1	1.00	0.05			
Bluntnose Minnow	N	O	C	T	68	68.00	3.44			
Central Stoneroller	N	H	N		323	323.00	16.35			
Largemouth Bass	F	C	C		1	1.00	0.05			
Johnny Darter	D	I	C		63	63.00	3.19			
Rainbow Darter	D	I	S	M	705	705.00	35.68			
Fantail Darter	D	I	C		41	41.00	2.07			
Mile Total					1,976	1,976.00				
Number of Species					10					
Number of Hybrids					0					

Species List

River Code: **18-011**	Stream: **Crab Creek**	Sample Date: **2008**
River Mile: **1.30**	Location: upst. McGuffey Ave.	Date Range: 06/16/2008
Time Fished: 3087 sec	Drainage: 16.8 sq mi	Thru: 07/28/2008
Dist Fished: 0.30 km	Basin: Mahoning River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	5	5.00	0.78			
White Sucker	W	O	S	T	178	178.00	27.81			
Western Blacknose Dace	N	G	S	T	104	104.00	16.25			
Creek Chub	N	G	N	T	50	50.00	7.81			
Bluntnose Minnow	N	O	C	T	26	26.00	4.06			
Central Stoneroller	N	H	N		59	59.00	9.22			
Largemouth Bass	F	C	C		1	1.00	0.16			
Green Sunfish	S	I	C	T	9	9.00	1.41			
Johnny Darter	D	I	C		115	115.00	17.97			
Rainbow Darter	D	I	S	M	92	92.00	14.38			
Brook Stickleback		I	C		1	1.00	0.16			
Mile Total					640	640.00				
Number of Species					11					
Number of Hybrids					0					

Appendix Table 4. Index of Biotic Integrity (IBI) metrics and scores for sites sampled in Crab Creek, 2008.

				Number of						Percent of Individuals					Rel.No.	
River Mile	Type	Date	Drainage area (sq mi)	Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	minus tolerants /(0.3km)	IBI
Crab Creek - (18-011)																
Year: 2008																
2.10	E	06/16/2008	12.9	7(1)	4(3)	2(3)	1(1)	3(3)	2(1)	54(3)	7(5)	8(5)	45(3)	0.1(5)	836(5)	38
2.10	E	07/28/2008	12.9	9(3)	5(3)	2(3)	1(1)	3(3)	2(1)	23(5)	5(5)	9(5)	24(3)	0.0(5)	2420(5)	42
1.90	E	06/16/2008	15.4	7(1)	4(3)	2(3)	1(1)	3(3)	2(1)	66(1)	11(5)	13(5)	33(3)	0.0(5)	486(3)	34
1.90	E	07/28/2008	15.4	10(3)	6(3)	2(3)	1(1)	3(3)	4(3)	23(5)	6(5)	12(5)	54(5)	0.0(5)	1470(5)	46
1.70	E	06/16/2008	15.7	7(1)	4(3)	2(3)	1(1)	3(3)	2(1)	56(1)	5(5)	9(5)	43(3)	0.2(3)	722(3)	32
1.70	E	07/28/2008	15.7	10(3)	5(3)	2(3)	1(1)	3(3)	3(1)	33(3)	3(5)	11(5)	40(3)	0.0(5)	1544(5)	40
1.30	E	06/16/2008	16.8	9(3)	4(3)	1(1)	2(1)	2(1)	4(3)	66(1)	35(1)	29(5)	32(3)	1.0(3)	142(1)	26
1.30	E	07/28/2008	16.8	11(3)	4(3)	2(3)	2(1)	2(1)	4(3)	53(3)	30(3)	32(3)	36(3)	0.7(3)	404(3)	32

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table 5. Ohio EPA macroinvertebrate results from Crab Creek, 2008.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Crab Creek

Collection Date: 07/28/2008 River Code: 18-011 RM: 2.10 upst. Hubbard Rd.

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	+
03360	*Plumatella sp*	+
08601	*Hydrachnidia*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
17200	*Caenis sp*	+
25510	*Stylogomphus albistylus*	+
51600	*Polycentropus sp*	+
52200	*Cheumatopsyche sp*	+
52430	*Ceratopsyche morosa group*	+
52440	*Ceratopsyche slossonae*	+
52530	*Hydropsyche depravata group*	+
52540	*Hydropsyche dicantha*	+
53800	*Hydroptila sp*	+
59720	*Triaenodes ignitus*	+
68708	*Dubiraphia vittata group*	+
69400	*Stenelmis sp*	+
71900	*Tipula sp*	+
77500	*Conchapelopia sp*	+
77800	*Helopelopia sp*	+
80420	*Cricotopus (C.) bicinctus*	+
80750	*Eukiefferiella devonica group*	+
84540	*Polypedilum (Tripodura) scalaenum group*	+
85821	*Tanytarsus glabrescens group sp 7*	+
95100	*Physella sp*	+
96900	*Ferrissia sp*	+

No. Quantitative Taxa: 0 Total Taxa: 28

No. Qualitative Taxa: 28 ICI:

Number of Organisms: 0 Qual EPT: 13

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Crab Creek
adj. YBM

Collection Date: 07/28/2008 River Code: 18-011 RM: 1.90

Taxa Code	Taxa	Quant/Qual	
01801	*Turbellaria*	2	+
03600	*Oligochaeta*	129	
06810	*Gammarus fasciatus*	1	
08230	*Orconectes (Crokerinus) obscurus*	1	
08601	*Hydrachnidia*	56	+
11120	*Baetis flavistriga*	140	+
11130	*Baetis intercalaris*	78	+
12200	*Isonychia sp*	1	
13400	*Stenacron sp*	25	+
17200	*Caenis sp*	1	+
51600	*Polycentropus sp*		+
52200	*Cheumatopsyche sp*	1108	+
52430	*Ceratopsyche morosa group*	265	+
52440	*Ceratopsyche slossonae*	2	
52530	*Hydropsyche depravata group*	662	+
52540	*Hydropsyche dicantha*	90	
53800	*Hydroptila sp*	431	+
68075	*Psephenus herricki*		+
68901	*Macronychus glabratus*	2	
69400	*Stenelmis sp*	18	
70600	*Antocha sp*	196	+
77500	*Conchapelopia sp*	300	+
80370	*Corynoneura lobata*	8	
80420	*Cricotopus (C.) bicinctus*	190	+
80430	*Cricotopus (C.) tremulus group*	136	
80440	*Cricotopus (C.) trifascia*	82	+
80750	*Eukiefferiella devonica group*	27	
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	82	
81270	*Nanocladius (N.) spiniplenus*	109	
81650	*Parametriocnemus sp*	136	
81825	*Rheocricotopus (Psilocricotopus) robacki*	300	
82070	*Synorthocladius semivirens*	136	
82220	*Tvetenia discoloripes group*	27	
83040	*Dicrotendipes neomodestus*		+
84450	*Polypedilum (Uresipedilum) flavum*	573	+
84460	*Polypedilum (P.) fallax group*	27	
84470	*Polypedilum (P.) illinoense*	27	
84480	*Polypedilum (P.) laetum group*		+
84540	*Polypedilum (Tripodura) scalaenum group*	218	+
84700	*Stenochironomus sp*	27	
85500	*Paratanytarsus sp*	55	
85625	*Rheotanytarsus sp*	218	
85800	*Tanytarsus sp*	109	
85821	*Tanytarsus glabrescens group sp 7*	82	
87540	*Hemerodromia sp*	1	
96900	*Ferrissia sp*	73	+

No. Quantitative Taxa: 42 | Total Taxa: 46

No. Qualitative Taxa: 21 | ICI: **44**

Number of Organisms: 6151 | Qual EPT: 9

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Crab Creek
adj. Aeroquip property

Collection Date: 07/28/2008 River Code: 18-011 RM: 1.70

Taxa Code	Taxa	Quant/Qual	
01801	*Turbellaria*	44	+
03360	*Plumatella sp*	2	
03600	*Oligochaeta*	99	+
04901	*Erpobdellidae*		+
05800	*Caecidotea sp*	1	
08230	*Orconectes (Crokerinus) obscurus*		+
08601	*Hydrachnidia*		+
11120	*Baetis flavistriga*		+
11130	*Baetis intercalaris*		+
13400	*Stenacron sp*	37	+
13521	*Stenonema femoratum*	20	+
17200	*Caenis sp*	17	+
24501	*Gomphidae*		+
51600	*Polycentropus sp*	3	+
52200	*Cheumatopsyche sp*	10	+
52530	*Hydropsyche depravata group*	1	+
53800	*Hydroptila sp*	28	+
68075	*Psephenus herricki*		+
69400	*Stenelmis sp*	1	+
72101	*Psychodidae*	16	
74650	*Atrichopogon sp*	8	
77500	*Conchapelopia sp*	114	+
77800	*Helopelopia sp*	65	
78655	*Procladius (Holotanypus) sp*	16	
80370	*Corynoneura lobata*	24	
80420	*Cricotopus (C.) bicinctus*		+
80430	*Cricotopus (C.) tremulus group*	16	
80490	*Cricotopus (Isocladius) intersectus group*	16	
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	65	
83040	*Dicrotendipes neomodestus*	114	
84210	*Paratendipes albimanus or P. duplicatus*	65	+
84300	*Phaenopsectra obediens group*	33	+
84460	*Polypedilum (P.) fallax group*	16	
84470	*Polypedilum (P.) illinoense*	16	
84540	*Polypedilum (Tripodura) scalaenum group*	504	+
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	179	
85625	*Rheotanytarsus sp*	16	+
85800	*Tanytarsus sp*	163	+
85821	*Tanytarsus glabrescens group sp 7*	33	
95100	*Physella sp*	251	
96900	*Ferrissia sp*	125	+

No. Quantitative Taxa: 33 Total Taxa: 42

No. Qualitative Taxa: 26 ICI: **30**

Number of Organisms: 2118 Qual EPT: 9

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Crab Creek
upst. McGuffey Ave.

Collection Date: 07/28/2008 River Code: 18-011 RM: 1.30

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	71 +
03360	*Plumatella sp*	4
03600	*Oligochaeta*	178
04664	*Helobdella stagnalis*	+
04960	*Mooreobdella sp*	1 +
05800	*Caecidotea sp*	+
08200	*Orconectes sp*	+
08601	*Hydrachnidia*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
13400	*Stenacron sp*	40 +
13521	*Stenonema femoratum*	1 +
17200	*Caenis sp*	30 +
23909	*Boyeria vinosa*	1 +
51600	*Polycentropus sp*	+
52200	*Cheumatopsyche sp*	29
52430	*Ceratopsyche morosa group*	+
52530	*Hydropsyche depravata group*	8 +
53800	*Hydroptila sp*	35
68075	*Psephenus herricki*	+
77120	*Ablabesmyia mallochi*	44 +
77500	*Conchapelopia sp*	323 +
77800	*Helopelopia sp*	15
80410	*Cricotopus (C.) sp*	+
80420	*Cricotopus (C.) bicinctus*	+
81200	*Nanocladius sp*	44
81650	*Parametriocnemus sp*	29
82070	*Synorthocladius semivirens*	29
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	15
83040	*Dicrotendipes neomodestus*	162 +
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	15
84300	*Phaenopsectra obediens group*	15
84450	*Polypedilum (Uresipedilum) flavum*	15
84460	*Polypedilum (P.) fallax group*	15
84540	*Polypedilum (Tripodura) scalaenum group*	250 +
84750	*Stictochironomus sp*	+
85261	*Cladotanytarsus vanderwulpi group Type 1*	15
85400	*Micropsectra sp*	15
85500	*Paratanytarsus sp*	176
85800	*Tanytarsus sp*	176
85821	*Tanytarsus glabrescens group sp 7*	176
95100	*Physella sp*	818 +
96900	*Ferrissia sp*	238 +

No. Quantitative Taxa: 31   Total Taxa: 44

No. Qualitative Taxa: 26   ICI: **30**

Number of Organisms: 2983   Qual EPT: 8

River Mile	Drainage Area (sq mi)	Number of Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
Crab Creek (18-011)													
Year: 2008													
1.90	15.4	42(6)	5(4)	6(6)	23(6)	4.0(2)	41.6(6)	7.5(2)	46.6(2)	7.3(6)	9(4)	3	44
1.70	15.7	33(4)	3(2)	4(6)	19(4)	3.5(2)	2.0(2)	18.5(4)	76.0(0)	23.9(2)	9(4)	3	30
1.30	16.8	31(4)	3(2)	3(6)	18(4)	2.4(2)	2.4(4)	18.7(4)	76.5(0)	41.9(0)	8(4)	3	30